OAQPS Economic Analysis Resource Document

U.S. Environmental Protection Agency
Office of Air Quality Planning and Standards
Innovative Strategies and Economics Group

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This document is intended to be a resource for understanding and performing economic analyses by OAQPS economists. This document should not be interpreted as guidance that will be followed exactly by OAQPS in its analyses. Each analysis performed by OAQPS presents unique features, so this guidance is only advisory in nature. This document will need to be revised to reflect changes in EPA's approach to implementing statutory or administrative requirements and to clarify and update text if the document is to continue to be a helpful resource.

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SECTION 1

INTRODUCTION

This document provides guidance on the preparation of economic analyses (EAs) in the Innovative Strategies and Economics Group (ISEG) of the U.S. Environmental Protection Agency's (EPA's) Office of Air Quality Planning and Standards (OAQPS). It is written for analysts who conduct these analyses and for other parties seeking information on their purpose, analytical requirements, and recommended methods. The current document updates its predecessor, "Analytical Methods Manual" (January 1985). The update reflects changes since 1985 in statutory and administrative requirements for EAs, regulatory procedures at EPA, and methodological developments relevant to EAs of environmental regulations. Notable among these changes is the issuance of Executive Order (EO) 12866—Regulatory Planning and Review, which establishes the foundation for performing EAs of Federal regulations.[1]

1.1 Regulatory Context

OAQPS establishes standards and regulations to improve the nation's air quality subject to the provisions of the Clean Air Act (CAA). Specific provisions of the CAA require that an economic impact assessment (EIA) be conducted for individual regulatory actions under the Act's authority. Requirements for economic analysis can be viewed in the broader context of overarching requirements for all Federal regulations as stipulated by the presidential executive order on regulatory review. EO 12866 requires regulatory agencies to submit all proposed and final regulations to the Office of Management and Budget (OMB) for review. Agencies must demonstrate that the regulation is necessary and that the potential benefits of the intended regulation justify its costs. For any "significant regulatory action,"[2]

[1]President Clinton issued EO 12866 on September 30, 1993. EO 12866 is similar in purpose to, and supersedes, EO 12291 issued by President Reagan in 1981. Key differences between these EOs are highlighted in Section 2 of this document.

[2]The definition of a significant regulatory action is discussed in Section 2 of this document.

the Agency is required to prepare a comprehensive EA, which contains descriptions of the benefits and costs of the proposed rule and of alternative approaches.

In the past, as stipulated in EO 12291, the comprehensive set of analyses sent to OMB for review was referred to as a "regulatory impact analysis (RIAs)." EO 12866 replaced EO 12291 and simply requires that benefits, costs, and other economic impacts be examined. Since EO 12866 did not provide a specific name for these reports, the naming convention has become somewhat loose. Therefore, even though the term RIA is still widely used throughout the Agency and OMB, the term "Economic Analysis (EA)" will be used in this document to refer to the assessment of benefits, costs, and other impacts required by EO 12866. The key point to be made here is that, whichever term is used, the analyses called for under EO 12866 are broader in scope than an EIA. The analyses include an assessment of benefits in quantified and monetized terms when possible and a comparison of benefits and costs to address the "cost justification" issue just described. The notion, under EO 12866, that a rule's benefits must *justify* its costs is a less restrictive requirement than existed in the predecessor, EO 12291, wherein benefits must be shown to exceed costs for the regulation to proceed. EO 12866 and EO 12291 are further contrasted in Section 2 of this document. It is important to recognize that EO 12866 does not supercede the authority to regulate under the CAA or any other statutory authority. EO 12866 cannot, for instance, negate a regulation based on benefit-cost criteria if the statutory authority precludes that from affecting the regulatory decision.

The regulatory context of OAQPS regulations and the corresponding requirements for economic analysis change through time as legislation and administrative policies are updated in response to a myriad of societal forces. For example, in the 5 years immediately preceding the preparation of this document, the White House has issued a number of EOs affecting the nature and scope of EAs performed in support of Federal regulations. In addition, Congress has adopted legislation requiring specific forms of economic impacts be analyzed and considered in the design of Federal regulation. Other legislation affecting economic analysis requirements is pending, though not necessarily assured of passage. In short, the regulatory background described here provides a snapshot of the situation in early 1999. The reader is advised to recognize these dynamics and to remain current with changes in the regulatory environment that determine the requirements for economic analysis.

1.2 Different Levels of Economic Analysis in OAQPS

Economic analysis of proposed rulemakings in OAQPS can be viewed as part of a hierarchical process:

- preliminary screening assessment,
- EIA, and
- EA.

The information generated by each of these analyses is summarized in Table 1-1.

Table 1-1. Information Provided by Different Types of OAQPS Economic Analyses

Information Provided	Preliminary Screening Assessment	Economic Impact Assessment (EIA)	Economic Analysis (EA)[a]
Costs	Qualitative or rough estimate of compliance costs	Size and distribution of social costs	Size and distribution of social costs
Benefits	Qualitative or rough estimate		Size and distribution of social benefits
Market outcomes		Price effects	Price effects
		Quantity effects	Quantity effects
		International trade effects	International trade effects
Distributional consequences		Distribution of social costs across society	Distribution of social costs across society
		Small business impacts	Small business impacts
		State and local governmental imports	State and local governmental imports
			Benefit and cost impacts on sensitive populations
Other		Energy consumption	

[a] Previously referred to as Regulatory Impact Analysis (RIA).

The purpose of the preliminary screening assessment is to obtain an initial read on the potential magnitude of the regulation's economic impact. This assessment may be somewhat qualitative in nature or may employ relatively limited data and other information to provide first-order quantitative estimates of impacts. When the initial assessment suggests a relatively small impact, ISEG can use this information to direct its analytical resources toward other regulations that are likely to have a larger impact. Those regulations will move up to the next tier and be targeted for a full EIA, which will provide a broader and deeper assessment of cost impacts of the rule. For "significant regulatory actions" as stipulated under EO 12866, a full EA is conducted. For all intents and purposes, an EA may employ the EIA as the basis for its cost estimates and augment the analysis with a benefits assessment and comparison of benefits and costs and evaluation of their distribution as required under EO 12866 and other mandates and legislation.

1.2.1 Stages of Analysis: Proposal versus Final Rule

Prior to rule proposal, the analysis will compare costs, impacts, and—in the case of an EA—benefits of the different regulatory alternatives being proposed. This is often referred to as the "proposal" draft. After taking into consideration public comments, the Agency may narrow the focus to the selected regulatory alternative. Consequently, the analysis that is prepared at the final stage rule (promulgation) will typically produce analytical results to support the selected regulatory option. This is often referred to as the "final" draft. EO 12866, however, does require the analysis to address the reasons for selecting the final rule over alternative regulatory and nonregulatory approaches. Therefore, some elements of the earlier analyses may be incorporated in the final draft to address these concerns. While not explicitly required in the EIA provisions of the CAA, some discussion of the selected regulatory option versus its alternatives in the final EIA report may help demonstrate how economic analysis was used to inform the rule selection decision.

The purpose of the final EA for significant regulatory actions is to demonstrate that the rule selected by EPA decisionmakers complies with the requirements of EO 12866. The final EA (RIA) must present the economic rationale for the proposed rule, the justification for regulatory intervention, the rationale for the particular regulatory requirements being proposed, the benefits and costs of the selected regulatory option, and the impacts of the proposed rule on specific entities or population groups. The final EA draws heavily from the preliminary EA to justify the proposed rule.

1.3 Scope of This Document

This guidance document discusses the contents and preparation of a full EA. As indicated above, the EA can be viewed as an expanded EIA—one that includes a benefits assessment and benefit-cost comparison. Therefore, while the document is designed to cover all aspects of an EA, by definition it also addresses the EIA, which is a subset of the larger analysis. Proposal and final assessments overlap significantly and, therefore, have a common structure that will be presented here. However, there are important differences in the purpose of the proposal and final assessments and the stage in the rule development process at which each is prepared. These differences and the implications for their preparation will be emphasized throughout this document.

This document also presents further background information on the CAA, EO 12866, and other statutes and EOs imposing analytical requirements. Recommended analytical methods and other practical issues that arise in conducting these analyses are also discussed. This information provides a broader understanding of the role of economic analysis in the regulatory process and ways the analysis can better inform that process.

Several issues relevant to economic analysis in ISEG are beyond the scope of this document. The following topics do not receive detailed treatment in this document, but they are important for the analyst to consider in performing these assessments:

- theoretical foundations of welfare economics and benefit-cost analysis,
- analysis of information collection requirements, and
- document style and formatting.

This guidance document is a companion to several other guidance documents available to ISEG staff, including

- *Economic Analysis of Federal Regulations Under Executive Order 12866*, Office of Management and Budget, January 11 1996;
- *EPA Interim Guidance for Implementing the Small Business Regulatory Enforcement Fairness Act and Related Provisions of the Regulatory Flexibility Act*, EPA SBREFA Task Force, February 5, 1997;
- *Interim Guidance for Incorporating Environmental Justice Concerns in EPA's NEPA Compliance Analyses*, EPA Office of Federal Activities, September 30, 1997;

- *Unfunded Mandates Guidance,* EPA Office of Regulatory Management and Evaluation, August 11, 1995;
- *Engineering Inputs for the Economic Impact Analysis*. Office of Air Quality, Planning, and Standards, Innovative Strategies and Economics Group. July 1997; and
- *Guidelines for Preparing Economic Analyses*. EPA, Office of Policy. Draft under revision in fall 1998.

Because the issues addressed in these documents tend to evolve, analysts should ensure that they have the most recent guidance on these issues. Although this document does overlap to some extent with the other guidance documents, its primary purpose is to address analytical and procedural issues specific to preparing economic assessments in OAQPS. Readers should refer to the other guidance documents for more detailed information on the specific statute or EO and its analytical requirements.

1.4 Organization of This Document

The remainder of this document is organized as follows:

- Section 2 presents background information on the rationale and criteria for EAs stipulated in the CAA and EO 12866, as well as the rationale and criteria put forth in a variety of statutes and EOs requiring various forms of "impact" analysis.
- Section 3 provides an overview of the regulatory development process both at the Agency level and for OAQPS/ISEG.
- Section 4 addresses the preparation of industry profiles, including their structure, connections between the industry profile and economic analysis, and listing of commonly used data sources.
- Section 5 presents the analytical framework and operational issues for estimating the social costs and direct economic impacts of the rule in an EIA.
- Section 6 addresses methodological issues for conducting various distributional impact analyses subject to administrative and statutory requirements.
- Section 7 presents the analytical framework and discussion of practical issues involved in estimating environmental benefits of a regulation.

- Section 8 discusses several key general methodological and policy issues, such as the establishment of a regulatory baseline, discounting procedures, and methods for addressing uncertainty.
- Section 9 recommends ways to communicate EA results so that they are transparent and understandable to decisionmakers.

SECTION 2

REGULATORY BACKGROUND

Several statutes and EOs are fundamental to the various forms of economic analysis performed in ISEG. This section describes the statutory authority under which all air quality regulations and standards are implemented by OAQPS: the Clean Air Act (CAA). It discusses the analytical requirements for economic analysis under the CAA, reviews the broader requirements for economic analysis of significant regulatory actions under EO 12866, and discusses several relatively new (as of mid-1998) statutes and EOs designed to supplement traditional EAs with what is broadly defined as "impact analysis."

2.1 OAQPS's Regulatory Authority

The purpose of the CAA is to establish, implement, and maintain standards for the nation's air quality. Since its inception the CAA has been amended several times, most recently in 1990. Pursuant to the 1990 Amendments, the CAA vests EPA with the authority to undertake the following actions:

- set national ambient air quality standards (NAAQS) for six "criteria" pollutants;
- establish national emissions standards for 188 listed hazardous air pollutants (NESHAP);
- establish new source performance standards (NSPS), imposing technology-based requirements on new or modified major sources of pollutants;
- establish emission standards for mobile sources;
- impose requirements to address specific air pollution problems, such as acid rain and depletion of stratospheric ozone;
- establish nonattainment areas for regions that have failed to meet the NAAQS standards for one or more of the criteria pollutants; and

- require each State to submit a plan for the implementing and enforcing national standards, thus referred to as State Implementation Plans (SIP). Also required within each SIP are measures to ensure against significant deterioration of air quality in areas that meet NAAQS standards.

In addition to possessing the legal authority to regulate, OAQPS is also required to examine efforts to deregulate or reverse previous rulemakings if they are found to be unwarranted by the underlying statutory authority. The move to consider deregulation follows from the Office of the Vice President's National Performance Review, often referred to as the "Reinventing Government" initiative.

EPA's regulations are designed to directly change the behavior of those entities whose activities result in the generation and release of air pollutants. These regulations are typically in the form of administrative controls (so-called "command and control" policies) that prescribe certain emitter behaviors (e.g., require the installation of stack gas scrubbers) or that set standards on the allowable releases of pollutants and allow polluters to determine how to achieve the standard. However, they may also take the form of market-type instruments (e.g., emission charges or transferrable rights) that are designed to induce certain behavioral responses by changing emitters' consequences of a given action. Finally, and less frequently, EPA's actions may be simply informational, designed to inform entities about the benefits or costs of their current or alternative behaviors (e.g., pollution prevention).

EPA's emission guidelines are developed to provide state and other governmental entities with guidance regarding the methods that may be used to achieve air quality objectives. In a sense, therefore, guidelines are an example of an informational policy. The information, in turn, may be used by the states and other authorities to develop administrative, market-type, or information policies of their own to address their air pollution problems and their responsibilities under the CAA. Changes in the behavior of emitters in response to federal or state level regulations will create economic impacts as resources are reallocated toward more environmental protection and as emissions are reduced.

2.2 Statutory and Administrative Requirements for Economic Analysis of Regulations

Regulatory agencies conduct economic analyses of potential regulatory actions to inform decisionmakers about the effects of the regulation on society's current and future well-being. In addition to informing decisionmakers within the Agency, economic analyses are conducted to meet the statutory and administrative requirements imposed by Congress

and the Executive Office. The statutes and EOs requiring economic analyses are listed in Table 2-1. For the purposes of this discussion, we distinguish between analyses in which both benefits and costs are estimated and compared ("benefit-cost analysis") and analyses that focus on the size and distribution of economic impacts among specific groups in society ("impact analysis").

Table 2-1. Statutes and Executive Orders Requiring Economic Analyses

	Benefit-Cost Analysis	Impact Analysis
Statutes	Periodic assessment of costs and benefits of the CAA (CAA Section 812)	Economic impact assessment of specific standards and regulations under the CAA (CAA Section 317)
		Regulatory Flexibility Act (RFA)
		Small Business Regulatory Enforcement Fairness Act (SBREFA)
		Unfunded Mandates Reform Act (UMRA)
		Paperwork Reduction Act (PRA)
		Foreign trade impacts (CAA Section 813)
Executive Orders	EO 12866: Regulatory Planning and Review	EO 12866: Regulatory Planning and Review
		EO 12875: Enhancing the Intergovernmental Partnership
		EO 12898: Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations
		EO 13045: Protection of Children from Environmental Health Risks and Safety Risks

Statutory requirements for economic analysis are often included in the language of the statute granting the Agency regulatory authority in a particular area. For example, the CAA requires EPA to perform a benefit-cost analysis of the entire CAA program on a periodic basis. In addition, the White House, through EO 12866, requires Executive Branch agencies to perform benefit-cost analyses of all rules it deems to be "significant"[1] and to submit these analyses to the OMB for review.

In addition to benefit-cost analysis, impact analyses are required in certain circumstances by both statutes and EOs. Of key importance for ISEG, the CAA requires that the cost and economic impacts (though not necessarily benefits) be estimated for specific regulations and standards proposed under the authority of the Act. This is the core purpose of the EIA reports described in Section 1. In addition, the Regulatory Flexibility Act (RFA), as amended by the Small Business Regulatory Enforcement Fairness Act of 1996 (SBREFA), requires EPA to give special consideration to the effect of Federal regulations on small entities and to consider regulatory options that might mitigate any such impacts. EO 12875 (Enhancing the Intergovernmental Partnership) and the Unfunded Mandates Reform Act (UMRA) of 1995 require agencies to evaluate the impact of their regulatory actions on State, local, and tribal governments.

The analytical requirements are now discussed in more detail and in correspondence with the underlying statutory or administrative authority.

2.2.1 Clean Air Act

Section 312 of the CAA requires the EPA Administrator to conduct a "comprehensive analysis of the impact of the [CAA] on the public health, economy, and environment of the United States. In performing such analysis, the Administrator should consider the costs, benefits, and other factors associated with compliance... ." This provision requires periodic assessment of the overall contribution of the CAA to society's welfare. However, Section 317 of the CAA requires that an EIA be performed for individual rulemakings under the Act's authority. For each proposed standard or regulation, the EIA will, to the extent practicable, include an analysis of the following impacts:

[1]A regulation is generally determined to be significant if it is expected to result in a substantial impact on the economy. The definition of a significant regulatory action is discussed in detail in Section 2.1.2 of this section.

- costs of compliance,
- potential inflationary or recessionary effects,
- effects on competition with respect to small businesses,
- effects on consumer costs, and
- effects on energy use.

Notably absent from the list is an assessment of benefits or comparison of benefits and costs. Moreover, CAA Section 317 clearly states that the EIA shall not " be construed to alter the basis on which a standard or regulation is promulgated ... preclude the Administrator from carrying out his responsibility ... to protect public health and welfare, or ... require any judicial review" (CAA §312[e]). Thus, an EIA is used to inform the regulatory process, but its findings are not strictly binding on the actions the Agency can take.

2.2.2 Executive Order 12866

In support of a rulemaking under EO 12866, regulatory agencies such as EPA must conduct an analysis of the benefits and costs of a proposed significant regulatory action. The analysis should organize information in a way that allows comparison of the benefits and costs of alternative regulatory approaches. As indicated in Section 1, this report is referred to here as an economic analysis (EA).

In various forms, EAs have been prepared in support of agency rulemakings for many years. It was not until 1981, however, when President Reagan signed EO 12291, that the Executive Office sought to determine the cumulative effect of the increasing amount of regulation being promulgated by various regulatory agencies under a growing number of statutory authorities. With the signing of EO 12291 the use and importance of economic assessments of the consequences of regulation increased. EO 12291 defined rules as either "major" or "nonmajor," based on their potential economic impacts. To assess these impacts, agencies were required to prepare analyses showing the implications of their regulations. For major rules, EO 12291 required the agencies to submit an RIA to OMB for review.

On September 30, 1993, the Clinton Administration rescinded EO 12291 and replaced it with EO 12866. Similar to EO 12291, EO 12866 requires centralized review of regulations by OMB; however, it changed many of the criteria on which regulatory review was based. In particular, EO 12866 does not categorize rules as major and nonmajor, but rather as

significant and nonsignificant. The effect of this change in terminology is to expand the range of rules that require some level of economic analysis subject to OMB review. In particular, EO 12291 considered any rule major if it was likely to have a substantial economic impact. EO 12866, however, includes not only economic impact criteria in determining which rules are significant, but also any Federal regulatory action that may interfere with State, local, or tribal governments; any regulation that may interfere with regulatory actions being undertaken by another Federal agency; and any rulemaking that raises a novel legal or policy issue. As a result of the scope of this definition, OMB has broad powers to review and request revisions to all regulatory proposals to ensure their consistency with the regulatory principles contained in the Order.

EO 12866 also changed the fundamental basis on which Agency rulemakings are evaluated. In particular, EO 12291 required that "regulatory action shall not be undertaken unless the potential benefits to society for the regulation *outweigh* (emphasis added) the potential costs to society," thereby requiring a strict benefit-cost approach to evaluating regulations (EO 12291 Section 2[b]). In contrast, EO 12866 requires that the Agency "shall...propose or adopt a regulation only upon reasoned determination that the benefits of the intended regulation *justify* (emphasis added) its costs," thereby including benefit-cost analysis among a number of inputs to the regulatory decisionmaking process (EO 12866, Section 1[b][c]). The difference between these two statements indicates a recognition by the Clinton Administration that sound regulatory decisions involve a wide range of considerations and that not all benefits and costs resulting from a regulatory action are easily expressed in monetary terms. Because many of the previous analyses of major (significant) rules performed by ISEG (and its predecessor groups) were based on EO 12291, Table 2-2 compares the economic analysis requirements under EO 12291 and EO 12866. The purpose is to highlight key differences between the types of information provided in the previous analyses and those now required.

2.2.3 Statutes and Executive Orders Requiring "Impact Analysis"

"Impact analysis" is a general term used to describe various analyses that are supplemental to the estimates of total benefits and costs. For the purposes of this discussion, these supplemental impacts are separate from the "cost and economic impacts" addressed in an EIA.

Table 2-2. Economic Analysis Requirements Under EO 12291 and EO 12866

Which Rules Require Economic Analysis?

EO 12291	EO 12866
"Major" rules require economic analysis: A major rule is any regulation that is likely to result in: 1. *An annual effect on the economy of $100 million or more;* 2. *A major increase in the costs or prices for consumers, individual industries, Federal, State, or local government agencies, or geographic regions; or* 3. *Significant adverse effects on competition, employment, investment, productivity, innovation, or on the ability of United States-based enterprises to compete with foreign-based enterprises in domestic or export markets.*	"Significant" regulatory actions require economic analysis: A significant regulatory action is any regulatory action that is likely to result in a rule that may: Have an annual effect on the economy of $100 million or more or adversely affect in a material way the economy, a sector of the economy, productivity, competition, jobs, the environment, public health or safety, or State, local, or tribal governments or communities;[2]

(continued)

[2]EO 12866 defines a significant regulatory action as one that either meets the $100 million material adverse effects criterion stipulated here or one of three other nonquantitative criteria (see Section 3f of EO 12866). However, the OMB guidance for EAs under EO 12866 stipulates that a full EA (benefit-cost analysis) is required only when the $100 million/material adverse effect criterion is met.

Table 2-2. Economic Analysis Requirements Under EO 12291 and EO 12866 (continued)

What Analyses are Required?

EO 12291	EO 12866
An RIA is required: Regulatory Impact Analysis…contains[ing] the following: 1. *A description of the potential benefits of the rule, including any beneficial effects that cannot be quantified in monetary terms, and the identification of those likely to receive the benefits;* 2. *A description of the potential costs of the rule, including any adverse effects that cannot be quantified in monetary terms, and the identification of those likely to bear the costs;* 3. *A determination of the potential net benefits of the rule, including an evaluation of effects that cannot be quantified in monetary terms;* 4. *A description of alternative approaches that could substantially achieve the same regulatory goal at lower cost, together with an analysis of this [sic] potential benefit[sic] and costs and a brief explanation of the legal reasons why such alternatives, if proposed, could not be adopted…*	An EA is required: An assessment of the potential costs and benefits of the regulatory action…the agency shall also provide to the Office of Information and Regulatory Affairs the following additional information developed as part of the agency's decisionmaking process…[a] 1. *An assessment, including the underlying analysis, of benefits anticipated from the regulatory action …together with, to the extent feasible, a quantification of those benefits;* 2. *An assessment, including the underlying analysis, of costs anticipated from the regulatory action, together with, to the extent feasible, a quantification of those costs; and* 3. *An assessment, including the underlying analysis, of costs and benefits of potentially effective and reasonably feasible alternatives to the planned regulation…and an explanation why the planned action is preferable to the identified potential alternatives.*

[a] Unlike its predecessor, EO 12866 does not require the development of a separate RIA for review by OMB. It is clear from the above list of requirements that all analyses required for OMB review should have already been conducted by the Agency in its development of the regulation.

Impact analyses are usually concerned with examining the types of costs (e.g., direct compliance costs, administrative costs, and recordkeeping costs) and the distribution of costs and benefits (e.g., among small businesses and individuals of various race, age, and income categories). They go beyond a strict benefit-cost analysis to examine various aspects of the composition and distribution of benefits and costs. While there are many types of impact analysis, the statutes and EOs listed in Table 2-1 provide the best guidance for the specific impacts to be evaluated in developing a regulation.

The first set of impacts to be included in an assessment of a regulation are those specifically cited in EO 12866. Many of these impacts may be addressed in an economic analysis; however, the analyst may find it desirable to address some of these impacts separately, depending on the nature of the regulation under consideration. The impact analysis requirements mentioned in EO 12866 include the impact of the regulation on

- the efficient functioning of the economy and private markets, including productivity, employment, and competitiveness;
- distribution of impacts and equity; and
- discrimination or bias.

While EO 12866 is quite broad in terms of the impacts that should be evaluated, more targeted impact analyses are specifically required by statute or administrative decree. Whether an impact analysis is required will depend on the nature of the regulation. Figure 2-1 illustrates the process of determining the necessary impact analyses.[3]

In general, the goal of impact analyses is to supplement an analysis of benefits and costs and the other information available to decisionmakers on the consequences of selecting a particular regulatory option for proposal or promulgation. These analyses should not be taken on their own to indicate any particular option as a preferred option nor to disqualify any particular option.

[3]The simple "Yes/No" decisions indicated in Figure 2-1 can be misleading. Typically, some level of screening analysis is required to determine whether a particular impact analysis is necessary.

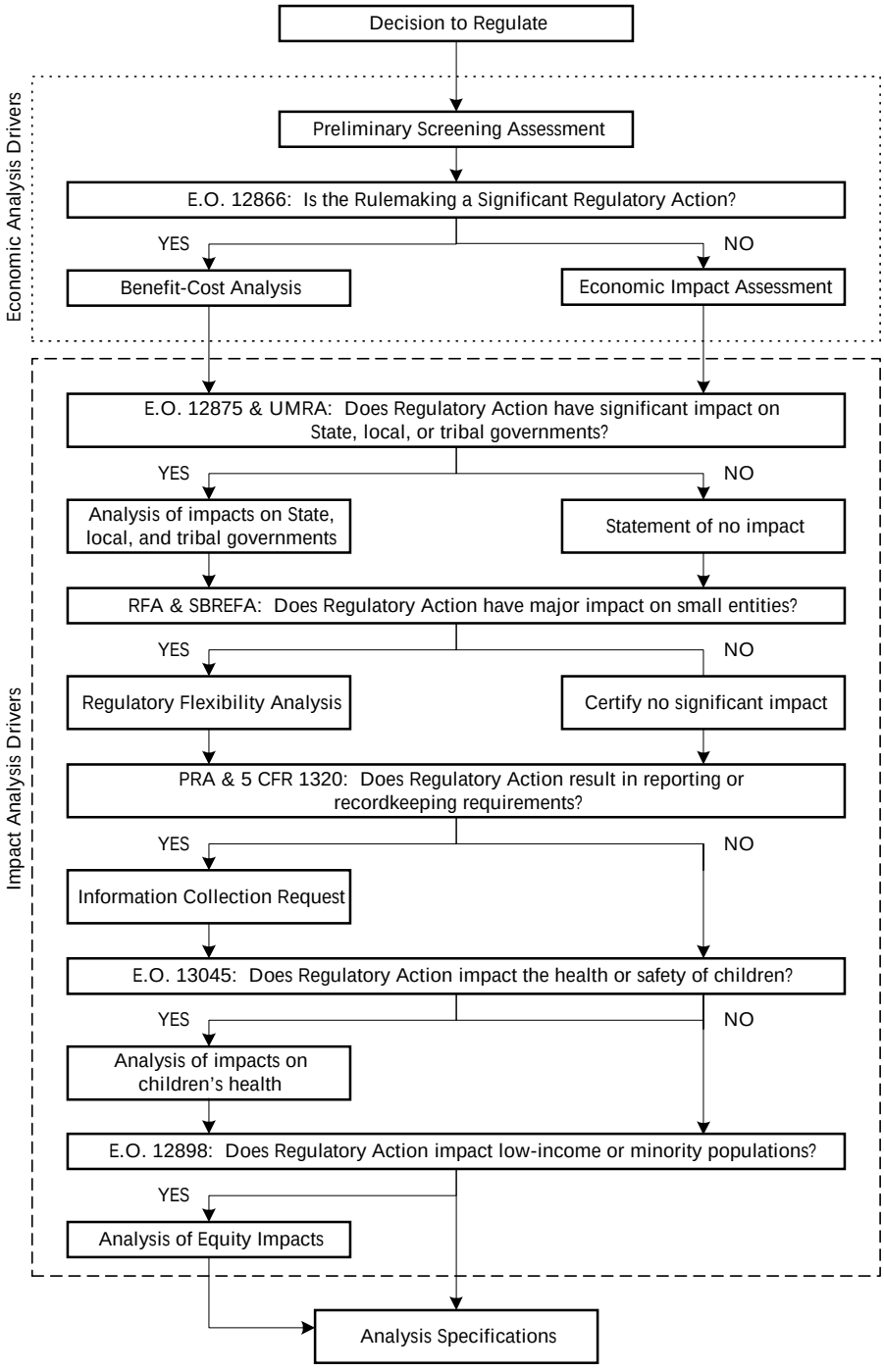


Figure 2-1. Sequence of Questions for Determining the Necessary Impact Analyses

2.2.3.1 Impacts on State, Local, and Tribal Governments

EO 12875, Enhancing the Intergovernmental Partnership, signed by President Clinton on October 26, 1993, requires that

> To the extent feasible and permitted by law, no executive department or agency...shall promulgate any regulation that is not required by statute and that creates a mandate upon a State, local, or tribal government, unless:
>
> (1) funds necessary to pay the direct costs incurred by the State, local, or tribal government in complying with the mandate are provided by the Federal Government; or
>
> 2) the agency, prior to formal promulgation of regulations containing the proposed mandate, provides to the Director of the Office of Management and Budget a description of the extent of the agency's prior consultation with representatives of affected State, local, and tribal governments, the nature of their concerns, any written communications submitted to the agency by such units of government, and the agency's position supporting the need to issue the regulation containing the mandate. (Section 1(a))

UMRA expands the coverage of EO 12875 to include regulations that affect the private sector. EO 12875 applies to all regulations affecting State, local, or tribal governments; UMRA applies only to regulations including a "Federal mandate that may result in expenditures by State, local, or tribal governments, in the aggregate, or by the private sector, of $100,000,000 or more (adjusted annually for inflation) in any one year." UMRA directs regulatory agencies to prepare a written statement, including a benefit-cost analysis, for all proposed and final rules including such a mandate. In particular, the statute requires that the Agency consider a reasonable range of regulatory alternatives and adopt the least costly, most cost-effective, or least burdensome alternative. Most of these requirements are already addressed under EO 12866. For additional guidance on conducting an impact

analysis under EO 12875 and UMRA, see the EPA draft *Unfunded Mandates Guidance* of August 11, 1993.

2.2.3.2 Small Entity Impacts

The RFA, as amended by SBREFA of 1996, requires Federal regulatory agencies to determine whether a proposed or final regulation will have a significant impact on a substantial number of small entities.[4,5] In particular, the RFA requires that agencies prepare an initial regulatory flexibility analysis (IRFA) for a proposed rule and a final regulatory flexibility analysis (FRFA) for a final rule unless the agency head certifies that the rule will not have a significant impact on a substantial number of small entities.[6] If the agency makes a "no significant impact" certification, it must support that certification with a factual explanation.

A major provision in the SBREFA amendments to the RFA is a requirement that EPA convene a "Small Business Advocacy Review Panel" for any proposed rule for which the Agency prepares an IRFA. The purpose of the panel is to solicit the input of small businesses, small governmental jurisdictions, and small nonprofit organizations that are affected by the rule. EPA's interim SBREFA guidance recommends that the Agency involve small entities early in the rulemaking process "when their comments and insights can inform the Agency's thinking about fundamental issues of rule design and scope, as well as more specific issues posed by the particular regulatory program at issue" (EPA, 1997f, p. 3-1).

Before promulgation, all major rules and any benefit-cost analyses conducted in support of the rule are subject to congressional review. The definition of a "major rule" under the RFA is identical to the definition of a "major rule" under EO 12291 and therefore

[4]According to the RFA, small entities include small businesses, as defined by the Small Business Administration (SBA), small government jurisdictions, and small nonprofit organizations. For more details on the definitions of small entities, see *EPA Interim Guidance on Implementing the Small Business Regulatory Enforcement Fairness Act and Related Provisions of the Regulatory Flexibility Act* (EPA, 1997f).

[5]For definitions of "significant impact" and "substantial number of small entities," see the SBREFA discussion in Section 8 of this guidance document.

[6]A certification of "no significant impact" in the proposed rule stage does not preclude a FRFA at the final rule stage, and an IRFA at the proposed rule stage does not preclude a certification of "no significant impact" at the final rule stage, because information provided through notice-and-comment rulemaking and changes to the substance of the rule can change the expected impact of the rule between the proposed and final stages.

potentially more narrow than the definition of a "significant regulatory action" under EO 12866. Under SBREFA, Agency rulemakings are also subject to judicial review.

Before the enactment of SBREFA, EPA policy on the implementation of the RFA required that a regulatory flexibility analysis be prepared for *any* rule that would have *any* impact on small businesses. According to *EPA Interim Guidance for Implementing the Small Business Regulatory Enforcement Fairness Act and Related Provisions of the Regulatory Flexibility Act*, current Agency policy is to implement the RFA as written; that is, "regulatory flexibility analyses as specified by the RFA will *not* be required if the Agency certifies that the rule will not have significant economic impact on a substantial number of small entities."

2.2.3.3 Reporting and Recordkeeping Requirements

In many rulemakings, various recordkeeping, reporting, labeling, testing, and other requirements are included to help EPA verify compliance with the rule after it has been promulgated. Under the Paperwork Reduction Act (PRA), the Agency is required to estimate the "burden hours" associated with the recordkeeping and reporting requirements and to weigh this burden against the "practical utility" of the information collection. This analysis must be presented to OMB for review in a standardized document known as an Information Collection Request (ICR).[7,8]

The definition of an information collection was expanded with the 1995 amendments to the PRA. In particular, 5 CFR 1320, the regulation implementing the provisions of the 1995 PRA, defines a collection of information to include "any requirement or request for persons to obtain, maintain, retain, report, or publicly disclose information" (Section 3(c)).

New to the 1995 amendments to the PRA is the inclusion of third-party reporting requirements in the definition of an information collection:

> Requirements by an agency for a person to obtain or compile information for the purpose of disclosure to members of the public or the public at large, through posting, notification, labeling or similar disclosure requirements constitute the "collection of information" whenever the same requirement to

[7]Under the PRA, burden hour estimates and ICRs are not required for paperwork requirements that affect fewer than ten entities.

[8]As of this writing, OMB is finalizing guidance on preparing ICRs.

> obtain or compile information would be a "collection of information" if the information were directly provided to the agency. (5 CFR 1320.3 (c)(2))

Determining the burden hours associated with reporting and recordkeeping provisions of Agency regulations is a crucial part of the regulatory development process, particularly when the purpose of the regulation is to codify reporting and recordkeeping requirements. Without OMB approval of the ICR, EPA cannot legally conduct any collection of information included in an Agency rulemaking.

The Agency is responsible for preparing estimates of burden hours associated with recordkeeping and reporting requirements as well as preparing the ICR itself. The group with primary responsibility for this task (ISEG or other groups within OAQPS) will vary by project. Burden hours should be estimated in the course of estimating the costs of any administrative requirements. The burden hour estimates should be clearly summarized in the impact analysis so that they can be easily incorporated into the ICR.

2.2.3.4 Impacts on Children

On April 21, 1997, President Clinton signed EO 13045, Protection of Children from Environmental Health Risks and Safety Risks. Under this Order, agencies are required to conduct certain analyses if a regulatory action is likely to result in a rule that may

> (1) be 'economically significant' under Executive Order 12866...; and
>
> (2) concern an environmental health risk or safety risk that an agency has reason to believe may disproportionately affect children. (Section 2)

EO 13045 requires two analyses:

> (1) an evaluation of the environmental health or safety effects of the planned regulation on children; and
>
> (2) an explanation of why the planned regulation is preferable to other potentially effective and reasonably feasible alternatives considered by the agency. (Section 5)

Although EO 13045 does not explicitly require an analysis of the economic implications of regulatory impacts on children, the analyses outlined above must be submitted to OMB, along with the other analyses outlined in this chapter.

2.2.3.5 Impacts on Low-Income and Minority Populations

Equity effects analysis involves examining the distribution of gains and losses resulting from a regulation and the magnitude of these gains and losses. Such an analysis should address any significant issues regarding the distribution of gains (who realizes reduced risk; the firms, industries, or products that have increased sales or profits) and losses (who bears new costs, reduced sales or profits, or increased risks) in industry and in the population at large. For a general discussion of conducting an analysis of the distributional effects of a regulation, see the "white paper" *Evaluating the Equity of Environmental Policy Options Based on the Distribution of Economic Effects: Preliminary Draft* (EPA, 1997g).

EO 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations, encourages the examination of the equity effects of regulatory actions:

> Each Federal agency shall conduct its programs, policies, and activities that substantially affect human health or the environment, in a manner that ensures that such programs, policies, and activities do not have the effect of excluding persons (including populations) from participation in, denying persons (including populations) the benefits of, or subjecting persons (including populations) to discrimination under, such programs, policies, and activities, because of their race, color, or national origin. (Section 2)

In response to EPA's *Environmental Justice Strategy* (EPA, 1995a) dated April 3, 1995, the EPA Office of Federal Activities (OFA) has developed guidance for incorporating environmental justice goals into the Agency's activities under the National Environmental Policy Act (NEPA) (EPA, 1997h). Although the OFA guidance does not specifically address regulatory analysis, it does provide guidance for identifying disproportionately high and adverse effects of alternative actions and recommends specific methods to analyze the effects of a regulatory action on minority and low-income populations.

2.3 Summary

As outlined above, the statutory and administrative requirements for economic analysis of Agency rules are extensive. Economic analyses of most regulatory actions are required by the CAA and EO 12866. In addition, each regulatory action is potentially subject to a number of impact analyses required by both statutes and EOs. These analyses include an analysis of impacts on State, local, and tribal governments under UMRA and EO 12875; an analysis of impacts on small entities under RFA and SBREFA; an analysis of reporting and recordkeeping requirements under the PRA and 5 CFR 1320; an analysis of the potential impacts of a regulation on the health and safety of children; and an analysis of equity impacts, particularly impacts on low-income and minority populations, under EO 12898.

SECTION 3

THE REGULATORY DEVELOPMENT PROCESS

To place EIAs and EAs in context, this section discusses the broader processes by which regulations are developed in EPA and OAQPS. The legal impetus for OAQPS regulations and the analytical requirements for economic analysis are discussed in Section 2. This section gives an overview of the regulatory development process at EPA in general and OAQPS in particular, emphasizing the role of the economic analyses performed by ISEG in this process. The section identifies benchmarks the ISEG analyst must adhere to along the way.

The section begins with an overview of the EPA regulatory process. This discussion is followed by a more detailed discussion of procedures within OAQPS and ISEG.

3.1 EPA Regulatory Development Process

EPA's regulatory development process (outlined in Figure 3-1) is designed to ensure that all statutory and administrative requirements for rulemaking are met. The process is also intended to allow for all EPA offices and regions with an interest in a rule to participate in development of and to approve of that rule.[1]

The Agency's Regulatory Policy Council (RPC) is responsible for overseeing the Agency's regulatory development process and ensuring that the process conforms with Administration policy and addresses cross-cutting analytical issues. The RPC also monitors the system to identify and implement any needed changes.

[1]For more detail on EPA's regulatory development process, see Browner, Carol M. Memorandum on Initiation of EPA's Regulatory and Policy Development Process. U.S. Environmental Protection Agency, Office of the Administrator. July 1, 1994.

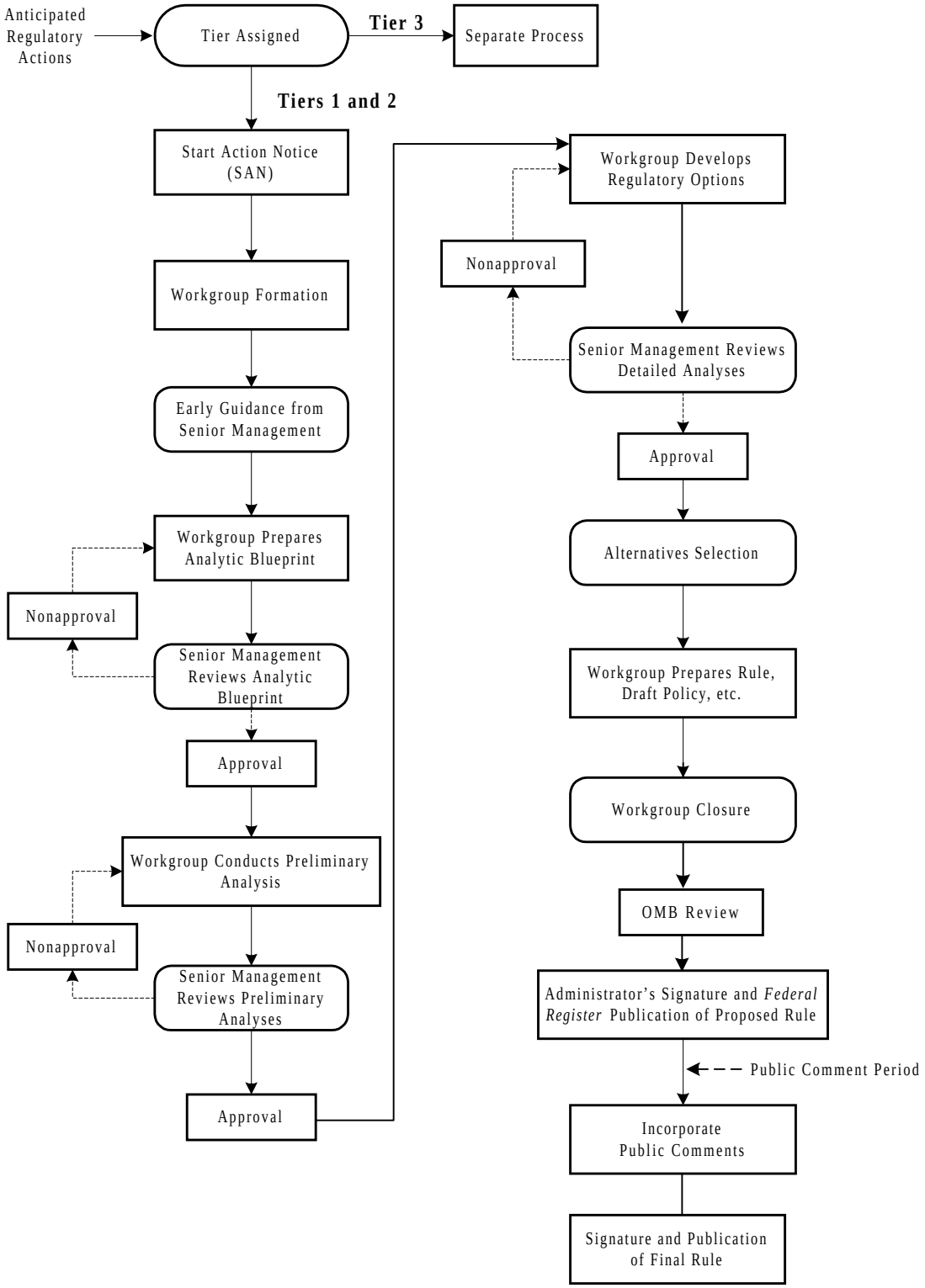


Figure 3-1. EPA Regulatory Development Process

The regulatory development process is initiated by the semi-annual submission of anticipated regulatory actions for tiering assignment by senior Agency staff. Each regulatory action is assigned one of three tiers:

- Tier 1: Administrator's Priority Actions—Involves the few top actions that demand ongoing involvement of the Administrator and extensive involvement of Assistant Administrators (AAs) and Regional Administrators (RAs) across the Agency.
- Tier 2: Cross-Agency Actions—Actions have extensive cross-media effects, requiring extensive cross-Agency involvement.
- Tier 3: Lead-Office Delegation—Actions with little or no need for cross-Agency participation.

This tiering process both prioritizes actions in terms of their potential for large and multimedia effects and ensures early involvement of key Agency personnel. The formal regulatory process outlined in Figure 3-1 and discussed below is required of all Tier 1 and Tier 2 actions. Tier 3 actions are dealt with less formally but can involve many or all of the procedural steps outlined here. While the tiering process imposes a hierarchy for Agency actions, there is no direct relationship between the tiering process and the designation of "significant regulatory actions" for OMB purposes (Browner, 1994).

3.1.1 Start Action Notice

Once the regulatory action has been assigned a tier, a Start Action Notice (SAN) is prepared by the lead AA/RA and is distributed to all AA and RA offices across the Agency. This notice serves to solicit workgroup membership and other input from offices across the Agency.

3.1.2 Workgroup Formation

After the SAN is approved by the RPC, the Agency workgroup is officially formed. The Agency workgroup is an EPA-wide, staff-level group formed to develop a regulatory action and supporting materials. The workgroup's primary responsibilities are to

- identify and assess principal policy issues and options;
- conduct technical and analytical work, including risk assessment work and economic analysis;

- resolve issues or elevate them for upper management resolution; and
- ensure the quality and completeness of regulatory packages, including the *Federal Register* (*FR*) notice.

Workgroup members are expected to represent the policy positions and perspectives of their management as well as to contribute their technical and analytic expertise.

During the regulatory development process, one of the key responsibilities of each workgroup member, including the economist, is to communicate key issues and results to workgroup members and senior management. Without proper interpretation and communication of results from the economic analysis, decisions might be made without proper understanding of the rule's economic implications. For more discussion on methods to communicate analytical results more effectively, see Section 9 of this document.

3.1.3 Early Guidance from Senior Management

Early involvement by senior management is one of the hallmark objectives of the 1994 reforms to the EPA regulatory development process. The purpose is to clarify, for the workgroup, the objectives of the rulemaking and to identify the issues of significant concern to senior management.

3.1.4 Analytical Blueprint

Consistent with the goal of having all regulatory actions be based on sound science, an analytical blueprint is prepared to guide all forms of analysis throughout the process—economic, scientific, legal, and institutional. The blueprint outlines the scope of the action and requirements for analysis. The blueprint is considered a "living document" so that the analysis plan can be modified if the situation warrants.

Once the blueprint is prepared, it is distributed to senior management across the Agency for review and approval. The workgroup may need to revise the blueprint based on cross-Agency review. The level and extent of review may differ slightly between Tier 1 and Tier 2 actions.

3.1.5 Preliminary Analysis, Regulatory Options Development, and Selection of Alternatives

In these stages, the workgroup analyzes and evaluates regulatory options to narrow the scope of regulatory alternatives considered and then selects the regulatory alternative

from among the group of alternatives. This process is typically iterative, with the elimination of some alternatives, possible addition of others, and ultimate selection of a final proposed alternative. Senior management approval is an essential part of the iterative process. Senior managers must accept that the options development process and final selection are based on sound analysis of the alternatives.

The analysis/options development/selection process is the venue in which solid economic (and other) analysis can make substantial contributions to the rulemaking process. The lead economic analyst's responsibility is to ensure that the economic analyses are technically strong and that the results of the analysis are communicated effectively to workgroup members and senior management to help inform their decisions.

3.1.6 Rule Preparation and Workgroup Closure

Once the analyses have been performed and the regulatory alternative selected, the workgroup must prepare the regulatory package for subsequent review and approval. The regulatory package includes the *FR* notice for the proposed rule and all supporting documentation.

The workgroup closure meeting occurs when the workgroup has prepared the regulatory package and the management of the lead office has approved the notice and analyses. The purpose of the workgroup closure meeting is to confirm that

- the workgroup has successfully completed its job, resolving as many issues as possible and clearly defining others;
- the rulemaking package is ready for review at the AA, RA, and Deputy Administrator levels; and
- Agency and external requirements have been met.

Members of the workgroup participate in the workgroup closure meeting as representatives of their AA/RA. Therefore, positions presented should be approved by the respective AA/RA prior to the meeting. Although OAQPS workgroup members attend the meeting, issues within OAQPS and Office of Air and Radiation (OAR) are not the focus of the meeting, because these issues will have been addressed prior to the meeting as a condition of package approval by the Office Director and the AA. Instead, the focus is on input provided by the workgroup members from other EPA offices or regions.

3.1.7 OMB Review

The period for OMB review is 90 days for a proposed rule and 45 days for a final rule if no material changes have been made since proposal; OMB can, however, extend this period when it needs more time or when issues are unresolved. In virtually all cases, rules do not go forward for final signature in EPA until the program office addresses OMB concerns and resolves outstanding issues. Court-ordered deadlines and stringent statutory deadlines may occasionally require that EPA publish a rule before OMB has finished its analysis and comment or be given less time to review.[2]

Once workgroup closure has been attained and the package has been cleared for submittal by the Administrator's office, the package is sent to OMB's Office of Information and Regulatory Affairs (OIRA) for review. Under EO 12866, each proposed significant regulatory action that the Agency issues must be sent to OMB for review before it is signed by the Administrator. Again, the determination of significance for OMB purposes is not directly related to EPA's tiering hierarchy. OIRA and the Agency will have determined in advance whether a rule is deemed significant. The purpose of OMB review is to ensure that the Agency's regulatory actions "are consistent with applicable law, the President's priorities, and the principles set forth in [Executive Order 12866] and do not conflict with the policies or actions of another agency" [EO 12866, Section 6(a)(4)].

Rules not considered significant can go straight to the Administrator for signature and *FR* publication without OMB review.

3.1.8 Administrator's Signature and FR Publication of Proposed Rule

Recommended changes in the rule brought forth by OMB's review must generally be addressed by the Agency before the rule can go forward. Once these issues are addressed, the proposed rule is ready for the Administrator's signature. Once obtained, the signed rule is forwarded to the Agency's *FR* liaison for final review and submission to the *FR* for publication.

[2]See Section 2 of this guidance document for further discussion of E.O. 12866 and OMB review.

3.1.9 Public Comment, Rule Revision, and Signature and Publication of Proposed Rule

Publication of the proposed rule is followed by a public comment period, typically lasting 60 days, in which any interested party has the opportunity to comment on the proposed rule or the supporting analyses.

3.1.10 Rule Revision, Signature, and Publication of the Final Rule

After the public comment period closes, the workgroup is reconvened to review and respond to the public comments and to prepare the final rule. The process for development of the final rule is the same as for the proposed rule: analysis, senior management review, workgroup closure, OMB review, Administrator's signature, and publication in the *FR*.

3.2 Economic Analysis in Regulatory Development

ISEG's primary role in the regulatory development process is to conduct the various analyses categorized as economic and to report the results of the analyses to regulatory decisionmakers. Each of those roles is described in more detail below.

3.2.1 Overview of Analysis Activity

Figure 3-2 presents an overview of the flow of analytical information in the regulatory development process, with an emphasis on economic information. Because proposed regulatory actions differ in scope, not all the activities presented in this figure may be performed by ISEG for each regulation. However, this figure does reflect the primary components of an economic analysis and illustrates the basic relationships between input data, analysis, and results. The majority of the ISEG analysts' efforts are focused on developing the industry profile, the economic impact analysis, and the benefits analysis.[3] These activities are summarized below.

Industry profiles provide detailed information on the affected industry, entities, and markets. Data are typically obtained from a combination of sources, including information gathered by EPA and summarized in previous regulatory support documents; data from publicly available sources; and data from stakeholders. The information is used to identify affected commodities; characterize baseline conditions in affected markets, including prices

[3]The "economic analysis," when prepared for major rules, is essentially a compilation of all relevant analytical results described here and does not involve additional substantive analytical work.

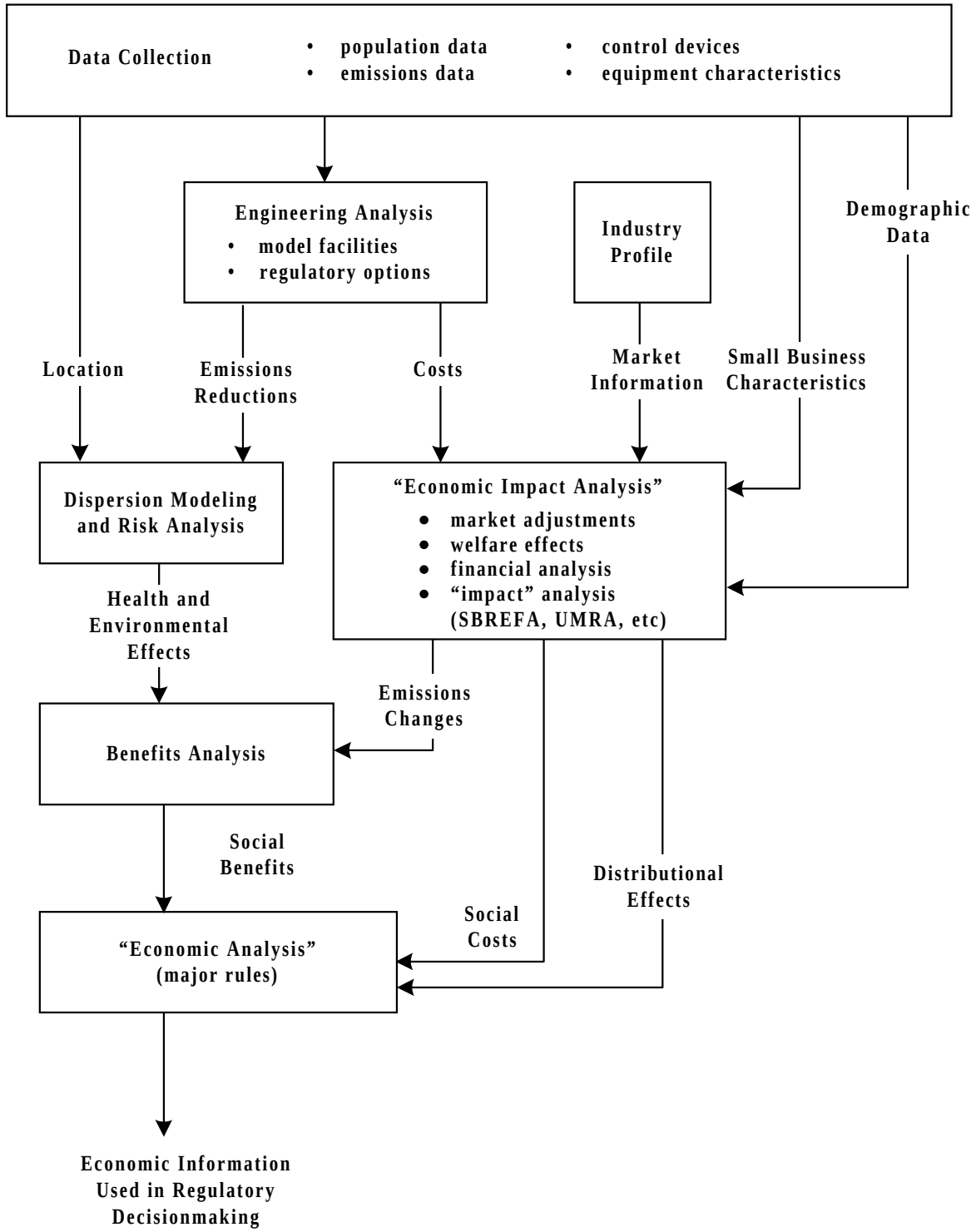


Figure 3-2. Flow of Analytical Information in Regulatory Development

and quantities, market structure, and international trade; identify and locate producers and consumers of affected commodities; identify and characterize the firms owning the affected facilities; and characterize baseline conditions in the communities where affected producers are located (the populations who will affected by the regulation). Section 4 provides details on the development of these industry profiles.

Economic impact analysis involves estimating the reallocation of society's resources and the social costs associated with the proposed regulatory action. The industry profile provides the baseline characterization of market conditions from which the impacts of the regulation are estimated. Frequently an analysis involves developing an analytical approach and computer model to simulate the behavioral responses of the affected entities to the regulation in a market context. The approach is designed to be consistent with economic theory and to produce integrated estimates of the responses of affected facilities, firms, and markets. Also included are impact estimates for selected location and company size categories to support impact analysis for small entities and minority and low-income populations. The analyst should refer to EPA (1997e) for more detailed discussion of the engineering inputs to the economic analysis. Section 5 provides details on the development of EIAs for ISEG, while Section 6 provides specifics on the supplemental impact analyses that are required by EO or statute.

Benefits analysis involves analyzing all the categories of benefits by first identifying then quantifying and, where possible, monetizing the benefits. The benefits of pollution controls are defined as the increases in human welfare that result from improvements in environmental quality. Assessing the benefits of air pollution controls requires a conceptual framework that specifically links reductions in air pollutant emissions to human welfare enhancements. Such a framework distinguishes the essential components of benefits and ensures that all relevant benefits are accounted for and not double counted. Section 7 provides details on the development of benefits analyses for ISEG.

3.2.2 A Note on Cost/Control Strategy Analysis for NAAQS

Economic analyses performed in ISEG often address industry or source-specific control strategies (e.g., MACT standards). In those cases, compliance strategies and their costs are fairly well-defined in the engineering analysis prior to economic analysis. However, the setting is different for the analysis of national ambient air quality standards (NAAQS), in which case compliance strategies and associated costs are not necessarily well-defined prior

to economic analysis. Important features of cost analysis unique to NAAQS rulemakings are highlighted here.

Under CAA section 110, EPA sets NAAQS for criteria pollutants. The CAA does not authorize the Agency to consider the cost of achieving a NAAQS in establishing the level of the standard; however, since most new or revised NAAQS met the definition of "significant" actions defined in Executive Order 12866, a NAAQS rulemaking package must be accompanied by an assessment of the potential cost and benefits of the standard. Unlike other federal rules that specify both the sources that must control, and the technologies or specific emission limits that must be met, NAAQS only establish an ambient air quality goal. Under the CAA, state and local governments (hereafter, states) and their designated air quality departments are responsible for developing the specific pollution control strategies that will enable an area designated out of attainment with a NAAQS to met the ambient air quality goal.

A benefit-cost assessment is more uncertain in this context because the specific pollution control strategies that states will use to attain the standard are not necessarily known. To simulate the possible costs and benefits associated with a new or revised NAAQS, EPA may construct one or more hypothetical implementation scenarios. In these scenarios, EPA attempts to model the potential control measures of other control strategies that states might adopt to meet the standard. For some NAAQS, only a few select areas of the country may not meet the standard, which indicates that smaller scale analyses are appropriate. However, for other NAAQS, many areas of the country may not meet the standard, which calls for an essentially nationwide analysis. In either case, EPA collects data on the emissions sources believed to be contributing to the air pollution problem, and develops control measures to estimate the costs and emissions reductions that can potentially be achieved.

Some larger sources are identified individually as "point" sources, while other smaller sources are identified collectively as "area" sources. For point sources, EPA may be able to collect enough source-specific information to develop reasonable study estimates (±30% accuracy) of the cost and emission reductions attributable to a particular control device or control measure. In these cases, total annual compliance costs are generated at the source level similar to the way compliance costs are generated for other source-specific regulations. For area sources, where source-specific information is sparse or nonexistent, EPA may develop more generic "cost-effectiveness" estimates, where total annual compliance costs for

a group of sources is generated by multiplying the cost-effectiveness value by the annual emission reduction that is expected from the source group. In these cases, the cost borne by any one source in the group is less certain.

3.2.3 Structure and Content of ISEG Reports

Although the ISEG analyst is responsible for all written technical support documents related to the economic analysis, the majority of time and effort will be spent preparing the industry profile and the EIA (EA) report. The structure and content of these reports are summarized below.

The industry profile report will typically include the following sections:

- *Introduction*. This section provides an overview of the regulated industry and the organization of the industry profile report.
- *Supply*. This section details the affected production processes, inputs, associated final products and residuals, and the costs of production.
- *Demand*. This section details the characteristics, uses, consumers of the affected commodities, and the substitution possibilities.
- *Industry organization*. This section discusses the market structure of the affected industry and provides detailed information on the manufacturing facilities and owning companies.
- *Markets*. This section provides historical and projected data on U.S. production, foreign trade, consumption, and market prices.

This profile is often included in the public docket with a summary version also included in the EIA (EA) report.

The technical support document that reports the methods and results of the economic analysis will differ in structure and content between nonsignificant and significant regulatory actions. For nonsignificant regulatory actions, the executive and legislative requirements are less demanding, so the EIA report will typically include the following sections:

- *Executive summary*. This section provides an overview of the regulated industry; the proposed regulatory alternatives and costs; the data, methodology, and assumptions of the economic analysis; and the economic impact results.

- *Introduction*. This section summarizes the scope and purpose, statutory authority, and the organization of the EIA report.
- *Industry profile*. This section provides a summary profile extracted from the industry profile report developed prior to the economic analysis.
- *Compliance cost analysis*. This section reviews the proposed regulatory alternatives and associated costs of compliance.
- *Economic impact analysis*. This section provides a summary of the analysis inputs and economic methodology for assessing the economic impacts of the proposed regulation and the analysis results, including the impacts on markets, facilities, and industry as well as the social costs.
- *Impacts analysis*. This section includes methods and results for the supplemental impact analyses as required by EO and statute. For an EIA, this section usually only includes an assessment of the impact on small entities (businesses, governments, organizations).

Alternatively, the report supporting a full EA for significant regulatory actions must meet additional executive and legislative requirements and should include the following:

- *Executive summary*. This section provides an overview of the regulated industry; the proposed regulatory alternatives and costs; the data, methodology, and assumptions of the economic impact and benefits analyses; and the economic impact and benefits results.
- *Introduction*. This section summarizes the scope and purpose, statutory authority, and the organization of the EA report.
- *Industry profile*. This section provides a summary profile extracted from the industry profile report developed prior to the economic analysis.
- *Need for regulation*. This section summarizes the market conditions that necessitate regulatory action, the harmful effects of the air emissions, and the consequences of regulation.
- *Compliance cost analysis*. This section reviews the proposed regulatory alternatives and associated costs of compliance.
- *Economic impact analysis*. This section provides a summary of the analysis inputs and economic methodology for assessing the economic impacts of the proposed regulation and the analysis results, including the impacts on markets, facilities, and industry as well as the social costs.

- *Impacts analysis*. This section includes methods and results for the supplemental impact analyses as required by EO and statute. For an EA report, this section may contain all of the required analyses, including impacts on small entities; minority or low-income populations; and state, local, or tribal governments and reporting and recordkeeping requirements.

- *Benefits analysis*. This section describes the analysis inputs and methods used for estimating and valuing the effect of reduced environmental and human exposure to air emissions.

- *Benefit-cost comparison*. This section provides a comparison of the social benefits and costs of the proposed regulatory action.

In addition, the EIA (EA) report should include technical appendices that provide the details on input data, assumptions, methods, and sensitivity results that may be of use to certain interested parties.

3.3 Specific ISEG Tasks in the Regulatory Development Process

Section 3.1 outlines the regulatory development process that is broadly applicable across program offices at EPA and Section 3.2 highlights the role of economic analysis in the process. This section deals specifically with the economic analysis tasks that take place in ISEG throughout the process. The main activities within ISEG are categorized in Figure 3-3 and reviewed briefly below.

3.3.1 Initial Screening

The purpose of the initial screening stage is to assess the likely magnitude of impacts of the proposed regulatory actions. This stage allows ISEG to prioritize its activities and thereby use its analytical resources more efficiently. At this point, ISEG must determine which of the analysis categories the proposed regulatory action falls into:

- minimal

- active (EIA)

- major (EA)

Those actions falling into the “minimal” category are rules that are expected to have very small impacts and thereby require relatively little formal analysis. “Active” projects are expected to have large enough impacts to warrant a full EIA, but not large enough to warrant

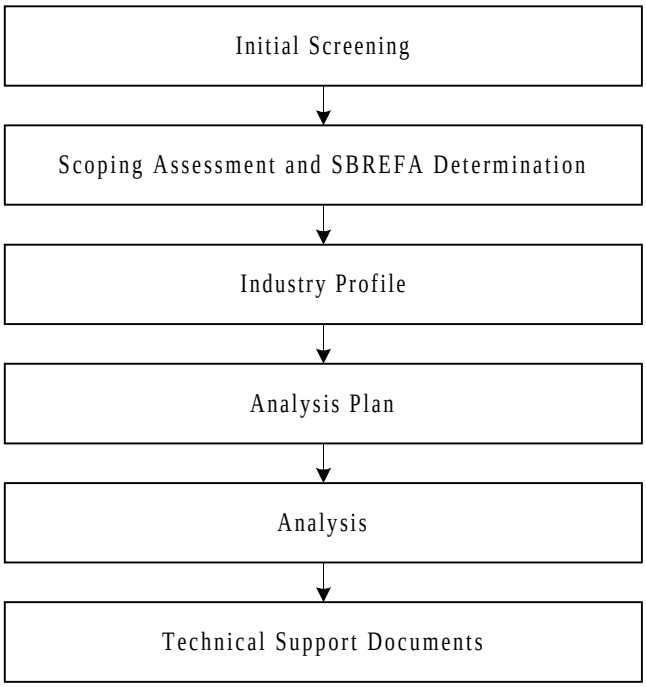


Figure 3-3. Main Activities Within ISEG in the Regulatory Development Process

a full EA. The "major" rules are those that are deemed significant regulatory actions under EO 12866 (see Section 2) and thereby require substantial analytical resources to perform a full analysis of benefits, costs, and other socio-economic impacts. Most of the OAQPS regulatory actions fall in the minimal and active categories (MACT standards, NSPS), with relatively few designated as major (NAAQS, some MACT standards).

3.3.2 Scoping Assessment and SBREFA Determination

In this stage, active and major projects are further scrutinized to determine the scope of analyses that need to be performed and the corresponding level of effort. This may involve reviewing information on the regulated industry or activity; the type of pollution control alternatives being considered; the expected effect on environmental quality; and the availability of data and models to estimate costs, benefits, and distributional effects. Often this information is generated by other groups within OAQPS as part of the Office's activity

prior to economic analysis. This information may need to be supplemented with additional secondary data.

This is also the point in the process where the Agency must determine whether the proposed rule is likely to have a significant impact on a substantial number of small entities, a threshold criterion established by SBREFA. Upon completion of the SBREFA screening analysis, the Agency must either certify that there will not be a significant impact on a substantial number of small entities or convene a SBREFA review panel to participate in the rulemaking process. See Sections 2 and 6 for more information on the regulatory background of SBREFA and the analytical methods for addressing SBREFA impacts.

3.3.3 Industry Profile

The industry profile stage is often the first intensive activity in the economic analysis process. The purpose of the industry profile is threefold:

- characterize the economic characteristics of the regulated industry that are important for understanding the potential benefits and costs of the proposed regulatory action,
- set the analytical context for the EIA/EA, and
- collect data for subsequent analysis.

The profile should provide detail on the relevant economic characteristics of the regulated industry in question and should compile the data necessary to define a baseline for the analysis and to estimate model parameters. The profile may draw from information provided earlier in the regulatory process within OAQPS. The purpose, structure, and data requirements of industry profiles are discussed in more detail in Section 4 of this document.

3.3.4 Analysis Plan

The preliminary scoping assessment described above should paint a broad picture of issues to be addressed in the economic analysis. Since this preliminary assessment, time has passed and allows for engineering information on the compliance costs and regulatory alternatives to influence the scope and scale of the economic analysis. Supplemented with the data and other economic information gathered in the industry profile, the next task is to prepare a detailed methodology for performing the analysis. This is part of the analytical blueprint stage referenced above.

The methodology for performing an EIA should specify how costs and economic impacts will be estimated and reported. Section 5 of this document presents an analytical framework for modeling costs and economic impacts, taking into consideration the economic responses of producers and consumers in the affected markets. The methods outlined in that section work toward providing estimates of costs and distributional impacts that are both consistent with economic theory and address the analytical requirements posed by the various statutory and administrative requirements presented in Section 2.

The analysis plan for performing a full EA for significant regulatory actions ("major" rules) should supplement the EIA methodology with a methodology for estimating the benefits of the regulatory action. An analytical framework for benefits estimation methods is presented in Section 7 of this document.

3.3.5 Analysis

In this stage, the methodology and data are combined to perform the analysis. Analysis tasks include

- model development,
- testing,
- preliminary analysis of regulatory alternatives,
- evaluation and external review, and
- final analysis of regulatory alternatives.

The analytical models will depend on the scope of the analysis to be performed. Potential model types include compliance cost estimation models, partial or general equilibrium models of the regulated markets, financial impact models, and benefits estimation models (e.g., health effects models, cost-of-illness models, valuation models, and benefits transfer).

Model testing is an essential component of quality assurance/quality control (QA/QC) procedures. Testing is absolutely necessary to ensure confidence in the model results on the part of the analyst, workgroup members, Agency management, stakeholders, and the general public. Testing and QA/QC, along with the peer-review process are integral parts of the Agency's policy for using sound science to support regulatory decisions.

As indicated in Section 3.1, analysis is usually an iterative process within the Agency's regulatory development process. Preliminary analysis results can be used by the workgroup to define and select regulatory alternatives. Or regulatory alternatives may change for reasons unrelated to the preliminary analyses, such as statutory factors, stakeholder input, or changes in data or analytical inputs. Ultimately, though, a final analysis will be performed on the selected regulatory option, and the analysis results will be used to support the regulatory decision in the OMB review and public comment periods.

3.3.6 Technical Support Documents

The CAA and EO 12866 both require that all analysis results relevant to the regulatory decision be documented in writing. Of primary importance to ISEG are the following written documents:

- the EIA (EA) report
- preamble to the *FR* notice
- public docket

The EIA (EA) report summarizes the data, methods, assumptions, and results used to analyze the regulatory actions under consideration. The report should be substantive, in the sense that the reader should have all of the information necessary to understand how the results were derived and what they imply. However, the report should avoid needless detail that will hamper its readability. The preamble states the need for regulatory action and summarizes the analytical results that support the proposed action. The docket includes all materials referenced in the analysis. Its function is to allow any interested parties access to all information used to support the regulatory decision.

SECTION 4

INDUSTRY PROFILE DEVELOPMENT

This section summarizes the development of the industry profile, which provides the foundation for the development of the economic analysis. The profile provides details on the relevant economic and financial characteristics and trends for the industry in question as well as a compilation of the data necessary to define a baseline for the analysis and estimate required parameters for the economic model. It is the responsibility of the economic analyst to supplement industry data generated in earlier stages of the regulatory process with available primary and secondary sources to complete the industry profile as described below.

4.1 Purpose and Use

As mentioned above, the industry profile provides the foundation for the development of the economic analysis. For a particular industry, or group of industries, the major purposes of the profile include the following:

1. to assemble, describe, and present all relevant financial and economic characteristics and trends—past, present, and future;
2. to provide an understanding of the industry organization, including market structure and the conduct and performance of affected firms;
3. to identify the key factors and trends that may influence the nature and magnitude of the economic impacts and that may be addressed in the economic analysis (e.g., significance of international trade); and
4. to provide information necessary to identify and characterize special populations in accordance with legislative and administrative directives (e.g., small businesses under SBREFA; state, local, and tribal governments under UMRA; and minority and low-income groups under E.O. 12898 on environmental justice).

The economic analyst uses the information provided in the industry profile in the following ways:

1. as the basis for determining the level of analysis to be performed and justifying the assumptions to be used in the economic analysis,

2. to provide the statistical and analytical basis for the selected methodological framework in defining the baseline for the economic analysis and/or estimating model parameters, and

3. to assess the feasibility of and provide the data necessary for calculating the impact of a regulation on special populations.

As described below, the market orientation of the methodological framework for economic analysis conducted by ISEG has determined the structure and content of the industry profile.

4.2 Structure and Content

Table 4-1 provides an annotated industry profile outline that should serve as the basis for developing an industry profile. The proposed structure and content should be considered a flexible framework for initial development of the profile that should be subsequently tailored to fit the specifics of the subject industry. The profile structure shown in Table 4-1 has been used for numerous industry profiles in ISEG, and the profile content has facilitated the development of many economic analyses of proposed regulatory actions. In addition, the industry profile conveys EPA's understanding of the potentially affected industry to other interested parties involved in the regulatory development process. This allows industry representatives and others to review and provide comments on the accuracy and appropriateness of the information that will serve as the basis for the economic analysis.

Because of time and resource constraints, in some cases, some of the industry profile data elements outlined in Table 4-1 cannot be obtained. When data are not readily available, the specific needs of the economic analysis should determine the choices made about selective data collection. In these cases, the EPA WAM should determine which data are essential for the completion of a satisfactory economic analysis. This decision will vary from case to case, so there is no unique list of minimum data requirements. However, data that would be considered indispensable in conducting a market analysis would include baseline market volumes and prices, assumed or estimated supply and demand price elasticities, and company-level sales and employment data to address impacts on small businesses.

Table 4-1. Annotated Industry Profile Outline

Section	Description
1	Introduction (Brief description of the source category, current economic condition and trends, and the environmental concerns. Overview of organization of profile.)
2	The Supply Side
2.1	Production Process (Describe production process to characterize inputs and final commodities that are to be the focus of the economic analysis and assist in identifying the appropriate economic representation of the production process, i.e., production functions and cost functions. Discuss joint production of commodities, input substitution possibilities, and final product substitution possibilities at the facility. Also, address input ratios and economies of scale and scope.)
2.2	Major By-Products and Co-products (Identify unregulated commodities resulting from the above production processes that are important in determining viability of the facility, i.e. valuable by-products that contribute to revenues. These commodities may be indirectly affected by the regulation and therefore should be included in the analysis or at least qualitatively identified.)
2.3	Types of Products/Services (Identify the various products resulting from the production process, which also contributes to identifying affected and unaffected products.)
2.4	Costs of Production (Identify major cost components to assist in projecting baseline costs of production and determining shape or form of marginal cost or average cost functions.)
2.4.1	Capital Costs
2.4.2	Raw Material Costs
2.4.3	Labor Costs
2.4.4	Energy Costs
2.4.5	Other Costs

(continued)

Table 4-1. Annotated Industry Profile Outline (Continued)

Section	Description
3	The Demand Side
3.1	Product Characteristics (Describe the product attributes that are desired by consumers.)
3.2	Uses and Consumers (Identify major uses and consumers of the products, which contributes to our characterization of demand, e.g., derived demand versus final product demand. Also, provide own-price demand elasticities from literature or estimates.)
3.3	Substitution Possibilities in Consumption (Discuss other products that are possible substitutes to consumers and provide any empirical data on elasticities of demand by use or consumer.)
4	Industry Organization
4.1	Market Structure (Define the products and producers that constitute the "market." Discuss market shares and behavior of consumers and producers, i.e., monopolistic, oligopolistic, or perfectly competitive markets. Base discussion on existing literature on these markets and industries.)
4.2	Manufacturing Plants (Provide this detailed information to assist in incorporating these facilities into the economic model. Manufacturing plants form the basis of the economic model whether explicitly incorporated or not.)
4.2.1	Location
4.2.2	Age
4.2.3	Production Capacity and Utilization
4.2.4	Employment
4.2.5	Trends
4.2.5.1	Plants and Capacity
4.2.5.2	Technologies

(continued)

Table 4-1. Annotated Industry Profile Outline (Continued)

Section	Description
4.3	Firm Characteristics (Characterize the potentially affected business entities that own the regulated facilities. This characterization includes legal form of ownership and issues of integration that influence how firms are affected by regulation, and firm size that contributes to conducting a regulatory flexibility analysis.)
4.3.1	Ownership
4.3.2	Size Distribution
4.3.3	Vertical and Horizontal Integration
4.3.4	Financial Condition
5	Markets (Provide historical and projected data on domestic production and consumption of relevant products, as well as international trade data. Influences the selection of a base year of analysis and informs about importance of including international trade in the economic analysis.)
5.1	Market Volumes
5.1.1	Domestic Production
5.1.2	Domestic Consumption
5.1.3	International Trade
5.2	Market Prices
5.3	Future Projections
5.3.1	Domestic Production
5.3.2	Domestic Consumption
5.3.3	International Trade
5.3.4	Market Prices
6	References

4.3 Data Sources

This section provides a summary and evaluation of the data sources used in developing industry profiles. In preparing these industry profiles, the economic analyst will gather information from a wide variety of sources. For source-specific regulations, the source category subject to the proposed regulation is typically identified by a standard industry code, formerly the Standard Industrial Classification (SIC) code, now the North American Industry Classification System (NAICS). This identification will determine the primary sources of information to be used for the profile (e.g., major trade associations and government agencies). For source-specific regulations, the starting point may be the survey responses by sources within the subject industry to EPA's ICR or Section 114 letters. In those cases, the ISEG analyst should obtain a copy of the survey instrument to determine the information that can be expected from these responses. The types of information usually provided for each source category include the following:

- identification and location of potentially affected manufacturing plants,
- identification of parent company owner of each plant,
- industrial processes and input usage at each plant,
- Industry codes and/or final product descriptions (i.e., type of product and/or end use),
- individual plant capacity (or process/equipment capacities), and
- age of manufacturing plant and/or equipment.

The analyst should review the data for accuracy and adequacy and report any major questions, data gaps, or other deficiencies to the work group to address possible shortcomings at the early stage of profile development. The economic analyst should then supplement these survey data with available primary and secondary sources to complete the industry profile.

To facilitate an understanding of subject industries and to identify data sources, EPA's Office of Enforcement and Compliance Assurance (OECA) has developed a series of profiles containing information on selected major industrial groups. These industry profiles, or Industry Sector Notebooks, provide useful summary information on industrial processes and input usage, final product characterization, industry organization, general economic trends, and existing regulatory requirements. These documents also provide an extensive list of

bibliographic references that can assist economic analysts in their initial literature search and data collection efforts. Industry Sector Notebooks range in length from 84 to 180 pages and are currently available for those industries listed in Table 4-2. OECA is also planning to add profiles on the following industries in the near future:

- aerospace,
- agricultural chemicals,
- agricultural crop production,
- agricultural stock production,
- coal mining, and
- oil and gas exploration and production.

These Notebooks are available for downloading from EPA's web site <http://es.epa.gov/oeca/sector/index.html> in one or more electronic file formats including HTML, Adobe Acrobat (PDF), WordPerfect for Macintosh 3.0/DOS 5.1/Windows 6.1, and Word for Macintosh 5.1a.

Primary sources of information for industry profiles will be industry trade associations and government agencies. Major trade associations related to the subject industry can be identified through the Industry Sector Notebooks, through discussions with the engineers, or through Internet searches. Additional sources for identifying trade associations include the *Encyclopedia of Associations* published by Gale Research Company and *National Trade and Professional Associations of the United States* published by Columbia Books, Inc. Major government sources of information include the U.S. Department of Commerce's Bureau of Census, the U.S. Department of Energy's Energy Information Administration and Office of Industrial Technologies, and the U.S. International Trade Commission. In particular, useful industry overviews and general data are provided by the U.S. International Trade Commission's *Industry and Trade Summaries* (individual reports for selected industries) and the U.S. Department of Commerce's *U.S. Industry and Trade Outlook* (single report covering all industries across U.S. economy, formerly the *U.S. Industrial Outlook*).[1]

[1]Tables from the U.S. Industry and Trade Outlook by industry sector are available online at <http://www.ita.doc.gov/industry/otea/usito98/tables.htm>.

Table 4-2. List of Industries with EPA Sector Notebooks

Industry Description	SIC Code(s)[a]
Air Transportation Industry	SIC 45
Dry Cleaning Industry	SIC 721
Electronics and Computer Industry	SIC 36
Fossil Fuel Electric Power Generation Industry	SIC 4911, 493
Ground Transportation Industry—Railroad, Trucking, and Pipeline	SIC 40, 42, 46, and 49
Inorganic Chemical Industry	SIC 281
Iron and Steel Industry	SIC 331
Lumber and Wood Products Industry	SIC 24
Metal Casting Industry	SIC 332, 336
Metal Fabrication Industry	SIC 34
Metal Mining Industry	SIC 10
Motor Vehicle Assembly Industry	SIC 37
Nonferrous Metals Industry	Part of SIC 33
Non-Fuel, Non-Metal Mining Industry	SIC 14
Organic Chemical Industry	SIC 286
Petroleum Refining Industry	SIC 2911
Pharmaceutical Industry	SIC 2833, 2834
Plastics Resins and Man-made Fibers Industry	SIC 2821, 2823, 2824
Printing Industry	SIC 27
Pulp and Paper Industry	SIC 26
Rubber and Plastic Industry	SIC 30
Shipbuilding and Repair Industry	SIC 3731
Stone, Clay, Glass, and Concrete Industry	SIC 32
Textiles Industry	SIC 22
Transportation Equipment Industry	SIC 2911, 3743, 3795, 3799, 4491, and others
Water Transportation Industry	SIC 44
Wood Furniture and Fixtures Industry	SIC 2511, 2512, 2517, 2519, 2521, 2531, 2541

(a) The Sector Notebooks were developed subject to the old SIC code referencing system. See the web page <www.census.gov/epcol/www/naics.html> to cross-reference from the old SIC system to the new North American Industry Classification System (NAICS).

The analyst, of course, should always conduct a detailed literature search through academic, research, or government libraries for books and articles related to the subject industry. These searches can now be performed online through the Internet. For example, the North Carolina State University libraries can be accessed through the Internet at <http://www.lib.ncsu.edu/ index.html>, while other academic and research libraries with web servers can be identified and accessed through Libweb at <http://sunsite.berkeley.edu/Libweb/>. Furthermore, other general sources for industry overviews and statistics include the following:

- Gale Research Company publications such as *Encyclopedia of American Industries*, *U.S. Industry Profiles: The Leading 100*, and *Manufacturing U.S.A.*;
- private consulting firm studies available online through information service providers (e.g., Profound, DIALOG) or directly from the consulting firm's web site (e.g., The Freedonia Group, SRI International);
- investor research reports published by Standard and Poor's, Moody's, and Value-Line Investments; and
- *Chemical Economics Handbook* (CEH), SRI International. The CEH is a comprehensive multi-volume study of the chemical industry consisting of hundreds of reports on major segments of the industry and on individual chemicals or related groups of chemicals. Each report in CEH is periodically updated and the reports range in age from 6 months to 6 or 7 years, with 2 or 3 years being average.

In addition, several web sites provide access to industry information and resources such as The Chemical Industry Home Page at <http://www.neis.com/> (industry-specific source) or Yahoo! Finance at <http://biz.yahoo.com> (general source across many industries). The specific sources typically used for each section of the profile outline presented in Table 4-1 are summarized below.

4.3.1 The Supply Side

This section of the profile provides information about the supply side of the affected industry, focusing on identification and characterization of the affected production processes, the resulting final and residual products, and the costs of production. Table 4-3 provides several resources that have been identified as providing useful information for this section of the profile. A discussion of these sources and the relevant information they are likely to provide is presented below.

In the engineering analysis stage of the regulatory process (see Figure 3-2), EPA identifies and characterizes affected production processes and, sometimes, the resulting products and residuals. Typically, the economic analyst must consult other sources to provide this information or to supplement the information provided by the engineering analysis. Additional primary sources for this type of information include the following:

- *EPA Sector Notebooks*. This government source provides very good summaries of the technologies, processes, and products for selected industries (current list shown in Table 4-2). These summaries include useful diagrams of the production flows as well as illustrations of specific equipment or processes.

- *Trade Associations*. Trade associations often publish brochures or summary reports that provide information on technologies, processes, and products. Many of these associations have World Wide Web sites that provide online reference materials, publications lists, and links to other data sources.

- *Company Web Sites*. Companies often provide general descriptions and diagrams of their production technologies and processes, as well as information on the resulting final and residual products (i.e., saleable or recyclable products and pollutants).

As shown, other sources include previous EPA investigations (i.e., profiles or economic analyses), textbooks and technical manuscripts published by industry or academic experts, Gale Research Company's *How Products are Made*, and industry or specialty reference materials such as the *Kirk-Othmer* and the *Ullmann's* chemical-related encyclopedias. The *Ullmann's Encyclopedia of Industrial Chemistry* contains 36 volumes with more than 800 major articles and over 26,000 pages of information in industrial chemistry, process engineering, materials science, environmental chemistry, food science, and biotechnology.[2]

Information on production costs for affected entities can also be provided through EPA's engineering analysis. However, most often, the economic analyst is required to consult other sources for this information. For source-specific regulations, general information on production costs for the subject industry can be obtained from trade association publications or economic or technical research literature. For example, some trade journals have annual survey articles that summarize these costs (i.e., *Rock Products* for cement operations), or some researchers have already estimated these costs or the relevant functional relationships.

[2]The recently released 6th edition is available in electronic format, see the Ullmann home page at <http://www.wiley-vch.de/vch/software/ullmann/index.html> for more details.

Table 4-3. Summary of Sources for Supply-Side Characterization

Source	Availability
Identify and Characterize Production Processes and Resulting Products and Residuals	
EPA engineering analysis	Print (Engineering Contractor)
EPA Sector Notebooks	Print and Online at <http://es.epa.gov/oeca/sector/index.html>
Previous EPA investigations	Print
Trade association publications, reports, web sites	Print and Online
Company web sites	Online
Textbooks and technical manuscripts	Print
How Products are Made	Print (Gale Research Company)
Kirk-Othmer Encyclopedia of Chemical Technology	Print (Wiley Publishing)
Ullmann's Encyclopedia of Industrial Chemistry	Print (Wiley-VCH)
Characterize Production Costs	
EPA engineering analysis	Print (Engineering Contractor)
Trade association publications, reports, web sites	Print and Online
Economic and technical literature	Print
Private consulting firm studies	Print and Online
Industry and Trade Summaries	Print (U.S. International Trade Commission)
BLS LABSTAT Database	Online at <http://www.bls.gov>
Energy Information Administration	Print and Online at <http://www.eia.doe.gov>
U.S. Geological Survey	Print and Online at <http://www.usgs.gov>
Synthetic Organic Chemicals: U.S. Production and Sales	Print (U.S. International Trade Commission)
Chemical Marketing Reporter	Print and Online at <http://www.chemexpo.com/news/newsframe.html>

In addition, the *Industry and Trade Summaries* reports published by the U.S. International Trade Commission often provide industry survey data on the production costs of the subject industry. Sources that can provide costs of specific factors of production include the following:

- BLS LABSTAT Database (labor),
- Energy Information Administration (energy and power),
- U.S. Geological Survey (raw materials), and
- Synthetic Organic Chemicals and Chemical Marketing Reporter (chemicals).

The factor-specific cost data obtained from these and other sources can be used to generate estimates of the production costs, given specification of the appropriate production or cost function.

4.3.2 The Demand Side

This section of the profile provides information about the demand side of the affected industry focusing on identification and characterization of the attributes of the affected product(s), consumers and end uses, and the substitution possibilities in consumption.[3] Table 4-4 provides several resources that have been identified as providing such information. Typically, the economic analyst must consult other sources to provide this information or to supplement the information provided by the engineering analysis. Furthermore, the U.S. ITC's *Industry and Trade Summary* reports provide very good summary information to identify and characterize consumers and end uses, as well as substitutes. Additional primary sources for this type of information include the following:

- *Trade Associations*. Trade associations often publish brochures detailing product characteristics and comparisons with substitutes, as well as statistic reports that provide historical and projected data on end-use market shares and volumes

[3]This section may also include specification of the elasticity of demand, which measures the responsiveness of quantity demanded to price changes. The demand elasticity is a necessary parameter in the market-based approach to conducting EIAs (as described fully in Section 5). Values for this key parameter can be obtained from previous academic or EPA analyses of the subject industry or can be estimated using econometric techniques as discussed in previous EIA reports (see Research Triangle Institute, 1998). If parameter estimates are not available or feasible to estimate, then the analyst may rely on other means to determine whether an elastic or inelastic characterization would be most appropriate for the economic analysis.

consumed. Many of these associations have World Wide Web sites that provide on-line reference materials, publications lists, and links to other sources of data.

- *Company Web Sites*. Companies often provide general descriptions of their products as well as useful comparisons of their product lines with competitors' products or other general substitute products.

- *U.S. Bureau of Census*. This government sources provide publications and data on U.S. economic activity and specific industries as identified formerly by SIC codes and currently by NAICS codes. For historical data on end-use volumes, the *Current Industrial Report* is a very good source for selected industries and products (available online at <http://www.census.gov/ftp/pub/cir/www/>.

- *U.S. Geological Survey*. This government source provides publications and data on the U.S. and global supply, demand, and flow of minerals and materials. For some minerals and materials, the information provides an identification of end uses and the historical volumes consumed by each end use (available online at <http://minerals.er. usgs.gov/minerals/pubs/product.html>).

- *Private Consulting Firm Studies*. These studies may be a good source of detailing product characteristics, identifying substitutes, and providing historical and projected data on end-use market shares and volumes consumed. However, the analyst should be aware that the data provided in these sources may be compilations of publicly available information, and the methodology or assumptions for projections are typically not provided in sufficient detail.

As shown, other sources of this type of information include previous EPA investigations (i.e., profiles or economic analyses), textbooks and technical manuscripts published by industry or academic experts, and industry or specialty reference materials such as *Kirk-Othmer* and *Ullmann's* encyclopedias.

4.3.3 Industry Organization

This section of the profile characterizes the structure of the subject markets, the plants that manufacture the affected products, and the firms that own these manufacturing plants.

4.3.3.1 Market Structure

Market structure is important to understanding an industry because it determines the behavior of producers and consumers in the industry. To assess the competitiveness of a market, economists often estimate four-firm concentration ratios (CR4) and Herfindahl-Hirschman indexes (HHI) for the subject market or industry. These measures of market

Table 4-4. Summary of Sources for Demand-Side Characterization

Source	Availability
Identify and Characterize Product Attributes	
Trade Association publications, reports, web sites	Print and Online
Company web sites	Online
Textbooks and Technical Manuscripts	Print
Kirk-Othmer Encyclopedia of Chemical Technology	Print (Wiley Publishing)
Ullmann's Encyclopedia of Industrial Chemistry	Print (Wiley-VCH)
Identify and Characterize Vonsumers and/or End-Uses	
EPA Sector Notebooks	Print and Online at <http://es.epa.gov/oeca/sector/index.html>
Previous EPA investigations	Print
Industry and Trade Summaries	Print (U.S. International Trade Commission)
U.S. Bureau of Census	Print and Online at <http://www.census.gov/prod/www/titles.html>
U.S. Geological Survey	Print and Online at <http://www.usgs.gov>
Trade Association publications, reports, web sites	Print and Online
Trade journals	Print and Online
Private consulting firm studies	Print and Online
Company web sites	Online
Identify and Characterize Substitutes	
EPA Sector Notebooks	Print and Online at <http://es.epa.gov/oeca/sector/index.html>
Previous EPA investigations	Print
Industry and Trade Summaries	Print (U.S. International Trade Commission)
Trade Association publications, reports, web-sites	Print and Online
Trade journals	Print and Online
Company web sites	Online
Textbooks and Technical Manuscripts	Print

concentration are provided by four-digit SIC codes in the U.S. Bureau of the Census publication *Concentration Ratios in Manufacturing*. An additional source of seller concentration measures is the *Market Share Reporter*, published by Gale Research Company, which annually compiles market share data on companies, products, and services. However, additional information must be obtained and evaluated in the industry profile because no objective criteria exist for determining market structure based on these concentration measures. Thus, the economic analyst should consult the economic and industry literature to inform the selection or characterization of markets.[4]

4.3.3.2 Manufacturing Plants

Although sources providing information at the facility level are limited, Table 4-5 provides several resources identified as providing such information. A discussion of these sources and the relevant information they are likely to provide is presented below.

Trade Associations. Trade associations often publish directories that list individual facility characteristics and other valuable information. Many of these associations have World Wide Web sites that provide publications lists, industry statistics, and links to other sources of data. For example, the American Portland Cement Association maintains a web site at <http://www.portcement.org> with useful general and economic information on this industry in addition to publishing an annual plant information summary that provides detailed data on location, technology, capacity, and company ownership information of manufacturing plants.

Industry Buyers' Guides. Many industries publish buyers' guides that list facility location information as well as product information. For example, the Chemical Marketing Reporter publishes the Chemical Buyers Directory that lists supplier and product information, while Chemical Week and Vertical Net, Inc. provide similar information through online guides (i.e., Buyers' Guide at <http://www.chemweek.com/tools/cwbg.html> and Chemical Online at <http://www.chemicalonline.com/suppliers.html>). In addition, MacRAE'S Blue Book is a comprehensive national buying guide of 50,000 prominent U.S. manufacturers including their products and trade names. This source is available in print and online through a fee-based subscription service at <http://www.d-net.com/macraes/>.

[4]See the pharmaceuticals (Research Triangle Institute, 1996b) or portland cement (Research Triangle Institute, 1996a) industry profiles for more detailed description of this issue.

Table 4-5. Data Elements for Facility-Specific Sources

Data Source	Legal Owner	Location	Process/Product Descriptions	Process/Product Capacity	Product Revenues	Employment
Industry Trade Associations	X	X	X	X		
Industry Buyers' Guides	X	X	X			
U.S. SEC/EDGAR Database[a]	X	X	X	X	X	X
Company Web Sites	X	X	X	X		
Dun & Bradstreet Market Identifiers[b]	X	X			X	X
American Business Disk		X			X	X
U.S. Manufacturers Database[c]	X	X	X		X	X

[a] Non-subscription service with web access via <http://www.sec.gov/edgarhp.htm>.

[b] Electronic database available through EPA's Facility Index System (FINDS).

[c] Fee-based subscription service with web access via <http://www.d-net.com/usm/>.

U.S. Security and Exchange Commission. EDGAR Database. This source consists of electronic filings by public corporations to the Securities and Exchange Commission (i.e., 10-K reports) and is available through the Internet at <http://www.sec.gov/edgarhp.htm>. Some companies publish detailed information on their manufacturing operations as well as markets served. However, this information may often times only include plant location.

Corporate Web Sites. Many corporations maintain web sites that may provide data on manufacturing facilities. The level of detail varies greatly across owning companies: some provide no information while others provide highly detailed facility information. Web addresses for companies may be provided in some company data sources or obtained through web searches via Internet search engines.

Other Sources. The Dun & Bradstreet Market Identifiers, American Business Disk, and U.S. Manufacturers Database generally only provide location, sales, and employment information. In addition, there are strict use limitations from these sources.

4.3.3.3 Firm Characterization

The profile must also characterize the potentially affected legal entities that own these manufacturing facilities. As shown in Figure 4-1, the chain of ownership may be as simple as one facility owned by one company (i.e., direct owner is parent company) or as complex as one facility owned by multiple companies (i.e., direct owner is subsidiary company or other legal entity). The legal entity of interest to the ISEG analyst is the ultimate parent company. Sources of data to be used in characterizing these parent companies include the following:

- InfoTrac—Information Access Company,
- SEC 10-K reports (via EDGAR search),
- Ward's *Directory of U.S. Private and Public Companies*,
- Standard and Poor's Stock Report Services,
- company annual reports and web sites, and
- industry trade publications and journals.

Based on the appropriate SBA size definitions, the ISEG analyst must characterize the owning firms by size to facilitate the future preparation of a regulatory flexibility analysis. For example, under SIC 3312, the SBA defines a small company as one having 1,000 or fewer employees. Therefore, based on the firms' sales or employment, the profile will identify the firms owning potentially affected manufacturing plants as small or not small. This characterization will also include an examination of vertical and horizontal integration that will affect how the firms will respond to the regulation. The profile will also include data, where possible, that will characterize the baseline financial condition of these companies, including income statements, balance sheets, and cash flow statements.

The New York Public Library publishes a guide to doing basic research on United States Companies that provides a fairly comprehensive list of company information resources. This guide is available through the Internet at <http://web.nypl.org/research/sibl/company/companyinfo.html>. Several of these sources can be classified as primary resources because they have consistently been used to provide company-specific information for previous industry profiles. In addition, other databases have also been identified as valuable sources of industrywide financial information. Table 4-6 presents a summary of company-specific

resources, while Table 4-7 presents the data elements that they provide. Each source is briefly described below.

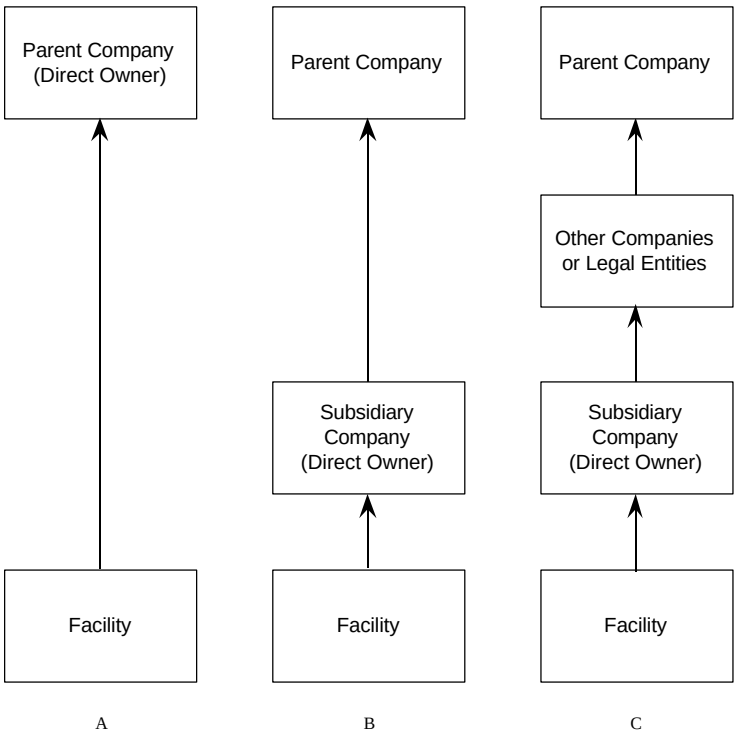


Figure 4-1. Possible Ownership Configurations in U.S. Industries

Table 4-6. Summary of Company-Specific Sources

Data Source	Identify Corporate Ownership	Information by Company Type			
		Public	Private	Foreign	Small
Information Access Corporation[a]	VG	VG	G	P	F
Ward's Business Directory	F	VG	G	P	F
Dun & Bradstreet Market Identifiers[b]	VG	VG	VG	P	VG
Hoover's Online[c]	VG	VG	G	F	F
Worldscope[d]	*	F	P	VG	P
Standard & Poor's Corporations[d]	F	VG	VG	P	VG
Directory of Corporate Affiliations	VG	G	F	VG	*
U.S. SEC/EDGAR Database[e]	G	VG	NA	NA	*
Company Web Sites	G	G	F	F	F

VG = very good
G = good
F = fair
P = poor
NA = not applicable
* = unlikely to contain this information

[a] Information Access Corporation. 1997. Business & Company Profile ASAP. [computer file] Foster City, CA: Information Access Corporation.
[b] Electronic database available through EPA's Facility Index System (FINDS).
[c] Nonsubscription service with web access via <http://www.hoovers.com/>.
[d] Electronic access via CD-ROM.
[e] Nonsubscription service with web access via <http://www.sec.gov/edgarhp.htm>.

Table 4-7. Data Elements for Company-Specific Sources

Data Source	WWW Address	Legal Form Organization	SIC Codes	Sales	Employment	Income Statement	Balance Sheet	Cash Flow Statement
Information Access Corporation[a]	X	X	X	X	X			
Ward's Business Directory		X	X	X	X			
Dun & Bradstreet Market Identifiers[b]			X	X	X			
Hoover's Online[c]	X	X	X	X	X			
Worldscope[d]		X	X	X	X			
Standard & Poor's Corporations[d]		X	X	X	X			
Directory of Corporate Affiliations		X		X	X			
U.S. SEC/EDGAR Database[e]		X	X	X	X	X	X	X
Company Web Sites	X			X	X	X	X	X

[a] Information Access Corporation. 1997. Business & Company Profile ASAP. [computer file] Foster City, CA: Information Access Corporation.
[b] Electronic database available through EPA's Facility Index System (FINDS).
[c] Web access via <http://www.hoovers.com/>.
[d] Electronic access via CD-ROM.
[e] Web access via <http://www.sec.gov/edgarhp.htm>.

The following sources provide information for specific companies of interest to the economic analyst.

Information Access Company's Business Index. This electronic source allows the user to search for individual companies by name or search for a list of companies in a particular industry based on four-digit SIC codes. Once a company has been identified, this source provides links to its corporate owner as well as recent articles about the company. This database provides information on the company's legal form of organization, sales and employment, and SIC codes. For some companies, the company's Internet address is also included. Although this source is updated weekly, information for some companies may be dated. The index is available at most university libraries or through the Internet at <http://www.insitepro.com/>. However, Internet access is restricted to subscribers.

Ward's Business Directory of U.S. and Private Companies. This print source allows the user to search company names alphabetically or by a particular industry based on four-digit SIC codes. The directory provides information on the company's legal form of organization, sales and employment, and SIC codes. It also identifies the immediate owner of the company, if applicable. The directory is published annually; however, the reported information does not necessarily correspond to one particular time period. For example, the 1998 directory reports sales and employment information based and several years of data (1994 through 1996).

Dun & Bradstreet (D&B) Database Available Through EPA's Facility Index System (FINDS). This electronic database allows the user to search for companies using a DUNS identification number or company name. However, information on the state in which the company is located is required to complete a company name search. Links to the ultimate parent companies are provided, if available, as well as sales, employment, and SIC code information. Although D&B is a good source of company data, there are strict use limitations for this database.

Worldscope. This electronic database is very good source for information on international companies. Users can search for companies by name and the database reports sales, employment, and SIC code information. It also provides historical information for company sales for the past 5 years.

Standard and Poor's Corporations. This electronic database is an excellent source of information on small and/or private companies. Users can search for companies by name or SIC codes. It provides corporate ownership, sales, employment, and SIC information.

Hoover's Online. This electronic database is an excellent source of information on U.S. public and private companies. Users can search for companies by name, ticker symbol, or keyword. It provides corporate ownership, sales, net income, and employment. Links are also provided to the company's web site and those of top competitors (if available), SEC filings in EDGAR Online, investor research reports, and news and commentary.

Directory of Corporate Affiliations. This print source provides good information on international corporations. Users can search an alphabetical list for company names. This database identifies corporate ownership and reports sales and employment data. Information is limited to larger corporations.

U.S. Security and Exchange Commissions: EDGAR Database. This source consists of electronic filings by public corporations to the Securities and Exchange Commission (e.g., 10-K reports) and is available through the Internet at <http://www.sec.gov/edgarhp.htm>. Users can search by company name to locate appropriate reports. In addition to sales and employment data, these reports typically include detailed financial information such as income statements, balance sheets, and cash flow statements that are not available from other sources. However, this source only includes information on publicly traded U.S. companies.

Corporate Web Sites. Many companies maintain web sites that can be good sources of financial information. These sites often include recent annual reports and links to industry-related sites. A starting point for searching for company web sites is <http://www.yahoo.com/Business_and_Economy/Companies/Directories/Regional/U_S__States/>. However, individual company names can be searched using any Internet search engine. As noted earlier, Information Access Company's Business Index also provides Internet addresses for selected companies.

Sources containing information on industry financial conditions and trends often provide general data that can be used to estimate missing data for specific companies. The following resources may provide this type of information:

- Dun & Bradstreet's *Industry Norms & Key Business Ratios*;
- Leo Troy's *Almanac of Business and Industrial Financial Ratios*;

- Robert Morris Associates' *Annual Statement Studies*;
- U.S. Department of Commerce's *Quarterly Financial Reports for Manufacturing, Mining, and Trade Corporations* <http://www.census.gov/prod/www/titles.html - qfr>; and
- Value Line Publications' *Value Line Investment Survey*.

These sources should be available in print or electronic format at most academic or research libraries.

4.3.3.4 Other Owning Entities

The profile must also characterize the other entities that are not firms but may own affected facilities or emissions sources. These other entities include Federal agencies; state, local, and tribal governments; and non-profit organizations. Table 4-8 provides several resources that have been identified as providing information to characterize these owning entities, including the following:

1992 Census of Governments: Government Finances–Compendium of Government Finances. Presents statistics on governmental finances for Federal, state, and local governments (separate tabulations are included for counties summarized by size). Data include revenue by source, expenditures by function, per capita figures, percentage distributions, and rankings. Finances of utilities operated by local governments are detailed by state and by type of utility and government.

City Government Finances. Provides a summary of city government finances as well as data on finances of city-operated utilities; supplementary detail on other utilities for individual cities and selected urban towns and townships of over 75,000 population; city finance items and per capita amounts of these items, by population-size groups; finances of individual cities and selected urban towns and townships of over 75,000 population; per capita amounts of financial items; and finances of individual city governments having 300,000 population or more.

County Government Finances. Provides a summary of county government finances including data on revenue and expenditures, finances of county governments by population-size groups, finances of individual county governments in counties of over 100,000 population, per capita amounts of selected financial items by counties, detailed finances of

individual counties of over 500,000 population, and finances of individual city-counties of over 100,000 population.

To facilitate RFA and SBREFA analysis, based on the information obtained from these sources and others, the industry profile will identify these other entities as small or not small. In addition, some of the sources listed in Table 4-8 allow the analyst to characterize the demographics and economic conditions within relevant governmental jurisdictions and geographic areas.

4.3.4 Markets

This section of the profile provides historical and/or projected market data on U.S. production, consumption, and foreign trade, as well as prices of affected commodities. Table 4-9 provides several resources identified as providing such information. As shown, these sources include statistical reports and trade articles published by trade associations and government publications from the U.S. Department of Commerce, U.S. Department of Energy, U.S. Geological Survey, and others. In addition, the U.S. International Trade Commission periodically publishes industry profiles, which contain market data and assessments of current and future market conditions for selected industries and/or products. The primary sources of this type of information include the following:

- *Trade Associations*. Trade associations often publish statistic reports that provide historical and projected data on U.S. production/shipments and foreign trade. Many of these associations have World Wide Web sites that provide online data tables and text descriptions, publications lists, and links to other sources of data.

- *U.S. Bureau of Census*. This government source provides publications and data on U.S. economic activity and specific industries as identified by SIC codes. For historical data on value and volume of U.S. shipments, the Census publications are very good sources for numerous industries and products/services (available online at <http://www.census.gov/prod/www/titles.html/>.

- *U.S. Geological Survey*. This government source provides publications and data on the U.S. and global supply, demand, and flow of minerals and materials. For most minerals and materials, this source provides historical data on U.S. production, foreign trade, and apparent consumption, as well as market prices (available online at <http://minerals.er.usgs.gov/minerals/pubs/product.html>).

Table 4-8. Summary of Sources to Characterize Other Owning Entities.

Source	Author/Provider and Availability
Revenues, Expenditures, Employment	
1992 Census of Governments Titles[a]	
1992 Census of Governments: Government Finances--Compendium of Government Finances[b]	Dept. of Commerce http://www.census.gov/prod/2/gov/gc92-4/gc924-5.pdf
City Government Finances, 1991-92[c]	Dept. of Commerce http://www.census.gov/prod-bin/pubgate.pl?/prod/2/gov/gc92-4/gc924-5.pdf
County Government Finances, 1991-92[d]	Dept. of Commerce http://www.census.gov/prod/1/gov/gf92x8.pdf
Government Finances, 1991-92[e]	Dept. of Commerce http://www.census.gov/prod/1/gov/gf92x5.pdf
Public Employment: Employment of Major Local Governments[f]	Dept. of Commerce http://www.census.gov/prod-bin/pubgate.pl?/prod/2/gov/gc92-3/gc923-2.pdf
Demographic and Other Economic Characteristics	
County Business Patterns: 1993, 1994, and 1995[g]	Dept. of Commerce http://www.census.gov/prod/www/abs/cbptotal.html
Demographic and Economic State and County Profiles[h]	Dept. of Commerce http://www.census.gov/datamap/www/index.html
Regional Economic Information System: 1969-1996[i]	Bureau of Economic Analysis http://govinfo.kerr.orst.edu/reis-stateis.html
National and State Population Estimates: 1990 to 1994[j]	Dept. of Commerce http://www.census.gov/prod/1/pop/p25-1127.pdf
Population Projections of the United States by Age, Sex, Race, and Hispanic Origin: 1995 to 2050[k]	Dept. of Commerce http://www.census.gov/prod-bin/pubgate.pl?/prod/1/pop/p25-1130/
Population Projections for States: 1995 to 2025[l]	Dept. of Commerce http://www.census.gov/prod-bin/pubgate.pl?/ftp/pub/prod/2/pop/p25/p25-1131.pdf
Labor Force Characteristics of U.S. Population[m]	Dept. of Commerce http://www.bls.census.gov/cps/cpsmain.htm
Characteristics of Business Owners Database[n]	Dept. of Commerce http://www.census.gov/econ/www/mu0400.html

[a] U.S. Department of Commerce. 1992.
[b] U.S. Department of Commerce. 1997.
[c] U.S. Bureau of the Census. 1996.
[d] U.S. Bureau of the Census. 1995.
[e] U.S. Bureau of the Census. 1996.
[f] U.S. Department of Commerce. 1997.
[g] U.S. Department of Commerce. 1998.
[h] U.S. Department of Commerce. 1999.
[i] U.S. Bureau of Economic Analysis. 1997.
[j] Byerly, Edwin R, and Kevin Deardorff. 1995.
[k] Day, Jennifer Cheeseman. 1996.
[l] Campbell, Paul R. 1997.
[m] U.S. Bureau of Labor Statistics. 1996.
[n] U.S. Bureau of the Census. 1996.

Table 4-9. Summary of Market-Level Data Sources

Sources	Data Elements			Availability
	U.S. Production/ Shipments	Foreign Trade	Market Prices	
U.S. Bureau of Census	VG	F	VG	Print and Online at <http://www.census.gov/prod/www/titles.html>
U.S. Geological Survey (former U.S. Bureau of Mines)	VG	G	VG	Print and Online at <http://www.usgs.gov>
Energy Information Administration	VG	VG	VG	Print and Online at <http://www.eia.doe.gov>
ITC Trade DataWeb	*	VG	*	Online at <http://205.197.120.17/>
Industry and Trade Summaries	G	G	G	Print (U.S. International Trade Commission)
Trade associations	VG	G	G	Print and Online
Trade journals	F	F	F	Print and Online
Private consulting firm studies	VG	G	G	Print and Online

VG = very good
G = good
F = fair
P = poor
NA = not applicable
* = unlikely to contain this information

Note: Although some sources provide consumption data, the market section of the industry profile typically derives apparent consumption based on production, foreign trade, and inventory changes.

- *U.S. ITC Trade DataWeb*. This government source provides U.S. imports and exports by customized list of products to obtain value, quantity, and unit value for products. (Version 1.7 of this database is currently available online at <http://205.197.120.17/>).

- *Private Consulting Firm Studies*. These studies may be a good source of historical and projected data on U.S. production/shipments, foreign trade, and apparent consumption. However, the analyst should be aware that the data provided in these sources may be compilations of publicly available information and the methodology or assumptions for projections are typically not provided in sufficient detail.

Other sources of this type of information include previous EPA investigations (i.e., profiles or economic analyses) and survey articles in trade journals published by industry or academic experts.

In addition to confirming the current status of the industry, these sources are often useful in exploring trends and projections. Future projections are available from trade associations, trade journals, government sources (e.g., U.S. Department of Energy forecasts), or industry experts. The economic analyst should review the assumptions upon which the forecasts are provided to determine the quality of these estimates and their validity given acquired knowledge of the subject industry and/or markets. These assumptions should be provided with the industry profile. Alternatively, the economic analyst can employ the historical data to develop future growth projections based on simple growth rates or econometric techniques using additional data on U.S. and global economic activity.

SECTION 5

EIA ANALYTICAL FRAMEWORK AND OPERATIONAL ISSUES[1]

"Economic impact analysis" is not a precise term in economics but an evolving term that describes the various analyses performed to gauge the economic consequences of EPA regulations. Over time, conducting EIAs has become an integral part of ISEG's role in EPA's regulatory development process. Based on legislative and administrative directives, the EIA's purpose for ISEG is primarily to describe and quantify the reallocation of society's resources in response to a proposed regulatory action. Under some circumstances, the EIA also provides the social cost estimate to be compared with social benefits in the benefit-cost analysis required in a full EA, as described in Section 2.

Generally, ISEG needs estimates of the following types of variables without and with the regulation for the time period of the analysis:

- facility- and industry-level impacts, which may include compliance cost burden; revenue, cost, and profit changes; changes in capacity utilization; facility and process closures; and employment changes;
- market-level impacts, which may include changes in market prices, domestic production and consumption, and foreign trade;
- company-level impacts, which may include compliance cost burden and its impact on financial viability and/or failure;
- community-level impacts, which may include changes in employment, facility closures, and changes in emissions;
- governmental impacts, which may include the costs of administrative, monitoring, and enforcement actions and changes in receipts from taxes or fees; and
- social costs and benefits.

[1]For a more comprehensive review of the basic economic concepts of social cost, the reader may refer to the document *Guidelines for Preparing Economic Analyses* prepared by EPA's Office of Policy (EPA, 1998d). As of July 1998, that document was in draft form.

By quantifying and evaluating these impacts in the EIA, the ISEG analyst is able to provide valuable inputs to policymakers in the regulatory development process and, if applicable, improve the benefit-cost analysis.

The section continues with a description of the methodological approach for performing EIAs in OAQPS. Section 5.1 provides a discussion of alternative approaches for performing EIAs and the rationale for the partial equilibrium, intermediate-run market model approach used in many ISEG analyses. Section 5.2 provides a conceptual overview of the market modeling approach for estimating economic impacts. Section 5.3 moves beyond the conceptual framework for market models to practical issues involved in developing an economic model, when information on the economic phenomena of interest is often sketchy and practical compromises must be made. Section 5.4 summarizes the analytical approach and concludes with the recommended structure for organizing and reporting analytical results.

5.1 Alternative Approaches for Economic Impact Analysis

The analyst faces potentially four fundamental issues in selecting an analytical approach for performing EIAs. The first is whether human behavioral responses are incorporated in estimating economic impacts. If not, the remaining fundamental issues are moot. If a behavioral approach is taken, the next issue is the extent to which market relationships are modeled. The third is the length-of-run over which human and market behavior is modeled. The fourth issue is whether a static or dynamic model is applied. Each of these issues is discussed in turn below.

5.1.1 Behavioral vs. Nonbehavioral Models

The analyst can choose among two fundamentally different approaches in conducting an EIA:

- nonbehavioral: engineering and financial analysis of compliance costs, and
- behavioral: analysis of economic responses to compliance requirements, usually in a market setting

In both cases, "engineering" estimates of the costs of compliance for actual or model plants in the regulated industry are the driving factor. With the nonbehavioral approach, the impacts of the regulation are simply assumed to fall on the entities owning the facilities faced with the compliance responsibilities. Analysis takes the form of gauging the severity of impacts, typically using accounting measures of profit and loss. Alternatively, the behavioral approach

explicitly recognizes, for example, that owners of the affected facilities are economic agents that can, and presumably will, make adjustments such as changing production rates or altering input mixes that will generally affect the market environment in which they operate. One likely market consequence is a change, typically a rise, in price that will then induce behavioral responses by consumers and producers, which affect resource allocation.

Thus, the behavioral approach allows for a more realistic assessment of the distribution of impacts across different groups within society than does the nonbehavioral approach. More specifically, the nonbehavioral approach focuses the impacts entirely on the entities directly affected by compliance requirements. The behavioral approach recognizes that regulated entities will tend to shift at least some of the burden to other parties, such as consumers or input suppliers. Thus, the nonbehavioral approach will tend to overstate the impacts on the directly affected entities. Moreover, only the behavioral approach allows one to appropriately estimate the potential price and international trade consequences of the regulatory action. Finally, if the "cost" results from the EIA are to be used subsequently in the benefit-cost analysis of an EA, then a conceptually correct measure of social costs should include an assessment of behavioral responses (see OMB, 1996).

Recognizing the conceptual advantages and the underlying ability to provide the information requirements of an EIA and EA, ISEG has traditionally employed the behavioral economic model approach when feasible under data and other resource constraints. Given this history, the discussion now moves to issues of market model scope and length of run.

5.1.2 Market Model Scope: Partial vs. General Equilibrium

A strictly partial equilibrium model tracks the effect of a regulatory action in one market; all other possible market interactions are ignored. A strictly general equilibrium model tracks the effects of a regulation in all sectors of the economy; no intersectoral linkages are ignored. In between these two extremes are models that capture a finite set of pre-defined important market linkages, ignoring effects in all other markets. These models are sometimes referred to as "general" equilibrium models (e.g., Just, Hueth and Schmitz, 1982), but they will be referred to here as multimarket partial equilibrium models.

Because the scope of many OAQPS regulatory actions is sector-specific and typically not large enough to substantially affect other sectors of the economy, partial equilibrium models are typically employed in estimating the economic impacts. These partial equilibrium models may be strictly partial (one product market) or may be extended to multiple markets

when more than one market is directly affected by a regulation, and/or other related product markets are potentially indirectly affected by the regulation.[2] For example, the EIA conducted for the Pulp and Paper Cluster rule modeled the interactions between the directly affected markets for pulp inputs and the indirectly affected final paper and paperboard products. Although these models may be extended to include multiple markets, they generally do not account for interactions with the entire U.S. economy, as does the general equilibrium approach.

5.1.3 Length-of-Run Considerations

In developing the partial equilibrium model, the analyst must determine the alternatives available to economic agents in response to regulation and the context within which these choices are made. This is largely dependent on the time horizon for which the analysis is performed. Three benchmark time horizons are considered here: the very short run, the long run, and the intermediate run.

5.1.3.1 Very Short Run

In the very short run, all factors of production are assumed to be fixed, leaving the directly affected entity with no means to respond. Within a short time horizon, regulated producers are constrained in their ability to adjust inputs or outputs due to contractual, institutional, or other factors. In essence, this is equivalent to the nonbehavioral model described earlier. Therefore, the impacts of the regulation fall entirely on the regulated entity. Producers incur the entire regulatory burden as a one-to-one reduction in their profit. This is referred to in the nomenclature of EIAs as the "full-cost absorption" scenario.

Unfortunately, there is no hard and fast rule for determining what length of time constitutes the very short run. Nonetheless, under most conditions, economic entities have some flexibility to adjust factors of production. And, as indicated above, ignoring those adjustments tends to overstate producers' losses.

[2]In addition to product markets, multiple markets may also be defined based on geographic boundaries if separate regionally distinct markets exist because of high transportation costs (e.g., cement, coke, hazardous materials).

5.1.3.2 Long Run

In the fullness of time, all factors of production are variable and producers can be expected to adjust production plans in response to cost changes imposed by a regulation. Figure 5-1 illustrates a typical, if somewhat simplified, long-run industry supply function. The function is horizontal, indicating that the marginal and average costs of production are constant with respect to output.[3] This horizontal slope reflects the fact that, under long-run constant returns to scale, technology and input prices ultimately determine the market price, not the level of output in the market.

Market demand is represented by the standard downward-sloping curve. The market is assumed here to be perfectly competitive; equilibrium is determined by the intersection of the supply and demand curves. The implications of imperfect competition on market equilibrium are discussed below. In this case, the upward parallel shift in the market supply curve represents the regulation's effect on production costs. The shift causes the market price to increase by the full amount of the per-unit control cost (i.e., from P_0 to P_1). With the quantity demanded sensitive to price, the increase in market price leads to a reduction in output in the new with-regulation equilibrium (i.e., Q_0 to Q_1). As a result, consumers incur

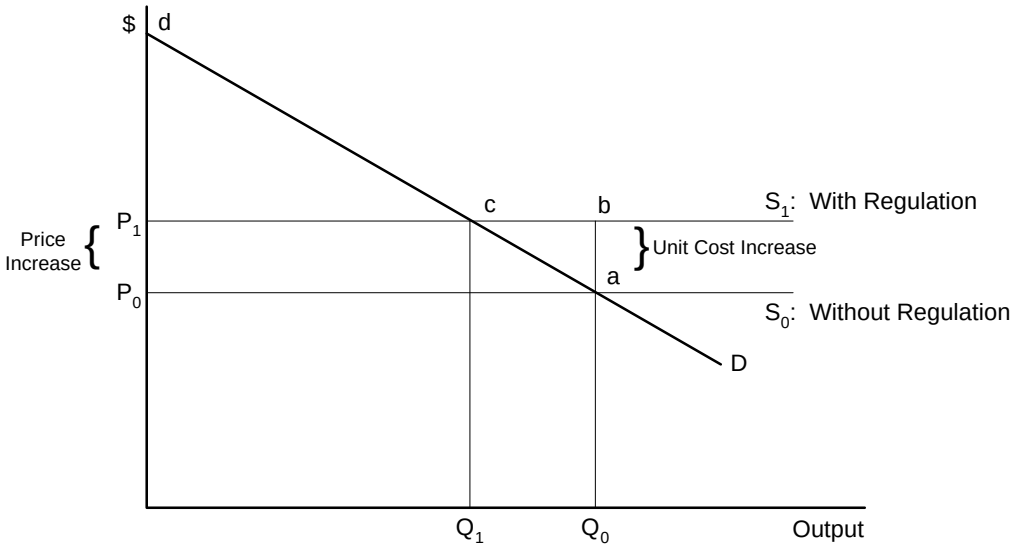


Figure 5-1. Full-Cost Pass-Through of Regulatory Costs

[3]The constancy of marginal costs reflects an underlying assumption of constant returns to scale of production, which may or may not apply in all cases.

the entire regulatory burden as represented by the loss in consumer surplus (i.e., the area P_0 ac P_1). In the nomenclature of EIAs, this long-run scenario is typically referred to as "full-cost pass- through."

Taken together, impacts modeled under the long-run/full-cost pass-through scenario reveal an important point. Namely, under fairly general economic conditions, a regulation's impact on producers is transitory. Ultimately, the costs are passed on to consumers in the form of higher prices. However, this should not be used as a justification to completely dismiss producer impacts in an EIA. For one, the long run may cover the time taken to retire all of today's capital vintage—perhaps decades. Therefore, transitory impacts could be fairly protracted. Given the call to discount the costs of a policy (see Section 8), transitory impacts could dominate long-run impacts in terms of present value. Moreover, the statutes and EOs referenced in Section 2 implicitly call for an assessment of impacts on current producers and workers; thus, a purely long-run approach is moot for addressing transitory, but important, concerns such as facility closures, capital displacement, and worker dislocation. Given the previously referenced limits of a very short run perspective, the analyst should ideally consider some intermediate case between the very short and long run to gauge economic impacts.

5.1.3.3 "Intermediate" Run

The "intermediate" run can best be defined by what it is not. It is not the very short run and it is not the long run. In the intermediate-run, some factors are fixed; some are variable.[4] The existence of fixed production factors generally leads to diminishing returns to those fixed factors. This typically manifests itself in the form of a marginal cost (supply) function that rises with the output rate, as shown in Figure 5-2.

Again, the regulation causes an upward shift in the supply function. The lack of resource mobility may cause producers to suffer profit (producer surplus) losses in the face of regulation; however, producers are able to pass through the associated costs to consumers to the extent the market will allow. As shown, in this case, the market-clearing process

[4]As a semantical matter, the situation where some factors are variable and some are fixed is often referred to as the "short run" in economics, but the term "intermediate run" is used here to avoid any confusion with the term "very short run."

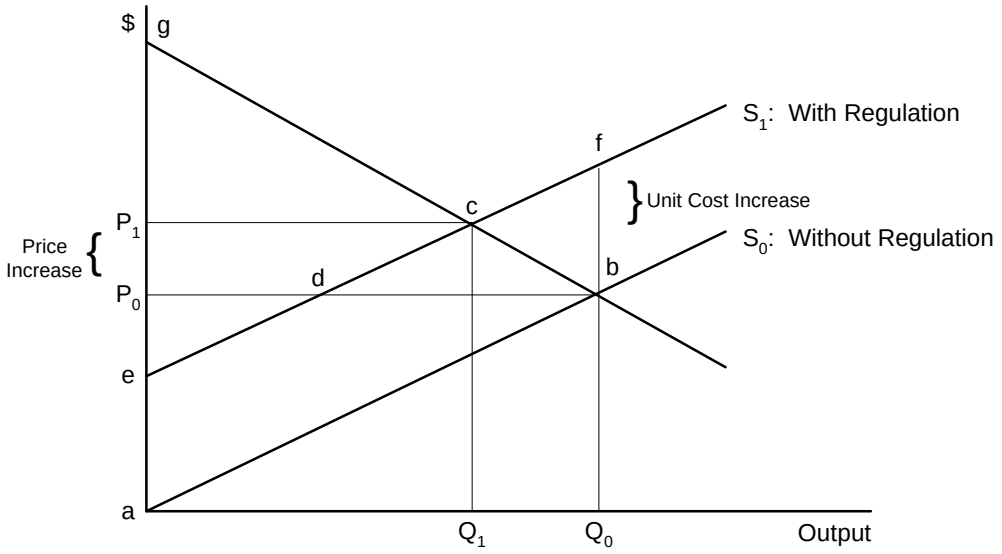


Figure 5-2. Partial-Cost Pass-Through of Regulatory Costs

generates an increase in price (from P_0 to P_1) that is less than the per-unit increase in costs (fb), so that the regulatory burden is shared by producers (net reduction in profits) and consumers (rise in price).

5.1.4 Static vs. Dynamic Models

At its core, the partial equilibrium model simulates a single period market outcome without and with regulation. Each solution of the model is, therefore, static in nature. The model can, in principle, be extended to incorporate temporal dynamics such as exit and entry over time and adoption of new technology. Then, time paths of market equilibria without and with the regulation can be simulated to track regulatory effects over time. This approach has some obvious attractions but is typically difficult to implement. Dynamic models of firm entry, exit, and technological change are difficult to estimate and generally quite sensitive to model specification and parameter values. Therefore, the common practice is to stimulate regulatory effects in a static setting, using a representative year as the basis for estimating annual regulatory impacts. More information on selecting the analytical baseline and time period of analysis is presented in Section 8.

5.1.5 Standard Approach for ISEG Industry-Level Analyses

The remainder of this section focuses on EIAs conducted for regulations of existing sources in a single regulated industry. This single-industry focus characterizes rulemakings such as the imposition of a MACT standard for a NESHAP. The standard approach for addressing these problems is the development and application of partial equilibrium/ intermediate-run/static (PEIS) models to assess impacts in the potentially affected market(s). The role of new sources and the impacts of new source performance standards, while not part of this document's focus, can easily be accommodated within the methods described here. However, that is not the case for industry-specific regulations that have costs large enough to substantially affect other sectors or regulations, such as NAAQS standards, that cut extensively across industries. Those extensive regulations need more serious consideration of general equilibrium and macroeconomic models to appropriately gauge economic impacts.[5] Those modeling topics are beyond the scope of the current document but may be included in future revised editions. Thus, the section continues by describing the conceptual underpinnings of the PEIS modeling approach.

5.2 PEIS Modeling Approach: Conceptual Framework

This section examines the impact of the regulations that affect the production costs for facilities in an affected industry. It provides an overview of the basic economic theory of the effect of the regulations on facility production decisions and the concomitant effect on market outcomes. The framework presented here employs standard concepts in microeconomics to model the supply of affected products and the impacts of the regulations on production costs and the operating decisions. The three main elements are

- regulatory effects on the manufacturing facility,
- market responses, and
- facility–market interactions.

[5]Although general equilibrium and dynamic aspects of the effects of regulation are not addressed explicitly in this section, these aspects certainly influence the magnitude and distribution of the regulatory burden (e.g., see Hazilla and Kopp, 1990). However, in the case of MACT standards, they are deemed by the analyst as having second-order impacts that are generally not worth the additional time and resources to formally address in the EIA model. Alternatively, some of these influences are addressed separately as described more fully in Section 8.

The remainder of this section describes each of these main elements.

5.2.1 Facility-Level Effects

At any point in time, the costs that an existing facility faces can be classified as either unavoidable (sunk) or avoidable. In the former category, we include costs to which the firm is committed and that must be paid regardless of any future actions of the firm. For instance, debt incurred to construct a production facility must be repaid regardless of the facility's production plan and even if the facility ceases operation prior to full repayment, unless the range of viable alternatives includes the declaration of bankruptcy by the owners. The second category, avoidable costs, describes any costs that are foregone by ceasing production. These can be further refined to distinguish between costs that vary with the level of production and those that are independent of the production level. For example, production factors such as labor, materials, and capital (except in the short run) vary with the level of output, whereas expenditures for facility security and administration may be independent of production levels, but avoidable if the facility closes down. The determination of both the avoidability and the variability of firms' costs is essential to the analysis of economic responses to the proposed regulations.

The current technical features of these facilities reflect the historical economic environment and managerial decisions of the firm. The existence of the fixed factors give rise to (eventually) diminishing marginal returns to production and, along with the terms under which the firm may purchase variable inputs, condition the shape of the cost curve of the facility. Figure 5-3 illustrates the derivation of a facility supply function for a subject product from the classical U-shaped structure of production costs with respect to output. Let AVAC be the facility's average variable (avoidable) cost curve and ATAC the average total (avoidable) cost curve for producing the product. The vertical distance between ATAC and AVAC is the per-unit average cost of nonvariable avoidable costs, which approaches zero as the number of units of output increases. MC is the marginal cost of producing the product, which intersects AVAC and ATAC at their respective minimum points. All these curves are drawn conditional on input prices and the technology in place at the facility.

Managers of existing facilities face operating decisions of whether to operate at all and, if so, the optimal rate of output. Depending on market structure, they may also face choices in the prices they pay for purchased inputs and the price they charge for their

produced commodity. The facility supply function is the section of the marginal cost curve bounded by the quantities q^m and q^M. q^m is the minimum economically feasible production rate that is determined by the minimum of the AVAC curve, which coincides with the price p^m. Suppose the market price of the subject product is less than p^m. q^M is the largest feasible production rate that can be sustained at the facility given the technology and other fixed factors in place, regardless of the output price. In this case, the firm's best response is to close the facility and not produce because P < ATAC implies that total revenue would be less than total costs if the facility operated at the associated output levels below q^m. Based on profit-maximizing behavior, these managers will select the output rate where the additional contribution of output to revenue (marginal revenue or MR) is equated to its additional contribution to cost (marginal cost or MC). For facilities competing in perfectly competitive markets this is where market price equals marginal cost, that is, at [P*, Q*] in Figure 5-3. Profits or quasi-rents are the difference between total revenues and total costs. This reflects annual return to the fixed factors and, as pointed out by Friedman (1962), is a consequence of the firm's operating decision, not a determinant of it. The fixed and variable costs ("contractual costs" in Friedman's terminology) are the determinants of the equilibrium (profit-maximizing) output rate.

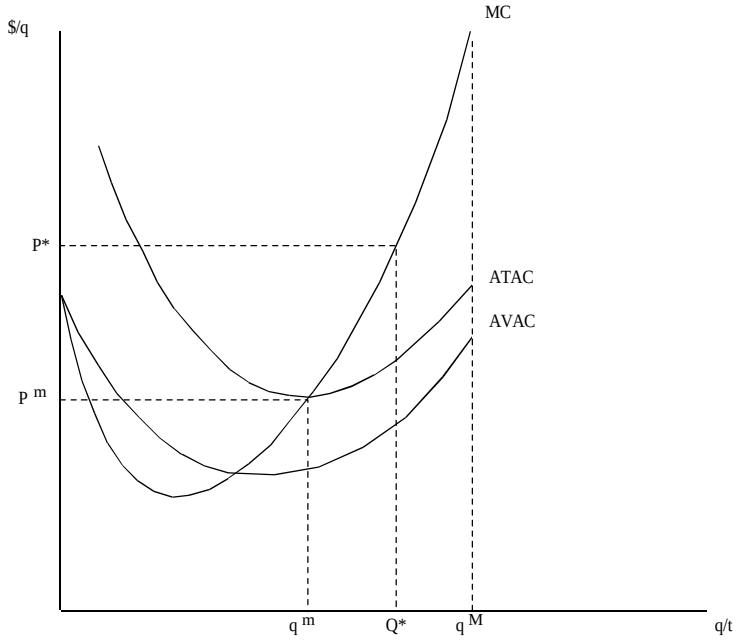


Figure 5-3. Product Supply Function at Facility

Now consider the effect of the proposed regulatory control costs. These fall into one of two categories: avoidable variable and avoidable nonvariable. These proposed costs are characterized as avoidable because a firm can choose to cease operation of the facility and, thus, avoid incurring the costs of compliance. The variable control costs include the operating and maintenance costs of the controls, while the nonvariable costs include compliance capital equipment. Figure 5-4 illustrates the effect of these additional costs on the facility supply function. The facility's AVAC and MC curves shift upward (to AVAC' and MC') by the per-unit variable compliance costs. In addition, the nonvariable compliance costs increase total avoidable costs and, thus, the vertical distance between ATAC' and AVAC'. The facility's supply curve shifts upward with marginal costs and the new (higher) minimum operating level ($q^{m\prime}$) is determined by a new (higher) $p^{m\prime}$.

5.2.2 Market Effects

To facilitate this discussion, it is assumed that prices for the commodities affected by regulation are determined in competitive markets. In this case, the individual facilities have negligible power over the market price and, thus, take the price as "given" by the market. The market supply curve is defined as the horizontal summation of the individual facility

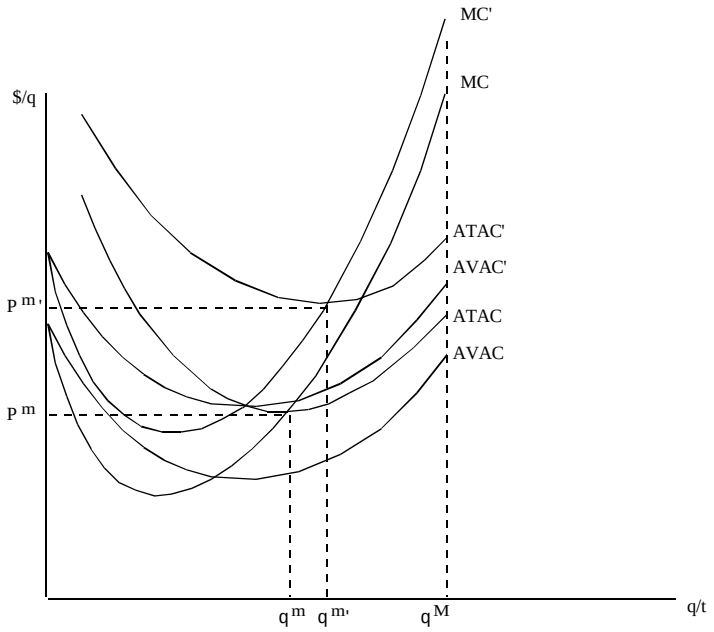


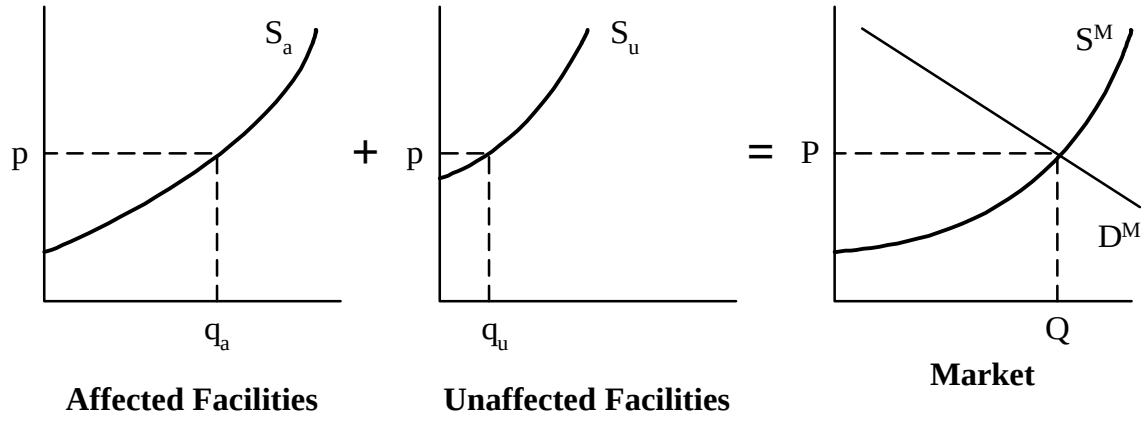
Figure 5-4. Effect of Compliance Costs on Product Supply Function at Facility

supply curves, and a market demand curve is the sum of the demand curves for all demanders of the product. As shown in Figure 5-5(a), under perfect competition, market prices and quantities are determined by the intersection of market supply and demand curves. The initial baseline scenario consists of a market price and quantity (P, Q) that is determined by the downward-sloping market demand curve (D^M) and the upward-sloping market supply curve (S^M) that reflects the sum of the individual supply curves of affected as well as unaffected facilities.

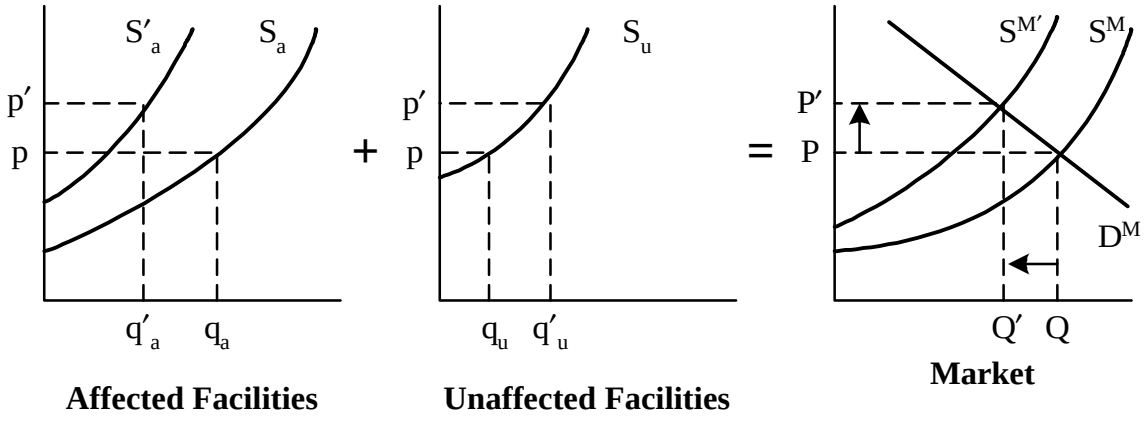
Now consider the effect of the regulation on the baseline scenario as shown in Figure 5-5(b). In the baseline scenario without the proposed standards, at the projected price, P, the industry would produce total output, Q, with affected facilities producing the amount q_a and unaffected facilities accounting for Q minus q_a, or q_u. The regulation raises the production costs at affected facilities, causing their supply curves to shift upward from S_a to S_a' and the market supply curve to shift upward to $S^{M'}$. At the new with-regulation equilibrium, the market price increases from P to P' and market output (as determined from the market demand curve, D^M) declines from Q to Q'. This reduction in market output is the net result from reductions at affected facilities and increases at unaffected facilities. Unaffected facilities will not face an upward shift in their product supply curves, so their response to higher product prices is to increase production. Foreign suppliers (i.e., imports), which do not incur higher production costs due to the regulations, will respond in the same manner as these unaffected producers.

5.2.3 Facility-Level Response to Compliance Costs and New Market Prices

The firm's response to a proposed regulatory action is both facilitated and constrained by commodity and financial market relationships that make up the economic system. The firm's adjustments discussed above reflect efforts to respond to the regulation in a profit-maximizing fashion. This may lead, for example, to changes in output that, when aggregated across all producers, lead to changes in the market-clearing price and feedback on the firms to alter their decisions. These adjustments are typically characterized as a simultaneous interaction of producers, consumers, and markets. Thus, to evaluate the facility–market outcomes the analysis must go beyond the initial effect of the regulation and project the net effect after the market(s) has adjusted.



a) Baseline Equilibrium



b) With Regulation Equilibrium

Figure 5-5. Market Equilibrium Without and With Regulation

Given changes in market prices and costs, the facility operator will elect to either

- comply with the regulation and continue to operate, adjusting production and input use based on new revenues and costs, or
- cease production at the facility and exit the market.

These options can be extended to the multiproduct facility where product lines may be closed if product revenues are less than product-specific avoidable costs, and/or the entire facility may be closed if total revenues from all products do not exceed facility-specific avoidable costs.

Therefore, after the interaction of facility and market forces is considered, the operating decisions at each individual facility can be derived. These operating decisions include whether to continue to operate the facility (i.e., closure) and, if so, the optimal production level based on compliance costs and new market prices. The approach to modeling the facility closure decision is based on conventional microeconomic theory. This approach compares the ATAC—which includes all cost components that fall to zero when production discontinues—to the expected post-regulatory price. Figure 5-4 illustrates this comparison. If price falls below the ATAC, total revenue would be less than the total avoidable costs. In this situation, the owner's cost-minimizing response is to close the facility. Therefore, as long as there is some return to the fixed factors of production, that is some positive level of profits, the firm is expected to continue to operate the facility.

If the firm decides to continue operations, then the facility's decision turns to the optimal output rate. Facility and product-line closures, of course, directly translate into reductions in output. However, the output of facilities that continue to operate will also change depending on the relative impact of compliance costs and higher market prices. Increases in costs will tend to reduce producers' output rates; however, some of this effect is mitigated when prices are increased. If the market price increase more than offsets the increase in unit costs, then even some affected facilities could respond by increasing their production. Similarly, supply from unaffected domestic producers and foreign sources will respond positively to changes in market prices.

The approach described above provides a realistic and comprehensive view of the effect of the regulations on responses at the facility level as well as the corresponding effect on market prices and quantities for the affected commodities. This is a substantial improvement over analytical methods that do not account for facility-level responses such as

quantity adjustments, input adjustments, and closure of product lines, or methods that ignore the effect of these regulations on market prices when determining the change in revenues and costs at the facility level. Methods that do not allow for production adjustments at the facility level essentially assume that firms cannot or will not adjust to changes in production costs. Without responses at the facility level, no credible model for a change in market prices as a result of the regulations exists. Both of these assertions—unresponsiveness of firms to market conditions and market price changes in response to regulation—seem unwarranted by observation.

5.3 PEIS Modeling Approach: Operational Issues

This section addresses the practical issues that must be resolved to provide an empirical analysis of economic impacts and social costs using the behavioral approach. The key information needed to develop this approach relates to the baseline characterization of affected producers and markets, engineering estimates of the regulatory control cost for affected entities, and modeling of the economic behavior of affected entities (e.g., position and shape of the supply and demand functions) and market outcomes.

5.3.1 Baseline Characterization

To perform the economic impact analysis, the model must allow for a comparison between the baseline equilibrium conditions and the counterfactual or with-regulation equilibrium conditions that the model produces under a changed policy regime. The assumption of an "observable" baseline equilibrium leads directly to the need for and construction of a data set that fulfills the equilibrium conditions for the industry or entities subject to a regulatory action. The issues of selecting and specifying the time period of analysis are discussed in detail in Section 8. This section addresses how to develop an analytical baseline that appropriately accounts for the entities, products, and markets to be affected by a regulatory action in a manner consistent with the available data from the industry profile and engineering cost analysis. Based on the EIA conducted for the Polymers and Resins II NESHAP, Table 5-1 provides an example of the typical components of a baseline scenario for use in an EIA.

Table 5-1. Baseline Characterization of U.S. Amino and Phenolic Resin Markets: 1991

	Amino Resins	Phenolic Resins
Market price ($/lb)	$0.26	$0.49
Market quantity(million lbs/yr)[a]	1,715.1	2,694.0
Domestic production	1,679.0	2,658.0
Affected	1,091.8	2,479.3
Unaffected	587.2	178.7
Exports	50.7	92.7
Imports	25.0	36.0

[a] Market quantity is the sum of domestic production and imports (exports are included within domestic production).

Another case where the analyst will need different measures of regulatory impact occurs when the regulatory action affects a factor of production (e.g., boilers or degreasers). In the majority of these cases, data are not sufficient for the analyst to model the final product markets or there are too many markets to be modeled. The direct impact measures most often used in these cases address the relative impact of the costs imposed on these inputs and the ultimate burden placed on users of these inputs (i.e., producers of final product). These measures include the following:

- annual control cost share of annual costs for the affected factor(s) and
- annual control cost share of value of shipments of the final product.

In lieu of a market analysis, the first measure above can be used to determine the likelihood that the factor will be substituted away from by the producer (i.e., comparison with costs of substitute inputs/processes), while the second measure can be used to project potential price increases to consumers of the final good or service (see the EIA conducted for NSPS on utility and industrial boilers).

5.3.1.1 Producer Characterization

The industry profile and industry responses to the EPA's Information Collection Request (ICR) form the basis for identifying and characterizing all known sources in the affected industry (e.g., manufacturing facilities or plants) or other affected entities (e.g.,

federal, state, or local governments). For inclusion in the economic model, these potentially affected entities must be either individually characterized or grouped together in terms of their technical and economic activities. The level of resolution for which these entities are included in the EIA depends on the data available from the industry profile and ICR survey and the engineering cost analysis methodology. Obviously, the economic analysis cannot identify and characterize the known sources beyond the limits imposed by the available data from the industry profile or ICR survey responses. However, a less obvious constraint on the economic analysis involves the level at which EPA is able to estimate the compliance costs of the regulatory action.

The most detailed and accurate method to determine compliance costs is to examine the requirements of each individual entity in the affected industry. Thus, the best case scenario occurs when the economic and engineering analysis are not limited in their ability to fully characterize individual facilities. If data are not sufficient to determine facility-specific requirements, the next best approach is to estimate these costs for model plants and to map the model plants (and related control costs) directly to actual facilities. If model plants are used, then they should appropriately capture all types of facility characteristics in the industry without any unnecessary limits (e.g., production process, capacity, vintage). The economic analyst should review the characterization of model plants and assignment to the industry to verify that it agrees with industry structure (as set out in the industry profile). Again, in this case, individual facilities are able to be fully characterized.[6] However, in cases where the number of affected entities is very large (e.g., 20,000 dry cleaners) and/or limited information is available, the model plant costs may be allocated to facility groupings based on a distribution rule (e.g., one-third of the affected facilities are represented by model plant A). In this case, the economic analyst is limited by the engineering analysis and can only characterize groups of suppliers within the affected industry. Similarly, those entities that are not directly affected by the regulatory action may be grouped together and modeled with single representative agents.

In addition, other economic considerations should be accounted for in characterizing affected entities. These considerations include issues such as the scale and scope of production. Potentially affected producers may be part of vertically integrated operations in which the directly affected product is captively produced and consumed within the firm for

[6]This scenario is the most often available and employed in conducting EIAs within ISEG.

use in the production of another intermediate or final product. For example, the pulp and paper industry is characterized by both nonintegrated and vertically integrated mills. Vertically integrated mills rely mostly on their own production of pulp to produce paper and paperboard products, while nonintegrated mills include pulp mills that produce market pulp as well as paper mills that purchase market pulp to produce paper and paperboard products. Thus, in conducting the EIA for the Pulp and Paper Cluster Rule, the ISEG analysts categorized mills in this manner to appropriately define their market activities and interactions (i.e., supplier versus demander) and, thus, better estimate the economic impacts. Furthermore, in the case of joint production, the specification of product lines at affected facilities depends not only on the available industry profile or survey data but also on the resolution of compliance cost estimates. For example, in the Pulp and Paper EIA, the integrated and paper-only mills jointly produced a myriad of final paper and paperboard products. The level at which the economic model addressed the production of individual product lines was determined by the ability of the engineers or economic analysts to appropriately assign or allocate compliance costs at a given mill across its products.

5.3.1.2 Market Characterization

In the cases where markets are well defined and impacts clearly should be addressed, the EIA evaluates the economic impacts in terms of market adjustments and the associated producer and consumer surplus measures welfare change, as described in Section 5.3. The market characterization process involves two main activities

1. Determining the markets that are affected by the regulation
2. Determining the competitive structure of affected markets

The determination of markets potentially affected by the regulation requires identifying the products that are produced at the affected facilities and linking them with specific markets in which they are traded. The product identification process will be determined to some extent by self-evidence (e.g., regulation of the Portland cement industry) and to some extent by the availability of product-level data at the affected facilities. The latter may occur either through the Agency information collection process or, in some cases, by secondary data.[7]

[7]For example, the pulp and paper industry produces a publication called Lockwood Post's Directory that provides some link between facilities and the type of products they produce.

Once affected products are identified, linking them to markets requires a clean definition of the relevant markets. For the purposes of this discussion, markets can be defined along the dimensions of substitutability and geography.[8]

The extent to which products serve as close substitutes has a large effect on whether they should be considered part of the same market. For instance, two herbicide products that are both used on corn are fairly close substitutes and would normally be considered in the same market. However, herbicides for corn and steel beams are not substitutes and would not be considered in the same market. The analyst is often aided in the market definition task by the existence of standard industry and product codes where substitutability is implicit in the definitions (e.g. SIC codes). In addition, industry trade publications often provide information on end use markets that is more detailed than SIC codes.

Once the analyst has determined the substitution dimension, the geographic extent of the markets must be defined. In many cases, the argument can be made for national markets for potentially affected products. However, regional or local markets may exist for products where the ability of producers to compete across regions is limited by physical or economic barriers to transport the product (e.g., cement and dry cleaning). In such cases, these regional or more localized markets should be defined and characterized to the extent available data allow.

Once the potentially affected markets are defined, the economic analyst must determine the practicality of including all potentially affected markets in the economic model. To aid in this determination, a screening analysis can be employed to avoid unnecessary inclusion of too few or too many markets. For example, information on the proportion of all producers (output, capacity) in the market that are potentially affected and the relative magnitude of their compliance costs can provide some insights on the merits of including that market in the analysis. In general, observing smaller proportions of affected producers and/or relative compliance costs reduces the value of modeling a particular market. In some cases, the screening analysis may suggest little need to conduct a market analysis altogether; that is, no market adjustment is expected in response to regulation or the expected adjustment is small enough to ignore.

[8]This follows early guidance on market definition by Stigler (1955) and Scherer (1980). See Viscusi, Vernon, and Harrington (1992, p.148-149) for a synopsis of the market definition issue.

For all markets that will be modeled, the analyst must characterize the degree of competition within these markets. The discussion generally focuses on perfect competition, or price-taking behavior, and imperfect competition, or the lack of price-taking behavior. Although most EIAs conducted by ISEG involve perfectly competitive markets (or, at least, assume this market structure), some EIAs have been conducted for imperfectly competitive industries, such as pharmaceuticals and cement. In fact, the OMB guidelines for EO 12866 specifically mention that elements of market power should be addressed in conducting EAs and measuring the social costs of regulatory actions. Therefore, it is important for the economic analyst to select the appropriate market structure for the subject industry because the projected market outcomes can vary greatly by specification of market structure.[9]

5.3.1.3 Characterizing Impacts Outside a Market Setting

In cases where markets are not well defined or impacts are negligible and not explicitly addressed, the analyst needs different measures of regulatory impact. The majority of these cases occur when a regulatory action directly affects government-owned[10] and nonprofit[11] entities by imposing control requirements and the associated compliance costs (e.g., landfills, municipal waste combustors [MWCs], publicly owned sewerage treatment works [POTWs], municipally owned electric companies).[12] The direct impact measures most often used in these cases address the relative impact of the costs imposed on these entities and the burden placed on citizens or consumers of the affected services. These measures include the following:

- annual control cost share of annual costs for the affected service(s),
- annual control cost share of annual revenues of the governmental unit, and
- per-household (or per capita) annual control cost share of median household (or per capita) income.

[9]See Research Triangle Institute (1996b) for discussion of market structure and its importance in conducting EIAs.

[10]Potentially affected government entities include states, cities, counties, towns, townships, water authorities, villages, Indian Tribes, special districts, and military bases.

[11]Potentially affected nonprofit entities include nonprofit hospitals, colleges and universities, and research institutions.

[12]The indirect impacts of a regulatory action on government entities are addressed separately in Section 5.3 (federal administrative, monitoring, and enforcement) and Section 8 (UMRA-related).

For some affected services, in lieu of a market analysis, the first measure above can be used to project increases in fees charged to local consumers of the service (see the EIA conducted for MWCs) or the likelihood that the service will be discontinued by the governmental agency (i.e., use of closure decision similar to that for private firms). In addition, baseline measures of the economic and financial status of the affected entity or community can provide insights on their ability to absorb the required expenditures.

5.3.2 Regulatory Control Costs

Before an EIA can be performed, quantitative estimates must be made of the control costs that will be incurred by the affected entities in complying with the regulatory alternatives. For stationary sources, pollution control cost estimates are typically developed by the Emission Standards Division (ESD). These cost estimates are determined for each control option and modified for any source-specific factors to estimate the compliance cost per source. The ESD analysis sums the source-specific costs to compute the aggregate, or national, compliance cost. Economic analysts (working for ISEG), in turn, use these costs to evaluate the economic and financial impacts of a regulatory action. The use of these costs for the EIA is summarized below.

As shown in Table 5-2, the engineering analysis typically estimates both fixed and variable control costs for each regulatory alternative. Fixed control costs include the costs associated with purchasing and installing pollution control equipment and other costs that are periodically recurring but do not vary with the level of emissions or production (e.g., fixed overhead, property taxes, insurance, and other administrative costs). Alternatively, those control costs that do vary with the level of emissions or production include the regularly recurring expenditures required to operate the control equipment as well as any costs incurred due to a change in operating practices as a result of regulatory action. For example, if a facility uses a substitute input in response to a regulatory action, the additional annual costs associated with using the substitute are included in the operating cost component. Net operating costs may include credits for reduced consumption of energy or material resources associated with pollution control. Also shown in Table 5-2 are monitoring, reporting, and recordkeeping (MR&R) costs. These costs may have a variable and/or fixed component. In absence of engineering determination of these components, these costs are typically included with other fixed costs.

Table 5-2. Required Compliance Cost Elements for Affected Entities

Fixed control costs (do not vary with emissions level)
Capital investment
Initial capital cost (total installed costs of compliance equipment)
Annualized capital (include separate info on equipment life and interest rate)
Other fixed costs
Overhead allocation
Property taxes
Insurance
Administrative fees/charges
Variable control costs (vary with output level)
Raw materials
Process
Maintenance
Energy/utilities
Labor
Waste treatment disposal fees
Replacement parts
Product recovery factors (may lead to cost savings)
Monitoring, reporting, and recordkeeping costs (may have fixed and variable components)

The engineering estimates of fixed capital and variable operating and maintenance (O&M) costs provide the measure of total annual compliance costs without accounting for behavioral responses. Annualized costs represent the total yearly pollution control expenditures and consist of the sum of the annual O&M control cost and the annualized capital control cost. To compute the annualized capital control cost, partitioning the capital cost into the equivalent of annual payments is necessary so that the total capital cost is not assessed against any single year in the operational life of the control equipment (see

Figure 5-6). The capital costs are annualized over the expected lifetime of the capital equipment using the opportunity cost of capital.[13] Although firm-specific costs of capital are desired for this approach, these rates are difficult to obtain from publicly available sources and are not generally available for use in the EIA. Therefore, in the absence of firm-specific estimates of the cost of capital, the EIA typically uses 7 percent based on the OMB Circular A-94. Please see the discussion in Section 8 on discounting for more information on the appropriate cost of capital to annualize capital investment required by regulation.

The total annualized control cost estimated for each affected entity is calculated on a per unit of output basis, typically the quantity of the good/service provided. These average control cost estimates are used in the economic impact modeling to project market adjustments in response to a regulatory action. However, it is important to note that the method used in the engineering analysis to estimate control costs and the magnitude of these estimates will affect the way in which the economic analyst is able to conduct the EIA. Specifically, the engineering analysis may affect the way in which the economic analysis is able to model the affected entities and markets. As discussed above, the economic analyst must consider the preliminary engineering cost estimates in developing the appropriate economic methodology.

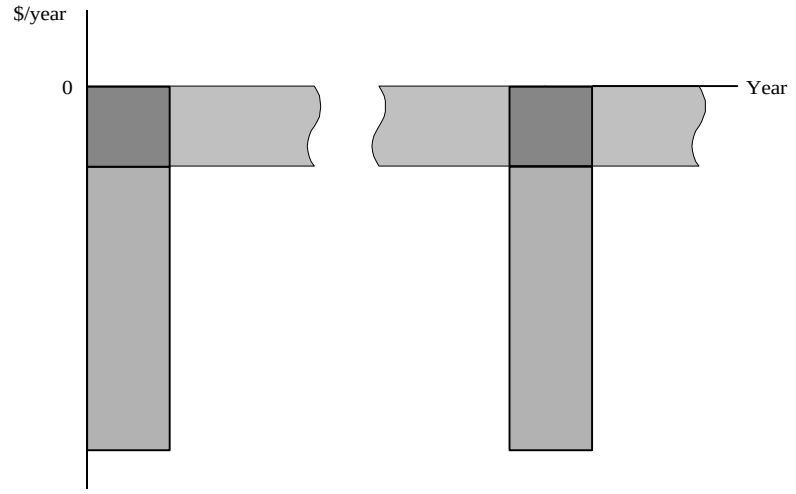
5.3.3 Modeling Economic Behavior

Building from the baseline characterization and regulatory control costs (as described above), the ISEG analyst can employ standard concepts in microeconomics to develop the behavioral economic model. The main elements are

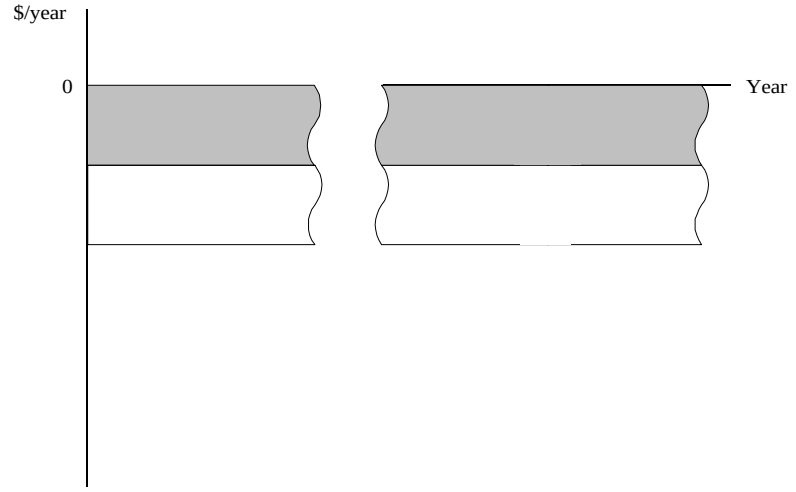
- characterize supply of each product at the individual and market levels,
- characterize demand for each product, and
- solve for the new with-regulation equilibrium.

This section provides an overview of these key operational issues in conducting EIAs.

[13]This approach is based on the properties of compound interest and the related concept of an annuity. The value of the annuity is the amount, which, if it is charged as a cost each year over the control equipment's useful life, will result in a present value equal to the total capital cost. In other words, the total capital cost will be recovered if the annuity is charged year by year for the lifetime of the control equipment. This recovered amount includes the principal value plus a return on the principal. The expected rate of return on the principal is referred to as the opportunity cost of capital, or simply the cost of capital (where capital refers to investment funds rather than equipment).



a) Actual Cash Outlays for Pollution Control



b) Annualized Costs for Pollution Control

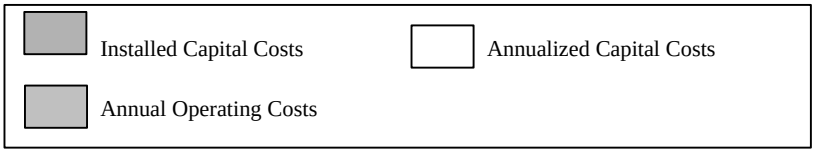


Figure 5-6. Actual and Annualized Estimates of Compliance Costs

5.3.3.1 Supply Characterization and Responses

Historically, most of the EIAs prepared by ISEG have been applied in situations where supply side issues have been critical. In these cases, implementation of a proposed regulatory action will affect the costs of production at existing sources of air emissions, which is expected to induce some facilities to alter their current level of production or to close. As a result, much of the attention has been placed on using information from the engineering analysis and industry profiles to characterize supply from potentially affected entities. The need to specifically address the distribution of producer impacts pursuant to RFA/SBREFA and UMRA suggests that supply-side factors will become even more prominent in future analyses.

Supply Function Specification. The supply function relates the quantity of a good supplied as a function of its price and other factors, such as the price of inputs, the price of substitute outputs, and technological factors. As with the demand function, factors other than the product's price are typically held constant in the supply analysis. Therefore, the focus of the supply function specification is to establish the quantitative relationship between price and quantity supplied in the affected market. The market-level supply functions presented in the conceptual discussion can be viewed as the aggregate sum of the supply functions of all individual suppliers in the market. The change in market supply in response to price then is the sum of all suppliers' responses to price.

First consider the polar case of the horizontal market supply function presented in Figure 5-7. In this case, all suppliers in the market have identical and constant marginal cost of production. Therefore, it is assumed that the market can supply an unlimited supply of product X at the given unit cost. This implies that all suppliers are identical (possess the same production technology) and that no factors raise marginal cost as output increases (e.g., diminishing returns to a fixed capital stock, inclusion of higher cost supply sources as market output expands). This type of supply function is often associated with the long run where technology and input prices ultimately determine the market price, not the level of output in the market. Given the previously referenced problems with taking a purely long-run view in the analysis of economic impacts, the horizontal aggregate supply function is, nonetheless, sometimes all that the data can support. In those cases, all that is needed is the baseline price level and the assumption that supply is perfectly elastic at that price. This may be further supplemented with data on baseline costs of production and output levels to compute average

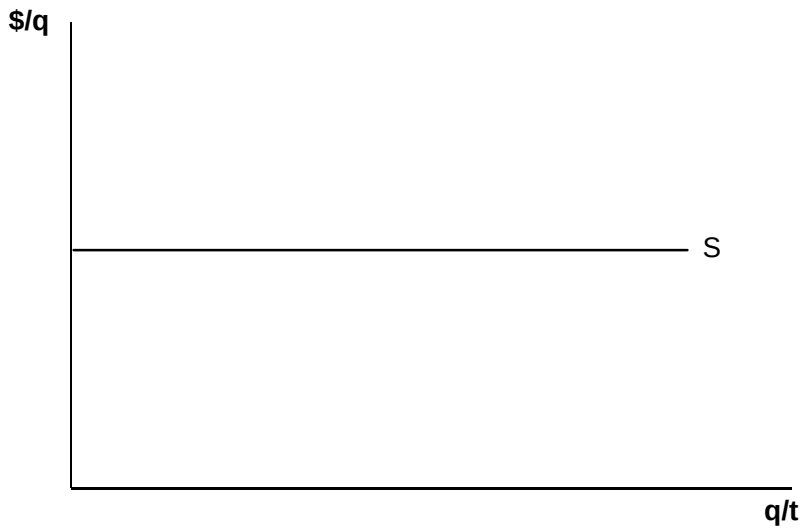


Figure 5-7. Horizontal Supply Curve

cost levels and compare with price. If market price and average cost differ substantially, this may cast some doubt on the validity of the horizontal supply function.

Alternatives to the horizontal supply function include the following:

- econometric estimation of supply,
- prototype supply function with parameter inputs, and
- step supply function.

The first option, econometric estimation, uses econometric methods applied to data on producer quantities, price, and the other theoretically relevant variables. For example, in conducting the EIA for the Pulp and Paper Cluster Rule, the Agency econometrically estimated product-specific supply curves for each affected commodity based on pooled time-series, cross-sectional production data for each affect facility. An additional econometric approach is simultaneous estimation of supply and demand systems (see Kennedy [1994] for an overview). Direct econometric estimation of supply functions has theoretical and empirical appeal but may be difficult to implement due to data and project resource limitations.

Moreover, estimation of only an aggregate market supply function will not allow for direct mapping of impacts to individual suppliers that may be differentially affected by the regulation.

The solution to the econometric implementation and producer heterogeneity issues just referenced may come in the form of characterizing the aggregate supply function as a collection of prototype supply functions, each of which captures a distinct segment of the supply side of the market. For example, a Cobb-Douglass specification is

$$Q_i^S = bP^e \qquad (5.1)$$

where i indexes each supply segment modeled. The price elasticity of supply is given by e, and b is a parameter representing the scale of the output-price relationship. In the extreme, there is a unique supply function for each supplier (firm, facility) in the market. More typically, there will be distinct model supply units characterized by factors such as technology, region, or other characteristics that differentiate supply conditions. This upward-sloping supply curve is illustrated in Figure 5-8. Based on the selected functional form, the economic analyst then proceeds to the issue of parameter estimation.[14] Supply function elasticity parameters can be econometrically estimated or based on previous econometric estimates in the literature. However, in the absence of these estimates, assumed elasticity values for the commodities of interest may be used and are good candidates for sensitivity analysis.[15]

While the collective prototype functions approach has the advantage of accounting for differences across suppliers, there may be conceptual or empirical reasons arguing against the use of smooth continuous upward-sloping supply functions as shown in Figure 5-8 to represent each supply unit. These might include inflexible production processes not easily varied in response to prices and binding capacity constraints. If such concerns are warranted,

[14]Ideally, the economic analyst would base the selection of functional form on technical aspects of the subject production process(es) affected by regulation to appropriately model producer behavioral responses. Because these technical aspects often do not directly relate to a particular functional form, the analyst is left to select from the most commonly used general forms such as Cobb-Douglas, constant elasticity of substitution (CES), Leontief, and Generalized Leontief. These mathematical forms can be found in intermediate or advanced texts in applied production theory (Chambers, 1988).

[15]One textbook on economic analysis of environmental regulation refers to this problem as the absence of an encyclopedic *Book of Elasticities* to which the analyst can always refer to get the appropriate parameter (Arnold, 1995, page 20). That textbook provides a very useful discussion of practical modeling issues confronted in performing OPPT's EA for the asbestos rule.

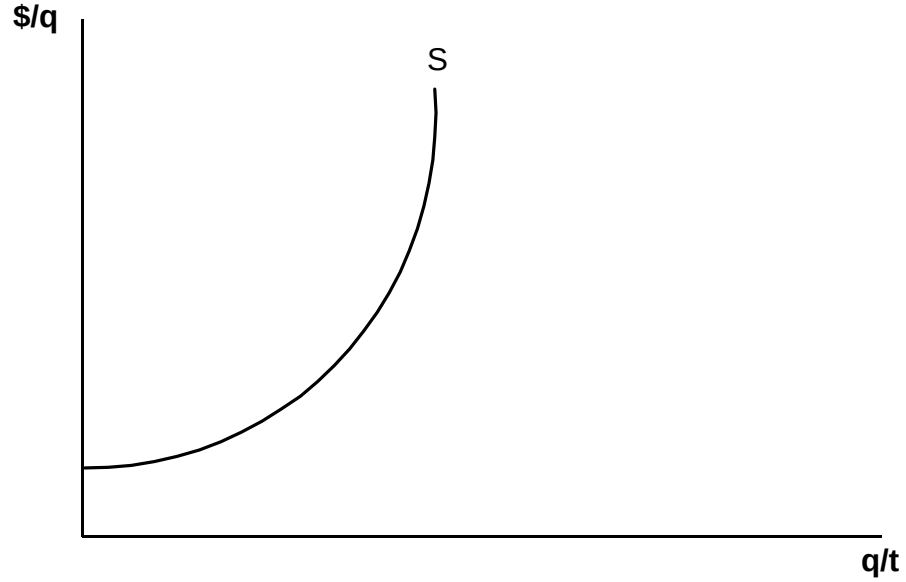


Figure 5-8. Upward-Sloping Supply Curve

then one instead can use a step supply function approach, as illustrated in Figure 5-9. Here, Step 1 represents the average cost of supply for producer 1, the lowest cost supplier. For any price at or above P_1, producer 1 is assumed to supply a fixed amount of output, Q_1. Supplier 2 is the next lowest cost supplier and will provide Q_2 for any price at or above P_2. As the price rises, more steps (higher-cost suppliers and quantities) are brought into the market and output expands. Based on this approach, the marginal producer defines the market price (i.e., the highest observed average variable cost of production is assumed to be the baseline market price).

Employing a step supply function requires information on the opportunity cost and output level for all potential suppliers (or model supply segments) in the market. In the short run, opportunity costs may be crudely approximated by the average variable cost (AVC) of production. These data may be difficult to obtain for individual suppliers in the market because of confidentiality constraints, unless the data were obtained through an ICR and maintained through Confidential Business Information (CBI) procedures. In other situations, secondary data may be available through industry or government sources to approximate costs by supplier type. Examples of this approach include the engineering cost analysis conducted

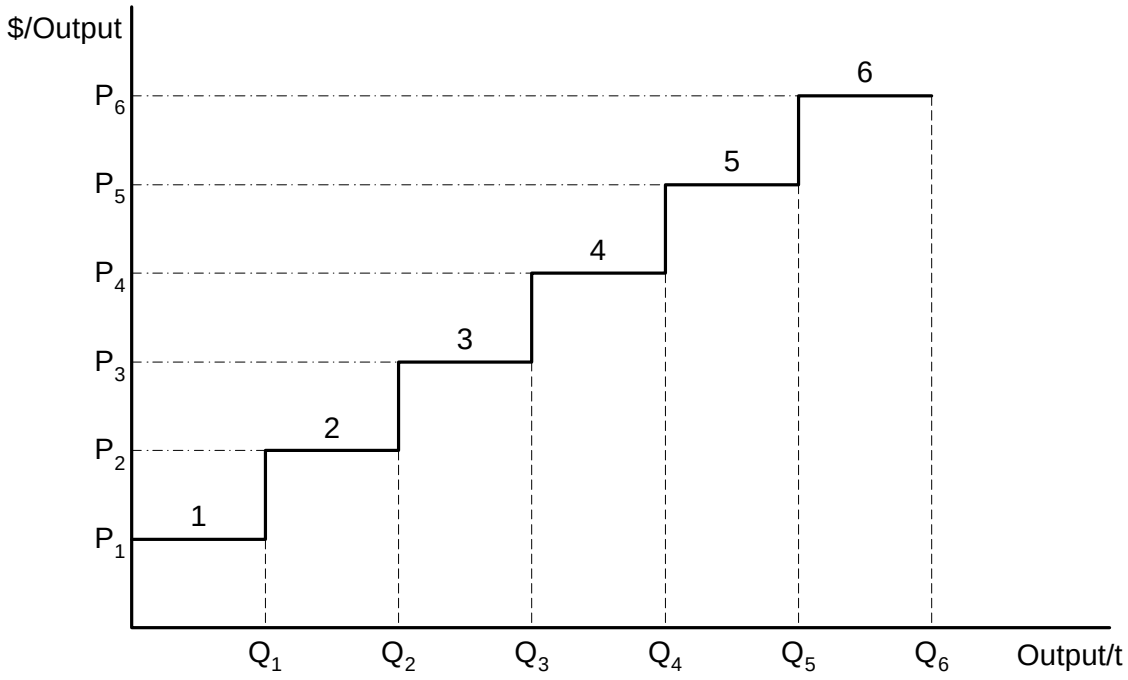


Figure 5-9. Step Supply Function

to estimate baseline AVC for individual coke batteries for use in the Coke Ovens EIA (Research Triangle Institute, 1992) and the fixed coefficient AVC function estimated for individual cement kilns for use in the Portland cement EIA (Research Triangle Institute, 1996a). An additional method described in Arnold's (1995) review of the asbestos EA is to estimate the value of the fixed capital stock for different supply segments in the market to proxy for the steps in the supply function.

The implicit assumption with the step supply function is that each producer has a supply limit due to capacity constraints. While the absolute capacity constraints provide some notion of the short-run rigidities that are elemental to an analysis of economic impacts, the constraints are rather rigid. Suppliers, even in the short run, usually have enough flexibility to modify production levels at least somewhat, hence the conceptual advantages of some sort of upward price responsiveness in the short run. Nonetheless, as a first approximation, the step supply function provides a substantial improvement to the horizontal aggregate supply function (i.e., a one-step/infinite-width supply function) by at least accounting for cost

differences across suppliers, which further enables a better characterization of impacts across suppliers.

An alternative, less elaborate approach to the step supply function of Figure 5-9 may be employed when data are not available to fully characterize this function. The alternative approach implicitly utilizes the step supply framework; but in the absence of actual data to parameterize the function, the analyst employs knowledge of the subject industry, the applicability of controls across the affected population, and economic theory to develop sensitivity scenarios that qualitatively address potential economic impacts of a proposed regulatory action. With a step supply function, the marginal (highest cost) producer determines the market price. Therefore, the compliance costs of the marginal supplier determine the increase in market price. If the marginal producer is expected to incur a higher level of compliance cost than the inframarginal producers, this suggests that producers, in aggregate, can more than pass on regulatory costs to consumers. Here, the expected price increase is higher than the per-unit compliance costs of inframarginal producers so these producers are expected to gain as a result of the regulatory action at the expense of consumers paying higher prices. Alternatively, if the marginal producer is expected to incur a lower relative level of compliance costs, then the regulatory burden is likely to fall more heavily on inframarginal producers as the expected price increase is lower than their per-unit compliance costs. This approach allows the analyst to inform the regulatory development process in cases with severe lack of data or time and resources.

Incorporating Import Supply. The discussion above focuses on domestic sources of supply for the affect product(s). However, if foreign imports account for a significant share of U.S. apparent consumption of the regulated product, then the ISEG analyst should attempt to incorporate them into the economic model. In this case, the preferred approach is to define the relevant markets as the United States and to include imports as a source of supply that is added to and competes with domestic sources of supply. In addition to providing insights on the regulatory effect on foreign competition, accounting for foreign imports will allow the market model to better measure the impacts on domestic suppliers in aggregate and their distribution across individual producers or producing segments. For example, if the supply curve for imports is perfectly elastic (i.e., a horizontal foreign import supply curve), then the U.S. market price is fixed at the world market price and will not change in response to the proposed regulatory action. This occurs because foreign imports will totally offset any reductions in domestic production as they are deemed perfect substitutes and unconstrained in

terms of availability. Under this scenario, domestic producers would have to absorb the entire regulatory cost burden and be more likely to close. A more plausible scenario is one with an upward-sloping supply curve for imports that reflects the ability of these sources to partially offset reductions in domestic production with increases in the U.S. market price.

This foreign source of supply is typically characterized using a prototype supply function with parameter inputs as described above for domestic suppliers. Therefore, the analyst must determine the elasticity of the import supply function through econometric estimation or appropriate literature estimates. The difficulty in econometrically estimating import and/or export elasticities from the international trade data has long been recognized. Orcutt (1950) demonstrated that elasticity estimates derived from regressions of a country's import (export) quantity on historical prices understate the true price responsiveness of imports and exports, typically by a substantial magnitude. Part of the difficulty derives from the identification problem in estimating a supply/demand system, which is more pronounced given the difficulty in procuring measures of exogenous demand and supply factors for foreign consumers and producers. However, Orcutt demonstrates how to derive the total elasticity of imports/exports, which accounts for the effect of the change in price on all (foreign and domestic) producing and consuming parties. In the absence of literature estimates of foreign trade elasticities, the ISEG analyst can employ this type of method to numerically compute the elasticities of import supply (export demand) as done for the EIA conducted in support of the Pulp and Paper Cluster Rule.

Regulation-Induced Shift in Supply Functions. The starting point for assessing the market impacts of a regulatory action is to incorporate the regulatory compliance costs into the production decision of affected producers. In other words, the focus here is to quantify the shift in the supply function caused by the regulation. An upward shift in the supply function represents the additional cost per unit of producing output because of compliance activities on a "before-tax" basis.[16] In most analyses, this shift is quantified by taking the total annual compliance cost estimate and dividing it by baseline output quantity and computing the average cost per unit of output. Then, the supply function is shifted up by that amount. In

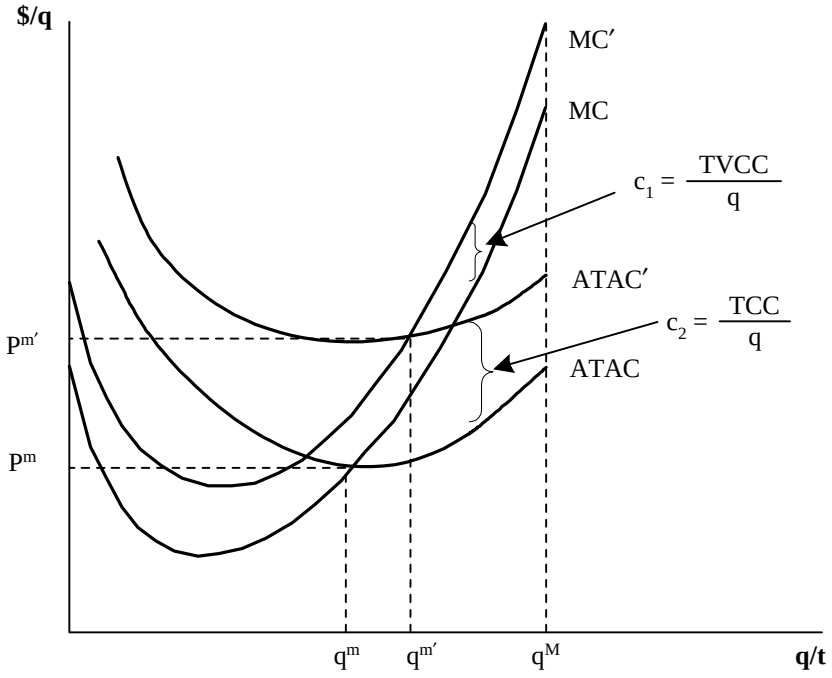
[16]Some economic analyses adjust the compliance costs to account for implications of the U.S. tax code on the regulatory burden (e.g., depreciation allowances). However, the extent to which these tax-related outcomes influence the behavior of affected producers is considered to be very small and therefore not typically included in the "supply shift." The after tax consequences seem to have a much greater influence on the ultimate distribution of the regulatory burden across stakeholders as producers attempt to pass along portions of their burden to U.S. Treasury or taxpayers through the tax code. The analysis of these types of impacts are more appropriately addressed in a complementary financial analysis.

essence, computing the supply shift this way treats compliance costs as the conceptual equivalent of a unit tax on output, and the computation of consumer and producer welfare effects follows the classical treatment of tax burden distribution in the public finance literature (e.g., Harberger, 1974).[17]

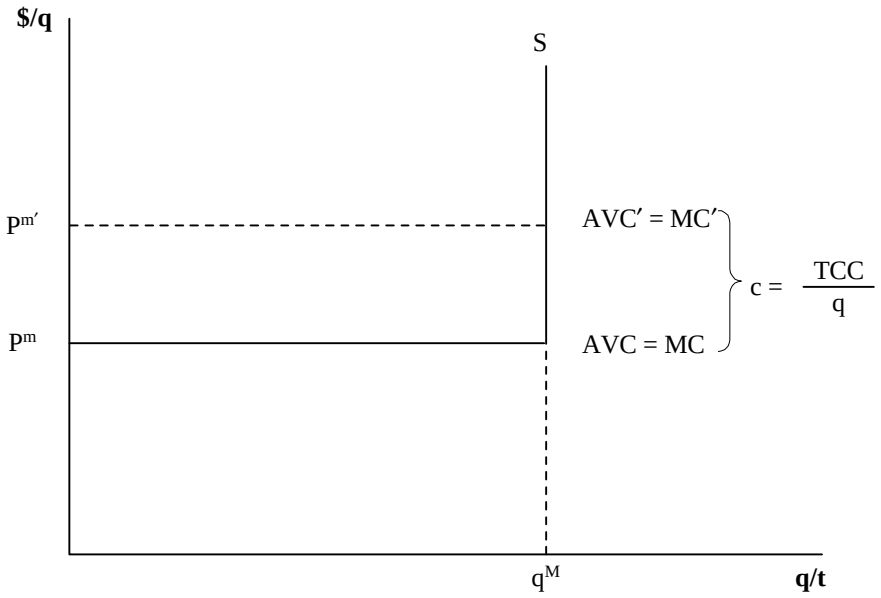
Because compliance costs are typically divided into capital and operating costs, the parallel shift illustrated previously (e.g., Figures 5-1 and 5-2) implies that both capital and operating costs vary with output levels. At least in the case of capital, this raises some questions. In the long run, all inputs (and their costs) can be expected to vary with output. But short(er)-run analysis typically holds some capital factors fixed. For instance, to the extent that a market supply function is tied to existing facilities, there is an element of fixed capital. As indicated above, the current market supply function might reflect these fixed factors with an upward slope or rising steps. Figure 5-10(a) provides the case with an upward-sloping supply curve. In this case, the MC curve will only be affected, or shift upwards, by the per-unit variable compliance costs (C_1), while the ATAC curve will shift up by the per-unit total compliance costs (C_2). Thus, the variable costs will directly affect the production decision (optimal output rate), and the fixed costs will affect the operating decision by establishing a new higher reservation price for the firm (i.e., $P^{m'}$). However, with regard to the capital costs of compliance, the argument can be made that these expenditures have not yet been made; therefore, their scale could, at least in principle, be thought to vary with the level of output. Thus, the imposition of capital costs as part of a parallel shift may not distort the situation too significantly. In general, the degree to which it is appropriate to include capital costs of compliance should be evaluated on a case-by-case basis and may be the subject of sensitivity analysis.

Under the special case of a step supply function, each step will rise by the amount of that segment's per-unit total compliance costs, as indicated in Figure 5-10(b). As shown, in this case, the MC curve will shift by the per-unit total compliance costs (C) to allow the new higher reservation price for the firm to appropriately reflect the fixed costs of compliance in the operating decision. This could cause a re-ordering of the steps to construct the market supply function because the compliance costs may cause some supply segments with lower

[17]There may be some conceptual shortcomings to treating pollution control as equivalent to an output tax. For example, the regulations may cause firms to alter their production processes to reduce the cost of compliance, in which case the output tax equivalent, computed with ex ante cost estimates may overstate the true size of the supply shift. As a practical matter though the output tax approach dominates current practice.



(a) Upward-sloping supply function



(b) Inverted L-shaped supply function

Figure 5-10. Regulation-Induced Cost Shifts by Supply Characterization

costs than other segments without the regulation to be higher cost than those same segments with the regulation. If a supply segment gets pushed to the point that it is entirely above the demand curve, then the market price will be below that segment's threshold price and it will not willingly supply the market. In those cases, the model predicts that the supply segment in question will exit the market in response to the regulation.

5.3.3.2 Demand Characterization and Responses

The demand function relates the quantity demanded of a particular commodity to its price and other factors, such as income and the price of substitutes. The factors other than the product's price are typically held constant in regulatory analysis, unless, for example, specific evidence is given that the market price of substitutes is substantially affected by the regulation. In that case, multiple market analysis or general equilibrium analysis may be necessary. But that is the exception rather than the rule. Therefore, the focus of the demand function specification is to establish the quantitative relationship between price and quantity demanded in the regulated market.

There are three options for demand function specification:

- econometric estimation,
- prototype demand function with parameter inputs, and
- step demand function.

The first option, econometric estimation, uses econometric methods applied to data on demand quantities, price, and the other theoretically relevant variables. For information on specific methods for estimating demand systems, refer to any one of a number of econometric textbooks' specific treatment of demand systems (e.g., Intriligator, 1978; Berndt, 1991) or simultaneous estimation of supply and demand systems (see Kennedy [1994] for an overview). Econometric estimation, if done correctly, has the advantage of tying together economic theory and data to produce a consistent and empirically defensible characterization of the demand function, which can then be used to simulate market outcomes and welfare effects of regulatory actions, as described above. Econometric estimation, however, is often hindered by practical concerns such as the absence of high quality data to support estimation or limited project resources. When this is the case, alternative approaches must be considered.

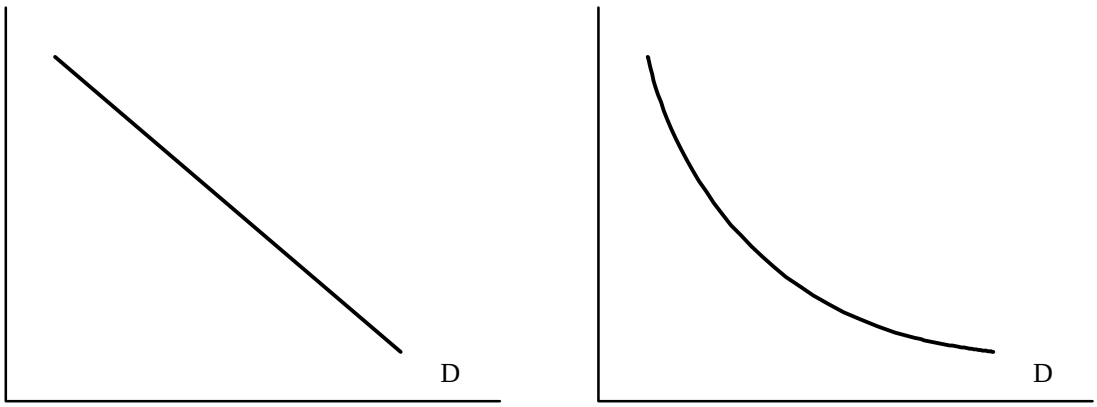
The first alternative to direct econometric estimation considered here is the specification of a general form for the demand function. As shown in Figure 5-11, the general form of the demand function may be linear or have constant elasticity. Again, the Cobb-Douglass form provides an example (i.e., constant elasticity form):

$$Q^D = aP^E \tag{5.2}$$

where Q^D is the demand quantity, P is the price, E is the price elasticity, and a is a parameter that represents the scale of the relationship between quantity and price. The scale parameter, a, can be "backsolved" given baseline values of Q^D, P, and E. Or the analysis can be performed to simply solve for changes in the quantity demanded as a function of changes in price as follows:

$$(\Delta Q^D/Q^D) = E(\Delta P/P) \tag{5.3}$$

and the proportional changes can be calibrated to baseline values to compute absolute measures of price, quantity, and welfare effects.



a) Linear **b) Constant Elasticity**

Figure 5-11. Demand Curves

The price elasticity, E, can be derived from previous econometric estimates in the literature. If no previous studies have been conducted for the market in question, then estimates from similar markets may be appropriate. The more uncertainty surrounding the true value of the demand elasticity, the more the analyst may want to rely on sensitivity analysis to capture the relevant range of parameter values. Figure 5-12 provides an example from an economic analysis of air pollution regulations for agricultural chemicals in which model results are evaluated for demand elasticities in the range found in the literature (Research Triangle Institute, 1997). More information on how to use sensitivity analysis to reflect underlying parameter uncertainty is presented in Section 8.

Incorporating Export Demand. The discussion above focuses on domestic sources of demand for the affect product(s). However, if foreign exports account for a significant share of U.S. domestic production of the regulated product, then the ISEG analyst should attempt to incorporate them into the economic model. In this case, the preferred approach is to define the relevant markets as the United States and to include exports as a source of demand that is added to domestic demand. In addition to providing insights on the regulatory effect on

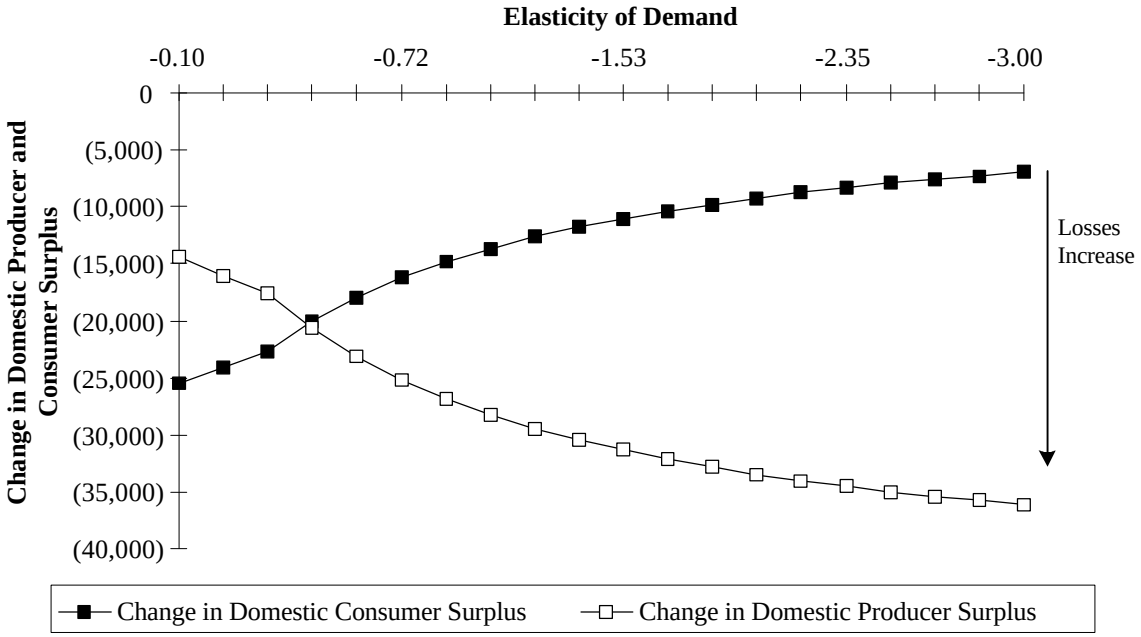


Figure 5-12. Sensitivity of Changes in Producer and Consumer Surplus to the Elasticity of Demand (Elasticity of Supply = 1.0)

foreign competition, accounting for foreign exports will allow the market model to better measure the impacts on market price and aggregate demand and their incidence across domestic and foreign consumers. This foreign source of demand is typically characterized using a prototype demand function with parameter inputs as described above for domestic demanders. Therefore, the analyst must determine the elasticity of the export demand function through methods similar to those discussed above for incorporating import supply.

5.3.3.3 Determine With-Regulation Equilibrium

Producers' and consumers' responses and market adjustments can be conceptualized as an interactive feedback process. Facilities face increased production costs due to compliance, which causes facility-specific production responses, the cumulative effect of which leads to a change in the market price that all producers (affected and unaffected) and consumers face, which leads to further responses by producers (affected and unaffected) as well as consumers and thus new market prices, and so on. The new equilibrium after imposition of the regulatory action requires total market supply equals total market demand, that is,

$$Q^S = Q^D, \text{ for all product markets.}$$

Given the producer and consumer behavioral response functions, this new equilibrium may be solved simultaneously using analytical solution mechanisms[18] or iteratively using numerical solution mechanisms.[19] These solution mechanisms allow for computation of a counterfactual or with-regulation equilibrium that can be compared with the baseline scenario to derive the economic impacts of a regulatory action as discussed in the next section.

5.4 Economic Impact Results

This section summarizes the measures of economic impacts that result from the modeling approach described above. The model results are summarized below as market-level, facility- or industry-level, company-level, and community-level impacts, as well as the social costs impacts due to implementation of a proposed regulatory action. The sample results tables in this section are taken from the EIA conducted in support of the

[18]This solution mechanism operates in proportional changes and employs the matrix algebra solution of the behavioral equations.

[19]This solution mechanism operates in total changes and employs a process of *tatonnement*, whereby prices approach equilibrium through successive correction modeled as a Walrasian auctioneer.

Polymers and Resins III NESHAP. Although the EIA results presented here are not large in magnitude, these tables provide good illustrations of the broad array of impact measures that can result from this modeling approach.

5.4.1 Market-Level Results

Table 5-3 provides an example of the market-level impacts of a proposed regulatory action. These impacts include the market adjustments in price and quantity for affected products, as well as the changes in foreign trade (if applicable). The increased cost of controlling air emissions from existing affected sources is shown to reduce their production, which subsequently causes price and output changes in each market. As expected, the proposed regulation is projected to increase the prices and reduce market output. In this case, the reduction in market quantities of each product is the net effect of reductions in domestic production and increases in foreign imports. Furthermore, as shown in Table 5-3, the reduction in domestic production is the net of changes at affected producers (reductions) and unaffected producers (increases). Thus, the market-based approach allows the analyst to evaluate the distributional impacts within the U.S. industry and across U.S. versus foreign producers.

5.4.2 Industry-Level Results

Table 5-4 provides an example of the industry-level impacts associated with a proposed regulation. Industry-level impacts include an evaluation of the aggregate changes in revenue, costs, and operating profits across individual producers; facility and product-line closures; and the change in employment attributable to projected closures and changes (increases/decreases) in production from directly and indirectly affected facilities. The industry revenues and costs change as market prices and individual facility production levels adjust to the imposition of the regulation. The post-regulatory compliance costs account for market adjustments and, thus, will be less than the initial engineering estimate of compliance costs due to reductions in production and/or market exits.

Based on projected individual and market responses, the economic analysis estimates changes in industry profits. The ultimate impact of the regulation on industry profits will depend on the incidence of compliance costs and the nature of demand and supply curves. In fact, under certain circumstances, the regulation may cause aggregate industry profits to increase. Assuming that demand is not perfectly inelastic, if the supply curve were to shift upward in a parallel manner, then the effect on producer surplus, or profits, would be

Table 5-3. Summary of Market-Level Impacts of the Proposed Polymers and Resins III NESHAP: 1991

		With	Changes from Baseline	
	Baseline	Regulation	Absolute	Percent
Amino resins				
Market price ($/lb)	$0.26	$0.26	$0.00	0.08%
Market output (million lbs/yr)	1,704.0	1,703.2	-0.84	-0.05%
Domestic production	1,679.0	1,678.1	-0.86	-0.05%
Affected[a] producers	1,091.8	1,090.5	-1.30	-0.12%
Unaffected producers	587.2	587.6	0.45	0.08%
Exports	50.7	50.7	-0.02	-0.05%
Imports	25.0	25.0	0.02	0.08%
Phenolic resins				
Market price ($/lb)	$0.49	$0.49	$0.00	0.07%
Market output (million lbs/yr)	2,694.0	2,693.6	-0.41	-0.02%
Domestic production	2,658.0	2,657.6	-0.44	-0.02%
Affected[a] producers	2,479.3	2,478.8	-0.56	-0.02%
Unaffected producers	178.7	178.8	0.12	0.07%
Exports	92.7	92.7	-0.01	-0.02%
Imports	36.0	36.0	0.02	0.07%

[a] Reflects aggregate resin production volumes from 40 major source manufacturing facilities affected by the proposed NESHAP.

negative. For this type of shift, the incidence of compliance costs across affected producers is independent of their baseline production costs. In some cases, however, the compliance costs may be higher for those producers that have the highest baseline production costs. Under this scenario, the supply curve movement will be a combined pivotal and parallel shift as shown in Figure 5-13. As shown by Miller, Rosenblatt, and Hushak (1988), depending on the value of the slope and intercept of the supply and demand curves, the joint effect of this type of shift may cause an overall increase in producer surplus rather than the expected decrease resulting from the parallel shift alone. In an extreme case, the new market price could be solely

Table 5-4. Summary of National-Level Industry Impacts of the Proposed Polymers and Resins III NESHAP: 1991

	Baseline	With Regulation	Changes from Baseline	
			Absolute	Percent
Resin revenues ($ million/yr)	$1,739.0	$1,739.8	$0.80	0.05%
Costs ($ million/yr)	$897.9	$899.9	$2.08	0.23%
Post-regulatory	$0.0	$2.5	$2.51	NA
Resin production	$897.9	$897.4	-$0.43	-0.05%
Operating profits ($ million/yr)	$841.1	$839.8	-$1.28	-0.15%
Operating product lines (#)	NA	NA	-2	NA
Employment loss (FTEs)	NA	NA	-33	NA

NA = not available
FTEs = Full-time equivalents

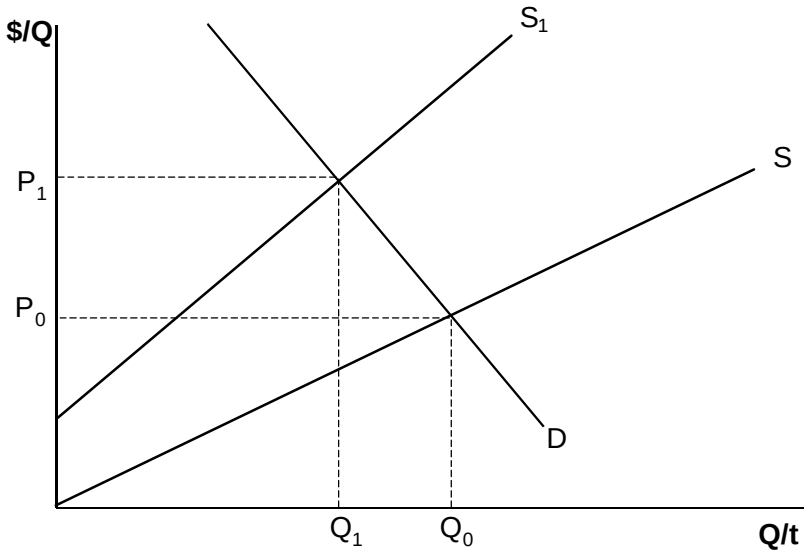


Figure 5-13. Market Outcomes with Nonparallel Supply Shift

determined by the increased costs of the marginal producer who would account for the entire reduction in output and profits with all inframarginal producers gaining profits at its expense.

As shown in Table 5-4, the projected reduction in profits is less than the regulatory costs they incur because producers reduce their production, resulting in higher market prices for each resin, which effectively shifts a portion of the regulatory burden onto consumers. Furthermore, the aggregate increase in industry profits is a result of the net change in profits at affected and unaffected U.S. producers. Table 5-5 provides results on distributional impacts of the rule within the industry that are not apparent from the aggregate industry-level impacts shown in Table 5-4. As discussed previously, in a market context, producers are able to adjust their production levels in response to the increase in costs as well as the projected increase in market prices. As shown in Table 5-5, affected resin producers are projected to incur a *decrease* in operating profits, while unaffected resin producers are expected to incur an *increase* in operating profits.

The economic analysis may also project closures of facilities or product lines associated with imposition of the regulatory action. In response to added costs of compliance, it could be that the optimal choice for a facility is to shutdown particular product lines, processes, or the entire operation altogether. The sufficient condition for production at a facility or production unit is defined as nonnegative net profits, that is,

$$\text{Profits} = TR - TC \geq 0$$

where total revenue (TR) is the sum of product revenue at the facility, and total cost (TC) is the sum of total variable production costs and total avoidable fixed costs. This closure decision does not typically include an annualized value for the liquidation opportunity cost, which is equivalent to assuming that the opportunity cost of fixed assets is offset by costs of closing the facility. It is important to point out that the estimates of facility and product-line closures are sensitive to the accuracy of the baseline characterization of these entities (e.g., prices received for manufactured products, costs of production) and the estimation of their costs of complying with the proposed regulatory action.

Table 5-5. Distribution of Industry-Level Impacts of Proposed NESHAP by Affected and Unaffected Producers: 1991

	Baseline	With Regulation	Changes From Baseline	
			Absolute	Percent
Affected[a] producers				
Resin revenues ($ million/yr)	$1,498.8	$1,499.2	$0.44	0.03%
Costs ($ million/yr)	$785.0	$786.9	$1.90	0.24%
Post-regulatory	$0.0	$2.5	$2.51	NA
Resin production	$785.0	$784.4	-$0.61	-0.08%
Operating profits ($ million/yr)	$713.7	$712.3	-$1.46	-0.20%
Operating product lines (#)	59	57	-2	-3.39%
Employment loss (FTEs)	2,437	2,404	-33	-1.36%
Unaffected producers				
Resin revenues ($ million/yr)	$240.2	$240.6	$0.33	0.15%
Costs ($ million/yr)	$112.8	$113.0	$0.18	0.16%
Post-regulatory	$0.0	$0.0	NA	NA
Resin production	$112.8	$113.0	$0.18	0.16%
Operating profits ($ million/yr)	$127.4	$127.6	$0.18	0.14%
Operating product lines (#)	NA	NA	NA	NA
Employment loss (FTEs)	NA	NA	NA	NA

[a] Reflects aggregate impacts for the 40 major source manufacturing facilities affected by the proposed NESHAP.

Furthermore, the regulatory action may displace workers from jobs through its impacts on levels of production. The methodology employed to estimate the number of displaced workers depends on the methodology used to project output effects (individual facility or aggregate market response). If facility output decisions are modeled, then changes in employment at facilities that continue to operate after regulation are estimated by multiplying

a facility-specific ratio of production workers per output (i.e., e) by the projected change in the facility's production (i.e., Δq). If the facility ceases to operate, then the change in employment at the mill equals total employment, both production and nonproduction workers (i.e., E). Thus, the estimate of the change in employment for the entire industry can be obtained by adding the sum of the employment changes across all facilities that continue to operate and the sum of total employment across all facilities that close. This produces a net estimate that aggregates the job losses at facilities that close or reduce production and job gains at facilities that increase production. Therefore, to estimate only employee displacement, or job losses, the analyst may sum the projected change in employment for those facilities that close or reduce their production level. Alternatively, if only market responses are modeled, then only a net measure of employment change may be computed by multiplying an industry-specific ratio of employment per output by the projected change in aggregate industry production.

5.4.3 Company-Level Impacts

A regulatory action to reduce air emissions from particular facilities will potentially affect the business entities that own the regulated facilities. Companies or individuals that own the facilities are legal business entities that have the capacity to conduct business transactions and make business decisions that affect the operations at the facility. The legal and financial responsibility for compliance with a regulatory action rests with these owners who must ultimately bear the financial consequences of their decisions. The owners' response options to a proposed regulatory action potentially include the following:[20]

- implement the cost-minimizing compliance option and continue to operate the facility,
- close the facility voluntarily, or
- close the facility involuntarily.

Owners are assumed to pursue the course of action that maximizes the value of the firm, subject, of course, to uncertainties about actual costs of compliance and the behavior of other companies. The market approach presented in this section addresses the first two response

[20]Firms also face financial choices regarding how to fund their compliance responses: diverting dividends from investors (i.e., out of profits), internal equity (i.e., issuing new stock), or external equity (i.e., borrowing). Although these financial decisions are not addressed in conducting the market-based approach, these decisions will influence the real resource burden to the firm and society.

options listed above. As mentioned in the introduction to Section 5, the facility and market impacts should feed into the financial analysis to assess the financial viability of the owning companies (i.e., company-level impacts). In other words, the analyst must identify which companies are likely to have problems meeting their debt obligations in the face of regulation and be required to liquidate facility assets under option three above. In addition, this type of analysis addresses distributional issues across these companies with special concern for disparate impacts on small businesses.

The financial analysis evaluates the change in firm health by computing the with-regulation financial ratios of potentially affected firms and comparing them to the corresponding baseline ratios or industry-specific standards. These financial ratios may include indicators of liquidity, asset management, debt management, and profitability. Although a variety of possible financial ratios provide individual indicators of a firm's health, they most often do not give the same signals. Therefore, the company-level analysis should focus only on changes in key measures of profitability, that is,

- return on sales, which is computed as net income divided by sales;
- return on assets, which is computed as net income divided by total assets; and
- return on equity, which is computed as net income divided by owner's equity, or net worth.

As a result of a proposed regulation, owners will potentially experience changes in profits associated with changes in the costs and revenues of their manufacturing operations. Net changes in profitability may be derived by summing facility cost and revenue changes across all facilities owned by each affected company. The net impact on a company's profitability may be negative (i.e., cost increases exceed revenue increases) or positive (i.e., revenue increases exceed cost increases). In most cases, there is little reason to go beyond the assessment of changes in profitability. Although issues of capital availability are important to address, especially in regard to small businesses, they are often difficult to assess accurately and may provide little more information beyond the assessment of firm profitability.

5.4.4 Community-Level Impacts

Based on the facility- and industry-level impacts, community or region-specific impacts of a proposed regulatory action can be computed for employment and tax revenues. Changes in employment and tax revenues are linked to the projected change in production and profits

at affected and unaffected producers located in the geographic areas of interest (i.e., counties, states, or regions). Computing the community impacts involves aggregating the facility-specific changes for each measure of interest.

5.4.5 Social Costs of the Regulation

As stipulated in E.O. 12866, when a proposed regulatory action is deemed "significant," an estimate of a regulation's social cost is compared with an estimate of social benefits to determine whether the benefits justify the costs. Toward that end, the social cost of a regulation should represent its opportunity cost (OMB, 1996, p. 32), which is the value of the goods and services that society foregoes to allocate resources to the pollution control activity.

The analyst considers three types of social cost in conducting EIAs:

- the costs of actions taken to comply with the regulation,
- the costs of administering and enforcing the regulation, and
- the costs associated with economic impacts.

The first category reflects the opportunity cost of the resources applied to compliance activities. When regulation takes the form of mandated private actions, the opportunity cost of these actions ideally is captured in measures of producer and consumer surplus from the markets affected by the regulation. These surplus measures can be directly computed from the market-based approach presented in this section and typically account for the majority of the total cost of a regulatory action. Thus, this estimate is most often presented in the EIA as the social cost of regulation.[21,22] The methodology for computing these measures is presented below. When lack of market data and model parameters impedes the computation of

[21]See Section 8 for a detailed discussion of a more comprehensive estimate of social cost for comparison with social benefits that accounts for the effects of discounting at different rate (i.e., private versus social discount rates).

[22]It is important to point out that the baseline conditions (excess capacity), model parameters (supply and demand elasticities), and market structure will influence the magnitude and distribution of these surplus-based measures. The reader is referred to the EIAs conducted for pharmaceuticals (monopoly) and portland cement (oligopoly) for illustrations of the effects of imperfectly competitive market structures on these estimates.

producer and consumer surplus measures, engineering or accounting methods must be used to approximate social costs.

However, other components of social cost may not be fully accounted for in the compliance cost estimates and, thus, not reflected in the partial equilibrium framework. These other components of social costs include government monitoring and enforcement costs and the costs associated with economic impacts such as involuntary unemployment, plant closings, and changes in innovation. In these cases, other valuation approaches must be used to separately examine and measure these other cost components.

5.4.5.1 Producer and Consumer Surplus Measures

The value of a regulatory action is traditionally measured by the change in economic welfare that it generates. Welfare impacts resulting from a proposed regulatory action on the U.S. society will extend to the many consumers and producers of affected commodities. Consumers will experience welfare impacts due to the adjustments in market prices and consumption levels that result from imposition of the regulation. Producer welfare impacts result from the changes in product revenues to all producers associated with the imposition of the rule and the corresponding changes in production and market prices. Based on applied welfare economics principles, Table 5-6 presents an example of the estimates of the social costs and their distribution by stakeholder from the EIA conducted in support of the Polymers and Resins III NESHAP.

The economic welfare implications of the market price and output changes associated with a proposed regulatory action can be examined using changes in the net benefits of consumers and producers. Figure 5-14 depicts this approach to estimating social costs by first measuring the change in consumer surplus and then the change in producer surplus. In essence, the demand and supply curves previously described as predictive devices are now being used as a valuation tool. This method of estimating the social costs of the regulation decomposes society into consumers and producers. In a market environment, consumers and producers of the good or service derive welfare from a market transaction. The difference between the maximum price consumers are willing to pay for a good and the price they actually pay is referred to as “consumer surplus.” Consumer surplus is measured as the area under the demand curve and above the price of the product. Similarly, the difference between the minimum price producers are willing to accept for a good and the price they actually receive is referred to as “producer surplus.” Producer surplus is measured as the area above

Table 5-6. Distribution of Social Costs Associated with the Proposed Polymers and Resins III NESHAP: 1991

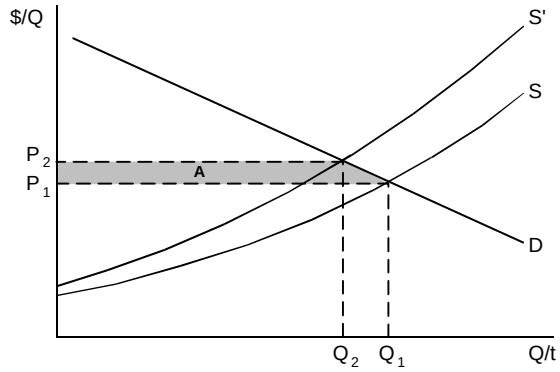
Stakeholder	Change in Value ($ million)
Consumer surplus, total	-$1.250
Amino resin consumers	-$0.336
Phenolic resin consumers	-$0.914
Producer surplus, total	-$1.276
Domestic producers	-$1.281
Affected[a]	-$1.458
Unaffected	$0.177
Foreign producers	$0.005
Social costs of regulation	-$2.527

[a] Reflects aggregate change in profits from the 40 major source manufacturing facilities affected by the proposed NESHAP.

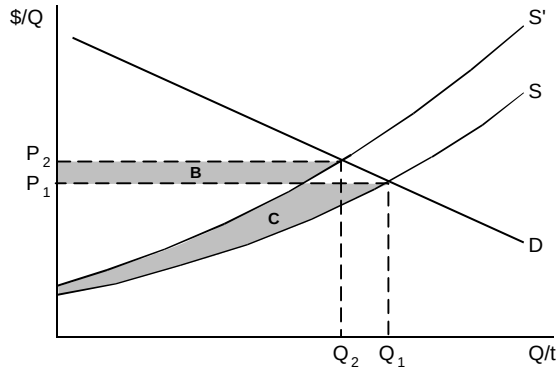
the supply curve below the price of the product. These areas can be thought of as consumers' net benefits of consumption and producers' net benefits of production, respectively.

In Figure 5-14, baseline equilibrium occurs at the intersection of the demand curve, D, and supply curve, S. Price is P_1 with quantity Q_1. The increased cost of production with the regulation will cause the market supply curve to shift upward to S'. The new equilibrium price of the product is P_2. With a higher price for the product there is less consumer welfare, all else being unchanged. In Figure 5-14(a), area A represents the dollar value of the annual net loss in consumers' benefits with the increased price. The rectangular portion represents the loss in consumer surplus on the quantity still consumed, Q_2, while the triangular area represents the foregone surplus resulting from the reduced quantity consumed, Q_1–Q_2.

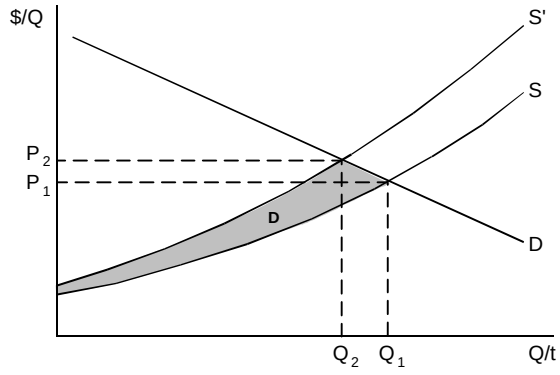
In addition to the changes in consumers' welfare, there are also changes in producers' welfare with the regulatory action. With the increase in market price, producers receive higher revenues on the quantity still purchased, Q_2. In Figure 5-14(b), area B represents the



(a) Change in Consumer Surplus with Regulation



(b) Change in Producer Surplus with Regulation



(c) Net Change in Economic Welfare with Regulation

Figure 5-14. Economic Welfare Changes with Regulation: Consumer and Producer Surplus

increase in revenues due to this increase in price. The difference in the area under the supply curve up to the original market price, area C, measures the loss in producers surplus, which includes the loss associated with the quantity no longer produced. The net change in producers' welfare is represented by area B–C.

The change in economic welfare attributable to the compliance costs of the regulations is the sum of consumer and producer surplus changes, that is, – (A) + (B–C). Figure 5-14(c) shows the net (negative) change in economic welfare associated with the regulation as area D. However, it is important to reemphasize that this measure does not include the benefits that occur outside the market, that is, the value of the reduced levels of air pollution with the regulations. Including this benefit may reduce the net cost of the regulation or even make it positive; that is, total benefits, which are private market benefits as estimated above plus the benefits in the quality of the environment, may exceed total costs.

5.4.5.2 Other Elements of Social Costs

Administrative and enforcement activities involve real resource expenditures that could be spent on the provision of other goods and services thereby imposing social opportunity costs that must be accounted for in the EA.[23] Administration and enforcement costs are borne by the taxpayers who fund regulatory government agencies such as EPA and state, tribal, or local agencies that enforce environmental regulations. Once rules are put in place, resources must be expended to administer the regulation and ensure compliance. The types of costs to consider are staffing, materials, and office rental costs (excluding those associated with rule development). Typically, these costs do not affect market outcomes and are appropriately added to the surplus-based estimates from above to gain a more complete estimate of social costs.

Government administrative and enforcement costs are usually estimated using straightforward methods based on added administrative activities and their associated costs. Information on resource requirements (e.g., full-time equivalent staff needs) and the cost (e.g., salary and fringe) can be obtained directly from enforcement agencies. The difficulty is in determining the extent to which a new regulation incrementally raises these costs. For example, enforcement agencies exist with or without the regulation. Rather than increase the size of the enforcement agency, the new regulation may just spread the responsibilities over

[23]These real resource costs are distinguished from tax transfers to or from the government, which have no net effect on social costs.

the existing staff. Assuming that the staff is not currently being underutilized, this may just reduce the frequency of enforcement activity for each regulation under the agency's purview.

Finally, the proposed regulatory action might generate economic impacts, the full social costs of which are not captured in the measures of compliance, administration, and enforcement costs. An example may be transitional costs associated with unemployment,[24] mandated obsolescence of otherwise useful capital, or reductions in long-run economic efficiency due to reduced innovation. The costs of these impacts are often difficult to quantify and are usually addressed in separate impact analyses to provide decisionmakers with a more detailed and richer characterization of the consequences of a particular regulatory action. These separate impact analyses are described in more detail in Section 8.

[24]Worker displacement costs have traditionally not been measured in EIAs conducted by ISEG analysts. The assumption has usually been made that workers costlessly move to new jobs of equal productivity and earnings, despite numerous studies that show costs borne by displaced workers are significant (see Flaim, 1984; Hamermesh, 1989; Maxwell, 1989; and Anderson and Chandran, 1987). Building on the work by Adams (1985) and Topel (1984), Anderson and Chandran (1987) constructed incremental willingness-to-pay (WTP) measures for job dislocations in a hedonic wage framework that may be employed to estimate worker dislocation costs.

SECTION 6

IMPACT ANALYSES

Impact analysis is a general term used to describe various economic analyses that are supplemental to the estimates of total benefits and costs. These analyses go beyond a simple benefit-cost analysis to examine various aspects of the composition of benefits and costs. The impact analyses required by EO and statute were introduced in Section 2 of this manual. Three statutes specifically require an analysis of regulatory impacts:

- UMRA requires an analysis of intergovernmental impacts.
- RFA, as amended by SBREFA, requires an analysis of impacts on small entities.[1]
- PRA, as amended, requires an analysis of recordkeeping and reporting impacts.

The requirements imposed by each of these statutes are described in detail in Sections 6.1 through 6.3. In addition, the Environmental Justice and Children's Health EOs require each Federal agency to assess the impacts of its regulations on minority and low-income populations and on children, respectively. These and other distribution effects are discussed in Section 8.4. Special emphasis is given in this section to those distribution effects mentioned in these EOs and in EO 12866 (Regulatory Planning and Review). The last subsection of this section briefly identifies other structural impacts addressed in economic analyses of regulations.

6.1 The Unfunded Mandates Reform Act (UMRA)

UMRA requires that Federal agencies assess the effects of Federal regulations on State, local, and tribal governments and the private sector. In particular, UMRA requires that agencies prepare a written statement to accompany any rulemaking that "includes any Federal

[1]Section 1(b)(11) of EO 12866 also requires that agencies tailor their regulations to impose the least burden on small businesses, small communities, and government entities, thereby implicitly requiring an analysis of the impacts imposed on these specific groups of entities.

mandate that may result in the expenditure by State, local, and tribal governments, in the aggregate, or by the private sector, of $100,000,000 or more (annually adjusted for inflation) in any one year" (Section 202(a)). The term "Federal mandate" means a Federal intergovernmental mandate or a Federal private-sector mandate. These terms are precisely defined in the statute as follows:

> 'Federal intergovernmental mandate' means (A) any provision in legislation, statute, or regulation that (i) would impose an enforceable duty upon State, local, or tribal governments, except (I) a condition of Federal assistance; or (II) a duty arising from participation in a voluntary Federal program... (B) any provision in legislation, statute, or regulation that relates to a then-existing Federal program under which $500,000,000 or more is provided annually to State, local, and tribal governments under entitlement authority, if the provision (i)(I) would increase the stringency of conditions of assistance to State, local, or tribal governments under the program; or (II) would place caps upon, or otherwise decrease, the Federal Government's responsibility to provide funding to State, local, or tribal governments under the program; and (ii) the State, local, or tribal governments that participate in the Federal program lack authority under that program to amend their financial or programmatic responsibilities to continue providing required services that are affected by the legislation, statute, or regulation.
>
> '*Federal private sector mandate*' means any provision in legislation, statute, or regulation that (A) would impose an enforceable duty upon the private sector except (i) a condition of Federal assistance; or (ii) a duty arising from participation in a voluntary Federal program; or (B) would reduce or eliminate the amount of authorization of appropriations for Federal financial assistance that will be provided to the private sector for the purposes of ensuring compliance with such duty (Section 421).

The written statement must

- identify the statutory authority under which the rule is to be promulgated;
- assess the benefits and costs of the rule; and

- describe the Agency's consultation with State, local, and tribal government officials during the development of the rule.

If a written statement is prepared for a proposed rule, then the final rule must also include a written statement, updated to reflect any changes in analysis or intergovernmental consultation that has occurred since the proposal stage. The written statement should be prepared as a joint effort between the ISEG analyst and the workgroup.

The statute provides specific directions regarding the contents of the benefit-cost analysis to be included in the written statement. In particular, UMRA requires that the analysis

- analyze the extent to which costs incurred by State, local, and tribal governments can be paid with Federal financial assistance;
- assess the extent to which Federal resources are available to carry out the Federal mandate;
- estimate future compliance costs;
- identify and analyze any disproportionate budgetary effect of the Federal mandate on a particular region of the country; a particular State, local, or tribal government; or a particular segment of the private sector;
- assess the effects of the rule on the national economy, including productivity, economic growth, employment and job creation, and international competitiveness; and
- identify and analyze a reasonable number of regulatory alternatives.

While the information developed to meet the EA requirements of EO 12866 will generally satisfy the analytical requirements outlined above, three basic requirements unique to UMRA need to be met independently of any EA conducted under another authority:

- ISEG analysts will need to conduct a preliminary expenditure assessment to determine whether the rule is likely to impose a mandate of more than $100 million in any one year. EPA guidance recommends that this preliminary assessment be conducted for *any* rule having consequences for non-Federal governments or the private sector. This preliminary assessment differs somewhat from an assessment conducted to determine whether a rule is economically significant under EO 12866. An economically significant regulation as defined by EO 12866 is any rule likely to have an annual *impact* of $100 million or more. In contrast, the

standard expressed in UMRA requires an analysis of direct expenditures by non-Federal governments or the private sector. The purpose of the expenditure assessment is, therefore, to determine whether direct expenditures by either non-Federal levels of government *or* the private sector are likely to exceed $100 million in any one year.[2]

- UMRA requires an analysis of possible Federal assistance to State, local, and tribal governments on which the mandate is imposed. This requirement is unique to UMRA and involves Federal budgetary considerations not usually addressed in an economic analysis prepared under EO 12866.

- UMRA specifically requires an analysis of the distribution of impacts across regions of the country, different levels or types of governments, and various sectors of the economy. In contrast, most analyses prepared under EO 12866 assess the impact of the rule on the nation as a whole, rather than on a region-by-region or sector-by-sector basis.

For further guidance on conducting expenditure assessments and impact analyses under UMRA, analysts are referred to the Agency's *Unfunded Mandates Guidance* (EPA, 1995b).

6.2 The Regulatory Flexibility Act (RFA) and Small Business Regulatory Enforcement Fairness Act (SBREFA)

The RFA, as amended by SBREFA of 1996, requires Federal regulatory agencies to determine whether a proposed or final regulation will have a significant impact on a substantial number of small entities.[3] In particular, the RFA requires that an agency prepare an IRFA for any proposed rule and an FRFA for any final rule that is subject to notice-and-comment rulemaking under the Administrative Procedures Act (APA) unless the agency head certifies

[2]The $100 million expenditure test must be applied to the governments and the private sector separately. For example, if a rule requires governments to spend $75 million and the private sector to spend $75 million in a given year, then a written statement would not be required under UMRA even though the total mandate exceeds $100 million.

[3]According to the RFA, small entities include small businesses, as defined by the SBA; small government jurisdictions; and small nonprofit organizations. For more details on the definitions of small entities, see *EPA Interim Guidance on Implementing the Small Business Regulatory Enforcement Fairness Act and Related Provisions of the Regulatory Flexibility Act* (EPA, 1997f).

that the rule will not have a significant impact on a substantial number of small entities.[4] [,5] According to *EPA Interim Guidance for Implementing the Small Business Regulatory Enforcement Fairness Act and Related Provisions of the Regulatory Flexibility Act* (EPA, 1997f), current Agency policy is to implement the RFA as written; that is, "regulatory flexibility analyses as specified by the RFA will *not* be required if the Agency certifies that the rule will not have significant economic impact on a substantial number of small entities." However, it remains Agency policy that, even when the Agency makes a certification of "no significant impact," program offices should assess the impact of every rule on small entities and minimize any impact to the extent feasible, regardless of the size of the impact or the number of small entities affected.

Because ISEG has always considered the effects of OAQPS rules on small entities, the enactment of SBREFA has not precipitated any major changes in ISEG's analysis of the small entity impacts of a regulatory action. However, as a result of SBREFA, the Agency must take additional actions when a certification decision is made. For example, if it is determined that the rule cannot be certified as having "no significant impact," the Agency must convene a Small Business Advocacy Review Panel.

In accordance with ISEG practice, analysts must conduct a screening analysis to determine if the rule is likely to have a significant impact on a substantial number of small entities. Pursuant to SBREFA, the SBA may vary its definition of "small business" by regulation. These definitions are codified at 13 CF 121.201. ISEG analysts are not required to use the SBA definitions; however, alternative definitions of "small business" must be developed in consultation with SBA and are subject to public comment.

In addition, EPA has developed guidelines for what constitutes a significant impact and the number of firms that constitutes a substantial number of small entities. First, the analyst must estimate the impact of the regulatory option on businesses, government entities,

[4]A certification of "no significant impact" in the proposed rule stage does not preclude an FRFA at the final rule stage, and an IRFA at the proposed rule stage does not preclude a certification of "no significant impact" at the final rule stage, because information provided through notice-and-comment rulemaking and changes to the substance of the rule can change the expected impact of the rule between the proposed and final stages.

[5]Although not specifically required by RFA or SBREFA, analysts also may want to analyze the effects of a rule on minority-owned businesses to support the analysis of environmental justice impacts (see below).

and nonprofit entities of different sizes. The recommended criteria for evaluating the economic impact of a rule on small entities are presented in Table 6-1.

The preferred criteria for estimating this impact vary across entity types. For small businesses, the preferred impact measure is annualized costs of the rule as a percentage of sales ("sales test"). For small government entities, the preferred impact measure is annualized costs as a percentage of government revenues ("revenue test"). And for small nonprofit organizations, the preferred impact measure is annualized compliance costs as a percentage of operating expenditures ("expenditures test"). Other impact measures can be used if appropriate; however, analysts should consult with ISEG management before doing so.

Table 6-1. Recommended Quantitative Criteria for Evaluating the Economic Impact of a Rule on Small Entities

Type of Entity and Criteria (preferred criteria in ***bold italics***)
Small Businesses
– ***Annualized compliance costs as a percentage of sales ("sales test")***
– Debt-financed capital compliance costs relative to current cash flow ("cash flow test")
– Annualized compliance costs as a percentage of before-tax profits ("profit test")
Small Governments
– ***Annualized compliance costs as a percentage of annual government revenues ("revenue test")***
– Annualized compliance costs to household (per capita) as a percentage of median household (per capita) income ("income test")
Small Nonprofit Organizations
– ***Annualized compliance costs as a percentage of annual operating expenditures ("expenditures test")***
– Annualized compliance costs as a percentage of total assets ("asset test")

Source: U.S. Environmental Protection Agency. February 5, 1997f. *EPA Interim Guidance on Implementing the Small Business Regulatory Enforcement Fairness Act and Related Provisions of the Regulatory Flexibility Act*. Washington, DC: EPA SBREFA Task Force.

These impact measures are then combined with estimates of the absolute number of small entities that will experience the impact and the percentage of all the small entities subject to the rule that will experience the impact. Based on estimates of these variables, the rule is put in one of three categories:

- Category 1: The rule is presumed to have no significant impact and is certified as such.[6]
- Category 2: No determination of the significance of the impact is assigned to the rule, and the screening analysis described above, along with a recommendation of the need for a regulatory flexibility analysis, is presented to the EPA Small Business Advocacy Chairperson.
- Category 3: The rule is presumed to be ineligible for certification, so an IRFA or FRFA should be prepared.

Table 6-2 presents the matrix used to determine the category into which a particular rule will fall. This table is based on interim Agency guidance. Analysts should keep abreast of changes in subsequent versions of the RFA guidance document. In addition, analysts should be aware that the criteria presented in Table 6-2 are only guidance, and analyses based on this guidance may still be contested by OMB.

The data used to perform the screening analysis should be collected during the development of the industry profile. See Section 4 for more detail on sources for company data that can be used in the screening analysis.

If the results of the screening analysis indicate that the rule cannot be certified as having "no significant impact," then the workgroup must prepare an IRFA. An IFRA must contain the following information:

- an explanation of the need for the rule;
- a statement of the objectives and legal basis for the rule;
- a description (estimate) of the number of small entities to which the rule will apply;

[6]If the agency makes a "no significant impact" certification, it must support that certification with a factual explanation. The results of the screening analysis can be used to support such an explanation.

Table 6-2. Summary of Quantitative Information Used to Identify Applicable Categories[a]

Quantitative Criteria			
Economic Impact Condition (based on preferred impact criteria)	**Number of Small Entities Experiencing Economic Impact Condition**	**Number of Small Entities Experiencing Economic Impact Condition as a Percentage of All Affected Small Entities**	**Regulatory Process Category[b]**
Less than 1% for all affected small entities	Any number	Any percent	Category 1
1% or greater for one or more small entities[c]	Fewer than 100	Any percent	Category 1
	100 to 999	Less than 20%	Category 1
	100 to 999	20% or more	Category 2
	1,000 or more[d]	Any percent	Category 2
3% or greater for one or more small entities	Fewer than 100	Any percent	Category 1
	100 to 999	Less than 20%	Category 2
	100 to 999	20% or more	Category 3
	1,000 or more[d]	Any percent	Category 3

[a] Nothing in this table on applying quantitative measures of economic impacts and enumerating the number of impacted small entities should be interpreted as indicating that the certification decision is strictly or solely based on application of the above quantitative steps. Additional information and other factors may be relevant in deciding whether to prepare a regulatory flexibility analysis or to certify under the RFA.

[b] In some cases, the extent of the impact (measured in quantitative or qualitative terms) is particularly severe, even though the number of affected small entities totals fewer than 100 or 20 percent of all affected small entities. In such cases, the lead office should consider placing the rule in a higher category than would otherwise be applicable.

[c] For purposes of applying this portion of the table, the number of small entities that will experience an impact of 1 percent to 3 percent must be aggregated with the number of small entities that will experience an impact of 3 percent or greater. The total number of small entities that will experience an impact of 1 percent or greater must be used here to determine whether the number of small entities so impacted is large enough to warrant preparation of a regulatory flexibility analysis.

[d] As the number of small entities that will be affected by a rule by more than 1 percent of sales or revenues approaches 1,000 in number, the substantial number criterion of 20 percent of affected small entities may become less relevant in determining whether a regulatory flexibility analysis or a certification should be prepared.

Source: U.S. Environmental Protection Agency. February 5, 1997f. *EPA Interim Guidance on Implementing the Small Business Regulatory Enforcement Fairness Act and Related Provisions of the Regulatory Flexibility Act*. Washington, DC: EPA SBREFA Task Force.

- a description of the recordkeeping, reporting, and compliance requirements contained in the rule, including an estimate of the classes of small entities subject to the requirement and the level of professional skill needed to prepare required reports or maintain required records;
- an identification of other Federal rules that may duplicate, overlap, or conflict with the rule; and
- a description of alternatives that accomplish the same stated objectives and may minimize the impact of the rule on small entities.

The IRFA or a summary of the IRFA must be published in the *FR* along with the proposed rule for which it was prepared. If the information required in the IRFA is included elsewhere in the preamble to the Notice of Proposed Rulemaking (NPRM) or other rulemaking documents, as is often the case, then the IRFA need not repeat this information but may simply cross-reference the preamble or other documents.

As a result of recommendations made by the Small Business Advocacy Review Panel and public comments on the IRFA, rules having significant small business impacts are often modified between the proposed and final rulemaking stages. These changes may require modifying the analyses presented in the IRFA or conducting new analyses all together. If new information or further analysis reveals changes in any of the three screening variables, the screening process is repeated at the final rule stage. If the screening process again indicates that the rule cannot be certified as having "no significant impact," then the analyst must conduct a FRFA. There are four major differences between the requirements for an IFRA and those for a FRFA:

- The FRFA does not require an identification of other related Federal rules.
- The FRFA does not require an analysis of alternatives to the rule.
- The FRFA must include a summary of the issues raised by public comments and the agency's response to those issues.
- The FRFA must contain a description of the steps the agency has taken to minimize the impact of the rule on small entities consistent with the stated objectives of the rule.

For further guidance on assessing small entity impacts under the RFA and SBREFA, analysts are referred to *EPA Interim Guidance on Implementing the Small Business*

Regulatory Enforcement Fairness Act and Related Provisions of the Regulatory Flexibility Act (EPA, 1997f).

6.3 The Paperwork Reduction Act (PRA)

In many rulemakings, various recordkeeping, reporting, labeling, testing, and other requirements are included to help EPA verify compliance with the rule after it has been promulgated. Under the PRA, the Agency is required to estimate the "burden hours" associated with the recordkeeping and reporting requirements and to weigh this burden against the "practical utility" of the information collection. This analysis must be presented to OMB for review in a standardized document known as an ICR.

In general, an ICR is composed of the following elements:

- a summary of the collection of information;
- a description of the need for, and proposed use of, the information;
- a description of the likely respondents, including the number of respondents and the frequency of response; and
- an estimate of the total annual reporting and recordkeeping burden that will result from the information collection.

An outline for a typical ICR is presented in Table 6-3.

The ISEG analyst may play a role in or be primarily responsible for preparing estimates of burden associated with recordkeeping and reporting requirements presented in Section 6 of the ICR. The workgroup chair for the rulemaking is usually responsible for preparing the remainder of the ICR. Cost and burden estimates should reflect any reporting and recordkeeping costs estimated in the cost section of the EIA. It is important to note, however, that the reporting and recordkeeping costs included in the ICR are estimated over a period of 3 years. In contrast, the reporting and recordkeeping costs estimated in the cost section of the EIA span the entire period of analysis considered in the EIA. These estimates should include the total time and resources needed to

- review instructions;

Table 6-3. Contents of the Supporting Statement for an Information Collection Request

1.	**Identification of the Information Collection**
1(a)	Title of Information Collection, Title of Corresponding Rule, EPA ICR Number, and Existing OMB Approval Number (if ICR is a renewal of or amendment to an existing information collection)
1(b)	Short Characterization (Abstract)
2.	**Need for the Information Collection**
2(a)	Need/Authority for the Collection
2(b)	Use/Users of the Data
3.	**The Respondents and the Information Requested**
3(a)	Respondent SIC Codes
3(b)	Information Requested
4.	**The Information Collected—Agency Activities, Collection, Methodology, and Information Management**
4(a)	Agency Activities
4(b)	Collection Methodology and Management
4(c)	Small Entity Flexibility
4(d)	Collection Schedule
5.	**Nonduplication, Consultations, and Other Collection Criteria**
5(a)	Nonduplication of Existing Information Collections
5(b)	Consultations with Stakeholders
5(c)	Effects of Less Frequent Collection
5(d)	Compliance with OMB Guidelines
5(e)	Confidentiality and Sensitive Questions
6.	**Estimating Burden and Cost of the Collection**
6(a)	Estimating Respondent Burden and Costs
6(b)	Estimating Agency Burden and Cost
6(c)	Bottom Line Burden and Cost-Master Table
6(d)	Change in Burden (if renewal of an existing ICR)
6(e)	Burden Statement

- develop systems for the purpose of collecting, validating, and verifying information; processing and maintaining information; and disclosing or providing information;
- adjust current practice to comply with the recordkeeping and reporting requirements;
- train personnel to respond to an information collection;
- search data sources;
- complete and review the information collection; and
- transmit or disclose the information.

Analysts should consult the Office of Policy (OP) *ICR Handbook* (EPA, 1998e) when preparing recordkeeping and reporting cost estimates to be included in an ICR.

As part of the statement of need for the proposed action, the ICR should also describe the practical utility of the information to be collected, maintained, or disclosed. 5 CFR 1320 defines practical utility as "the actual...usefulness of the information to or for an agency, taking into account its accuracy, validity, adequacy, and reliability, and the agency's ability to process the information it collects...in a timely fashion." Practical utility is typically established by qualitatively describing the use of the information. The discussion of practical utility is usually left to the workgroup.

6.4 Distributional Impacts

The benefits and costs of a rule are often distributed unevenly across different sectors of the economy or among different categories of individuals. The statutory requirements for impact analysis discussed in the preceding sections generally address the distribution of costs across sectors of the economy, including governments and the private sector. In addition, UMRA requires that analysts identify the distribution of costs across different geographic regions. The distribution of benefits and costs among different categories of individuals often evokes concerns about equity and fairness; however, because most EAs attempt to measure benefits and costs in the aggregate, the distribution of those benefits and costs can easily be overlooked. Also, EO 12866 (Regulatory Planning and Review) includes the reduction of discrimination or bias among the possible benefits of a regulation to be considered. Therefore, this section identifies the various ways in which the distributional effects can be examined to more fully inform decisionmakers of the consequences of a regulatory action.

The impacts of a regulation may be distributed unevenly across a number of personal or demographic characteristics.[7] These characteristics include income, gender, race, and age. Also, decisionmakers may be interested in the impact of a regulation on certain sensitive subpopulations. Although the term "sensitive subpopulations" is not clearly defined, it is often used in reference to individuals whose existing health status may make them especially vulnerable to environmental hazards. While impact analyses can be conducted to determine the distribution of effects across any or all of these categories, two EOs (12898 and 13045) specifically require Federal agencies to consider the three primary characteristics (income, race, and age) when proposing or promulgating a regulation:

- EO 12898—Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Population—requires each agency to address and identify "...disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority and low-income populations..." (Section 1.1). An analysis of the distribution of benefits and costs of a regulation across individuals of different races and levels of income serves to inform decisionmakers of the environmental justice consequences of OAQPS regulations.[8]

- EO 13045—Protection of Children from Environmental Health Risks and Safety Risks—requires that Federal agencies examine the impacts of each regulatory action on children for any economically significant regulation (as defined by EO 12866) that the agency has reason to believe may disproportionately affect children. This EO implicitly requires an analysis of the distribution of impacts across age cohorts within the population for any OAQPS regulation designed to protect human health.[9]

[7]Determining the distribution of impacts involves more than estimating impacts on identified subpopulations. In particular, ascertaining if disparate impacts exist involves determining if observed differences are statistically significant. In many cases, however, the data are insufficient to make such a determination.

[8]Although the Agency has not developed guidance for specifically addressing environmental justice concerns in its rulemakings, two documents provide overviews of environmental justice and may be of interest to analysts: *Interim Final Guidance for Incorporating Environmental Justice Concerns in EPA's NEPA Compliance Analysis* (EPA, 1997h) and *Evaluating the Equity of Environmental Policy Options Based on the Distribution of Economic Effects: Preliminary Draft* (EPA, 1997g).

[9]Although the Agency has not developed guidance for addressing impacts on children, analysts are again referred to *Evaluating the Equity of Environmental Policy Options Based on the Distribution of Economic Effects: Preliminary Draft* (EPA, 1997g) for an overview of equity considerations based on age.

As mentioned above, unevenly distributed economic impacts often result in concerns about equity and fairness. Although classical economics and benefit-cost analysis avoid the direct evaluation of fairness, an analysis of the distribution of impacts across various segments of society provides decisionmakers with a framework in which to judge the equity of a regulatory action. In an effort to incorporate notions of equity and fairness in EPA decisionmaking, OP has drafted *Evaluating the Equity of Environmental Policy Options Based on the Distribution of Economic Effects: Preliminary Draft* (EPA, 1997g). This document provides guidance on how to incorporate distributional impacts analysis into an EA. In particular, the following recommendations are made:

- Do not address very low impact regulations, options, and effects. For regulations with small distributional impacts, the additional information provided by an impact analysis may not warrant the resources required to conduct the analysis.
- Identify and define the personal and demographic characteristics (e.g., race, age) of concern. In this step, the analyst should list all expected distributional effects and prioritize them.
- Determine the limits of the analysis by identifying the markets in which distributional effects are expected to occur.
- Determine whether distributional impacts exist within the scope of the analysis, noting that, in some cases, distributional effects may not occur in the markets directly affected by the regulation.
- Measure distributional impacts using a range of assumptions to characterize the possible distributions of expected impacts.
- Examine distributional impacts over the expected course of market adjustments because some impacts may be a direct result of markets adjusting to regulatory requirements and may change over time.

6.5 Structural Impacts

In addition to distributional impacts, a regulation may result in fundamental changes in more aggregate macroeconomic variables such as trade, innovation, inflation, and employment. EO 12866 explicitly calls for an analysis of productivity, employment, and competitiveness impacts as part of the assessment of the potential costs of a regulatory action. Likewise, the written statement prepared pursuant to UMRA must include an assessment of the impact of a regulation "on the national economy, such as the effect on productivity,

economic growth, full employment, creation of productive jobs, and international competitiveness of United States goods and services." The assessment must be performed "to the extent that the agency in its sole discretion determines that accurate estimates are reasonably feasible and that such effect is relevant and material" (UMRA, Section 202(a)). A memorandum to the heads of executive departments and agencies from OMB (Katzen, 1995) provides further guidance for analyzing structural impacts under UMRA.[10]

Unlike distributional impacts, structural impacts require more than simply disaggregating benefits and costs to determine their effect on different segments of society. Instead, an analysis of structural impacts usually requires that the analyst trace the effects of a regulation beyond the market or economic sector in which they directly occur to determine the impact on the economy as a whole.

Analyses of structural impacts often require either multiple partial equilibrium analyses or some form of general equilibrium analysis. Because computing benefits and costs in multiple markets can significantly raise the cost of analysis, the analyst should first informally assess whether the rule is likely to have macroeconomic impacts. This will generally depend on the size of the affected industry and whether it engages in international trade. If the informal assessment reveals that such impacts are likely, the analyst should consult ISEG management about how best to apply time and resources to such an analysis.

[10]This memo does, however, contain an error of which ISEG analysts should be aware. The memo notes that macroeconomic impacts are measurable only if the impact of the rule exceeds 0.25 to 0.5 percent of gross domestic product and indicates that this range is equal to $1.5 billion to $3 billion. GDP in 1997 totaled approximately $8.1 trillion. Therefore, 0.25 percent to 0.5 percent of GDP would total approximately $20 billion to $40 billion. It is not clear whether the percentages or the dollar amounts are in error. Therefore, ISEG analysts should use caution when using the guidance provided in this memo.

SECTION 7

FRAMEWORK FOR QUANTITATIVE BENEFITS ANALYSIS

As described in Section 2 of this document, OAQPS has the authority to undertake the following regulatory actions:

- set national ambient air quality standards (NAAQS) for six "criteria" pollutants;
- establish national emissions standards for 189 listed hazardous air pollutants (NESHAP);
- establish new source performance standards (NSPS), imposing technology-based requirements on new or modified major sources of pollutants;
- establish emissions standards for mobile sources;
- impose requirements to address specific air pollution problems, such as acid rain and depletion of stratospheric ozone;
- establish nonattainment areas for regions that have failed to meet the NAAQS standards for one or more of the criteria pollutants; and
- require each State to submit a plan for the implementing and enforcing national standards, thus referred to as State Implementation Plans (SIP). Also required within each SIP are measures to ensure against significant deterioration of air quality in areas that meet NAAQS standards.

In the case of NAAQS, OAQPS sets limits on ambient concentrations of six "criteria" pollutants, allowing the States to determine how best to achieve these standards. For NESHAPs, NSPS, and emissions standards for mobile sources, OAQPS places limits on the quantity of releases of pollutants into the atmosphere. Although the specific focus of these rulemakings may differ, the ultimate objective is the same. As a result, the benefits of all OAQPS regulations can be described as a function of reductions in human health and environmental impacts caused by exposure of humans and the environment to ambient concentrations of air pollutants. The purpose of this section is to describe a framework for estimating these benefits.

7.1 Economic Benefits: An Overview

The benefits of an environmental regulation generally consist of the effects that an improvement in environmental quality has on human welfare. Individuals derive satisfaction (abstractly known as utility) from the services provided by the natural environment. To the extent that improvements in the quality of the natural environment improve the service flows provided to humans, individuals experience a utility gain. Conversely, any damage to the physical environment that decreases the quantity or quality of these service flows results in a utility loss. In this context, the atmosphere can be viewed as a natural asset, the services of which include (but are not limited to) such things as life support for humans and other living things, as well as visual amenities. Changes in air quality that result from pollution hinder the atmosphere's ability to provide such service flows to humans.

To understand the effect that an environmental regulation has on the service flows provided by the natural environment, one must consider three functional relationships (Freeman, 1993). The first relationship describes the effect of human activities on environmental quality. This relationship estimates ambient concentrations of pollutants in environmental media as a function of air emissions. Fate and transport models are used to characterize this relationship. The second functional relationship is that between environmental quality and the service flows provided by the natural environment. This relationship characterizes such service flows as a function of ambient pollution concentrations, usually in the form of concentration-response or dose-response function. The third, and final, relationship translates environmental service flows into human welfare. The use of these functional relationships in estimating the benefits of a regulation is presented in Figure 7-1.

Recall from the discussion above that the benefits of OAQPS regulations result from *changes* in emissions to the atmosphere. Therefore, the first functional relationship presented in Figure 7-1 relates these changes in emissions to changes in ambient concentrations of pollutants in environmental media through fate and transport models. The boxes at the top of Figure 7-1 represent emissions under two different states of the world—the baseline and the control. The baseline corresponds to the state of the world in the absence of the regulation. In contrast, the control corresponds to the level of emissions in a world with the regulation. The difference between these emissions levels is the primary result of the regulation.

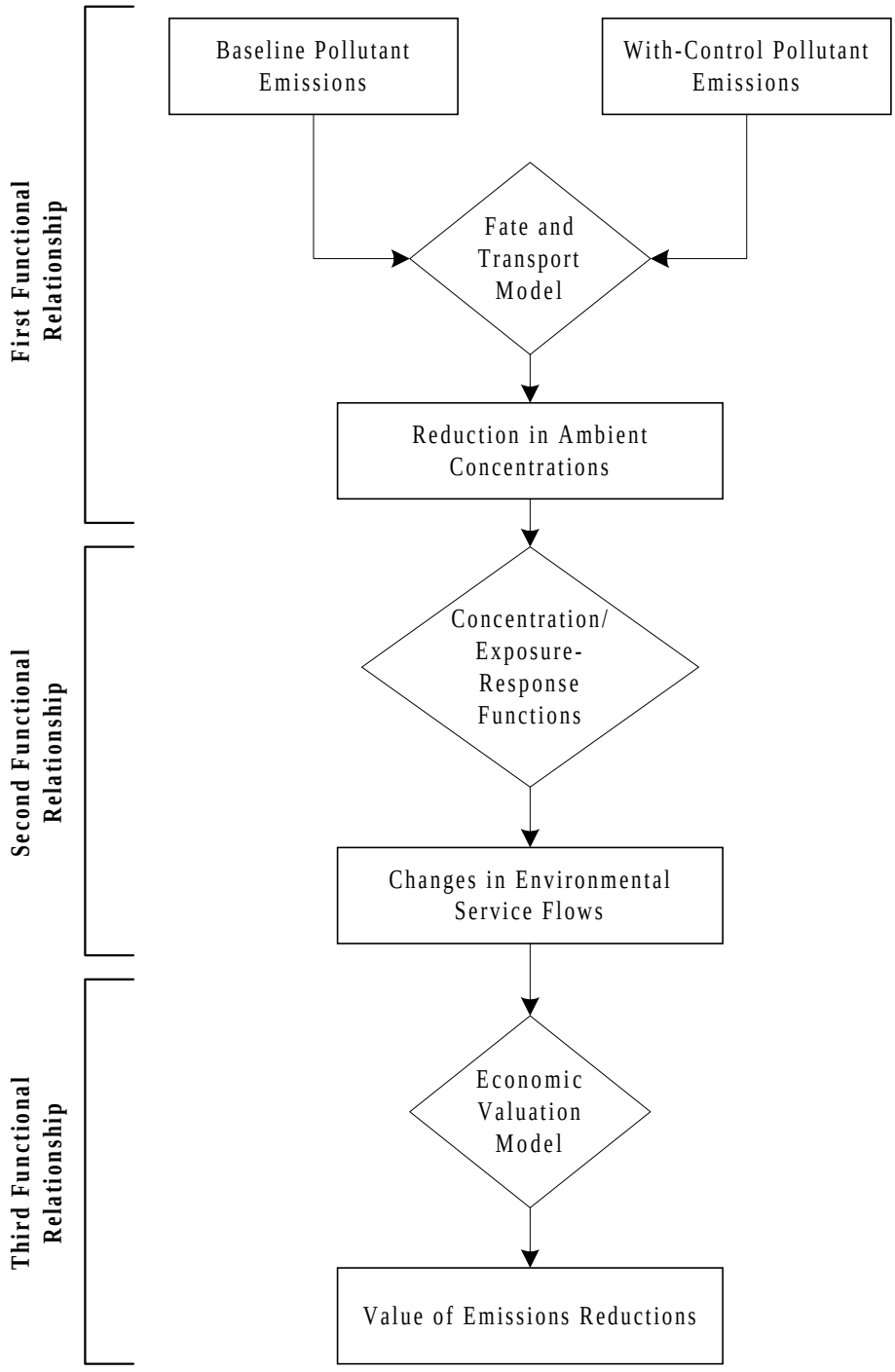


Figure 7-1. Functional Relationships in Benefits Analysis

Once the change in ambient concentrations has been estimated by applying fate and transport models to the change in emissions, the analyst must use concentration-response relationships or dose-response relationships to determine reductions in the damages resulting from the changes in ambient concentrations.[1] Economic valuation methods can then be used to estimate the value individuals place on these improved environmental service flows.

7.2 Steps in Conducting Benefits Analysis

As a practical matter, there are three primary steps to estimating the benefits of an environmental regulation. First, the analyst must identify the reductions in human health and environmental damages expected to result from the regulation. Next, these identified benefits must be quantified. And finally, quantified benefits should be expressed in monetary terms to the extent possible. In the sections that follow, these steps are described relative to the functional relationships presented above.

7.2.1 Identifying Benefits

Identifying the benefits of a regulation is analogous to identifying the reductions in damages to environmental service flows attributable to the rule. The damages that can be avoided by reducing pollutant emissions fall into three broad categories (adapted from Freeman, 1993):

1. *Direct damages to humans*, including health damages and aesthetic damages;

   - *Health damages* result from human exposure to pollutants. These damages include increases in the risk of death (mortality risk) or increases in the risk of experiencing an adverse health effect (morbidity risk). Adverse health effects can be divided into acute effects such as headaches or eye irritation which generally last only a few days, and chronic effects such as emphysema or asthma which are generally associated with long-term illness.

   - *Aesthetic damages* result from contamination of the physical environment and include increased problems of odor, noise, and poor visibility.

[1]Although characterizing and estimating the first two functional relationships are tasks for risk assessors, the steps required to conduct these analyses are described in this section so that ISEG analysts have a clear understanding of the benefits to be monetized in an economic analysis.

2. *Indirect damages to humans through ecosystems*, including productivity damages, recreation damages, and intrinsic or nonuse damages;

   - *Productivity damages*, including reduced productivity of farmland, forests, and commercial fisheries, result from pollution damages to physical environments which support these commercial activities.

   - *Recreation damages* result from the reduced quality of environmental resources such as lakes and rivers used for recreational activities.

   - *Intrinsic or nonuse damages* include losses in the value people associate with preserving, protecting, and improving the quality of ecological resources that is not motivated by their own use of those resources.

3. *Indirect damages to humans through nonliving systems*, including damages to materials and structures (e.g., buildings and equipment) that are caused by pollution and can reduce the productivity of these assets.

The process of identifying the benefits of a regulation is equivalent to *qualitatively* describing the first and second functional relationships presented in Figure 7-1. That is, identifying benefits essentially involves describing the relationship between changes in pollutant emissions and ambient concentrations in environmental media and then describing the relationship between those ambient pollution concentrations and the services provided by the physical environment. Figure 7-2 outlines the linkages between NO_X emissions and environmental damages.

As is evident from the amount of activity in the figure between pollution emissions and ambient concentrations, the fate and transport of pollutant emissions through the atmosphere usually involve a number of interactions between the emissions of interest and other atmospheric constituents. In particular, NO_x has both direct effects on human health and the environment and indirect (precursor) effects resulting from its interaction with other chemicals in the atmosphere. Therefore, care should be taken when describing the fate and transport of pollutant emissions through the environment. Likewise, the relationship between ambient pollutant concentrations and environmental damages can also be complex.

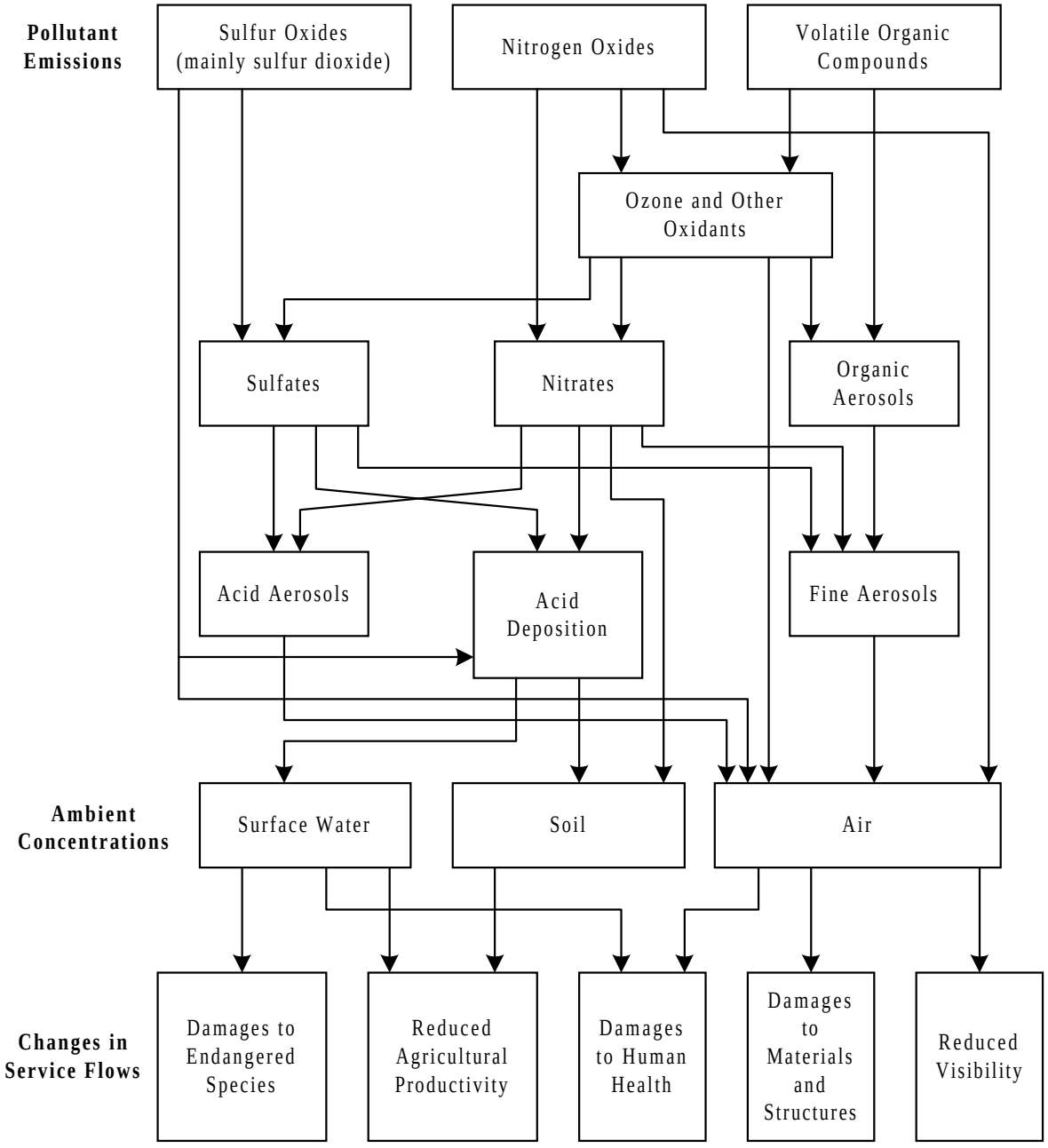


Figure 7-2. Functional Relationships Between NO_x Emissions and Environmental Service Flows

Based on a figure in DOE (1993).

7.2.2 Quantifying Benefits

Just as identifying the benefits of a regulation requires qualitatively describing the first and second functional relationships presented in Figure 7-1, quantifying benefits requires calculating the effects that changes in emissions have on environmental service flows. This involves quantifying changes in emissions, using fate and transport models to estimate the corresponding changes in ambient concentrations of pollutants in environmental media, and then estimating dose-response or concentration-response relationships[2] to translate these changes in ambient concentrations into quantitative changes in environmental damages.

7.2.2.1 Quantifying Health Benefits

In general, quantifying health benefits involves six steps. These steps include determining the following:

1. the dose-response relationship for each health effect,
2. total exposure in the absence of the regulation,
3. the number of baseline cases for each quantifiable health effect,
4. total exposure with the regulation (for each regulatory alternative),
5. the number of cases for each quantifiable health effect with the regulation (for each regulatory alternative), and
6. the number of cases avoided as a result of each alternative.

Each of these steps is described below.

Step 1: Determining the Dose-Response Relationship for Each Health Effect

A dose-response relationship is an estimate of risk per unit of exposure to a pollutant. For cancer assessments, dose-response has typically been modeled as a *linear no-threshold relationship*; that is, every unit of exposure contributes equally to aggregate risk. For

[2]A dose-response estimate is a value that quantifies the increased risk of incidence of some health effect associated with a one-unit increase in exposure to a pollutant. A concentration-response estimate is a value that quantifies the increase in some environmental damage associated with a one-unit increase in the ambient concentration of a pollutant.

example, 100 units of human exposure result in a given amount of risk, regardless of whether there is a one-time exposure of 100 units to one person, ten exposures of one unit each to ten different people, or one-time exposures of one unit each to 100 different people. However, the Agency has been moving toward the use of nonlinear health effects models. These models may become more prevalent in future analyses. For noncancer health effects, dose-response relationships may include a threshold and/or may be nonlinear with respect to the level of exposure.

Step 2: Determining Baseline Exposure

Human exposure to a pollutant is a function of ambient concentrations of that pollutant in environmental media. Determining baseline exposure requires estimating two parameters. First, analysts must identify the exposed populations (e.g., occupational groups, consumers of particular products, the general population living in a particular area) and the number of exposed individuals in each group. Then one needs to determine the level, duration, route, and frequency of exposure (e.g., 100 ppm time-weighted average exposure for an 8-hour day, 50 days per year).

At this point in the discussion, it is important to note that individuals may take action to reduce their exposure to harmful substances. For example, individuals may purchase bottled water to avoid exposure to contaminants found in tap water. Such averting behaviors affect the size of the exposed population. Therefore, any exposure assessment should take into account individual actions designed to reduce exposure. However, inclusion of such behavior is usually, at best, only implicit in the exposure assessment. As a result, in the remainder of this section, the discussion of averting behavior in an economic analysis is limited to the use of averting expenditures as a proxy for individual WTP to avoid the health effects expected to result from human exposure to environmental contaminants (see Section 7.2.3.1).

Step 3: Determining the Number of Baseline Cases for Each Quantifiable Health Effect

The number of baseline cases for each quantifiable health effect is the product of the baseline number of people exposed, the amount (level, duration, and frequency) of baseline exposure, and the dose-response relationship; that is, the baseline number of cases for each exposed population equals:

Number exposed x Baseline exposure x Dose-response relationship.

Step 4: Determining Exposure after the Regulation (for Each Regulatory Option)

Each regulatory option may result in a reduction in the exposure level, a reduction in the exposed population, or some combination of the two. Therefore, there are two dimensions to characterizing post-regulatory exposure. First, it is necessary to estimate the impact of the option on exposure levels. For example, a regulatory option may reduce (but not eliminate) the exposure to the pollutant from a particular exposure pathway. Second, it is necessary to estimate the expected post-regulatory level of exposure for that exposure pathway.

Step 5: Determining the Number of Cases for Each Quantifiable Effect with the Regulation (for Each Regulatory Option)

In this step, Step 3 is repeated, using the post-regulatory estimates of exposure (number of people exposed; frequency, duration, and level of exposure) derived in Step 4. Multiplying the new exposure estimates by the dose-response estimate yields an estimate of the post-regulatory number of cases.

Step 6: Determining the Number of Cases Avoided as a Result of Each Regulatory Option

To determine the number of statistical cases avoided as a result of a regulatory option, the number of post-regulatory cases (from Step 5) is subtracted from the baseline number of cases (from Step 3). The difference is the quantified benefits of the regulation as follows:

Quantified Health Effects	=	Baseline Cases Resulting from Exposure to Pollutant	–	Post-Regulatory Cases Resulting from Exposure to Pollutant

Estimating the concentration-response relationship provides an alternative to the six-step process outlined above. Although estimating individual risk per unit of exposure and then multiplying this estimate by total exposure is the more accurate method of quantifying health effects, the data required for such an analysis are often not available. In those cases, it may be possible to estimate the extent of health effects as a function of ambient concentrations of pollutants in the atmosphere. This process involves the determining the following:

1. the concentration-response ratio for each health effect,
2. ambient pollutant concentrations in the absence of the regulation,
3. ambient pollutant concentrations with the regulation (for each regulatory alternative),
4. the number of cases for each health effect with the regulation (for each regulatory alternative), and
5. the number of cases avoided as a result of each alternative.

This process differs from the six-step process described above only in that the estimation of a dose-response relationship and exposure for each health effect for each regulatory alternative are combined into one step—the estimation of a concentration-response relationship. A concentration-response relationship is an estimate of the number of health effects associated with a given ambient pollutant concentration (e.g., number of asthma attacks associated with a particular concentration of ground-level ozone). If the ambient concentration of the pollutant is known both with and without the regulation, then a concentration-response relationship can be used to estimate changes in the number of health effects resulting from the regulation. Examples of concentration-response relationships for health effects developed in the literature include Schwartz (1993), Ostro and Rothchild (1989), and Pope (1989).

7.2.2.2 Quantifying Ecological Benefits

Quantifying ecological benefits is similar to quantifying health benefits using concentration-response relationships. In particular, when the effect of a regulation on the ambient concentrations of a pollutant can be estimated, and the relationship between ambient pollution concentrations and environmental service flows is known, then the ecological benefits of a regulation can be quantified. For example, the National Crop Loss Assessment Network (NCLAN) developed concentration-response relationships linking ground-level ozone to leaf damage and reduced seed size in an effort to determine the effect of ozone on crop yields.[3] Other sources of concentration-response relationships for ecological damages include Martin and Banzhaf (1994); Heagle, Spencer, and Letchworth (1979); Kopp, Vaughan, and Hazilla (1984); Brewer and Ashcroft (1982); Oshima et al. (1976); Leung,

[3]For information about the design and results of the specific NCLAN experiments, refer to Heck et al. (1982).

Reed, and Geng (1982); Foster et al. (1983); Rowe and Chestnut (1985); Clark, Henninger, and Brennan (1983); and Keller (1985).

7.2.2.3 Quantifying Benefits through Nonliving Systems

Degradation of many materials, including metals, masonry, and paints, is accelerated by exposure to pollutants. For example, corrosion rates for galvanized steel and zinc as well as erosion rates of carbonate stone have been studied and strongly linked to acidic deposition. Building stone, which includes limestone and marble, is also affected by pollutant emissions. Painted surfaces incur the largest economic losses from pollutant exposures (Bernabo et al., 1988). Although the physical links between pollutant emissions and materials damages are well established, the precise quantitative relationship between degradation rates and exposures are not. The effectiveness of preventive maintenance has further complicated the assessment of pollution damages. Therefore, quantifying the effects of pollutant emissions on materials and structures may be quite difficult. Nonetheless, because reductions in materials damages could constitute a significant economic benefit of an air quality regulation, it is important to describe these effects to the greatest extent possible, even if only qualitatively.

7.2.3 Monetizing Benefits

Monetizing the benefits of a regulation involves estimating society's willingness to pay (WTP) for quantified changes in environmental service flows. In economics, WTP refers to the maximum amount an individual is willing to pay to acquire a benefit. It is measured as the reduction in income required to return an individual to the level of utility he or she enjoyed prior to receiving the benefit. An alternative measure of economic value is an individual's willingness to accept (WTA) compensation to forego a benefit. Conceptually, WTA is measured as the minimum compensation to required for an individual to achieve the same level of utility he or she would have attained if the benefit had been realized. From a theoretical perspective, the appropriate measure (WTP or WTA) depends on the implicit property rights in the valuation context, and the two measures should be close in value. WTP estimates have been generally preferred in the empirical economics literature. The remainder of this section is devoted to describing the methods used to estimate WTP for environmental improvements.

7.2.3.1 Monetizing Health Benefits

Nonfatal Illness and Injury (Morbidity). Economists use a number of approaches to monetize a change in the number of cases of a particular morbidity effect. The four primary approaches are cost-of-illness (COI) methods, expressed preference methods, averting action methods, and hedonic wage and property value methods. Of these, COI methods are most often employed in economic analyses of human health benefits. Other methods include risk-risk tradeoffs, health state indexes, and damage award approaches. The four primary approaches are examined below.[4]

Cost-of-Illness Approach. Because of the difficulties associated with generating or using estimates of WTP for reductions in the risk of nonfatal illness or injury, analysts often prefer valuation methods based on the avoided costs of illness or injury. The COI approach to morbidity valuation measures the direct and indirect costs resulting from a health effect. Direct costs include such things as the value of goods and services used to diagnose and treat individuals suffering from the health effect. Indirect costs consist primarily of foregone productivity measured by lost wages. Total COI is the sum of direct and indirect costs. Because the COI approach does not account for the full range of costs associated with an illness or injury (e.g., pain and suffering are not included), the results of these analyses should at best be viewed as lower-bound estimates of society's WTP for reductions in such risks.

As mentioned above, the theoretically appropriate measure of economic benefits is society's WTP to reduce the risk of a health effect (i.e., society's WTP to avoid the risk prior to the actual occurrence of a health effect). It is important to note that the COI approach measures costs after a health effect has occurred rather than an individual's WTP to avoid the health effect in the first place. In addition, the COI approach measures the costs to the individual (out-of-pocket costs and lost wages), the costs to the individual's employer (in the case of paid sick leave), and the costs to third-party payers (payment of insured medical expenses or charity care), but not changes in individual well-being caused by the illness.

There are two primary approaches to measuring COI: the prevalence approach and the incidence approach. The prevalence approach measures total costs of a particular illness

[4]For a thorough discussion of the full set of methods used to value nonfatal health effects, readers are referred to IEc (1997).

or injury in the population for a given year. In contrast, the incidence approach measures the cost of an individual case of illness from onset through recovery or death. For assessing the benefits of OAQPS regulations, the incidence approach to measuring the cost of an illness or injury is most appropriate because the health benefits of OAQPS regulations are typically expressed in terms of the number of cases of a particular health effect avoided as a result of the regulatory action. Use of the prevalence approach would be appropriate if the effect of a regulation eliminated a particular health effect.

Expressed Preference Methods. Expressed preference methods, including contingent valuation (CV) and conjoint analysis, can be used to elicit an individual's WTP to avoid a given health effect. CV techniques are the primary expressed preference method used to estimate health effects. CV uses surveys to directly elicit an individual's WTP to reduce the risk of a given health effect. In particular, a CV survey asks each respondent about his or her personal characteristics, attitudes concerning the commodity being valued (reductions in the risk of an adverse health effect in this case), and WTP to acquire the commodity. From the survey responses, analysts can estimate WTP to reduce the risk of an adverse health effect as a function of personal characteristics and attitudes.

Although they are the most broadly applicable valuation methods, CV techniques remain controversial because of their hypothetical nature. In particular, there are two primary criticisms of CV. First, because an individual will not actually have to pay the amount he or she indicates in response to the survey, the individual may have little incentive to respond truthfully. Second, critics contend that survey respondents often are unable to comprehend the commodity they are being asked to value; particularly when the commodity is a very small change in the risk of experiencing a health effect. Proponents of CV assert that many of the problems raised by critics can be effectively controlled through good survey design. Although OAQPS generally does not conduct original CV studies due to time and other resource constraints, analysts should be mindful of these criticisms when using existing CV estimates to monetize benefits.[5]

Rather than directly asking an individual his or her WTP, conjoint methods ask individuals to choose among different sets of alternatives. Each alternative is broken down

[5]Analysts planning to use WTP estimates developed using the CV method are referred to the fall 1994 issue of the *Journal of Economic Perspectives* for a more thorough discussion of the debate over CV. A detailed discussion of benefits transfer issues is presented in Section 7.3.

and described according to a common set of attributes, usually including the health effect of interest and some monetary measure. The levels of these attributes are varied across alternatives. By analyzing an individual's choices across a number of pairs of alternatives, analysts can derive estimates of the trade-offs the individual is willing to make among the different attributes (including cost), thereby estimating the individual's WTP to acquire a change in an attribute such as reduced risk of a specific health effect. Although conjoint analyses show promise in valuing health effects, these techniques are not commonly used for such a purpose.

Averting Action Methods. In the face of a potential risk, individuals will often take defensive or averting action. For example, in the case of groundwater contamination, averting action might include purchases of water filters, bottled water, and other alternative water supplies. In the case of air pollution, averting actions may include such things as avoiding going out of doors. These types of observable behavior can provide analysts with information about an individual's WTP to avoid specific health risks; however, more generally they provide information about the costs of these behaviors, their relation to the source of such risk, and the magnitude of cost savings that would result from controlling the source.

As noted above, examining averting behavior provides the analyst with information regarding individuals' WTP to avoid exposure to a source of risk. Averting actions taken in response to risk may also enter the regulatory analysis in the risk assessment to the extent that these actions reduce the overall exposure of the population to harmful pollutants. If the exposure assessment of a regulatory analysis takes into account changes in averting behavior between the baseline and control scenarios, then the cost savings attributable to the reduced need for averting action can be considered one component of the benefits of the rule. When examining expected reductions in averting behavior, the analyst must be careful not to double count. In particular, analysts must estimate the benefits to those who, because of the rule, change their averting behavior separately from those who experience a reduction in exposure (and subsequent risk) without changing their own averting behavior. To the former, averting expenditures measure potential cost savings resulting from the rule. To the latter, averting expenditures provide an estimate of WTP to avoid exposure.

Averting action methods are often preferred to expressed preference methods because they are based on actual behavior; however, measuring the benefits and costs of averting actions is often difficult. First, to determine an individual's WTP to avoid a specific health

effect by examining his or her averting behavior, it may be necessary to determine the benefit the individual expects to receive as a result of his or her averting actions. Second, averting actions are typically taken to avoid a health outcome by reducing the individual's exposure to a harmful event. Therefore, WTP measures estimated based on averting actions are usually employed as estimates of WTP to avoid exposure and not as measures of WTP to avoid a specific health effect.[6] Therefore, using averting action methods to value specific health outcomes of an OAQPS rulemaking may be difficult.

Hedonic Methods. Two common applications of hedonic methods are used to value changes in health risks: hedonic wage models and hedonic property value models. Hedonic wage models are based on the premise that, all else equal, an individual working in a risky occupation will require higher compensation for his or her labor than will the same individual working in a less risky occupation. By examining wage differentials among individuals working in various occupations, analysts can estimate a worker's WTA for exposure to higher levels of risk on the job.

Hedonic property value models are based on the theory that the price of a residential property is equal to the discounted present value of the lifetime residential value of the home. The price of the home can then be estimated as a function of its structural characteristics and the characteristics of the surrounding community. By estimating housing prices over a range of properties, each with varying structural and community characteristics (including air quality), analysts can infer a household's WTP for each of these characteristics. For a good example of a hedonic study designed to estimate the value of avoiding environmental health risks, see Mendelsohn et al. (1992).

Fatality. The benefits of OAQPS regulations can also include reductions in the risk of premature death. The economics literature discussing the value of changes in fatality risks is rather extensive and provides a relatively strong basis for monetizing benefits when the number of deaths avoided as a result of a regulatory action can be calculated.

Value of a Statistical Life (VSL). Monetary estimates of changes in fatality risk are often expressed in terms of the VSL. The term "value of a statistical life" is easily misinterpreted and should be carefully described when used in benefits analysis. In particular,

[6]One exception is Dickie and Gerking (1991) who use individuals' expenditures on air conditioning and electric (rather than gas) stoves to model WTP to avoid acute health effects of air pollution.

VSL refers to the WTP for reductions in the risk of premature death aggregated over the population experiencing the risk reduction; that is, VSL refers to the sum of many small reductions in fatality risks.[7] For example, if the annual risk of death is reduced by 1 in 1,000,000 for each of 2,000,000 people, then two statistical lives are saved each year as a result of the risk reduction measures. If each individual is willing to pay $5 for the risk reduction of 1 in 1,000,000, then the value of each statistical life saved is $5 million.

The basic assumption underlying the VSL approach is that equal increments in fatality risks are valued equally. For example, a reduction in the risk of death of 1 in 1,000,000 is valued the same whether or not the original fatality risk was 1 in 100,000 or 1 in 1,000,000. This assumption is generally defensible if the level of risk prior to the change is small (usually 1 in 100,000 or less) as is usually the case for fatality risks resulting from environmental hazards. Because economic theory maintains that the marginal utility of risk reduction is an increasing function of the level of baseline risk, this assumption may not be valid for risks greater than 1 in 100,000.[8] For similar reasons, the VSL approach is only appropriate for marginal changes in the risk of death and should not be used to value more significant changes. Because changes in individual fatality risks resulting from environmental regulation are typically very small, the VSL approach is usually acceptable for OAQPS benefits analyses.

The literature indicates that empirical estimates of WTP for risk reduction are sensitive to whether the risk is borne voluntarily. In general, it is believed that risk-averse individuals have a greater WTP for marginal risk reductions than those who choose risks voluntarily. Because most VSL studies are based on wage compensation data, the results are applicable to changes in voluntary risks, and the population over which these values are estimated is often not representative of the population affected by a regulation; however, because, as noted above, fatality risks from both involuntary environmental hazards and occupational fatality risks tend to be quite small, using VSL estimates developed using wage compensation data is reasonable.

In the past, most EPA analyses have used point estimates of VSL derived from the economics literature. There are two alternatives to this approach. First, analysts could apply

[7]It is important to note that VSL does not attempt to value the life of an identified individual.

[8]See Chapter 10 of Freeman (1993) for a more detailed discussion of the diminishing marginal utility of risk reduction.

a range of VSL values found in the existing literature to develop upper- and lower-bound estimates of the total value of lives saved as a result of a regulation. This approach, however, often gives equal weight to very high and very low estimates that may be found infrequently in the literature. Alternatively, analysts could use distributions of VSL values rather than point estimates or ranges. Distributions give quantitative weights to the likely accuracy of the different VSL estimates based on the frequency with which they are found in the existing literature.

In assessing the benefits of the CAA, analysts conducted a meta-analysis of VSL estimates found in the literature and fit the results to a Weibull distribution to characterize the range of possible benefit values (EPA, 1996a). This approach revealed that the majority of VSL estimates found in the literature tend to cluster in the range of $3 million to $7 million, with a central estimate of approximately $5 million. A review of methods used by EPA in valuing changes in mortality risks conducted for OP by Chestnut, Mills, and Alberini (1997) notes that there is an insufficient empirical basis to justify the disparity in VSL estimates chosen across programs within the Agency. Although this report does not recommend specific VSL estimates to be used in EPA economic analyses, it does suggest that the central tendency of $5 million revealed in the CAA benefits analysis may provide the best starting point.

Value of a Statistical Life Year (VSLY). An alternative method of expressing reductions in mortality risk is the VSLY. For example, if a regulation is estimated to save one statistical life among a population of working adults whose average life expectancy is 40 years, then the regulation would result in 40 life-years extended. In general, there are two methods for valuing the number of life-years extended:

- applying results from studies in which the WTP for a risk reduction is estimated as a function of age; and
- annualizing VSL estimates using an appropriate discount rate and average life expectancy.

Both of these approaches have some fundamental shortcomings. In particular, when deriving values of risk reduction as a function of age, the type of risk and the size of the marginal change in risk used to estimate the value of a risk reduction must closely match the risk reductions resulting from the regulation. Annualizing VSL estimates does not provide an independent estimate of VSLY but simply rescales the VSL estimate. Current research does

not suggest a definitive method for estimating VSLY that is sensitive to such variables as current age, latency period, life-years remaining, and the social value of different risk reductions.

7.2.3.2 Monetizing Ecological Benefits and Benefits to Materials and Structures

Once changes in ecological service flows have been identified and quantified, analysts can use a number of valuation methods to monetize the benefits of a regulation. The four primary methods for monetizing ecological benefits are

- hedonic property value models,
- travel cost models,
- expressed preference methods, and
- market models.

Table 7-1 shows the categories of benefits for which each of these valuation methods is most applicable. Each of these methods is briefly described below.

Hedonic Property Value Models. As noted above, hedonic pricing theory maintains that the housing market functions as a market for environmental quality insofar as environmental quality is a characteristic of the property being purchased or of the community in which the property is located. Although often used to assess WTP to avoid environmental health risks, hedonic property value models can be used to estimate the value individuals and households place on the perceived amenity and recreation benefits provided by the property. In addition, hedonic methods could conceivably be used to estimate housing damages related to pollutant exposure; however, these methods have not been used for this purpose to date.

Travel Cost Models. Travel cost models have become a common method in the economics literature for estimating the benefits of environmental improvements to recreators. For example, these models can be used to estimate anglers' WTP to reduce toxic contamination of a water body that otherwise would be subject to a fish consumption advisory (see, for example, Montgomery and Needelman, 1997). Most often, travel cost models take the form of a discrete-choice model known as a random utility model (RUM) in which a recreator's choice among a set of unique recreation sites is modeled as a function of the

Table 7-1. Applicability of Valuation Methods to Assess Categories of Ecological Benefits

	Aesthetic and Other Amenity Benefits	Recreation Benefits	Passive Use and Nonuse Benefits	Reduced Damage to Materials and Structures	Agricultural Productivity Gains
Hedonic Property Value Models	✔	✔			
Travel Cost Models		✔		✔	
Expressed Preference Methods	✔	✔	✔		
Market Models				✔	✔

characteristics of that site, including environmental quality. Because these models assume that the cost of reaching each site is a function of travel and time costs, researchers can exploit observed differences between travel distance and environmental quality to estimate the monetary value of each site characteristic.

Expressed Preference Methods. Analysts use two primary expressed preference methods to estimate the value of improvements in ecological systems. These include CV studies and conjoint analyses. The characteristics of these methods are described in Section 7.2.3.1, but it is important to note that only expressed preference methods can be used to estimate nonuse values. Examples of CV studies used to estimate the value of environmental improvements are Krutilla (1967) and Kopp (1992).

Market Models. Market models can be used to assess the impact of changes in ecological services on both producers and consumers of market goods that rely on these services. Producers often use natural resources as inputs into the production of goods and services. To the extent that the quality of a natural resource such as groundwater is affected by regulations designed to reduce the ambient concentrations of pollutants in groundwater, so too will the cost and mix of inputs. These changes in the input mix and production costs can be modeled using a firm's cost and factor demand functions. The resulting market supply function can be coupled with the demand for the good or service being produced to determine changes in producer and consumer surpluses. In addition, when the market good of interest is

an agricultural commodity, changes in increases in crop yield related to decreases in ambient pollutant concentrations can be directly analyzed by estimating changes in consumer and producer surpluses in the market for that commodity.

7.2.3.3 Benefit Values per Unit of Emissions

Often, the effect of a regulation on ambient concentrations of pollutants cannot be easily determined. Likewise, it may be difficult to estimate the dose-response relationship or concentration-response relationship needed to quantify the effect of a regulation on environmental service flows. As an alternative to identifying, quantifying, and monetizing the benefits of a regulation, it may be possible to forego the quantification step altogether and directly relate changes in pollutant emissions to monetized environmental benefits. The two most commonly studied types of pollutants are criteria air pollutants and greenhouse gases. The results of these studies are presented below.

Criteria Air Pollutants. In developing its RIA for the recently proposed particulate matter (PM) and ozone NAAQS, EPA estimated values for several impacts resulting from reductions in ambient levels of ozone and particulate matter (PM). Although not entirely comprehensive, these estimates include health values (mortality and morbidity), visibility values, changes in agricultural productivity, and damages (soiling) to structures.

In a more recent analysis of its proposed PM and ozone rule for controlling emissions from pulp and paper production (EPA, 1997a), EPA used the PM and ozone NAAQS rule analysis to develop unit (i.e., per ton) estimates of the value of emissions reductions for volatile organic compounds (VOCs), PM, and sulfur oxides (SO_X). This was accomplished by allocating the estimated total value of the NAAQS rule to each category of emissions and then dividing these values by the respective emissions reduction estimates. The unit estimates and their suggested application are shown in Table 7-2. Note: These estimates and their applications are shown here for expository purposes only. Future analyses using the benefit-per-unit-of-emissions approach should consider estimates most appropriate for the regulated pollutant of interest.

Greenhouse Gas Emissions. The global warming impacts of greenhouse gas emissions have been widely studied over the last decade. These include impacts on agricultural production, sea level rise, biological diversity, fresh water supplies, and human health. The

Table 7-2. Examples of Estimated Value per Mg for Selected Pollutants (1996$)

Pollutant	Location	Estimate	Benefit/Mg	Application
VOC		Low estimate	$588	Apply only to VOC emissions reductions estimated for areas with ozone concentrations that would potentially violate the ozone NAAQS
		High estimate	$2,656	Apply to all VOC emissions reduction
PM			$12,992	Apply to all PM emissions reductions
SO_2	Eastern U.S.	Low estimate	$5,834	Apply to all SO_2 emissions impacts estimated for eastern mills
		High estimate	$12,921	Apply to all SO_2 emissions impacts estimated for eastern mills
	Western U.S.	Low estimate	$4,221	Apply to all SO_2 emissions impacts estimated for western mills
		High estimate	$5,035	Apply to all SO_2 emissions impacts estimated for western mills

Source: U.S. Environmental Protection Agency. November 1997a. "Benefits-Transfer Analysis for Pulp and Paper." OAQPS Staff Paper. Research Triangle Park, NC: OAQPS.

range of uncertainty associated with estimates of these impacts is generally quite large, and relatively few of these studies have attempted to measure these impacts in monetary terms. Nevertheless, a few studies do exist that provide order-of-magnitude estimates of monetary damages per unit of greenhouse gas emissions. Table 7-3 summarizes a number of these estimates. Most of these studies have used focused primarily on the global costs of sea level rise and damages to agriculture, although the later studies include more complex models of the interactions between economic activity and climate changes and have included estimates of nonmarket impacts. It must be emphasized that these estimates are preliminary and are very sensitive to the assumptions and features of the respective models, such as the climate change model used, the discount rate used (usually between 2 percent and 6 percent), the time frame selected, and the future economic growth rates assumed.

As with all benefits transfers, analysts should exercise caution when using estimates of the benefits per unit of emissions in an economic analysis of an air regulation. In particular, analysts should clearly identify the benefits categories to which these values apply. Analysts should also describe the methods used in the original empirical studies to estimate these

Table 7-3. Estimates of the Global Social Costs of Greenhouse Gas Emissions

Study	Chemical	Chemical Name	Units	Range	Average	Time Period Covered
Nordhaus (1991[a] and [b])	CO_2	Carbon dioxide	$/tC	[a]	7.3	1991-2030
Ayers & Walter (1991)	CO_2	Carbon dioxide	$/tC	30 – 35		2001-2010
Nordhaus (1992)	CO_2	Carbon dioxide	$/tC	5.3 – 10	7.68	1991-2030
Peck & Teisberg (1993)	CO_2	Carbon dioxide	$/tC	10 – 22	15	1991-2030
Fankhauser (1994)	CO_2	Carbon dioxide	$/tC	20.3 – 27.8	24.05	1991-2030
Fankhauser (1994)	CH_4	Methane	$/t$CH_4$	108.0 – 176.0	141.25	1991-2030
Fankhauser (1994)	N_2O	Nitrous oxide	$/t$N_2O$	2,895.0 – 4,489.0	3666.0	1991-2030
Fankhauser & Pearce (1994)	CO_2	Carbon dioxide	$/tC	[a]	20.4	
Fankhauser & Pearce (1994)	N	Nitrogen emitted as nitrous oxide	$/Kg	[a]	2.94	
Fankhauser & Pearce (1994)	CH_4	Methane	$/t$CH_4$	[a]	110.0	

Note: All units are metric tons unless otherwise noted.

[a] Data or range not available.

benefits and the methods by which these study results were translated into benefit values per unit of emissions. In addition, analysts should note the magnitude of emissions reductions estimated in the original study and the corresponding range of emissions reductions expected to result from the rule in question. It is important to consider that, at the margin, the effects of emissions reductions may differ depending on the baseline level of emissions, and the magnitude of the planned emissions reduction. Finally, analysts should consider the population affected by emissions reductions in the original study and the population expected to be affected by the rule in question. It may be necessary to adjust the per-unit benefits to reflect such differences. For a more detailed discussion of benefits transfer, see Section 7.3.

7.3 Benefits Transfer

Monetizing the benefits of a regulation typically involves using benefits transfer; that is, applying monetary values estimated in existing empirical studies to assess the value of a quantified effect in a different study. In practice, this approach typically involves searching the relevant empirical literature to identify existing studies that value effects similar to those in which the analyst is interested. For example, if an analyst is evaluating the benefits of a regulation for which the primary benefit is X premature deaths avoided, then the analyst will want to identify studies that have estimated the values of a premature death avoided (i.e., the VSL saved).

Once a relevant study (or studies) has (have) been identified, the analyst will need to apply the results found in the study to his or her own economic analysis. In general, this can be done in one of two ways:

- by applying per-unit value estimates from the existing literature to the quantified effects in the regulatory analysis, or
- by using the functional form and parameter estimates presented in the existing literature, along with data describing the population affected by the regulation, to derive a new set of value estimates specific to the regulation.

The first approach (value transfer) is the simpler of the two methods; however, if the analyst chooses this approach, he or she must use caution in identifying the empirical study (or studies) to be used. In particular, to ensure that the results of the benefits transfer are defensible, the analyst must ensure that the commodity valued in the existing study is comparable to the identified benefit of the regulation and that the study population over which the existing value estimate was derived is sufficiently similar to the population that will receive the regulatory benefit.

The second approach (functional transfer) alleviates a majority of the problems associated with specifying the appropriate population. For example, if the existing literature defines WTP to avoid a premature death as a specific function of income or age, then this relationship can be used to more accurately specify a value estimate for the regulatory context. If the population affected by a rule has a high average income or age, then the benefit function can be used to estimate WTP conditional on these characteristics. Compared to using an unconditional unit-value estimate from existing studies, this approach should provide a value

that more accurately reflects the affected population's WTP. Even though the functional transfer approach enables the analyst to tailor the empirical results to the specific population of interest, the analyst must still ensure that the effect being analyzed in the existing literature resembles, as closely as possible, the effect of interest to the analyst.

Analysts applying benefits transfer techniques are referred to the March 1992 edition of *Water Resources Research* for a thorough discussion of the advantages and criticisms of using benefits transfer.

SECTION 8

GENERAL METHODOLOGICAL ISSUES

Several methodological issues are fundamental to any EA. Addressing these issues is necessary to ensure that the benefits and costs of a regulatory option can be directly compared with each other and with the benefits and costs of other regulatory options. This section focuses on four general methodological issues:

- specifying the time period of analysis,
- specifying a baseline for analysis,
- discounting benefits and costs, and
- addressing uncertainty.

8.1 Specifying the Time Period of Analysis

By their nature, most regulations impose costs and confer benefits for many years. In fact, the intent of a regulatory action is usually to correct a current problem indefinitely. As a result, EAs of regulatory actions must be designed to facilitate the comparison of regulatory benefits and costs over time. However, because analytical resources are not unlimited and because the accuracy of cost and benefit estimates decreases for values far in the future, it is often necessary and appropriate to limit that time period to a finite time period. There is frequently no clear basis for determining the appropriate time period for analysis. The time period must allow the analyst to capture any specific identified changes expected to occur over time, and it must be applied consistently to the calculation of both benefits and costs.

It is common practice to calculate the costs of a regulatory option over the period of time corresponding to the expected useful lifetime of capital equipment purchased to comply with the rule. For example, if the capital equipment purchased as a result of the rule has an expected useful life of 15 years, an analyst might calculate the expected costs of the rule over a 15-year period. For consistency, benefits should be calculated over the same 15-year period.

It is often not necessary to extend the time period of analysis beyond the length of a single capital life cycle. In most cases the estimated benefits and costs of distant years will not differ substantially from those of the years immediately following the effective date of the regulation. Also, it is often difficult to predict factors, such as the development of new technologies, changes in demand, or changes in behavior patterns, that could cause substantial changes in costs or benefits over time. Therefore, the benefits and costs estimated for the first several years will typically represent all that can be said in the analysis regarding the impacts of the rule for the indefinite future.

Some of the benefits resulting from actions taken during the capital life cycle, however, may not be realized during the time period of analysis. For example, if the cost analysis calculates costs over a 15-year period, the benefits analysis should include any benefits realized during Years 1 through 15 as well as any benefits realized after Year 15 attributable to actions taken to comply with the regulation during Years 1 through 15. Benefits realized in Year 20 should be counted if they are related to compliance actions taken in Year 15 or earlier; they should not be counted if they are related to actions taken in Year 16 or later. In general, benefits realized in the future should be counted in the analysis if they can be directly related to actions taken during the period of analysis used for estimating costs.

For some regulations, using the equipment cycle criterion to select the analysis time period may be difficult to apply either practically or conceptually. From the practical standpoint, a regulation might require the regulated entity to purchase multiple capital equipment items, each having different service lives. In these cases, determination of the appropriate capital cycle is a judgment call. In other cases, the capital cycle may be of limited conceptual relevance. For instance, the required capital expenditure might simply involve a one-time expenditure to change a production process, or it may involve the acceleration of purchases that would be made as normal business practice (e.g., accelerated replacement of equipment). Because both of these situations involve an initial expenditure of funds to generate service flows over time, they are appropriately viewed as capital expenditures. However, in contrast to the purchase of a specific piece of equipment, the “useful life” of the one-time expenditure or accelerated expenditures is not as well defined.

An example of an OAQPS regulation in which useful life conceptual issues arise is the architectural coatings rule (EPA, 1998b). That rule required some producers of architectural coatings to reduce the content of volatile organic compounds (VOCs) by reformulating their products. Reformulation—for the purposes of compliance—would presumably occur only

once. In that regard, the useful life of this initial action is not necessarily confined to a finite period, as would be the case for equipment that physically depreciates and must be replaced at some point in the future. An alternative view is that reformulation is a normal business practice and that the rule requires some producers to simply expedite that process. The EIA prepared for the architectural coatings presents a variety of different service life interpretations for the reformulation requirement and evaluates their cost implications.

One way to minimize the confusion surrounding the capital cycle issue is to convert all costs and benefits to their annualized equivalents. This does not entirely circumvent the service life issue. The analyst must still select a service life over which to annualize any capital requirements. However, it ensures that costs and benefits will be compared on a consistent time frame basis and does not require the arbitrary selection of a multiyear time period for analysis. Moreover, issues of economic significance addressed in various statutes and EOs (e.g., UMRA and EO 12866) often use annual impact as a criterion.

Discounting may also provide some perspective on the appropriate time period of analysis. In particular, once discounted future benefits or costs become negligible, little is gained by extending the analysis further into the future. It is important to note, however, that this method of determining the time period of analysis is highly sensitive to the discount rate used. Discounting methods and rates are discussed in more detail later in this section.

8.2 Specifying a Baseline for Analysis

To develop estimates of the benefits and costs of a regulatory option, the analyst must project what the world would look like if the provisions of the rule are enacted—the post-regulation state of the world. To clearly identify the effects of the rule, the analyst must then characterize the world in the absence of the regulation and compare the two states of the world. The expected state of the world without the regulation is referred to as the baseline. Although many issues must be decided when establishing a baseline for use in an EA, a 1997 EPA policy briefing provides recommendations that should apply to all baseline decisions (EPA, 1997i). In particular, the policy briefing recommends that analysts should

- use a realistic set of assumptions about expected future conditions in the absence of the program;
- use a consistent baseline in all parts of the EA;

- identify those assumptions that most affect benefit and cost estimates and concentrate scarce analytical resources on refining and exploring these assumptions;
- emphasize a single baseline for clarity of presentation but present analyses with a range of relevant baselines when appropriate; and
- clearly describe the assumptions underlying the specification of the baseline, measurement of the baseline, and the reasons why the chosen specification is appropriate.

According to OMB's guidance for conducting EAs, "the baseline should be the best assessment of the way the world would look absent the proposed regulation" (OMB, 1996). Developing such an assessment has many components, including

- forecasting economic activity in the absence of the regulation;
- assessing the rate of compliance with existing regulations;
- anticipating future regulatory actions by other Federal agencies, by other offices within the Agency, and by State, local, and tribal governments;
- anticipating the effects of nonregulatory programs; and
- developing a starting point for the baseline.

Each of these components is discussed in more detail below.

8.2.1 Forecasting Economic Activity in the Absence of the Regulation

Typically, for OAQPS regulations, forecasting economic activity centers on predicting the levels of production and consumption of the regulated product in a world without the regulation.[1] To generate accurate cost and benefit estimates, it is necessary to incorporate changes in production expected during the period of analysis into the baseline scenario.

Analysts use three basic approaches to specify baseline production:

- *Project changes in production over time*—Obtaining or developing very specific estimates of changes in production levels over time may be possible. Alternatively, it may be possible to apply constant rates of change to current production

[1]Although production and consumption can differ by changes in the stock of inventories, it is assumed for the purpose of this discussion that production equals consumption and the change in inventories is zero.

estimates (e.g., current production totals 1 million units and is expected to grow at 3 percent annually). However, this approach can impose significant computational burden on the analyst and may not yield a great deal of information.

- *Estimate current production and hold constant*—In many cases, changes in production are difficult to predict or do not have much impact on the conclusions of the analysis. For example, if both benefits and costs for all options are directly proportional to the level of production, the level of production will influence the magnitude of the cost and benefit estimates but will have no impact on the ranking of options or on the determination of whether they offer positive net benefits. In such cases, forecasting changes in production should not be necessary.

- *Estimate "representative-year" production and hold constant*—Even if the level of production is expected to change over time, it may be possible to develop an estimate for a single year that represents some weighted average of the level of production over the entire period of analysis. Alternatively, it may be reasonable to project production levels for up to 5 years into the future and use the fifth-year estimate as the expected level of production in the remaining periods. This approach combines the advantages of the first two approaches. In particular, it will account for changes in production over time and therefore approximate the correct magnitude of benefits and costs without the need for separate year-by-year calculations.

8.2.2 Assessing the Rate of Compliance with Existing Regulations

Often a planned regulatory action is intended to modify an existing Agency rule. In such cases, the baseline must incorporate some assumption regarding the rate of compliance with existing rules. The determination of a baseline must also include some assessment of expected future compliance with existing rules. The primary reason for establishing current compliance is to better gauge the likely effectiveness (benefits) of the proposed regulation as well as the costs.

Although there is no stated Agency policy regarding the treatment of current compliance in establishing the baseline, most EAs assume full compliance with existing regulations. In reality, overcompliance and noncompliance exist. For example, in certain industries air pollutant emissions are below the maximum level allowed by existing emissions standards. In other cases, plants may be out of compliance with emissions standards, and their noncompliance is undetected because of variability in enforcement efforts across states. The question the analyst must consider in developing a baseline is simply whether the full-compliance assumption makes sense for this analysis. For example, when the purpose of a

rule is to clarify enforcement or monitoring procedures, assuming full compliance with existing regulations may understate the benefits of the regulation if its primary purpose is to improve compliance with existing regulations. Likewise, if the purpose of the rule is to strengthen existing requirements in an industry that is performing better than the current rule requires, assuming compliance with the current standards would overstate both benefits and costs.

Realizing that the full-compliance assumption simplifies an analysis and that determining actual levels of compliance can often be costly, a 1997 EPA policy briefing on selecting a baseline for analysis recommends using actual compliance estimates when establishing a baseline for the following types of regulations:

- procedural, enforcement, and monitoring rules;
- rules strengthening current standards when noncompliance is common among regulated entities;
- rules loosening current standards (deregulation) when noncompliance is common among regulated entities; and
- any rulemaking undertaken when the performance of regulated entities exceeds current requirements (EPA, 1997i).

8.2.3 Anticipating Future Regulatory Actions by Other Federal Agencies, by Other Offices within the Agency, and by State, Local, and Tribal Governments

In the United States, regulatory authority is shared not only by a number of agencies within the Federal government, but also among State, local, and tribal governments. Sometimes the regulatory programs of these entities overlap. For example, emissions from pesticide production facilities may be regulated under the CAA, but the pesticide products themselves are regulated under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), as chemical substances under TSCA, and as food additives under the Food, Drug, and Cosmetic Act (FDCA). Therefore, any forecast of future conditions ideally considers the potential regulatory actions of other agencies or levels of government.

In establishing a baseline, it is reasonable to assume that previously promulgated regulations and regulations that will be promulgated prior to the effective date of the rule being analyzed are in full effect at the time of the analysis. The potential impacts of rules in earlier stages of development are more difficult to assess. The two most practical methods for

addressing these potential actions are to discuss rules that may affect the baseline qualitatively and to assume that the effective dates required by statute or listed in the *Unified Regulatory Agenda* will be met and incorporate the expected impacts of these rules in the baseline.

8.2.4 Anticipating Nonregulatory Factors

Over time, both industrial and household behavior may change in a way that affects output and pollution levels for reasons completely independent of any regulatory requirement. For example, firms may also modify their behavior and resulting pollutant loadings to avoid litigation. As judicial decisions clarify or redefine property rights, polluting firms may adjust their behavior to reduce emissions; reduce exposure; or increase safety for their workers, their consumers, or the surrounding community. One factor causing changes in behavior may be the Agency's nonregulatory initiatives. For example, information provided by EPA's Design for the Environment program may result in firms choosing EPA-recommended equipment over other alternatives that would result in higher pollutant emissions.

The effects of nonregulatory factors are often ignored in developing a baseline for EAs usually because of limited time and resources available for conducting an EA. Ideally, however, these effects should be included, to the extent feasible, in the baseline. At a minimum, nonregulatory factors that could reasonably be expected to influence the baseline should be discussed qualitatively.

8.2.5 Developing a Starting Point for the Baseline

Once the fact that an agency is considering a regulatory action becomes public, households and firms may begin to adjust their behavior in anticipation of the rule. As a result of such preemptive actions, the state of the world may change prior to promulgation of the rule. The question then becomes whether these changes should be included in the baseline or considered an effect of the rule.

Whether actions taken by potentially regulated entities after a pending rule becomes known, but prior to rule promulgation, should be considered part of the baseline depends on the answer to a hypothetical question. If these actions would not likely continue if, for some reason, the rule is not promulgated, then the actions themselves are viewed as being caused by the rule and should therefore should *not* be included in the baseline. If, instead, these actions would likely persist even in the absence of a final rulemaking, then these changes cannot easily be attributed to the rule itself and should be considered part of the baseline. If an activity is

included in the baseline, then its costs and its benefits should not be attributed to the rule in the EA.

If the analyst believes that behavioral changes induced by knowledge of the regulatory action should be considered an effect of the rulemaking, the baseline should begin at the date corresponding to the first public notice of the rulemaking. In the case of a regulatory action required by statute, this would be the date the legislative action requiring the rule becomes law. When a regulation is a result of an Agency initiative, independent of a statutory deadline, knowledge of the proposed action typically becomes public by official notice (e.g., ANPR or NPRM) in the *FR* or through the rule's inclusion in the *Unified Regulatory Agenda*. If, instead, the analyst believes that actions taken in anticipation of the rule should not be considered a direct result of the rulemaking, then these anticipatory actions should be included in the baseline. Then the baseline should begin either at the date of promulgation or the effective date of the rule.

8.3 Discounting Benefits and Costs

The manner in which the benefits and costs of a regulatory action are discounted to account for differences in their timing is perhaps the most contentious of all methodological issues in the economic analysis of environmental policy. The reasons for this are both simple and complex. The simplicity derives from the fact that the mere mechanics of discounting can have a decisive impact on whether benefit-cost results favor a particular action because environmental regulation often involves costs now and benefits later. When discounting is used, the future benefits decline in comparison to the present costs. When a higher discount rate is used, the results are less favorable for the action generating the future benefits. The complexity derives from the fact that the decision to discount future events involves implicit acceptance of certain political and economic philosophies, and the selection of an appropriate discount rate requires consideration of what some policymakers might perceive as complex economic concepts.

With the controversy and complexity of discounting as background, the *Journal of Environmental Economics and Management* (*JEEM*) in 1990 devoted an entire issue to the conceptual, empirical, and practical considerations of the discounting issue. This issue of *JEEM* helped elucidate many of the issues, but it did not—nor did it intend to—arrive at a set of recommended rules for applying discounting methods in environmental policy evaluation. In 1996, EPA convened the Economic Consistency Workgroup. This workgroup

commissioned a series of "White Papers" to address a number of methodological issues, including social discounting. These white papers will provide the basis for the issuance in 1998 of an agencywide guidance document for economic analysis. The white paper on discounting is an important reference point for the current document.[2]

Abstracting from these earlier and ongoing assessments of discounting methods, the following discussion addresses discounting considerations in economic analysis of OAQPS regulations. The issue is addressed by first describing why discounting is necessary to evaluate both private decisions and public policies. Then, the mechanics of discounting in net present value methods are presented. The discussion then focuses more specifically on which discount rate is appropriate for annualizing capital costs, and it presents prescriptions other researchers have made for costing methods that are consistent with principles of welfare economics. Economists have recently defined the openness of capital markets as a key determinant of the aggregate social cost of a policy intervention. That issue is addressed here both in the context of aggregate social benefit-cost analysis found in EAs and the more narrowly scoped assessment of impacts found in an EIA. The discussion concludes with a recommendation for capital cost discounting in economic analysis of OAQPS policies.

8.3.1 Basic Considerations in Discounting

Discounting is the process by which the different time streams of benefits and costs of a particular action can be placed on a comparable basis. Discounting is relevant for private consumption and investment decisions and therefore is relevant, in a somewhat more complicated manner, for public decisions that affect consumption and investment patterns of individuals affected by the decision.

8.3.1.1 Discounting and Private Decisions

In this context, private decisions refer to choices made by households and firms that affect the allocation of their own resources over time. The general premise is that both households and firms are not indifferent to the time pattern of resource allocation. Both prefer to either consume (households) or receive profits (firms) and income (households)

[2]The white papers and agency guidance document are, at the time of this writing, evolving documents. Latest versions can be obtained from the Economy and Environment Division of EPA's Office of Policy (formerly Office of Policy, Planning, and Evaluation).

sooner rather than later. There are two basic models demonstrating time preferences for consumption and investment.

Consumption. For ease of presentation, the term household is used synonymously with the individual consumer. While some models distinguish between individual and group (household) decisions, those distinctions are not addressed here.

Households are typically viewed as seeking to maximize their utility over time. Utility (U) is dependent on the consumption of goods and services (C):

$$U = U(C) \tag{8.1}$$

More consumption yields higher utility (i.e., $\partial U/\partial C \geq 0$). The need to discount can be evaluated by considering consumption over two time periods. This evaluation can be extended to more time periods without loss of generality. The two-period objective function is specified as follows:

$$V = U(C_0) + U(C_1)/(1+\rho) \tag{8.2}$$

where V is the present value of the utility gained from consumption in the current (0) and next (1) period and ρ is the single-period discount rate for consumption. Generally, $\rho > 0$, reflecting the notion that a unit of consumption deferred to the next period is valued less by the household than if the unit were consumed presently. In this context, ρ is often referred to as the marginal rate of time preference or the consumption rate of interest. Therefore, when households evaluate the consequences of an action that alters consumption patterns over time, for instance, by investing (reducing consumption) today to generate future benefits (increased consumption) in the future, they will generally require more consumption in the future to compensate for a given level of foregone consumption today.

Investment. Investment is the process of expending funds today to purchase an asset (capital) that generates a stream of future income. Although asset characteristics differ across households and firms, the underlying concept of an opportunity cost of the investment is relevant across all asset types. Consider an investment requiring I_0 of funds today that returns income of Y_1 a year from now. The net present value (NPV) of this action can be expressed

$$Z = Y_1/(1+r) - I_0 \tag{8.3}$$

where Z is the NPV of the investment and r is the single-period discount rate. Generally, $r > 0$, reflecting the notion that income received next period is valued less than current income.

This discount factor, r, is conceptually distinct from the consumption rate, ρ, referenced above, in that it reflects the opportunity cost of capital committed to the investment rather than the disutility of deferring consumption. The reason to discount future income streams generated by an investment is that committing funds to that particular asset requires foregoing income streams from alternative investments. The term, r, reflects the rate of return on alternative assets. Thus, the I_0 worth of funds allocated to this investment could generate a return of $I_0(1+r)$ next period if invested elsewhere. Therefore, the expected income next period, Y_1, must be discounted by the factor (1+r) to appropriately value the investment. Having performed the appropriate discounting, the investment should be undertaken if the NPV, Z, is positive.

Another way to characterize the situation is in terms of capital's rental cost. Investing ties up capital in the ownership of the asset. By not allowing these funds to flow elsewhere, the capital is "rented" in the form of this particular asset. Ignoring the issues of asset service life, depreciation, and capital gains, the rental cost of capital is $r \bullet I_0$, also referred to as the annualized cost of capital.

Summary Point. The motivation for discounting in private decisions is similar, whether the decisionmakers are households or firms and whether the economic activity is consumption or investment. In all cases, the future is discounted relative to the present. Households discount future consumption because they prefer present consumption. Firms and households discount the future returns from an investment because the capital tied up in the investment could be invested elsewhere. The mechanics of discounting are essentially the same in both situations, with the consumption rate of time interest (ρ) determining the value of consumption streams and the opportunity cost of capital (r) determining the value of investment streams. However, as discussed below, these two discount rates will, in general, differ. Therefore, discounting methods must account for these differences.

8.3.1.2 Discounting and Public Policy Decisions

While the private decisions just described are driven by the benefits and costs accruing to the individual household or firm making the decision, public policy decisions must account for the benefits and costs accruing to the entire society, empowering the public decisionmakers. Hence, the term *social* benefit-cost analysis (SBCA) is used for the types of public decisions faced by EPA.

Assuming that public policies have the objective of raising society's welfare, the time preferences of that society are relevant to the benefit-cost criterion for public policy analysis. As described above, people generally demonstrate a preference for current consumption over future consumption. Moreover, investing funds in a particular project foregoes an income stream generated by another use. Therefore, policies that require investment and alter the time pattern of consumption must account for these temporal factors, hence the need to discount in SBCA.

Economic welfare measures are generally derived from the consumption of goods and services. As a result, SBCA should be ultimately translated to corresponding effects on society's consumption patterns over time. Differences in consumption across time periods can be compared after adjusting for the consumption rate of interest, which is the rate of return at which individuals are willing to trade off current consumption for future consumption.

At this point, the distinction between the benefits and costs of a regulatory action is important. The appropriate welfare measure for benefits is the amount that parties are willing to pay to obtain these benefits. An example might be the amount parties are willing to pay to reduce the population risk of cancer by 0.1 percent. For all intents and purposes, this can be viewed as a consumption equivalent, and the multiperiod consumption model presented above applies. Then, benefits that accrue over time can be compared and aggregated using the consumption rate of interest.

The social cost of a regulatory action is the value of opportunities foregone by allocating resources to the activity. Society could have otherwise used the funds for current consumption or invested those funds in other economically productive activities (thereby enhancing future consumption). Once costs are expressed in consumption equivalents, they can be discounted at the same rate as benefits. Special discounting issues related to the social opportunity cost of mandated capital expenditures and its connection to the capital cost estimated in an EIA are addressed in more detail below.

The need to discount in benefit-cost analysis of public policies can be summarized as follows:

1. Environmental regulation implicitly aspires to raise social welfare.

2. Social welfare, as modeled in economics, is determined by consumption of market and nonmarket goods and services; therefore, the effects of a particular policy or

regulation should be transformed to consumption equivalents to evaluate its welfare consequences.

3. The evaluation of the social welfare consequences of policies that affect current and future patterns of consumption should account for the fact that individual members of society are generally observed to value current consumption more than future consumption.

4. Discounting is the mechanism by which these preferences are imposed on social welfare measures of policy options.

The two-stage discounting procedure can be used to discount benefits and costs of a regulatory action in a theoretically consistent manner.

8.3.2 The Two-Stage Discounting Procedure[3]

The *shadow price of capital* approach calls for converting all mandated private capital costs to annualized consumption equivalents by using an estimate of the pre-tax private rate of return to generate the annual stream of costs (foregone consumption) (Kolb and Scheraga, 1990).[4] This cost stream can then be converted to a present value using the consumption rate of time preference. The cost value can then be compared to the present value of benefits, which is computed using the consumption rate of time preference exclusively. This method is applied by using the two-stage discounting method discussed in this section.

The two-stage discounting procedure uses two different discount rates (see Scheraga, 1989). This approach is a variant of the shadow price of capital approach in that capital costs are adjusted upward to reflect the social cost of displaced investment before benefits and costs are discounted at the consumption rate of interest. The steps involved in the two-stage discounting process are as follows:

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[3]In October 1992, OMB issued a revised version of its Circular A-94, which contains guidance on discounting in regulatory analyses. OMB's 1996 economic analysis guidance defers to the 1992 Circular. EPA's Office of Policy continues to examine this issue through the development of its new EA guidance document, and changes in EPA's recommended discounting methods may be forthcoming.

[4]The discount rate reflecting the opportunity cost of capital, as specified in OMB Circular A-94, is currently estimated to be 7 percent. This represents the average of the returns on low-yielding capital investments, such as housing, and the returns on high-yielding investments, such as corporate capital. OMB's EA guidance recommends using the opportunity cost of capital for discounting in EAs of regulations (OMB, 1996).

1. Annualize capital costs over the expected lifetime of the capital equipment using the opportunity cost of capital. In ISEG, 7 percent is typically used as the opportunity cost of capital (consistent with OMB Circular A-94). After annualizing capital costs, add annual noncapital costs to annualized capital costs to yield total annual costs.

2. Discount the stream of annualized costs at the consumption rate of interest. In general, this rate will be lower than the opportunity cost of capital. As described below, 3 percent is commonly used for the consumption rate of interest. The stream of benefits is also discounted using this rate.

These procedures result in present value cost and benefit estimates that can be directly compared with one another and with other present value estimates.

To illustrate how the two-stage discounting procedure works, consider the following example.[5] A regulatory option will impose $20 million in capital costs during the first year for equipment that is expected to last 15 years. In addition, there will be $5 million in annual operating costs, also beginning in the first year. Benefits of $8 million will be realized each year over the 15-year time period. The question is whether the $8 million in annual benefits exceed the costs.

Stage 1: Annualize Costs

To estimate the present value of the costs of the regulation over the useful life of the capital, it is first necessary to annualize the capital costs, using the opportunity cost of capital. Annualization is the calculation of the value that, if paid out in equal annual amounts over a specified period and discounted, would be equal to the present value.[6] Annualization is the calculation of the value **x** that solves Eq. (8.4).

$$I = \frac{x}{(1+i)} + \frac{x}{(1+i)^2} + \ldots + \frac{x}{(1+i)^n} \qquad (8.4)$$

[5]This example is borrowed directly from the document, *Guidance on the Preparation of Economic Analyses in OPPT*, Office of Pollution Prevention and Toxics, Economic Analysis and Policy Branch, September 1998c.

[6]This is identical to the types of calculations made to determine mortgage payments or car payments.

where

I = the present value of the capital investment,

x = the annualized value,

i = the discount rate, and

n = the number of years over which the value is annualized.

Note that the annualized costs are evaluated as if they occur at the end of each year. The annualized capital cost can be computed by manipulating Eq. (8.4) to solve for x as follows

$$x = I \frac{i(1+i)^n}{(1+i)^n - 1} \qquad (8.5)$$

In this example, the annualized cost of I = $20 million over n = 15 years at i = 7 percent is approximately $2.2 million. For purposes of calculating the total annual costs of the regulation, the annualized capital cost of $2.2 million is added to the $5 million in costs incurred each year for a total annual cost of $7.2 million.

Stage 2: Compute "Consumption Equivalent" Present Value of Costs and Benefits

In the second stage, the annual values estimated in the first stage are converted into a present value, using the consumption rate of interest. This calculation can be performed using Eq. (8.4), with the following values: x = $7.2 million (total annual cost), i = 0.03 (the consumption rate of interest), n = 15 years. The present value of an annual cost of $7.2 million over 15 years at a 3 percent discount rate is $85.9 million.

To calculate the present value of benefits, the same procedure described above for the second stage of the cost calculation is used. In this example, the annual benefits are $8 million per year. The present value of a 15-year annual stream of benefits, using a 3 percent discount rate, is $95.5 million. This regulatory option would therefore yield positive present value net benefits of $9.6 million ($95.5 million benefits minus $85.9 million costs) over the period of analysis.

It is important to note that in this example the calculation of present value benefits and costs is not necessary to determine the correct decision. Once the annualized total costs are

estimated, enough information is revealed to determine the annualized net benefits of the regulation. In cases such as this, in which both benefits and costs can be expressed at a constant rate over the same time period, calculating the present value of net benefits is redundant. Instead, annual costs (with capital costs annualized using the opportunity cost of capital) can be compared with annual benefits. If annual benefits exceed annual costs in each year, then the net benefits of the rule will be positive.

If, however, benefits vary across years or accrue over a time period different from the one in which costs are incurred, the full calculation is necessary to determine whether the net benefit condition is met. In such cases, the analyst will typically calculate the present values of both the cost and benefit streams. Alternatively, the present value of the stream of benefits can be calculated and then annualized over the time period in which the costs are imposed to facilitate an annual comparison.

Regardless of whether costs are expressed on an annualized or present value basis, it is critical that

- any calculations make proper use of discounting procedures and rates to arrive at the correct annualized or present value, and
- the same procedures be used to calculate benefits and costs when these values are to be compared. In other words, if costs are expressed in annualized terms, benefits should be expressed on the same basis.

8.3.3 Discounting Issues Deserving Further Attention: Nonmonetized Benefits and Long Time Horizons

Although reviewing all the economic theory relating to the discounting of benefits is beyond the scope of this economics manual, discounting nonmonetized benefits and benefits accruing to future generations merits some further discussion.

As mentioned above, EPA guidelines indicate that benefits should be discounted using the rate of time preference. It is important to note that both quantified and monetized benefits should be discounted. On conceptual grounds, benefits that are quantified but not monetized can be discounted in the same manner as monetized benefits. The absence of monetary values simply means that nonmonetized benefits cannot be compared directly to monetized benefits or costs. However, if these benefits are quantified by some nonmonetary metric (e.g., adverse health effects avoided) there is no reason, in principle, why future effects should not be discounted relative to present effects. The underlying premise is that these quantified

effects positively affect utility, thereby carrying some (apparently unmeasurable) value society is willing to pay. Thus, discounting these benefits is no less warranted than discounting monetized benefits.

Discount rates essentially reflect choices revealed in credit markets by the current generation. In some instances, however, the benefits of a regulatory action may accrue well into the future (e.g., reducing the threat of catastrophic climate change). These situations raise unique questions about intergenerational equity. Because the parties benefitting from such regulations are not yet born, it is not clear whether a market-based rate of time preference adequately incorporates the expected utilities of future generations.

Analysts disagree whether long time horizon problems merit special consideration. Some economists and policy analysts argue that benefits accruing to future generations should not be discounted at all. Others believe that intergenerational concerns can often be addressed by using a social rate of time preference—the rate of time preference modified to reflect intergenerational equity considerations (EPA, 1997j). The draft EPA white paper on discounting suggests that when faced with a situation involving intergenerational concerns, the analyst should acknowledge that both sides of this debate have merit and calculate the present value of future benefit streams using both a zero discount rate (not discounting at all) and the rate of time preference (effectively discounting all expected future benefits in the same way) (Arnold, Sussman, and Deck, 1997). The analyst should refer to OP's forthcoming *Guidelines for Economic Analysis* (referenced in Section 1) for further guidance on discounting methods for long time horizon problems.

8.3.4 Discount Rates and the Capital Costs of the Regulation

The basic premise of the two-stage discounting method is that a different rate should be used to annualize the capital costs of a regulation than is used to discount streams of benefits and costs through time. In EIAs or EAs performed by ISEG, the selection of the rate to annualize costs is at least as important, if not more so, than the rate used to compute present values of the net benefits. This is particularly true when all costs (and/or benefits) are computed on an annualized basis, as they are with many of the analyses performed in ISEG. In those cases, the rate used to compute present values is moot, and the *only* discount rate that matters is the rate used to annualize capital costs. As a result, the selection of the proper rate to annualize capital costs is of paramount importance in ISEG analyses.

8.3.4.1 Conceptual Issues

Government can intervene to achieve public policy objectives in essentially two ways. One is to use public funds to produce a good or service that the private sector cannot or does not have the incentive to produce (e.g., national defense). The other is to mandate private expenditures to achieve a public objective. The importance of distinguishing between public programs and mandated private expenditures relates to the opportunity costs of the funds spent on the activity. Although much of the discussion surrounding social discount rates draws from examples of public expenditure (see Lind, 1990), mandated private expenditure is relevant to the discussion of environmental regulation and is the point of departure here.

Sectoral vs. Economywide Measures of Social Costs. Before proceeding, important points must be made regarding factors that often complicate the dialogue on costs, economic impacts, and social welfare. One is the need to distinguish between the social cost measured in the economic sector directly affected by the regulation and the total social cost of a regulation. Section 5 of this document demonstrates how to estimate social cost-based measures (i.e., producer and consumer surplus) of the regulation in the directly affected industries (markets). There may be differences between those measures and the "true" social cost due to the indirect effect that changes in the regulated market might have on other sectors of the economy. This issue has typically been viewed from a pragmatic standpoint. Except in cases where the direct impacts in one market are extremely large and/or cut across many sectors of the economy (e.g., climate change) it is usually acceptable to ignore the muted indirect impacts in other markets and take the impacts in the directly affected markets as the appropriate measure. When the impacts are too large to ignore, it may require the use of general equilibrium modeling approaches to capture these impacts (e.g., Hazilla and Kopp, 1990). General equilibrium considerations are not addressed in the present discussion. Instead, the key issues relate to the emerging literature on discount rates (as summarized in the EPA White Paper), namely, that the assumption one has about corresponding effects in the capital market determines the appropriate rate for estimating aggregate social costs.

This section continues with a discussion of methods for annualizing capital costs in a typical EIA. The primary objective of an EIA is to estimate the magnitude of a regulation's cost and the distribution of the burden of those costs among the producers and consumers in a particular regulated industry. EIAs generally give a first-order approximation of the total social cost of a regulation. The second part of the discussion considers factors that *may* impart differences between the social costs estimated in an EIA and the "true" aggregate

social costs of a regulation. Of particular concern is the role that assumptions on the mobility of capital may have on differences between these two estimates. Because the EIA is often the basis for the cost estimate in a full SBCA required in an EA, the discussion attempts to reconcile the two measures. This identifies the critical assumptions and parameters determining their difference and allows the analyst or policymaker to choose between methods based on the reasonableness of the underlying assumptions and parameters.

8.3.4.2 Estimating Capital Costs in Economic Impact Analysis

The CAA as amended requires that an EIA be performed to estimate the costs of a set of pollution control responsibilities and to determine how those costs are distributed among producers and consumers in the regulated industry. As part of an EA, the SBCA compares the social costs of a regulation to its social benefits to help policymakers assess whether the regulation is justified under the provisions of EO 12866—Regulatory Planning and Review. As indicated in Section 2 of this document, EAs (SBCAs) are required only for regulations deemed to be economically significant. Therefore, while many OAQPS regulations require an EIA, relatively few lead to SBCAs (EAs). Nonetheless, it is important that EIAs generate information that is transformable to a full SBCA. Specifically, the EIA should produce an estimate of the social cost of a regulation that is theoretically consistent and therefore comparable to estimates of social benefits, should the comparison be called for in a subsequent SBCA.

Typically, the EIA is preceded by an analysis that estimates the cost of regulatory compliance for each pollution source subject to the regulation. The pollution sources in the analysis may constitute a full and exhaustive census of all facilities in the regulated industry or, more likely, an array of model facilities or some combination of actual and model facilities. Consistent with the goal of estimating the size and distribution of social costs among different parties affected by the regulation, and given that the distribution of these costs is largely determined by economic behavior, an EIA ideally employs an analytical framework that captures the effect of the control responsibilities in a market setting. The modeling mechanism for capturing these market effects is discussed in Section 5.

The firm that is faced with pollution control responsibilities will incur the cost of the required capital equipment. Operating and maintenance (O&M) costs are ignored here to focus on the capital discounting issue. The current discussion also ignores the need to periodically replace the capital equipment and simply assumes that the service life of the

capital is infinite. As a consequence, the annualized cost of the capital purchase is rK where K is the purchase price of the compliance capital and r is the firm's cost of capital. The cost of capital represents what it must give up (annually) to make this capital purchase. This is either the foregone opportunity to invest K worth of internal funds in another investment, to distribute K worth of funds to shareholders, or to repay a party for lending it the funds to invest K in pollution control. In any case, the cost of compliance capital reflects the rate of return the funds can achieve in another use.

As indicated in Section 5, a market model can be constructed to simulate economic behavior on the part of producers responding to compliance requirements and consumers responding to any corresponding change in price. As a result, the burden will, in general, be shared by producers and consumers as measured by changes in producer and consumer surplus. For ease of exposition, the present discussion assumes that the producer absorbs the entire cost of the regulation (i.e., no change in market prices or consumption occur), but the main result can be generalized to cases where the burden is shared with consumers.

If producers absorb the full cost of a regulation, then their pre-tax profits decline by the amount of the compliance cost. This is given by

$$\Delta\Pi = -rK \tag{8.6}$$

However, producers pay taxes (T) to the government, based on their level of profits (Π)

$$T = t \bullet \Pi \tag{8.7}$$

where t is the tax rate on profits. Because producer profits decline by the amount of the compliance cost, their taxes fall as well. As a result the net post-tax loss to the producer is

$$\Delta PS = \Delta\Pi \bullet (1–t) = -rK \bullet (1–t). \tag{8.8}$$

However, there is also the net loss in tax receipts to the government

$$\Delta GS = -rK \bullet t. \tag{8.9}$$

The total welfare loss due to the regulation, as measured in the market for the regulated product, is

$$\Delta WF = \Delta PS + \Delta GS = -rK \bullet t - rK \bullet (1–t) = -rK. \tag{8.10}$$

Therefore, pre-tax measures, such as the market rate of return on capital, determine the absolute size of welfare effects, though the distribution is affected by taxes. This demonstrates the point that the private cost of capital is the appropriate measure for estimating welfare impacts (annualized capital costs) in the regulated market.

General Conclusion about Discounting Costs in EIAs. An EIA can and should vary the market assumptions to generate a case between the full-cost pass-through and absorption extremes presented here, wherein the burden is shared between consumers and producers in the affected markets (and taxpayers). The magnitude of these impacts, however distributed, will still be determined by the producers' cost of capital. Thus, the prescription for capital discounting seems clear for EIAs—use the pre-tax rate of return on capital to measure the welfare impacts on the direct parties of interest. In fact, the EPA White Paper on discounting, which recommends against the use of the pre-tax rate of return on capital for estimating the social cost of a regulation under some circumstances, specifically recommends the use of this rate in the estimation of private-sector economic impacts in all circumstances. The (potential) difference between economic impacts and social costs is discussed in more detail below.

8.3.4.3 Reconciling Social Costs in an EIA with "True" Social Costs

In contrast to the sector-specific emphasis of the EIA, most of the theoretical literature on the discount rate for SBCAs implicitly addresses the issue from a more aggregate (economywide) perspective. In that context, the cost of a regulation is what society gives up by mandated private expenditures on pollution control. The sectoral and economywide perspectives are reconciled here and the extent to which they affect selection of the discount rate and calculation of social costs is addressed.

Capital Market Factors. Following Lind (1990) the current literature suggests that selection of the social discount rate depends on which of the following hypotheses about the capital market holds:

- The supply of capital to the economy is fixed ("closed economy").
- The supply of capital to the economy is variable ("open economy").

Each is discussed in turn below.

Capital Costs Under the Closed Economy Hypothesis. Under the closed economy hypothesis, mandated pollution control expenditures, by definition, displace other forms of private investment. As a result, the social opportunity cost of the mandate is the pre-tax

private rate of return of capital (i.e., the value of market goods and services that could have been generated had the displaced private investment occurred). More to the point of the present discussion, if the fixed capital/closed economy assumption holds, then the estimate of net welfare impacts from an EIA, which derives from the pre-tax rate of return of private capital, is a valid measure of social costs.

Argument for Lower Capital Cost Under the Open Economy Hypothesis . The gist of the open economy argument is capital supplied to any one industry is almost perfectly elastic; therefore, virtually limitless capital can be supplied to that industry without affecting the world price for capital. Moreover, the effect of environmental regulation's capital requirements on the U.S. economy, much less any one industry, is small relative to the global supply of capital and all other global capital demands. Thus, it is seen as unlikely that the global price of capital will change in response to a particular environmental regulation. Because the capital price does not change, the argument goes, all investments opportunities that would have been taken in the absence of the regulation will still be taken (i.e., no capital is displaced as a result of the regulation). For now, this is taken to mean that society does not forego investment opportunities to fund pollution control; rather it foregoes consumption. The consistency of the no-capital-displacement assertion with a model of global capital market equilibrium is addressed in more detail below.

If one accepts the notion that a regulation's capital requirements replace consumption rather than investment, the crucial point is that the opportunity costs of consumption and investment generally differ because of tax distortions in the U.S. and most other market economies. As discussed above, the opportunity cost of consumption is generally lower than the opportunity cost of capital. This point is demonstrated by reference to a model of a perfectly functioning, undistorted capital market. In such a world, the market rate of interest would simultaneously equal both the consumption rate of time preference and the private rate of return of capital. Any distinction about which discount rate to use would be moot—the market interest rate would serve the purpose. However, capital markets in most market economies, including the U.S., have a systematic distortion stemming from the fact that capital income is taxed and consumption (for all intents and purposes) is not. Therefore, capital investments must generate a pre-tax rate of return that is sufficient to satisfy the investor's willingness to trade consumption, which is purchased with post-tax income, between time periods. Therefore, in equilibrium, the capital market should produce the following relationship:

$$r(1-t^{rK}) = \rho. \quad (8.11)$$

The consumption rate of interest (ρ) equals the after-tax rate of return on private capital investment (r), which is presented as taxed at the rate, t^{rK}.[7] In short, the price at which individuals trade consumption through time (ρ) is lower than the rate at which capital generates consumable goods and services (r). Thus if pollution control expenditures replace consumption, the social costs are lower than if they replace capital investment.

The gap between the consumption rate of interest and the rate of return of capital has long been recognized and has been the impetus for the shadow price of capital (SPC) approach for discounting costs (Bradford, 1975). The SPC view is operationalized into the two-stage discounting procedure described above. Because it is a common practice in EIAs and SBCAs to express costs on an annualized basis, the critical point is that the pre-tax rate of return of capital should be used to compute the annualized cost. Thus, the social cost process outlined in the EIA discussion is entirely consistent with the SPC approach.

While the SPC view explicitly recognizes the difference between consumption and investment opportunity costs, the two-stage method still follows the implicit assumption that pollution control expenditures displace private capital investment. That is the premise of stage 1, in which the capital allocated to pollution control is converted to its consumption equivalent, that is, the amount of consumption (income) that could have been generated by a private investment. However, the open economy adherents would reject the stage 1 adjustment, or at least make it so that the consumption rate of the interest, ρ, is used in the stage 1 annualized cost assessment, thereby making the entire adjustment process redundant. In other words, the open economy view holds that no investment is displaced by the regulatory requirement; therefore, no upward adjustment for the opportunity cost of capital is necessary.

As a practical matter, this suggests that the market adjustment made in the EIA model, which is based on the private capital cost of r, leads to an overstatement of the true social opportunity cost of the regulation if the open economy assumption holds. Under the limiting case of capital with an infinite service life, the degree of overstatement is roughly given by the ratio of the two discount rates, r/ρ. For instance, if the EIA impacts are computed using a market rate of, say, 7 percent and the corresponding consumption rate of interest is 3 percent,

[7]Details on taxation of private capital investments and how that may differ between suppliers and demanders of capital are presented below.

EIA social cost impacts would overstate true aggregate social cost impacts by a factor of more than two. The distortion is reduced when finite capital service lives are considered.

Reconciling the Difference Between the Open Economy and Closed Economy Measures. It has thus far been argued that the pre-tax rate of return of capital, r, should generally be used for an EIA and that the consumption rate of interest, ρ, may be appropriate for estimating aggregate social costs under some circumstances. Given that this approach will lead to sectoral impacts that exceed social impacts, who in society receives the offsetting gains that are ignored in a typical EIA?

As demonstrated above, when investable funds are assumed fixed, the losses to the private sector and government (which sum up to the total social cost) equal the private cost of capital. However, when capital is fully mobile through a global capital market, the argument has been made that no investment has been displaced, only consumption. From the aggregate welfare perspective, the funds needed for pollution control in Industry X are reallocated from nontaxed activity (consumption) to a taxed activity (investment). Therefore, the government receives an increase in tax revenue directly from the new investment activity in the amount of ($t^{rK} \bullet rK$). Drawing again from the full-cost absorption example, Eqs. (8.9) to (8.10) are restated as follows:

$$\Delta PS = -rK \bullet (1-t) \tag{8.12}$$

$$\Delta GS = -rK \bullet t + rK \bullet t^{rK} = -rK(t-t^{rK}). \tag{8.13}$$

If the tax rate on profits is the same as the tax rate on investment income ($t = t^{rK}$), then the loss in profits tax due to the mandated investment is just offset by the gain in taxes from the capital income. Thus, the net effect on government revenues would be zero. In that case, the net welfare cost of the regulation is

$$\Delta WF = \Delta PS = -rK \bullet (1-t) \tag{8.14}$$

indicating that the after-tax rate of return of capital is the appropriate measure of social costs. In an efficient capital market, the after-tax rate of return of capital equals the consumption rate of interest (Eq. 8.9). Therefore, the consumption rate of interest would be used for discounting costs in this case.

In essence, while taxpayers were shown to bear part of the burden through a loss in profits tax under the closed economy/EIA model, they bear none of the burden in the open

economy model. So regarding the question of who gains in the aggregate social cost computation versus the sectoral impacts computation of social cost? The taxpayer.

More on Global Capital Markets and the Implications for Social Cost. The open economy arguments put forward by Lind (1990) and the EPA white papers on discounting (Arnold, Sussman, and Deck 1997) rely largely on heuristic descriptions of the global capital market and international flows of funds. To illuminate the displacement issue further, a simple model of a global capital market is put forth here.

The global supply of capital is a function of the global price of capital (r):

$$S_G = S_G(r). \tag{8.15}$$

The global demand for capital is the sum of the demand from U.S. Industry X that is directly affected by the regulation (D_X), all other U.S. industries (D_U), and all other sources of investment demand in the rest of the world (D_W):

$$D_G = D_X(r) + D_U(r) + D_W(r). \tag{8.16}$$

The global capital market equilibrium equates global supply with global demand:

$$S_G = D_G = D_X(r) + D_U(r) + D_W(r). \tag{8.17}$$

The equilibrium supply of capital to Industry X (S_X) is the "excess supply" of global capital not demanded by all other sources in the world market:

$$S_X = S_G(r) - D_U(r) - D_W(r). \tag{8.18}$$

Therefore, if the regulation imposes capital requirements that cause Industry X to increase its demand for investable funds, those funds must be supplied by some combination of an increase in global capital supply, displacement of capital invested in Industry X, displacement of capital to other U.S. industries, or displacement of capital to the rest of the world.

The common interpretation of the open economy hypothesis is that no investment is displaced by the claims on the capital market placed by regulatory capital requirements. Yet the global capital market equilibrium just described suggests that the capital needed for the expenditure mandated by the regulation must be diverted either from consumption or other capital uses to maintain a global equilibrium. But if the capital price does not change at all, there is no mechanism by which capital supplies will increase or capital will be diverted from other capital uses to fund the regulated industry's capital requirements.

Perhaps a more correct interpretation of the implications of a global capital market can be stated as follows. The investment requirements for a typical industry-level regulation are so small relative to world capital markets that

- the effect on the global capital price is indetectable and
- the displacement of global consumption, U.S. investment, and non-U.S. investment is imperceptibly small, relative to baseline values.

Thus, the notion that the global markets are essentially unaffected by the regulation's capital requirements would not be far from the truth.[8] In other words, a regulation requiring $20 million worth of capital expenditures is, no doubt, too small to materially alter the world capital rate or to have a noticeable effect on net global investment. However, it seems quite a different matter to conclude that the $20 million did not involve the displacement of other capital. Re-establishment of a global capital market equilibrium suggests that the $20 million must be supplied to Industry X through some combination of displaced consumption and displaced capital in other uses. Thus, the opportunity costs of the capital allocated to Industry X's compliance requirements will be a weighted average of the opportunity costs of displaced consumption and investment.

The extent to which displaced global consumption and displaced non-U.S. investment—rather than displaced U.S. investment—supplies the capital for Industry X's regulatory compliance will bring the (U.S.) social opportunity cost closer to the lower-bound (consumption rate) value proposed above. Again, this is because the regulation causes the substitution of taxed activity (*U.S.* investment) for nontaxed activity (consumption and *non-U.S.* investment). This reduces the burden borne by U.S. taxpayers in terms of reduced profit taxes from Industry X. Of course, the extent to which it is consumption and non-U.S. investment that is displaced, rather than U.S. investment, is an empirical issue.

8.3.4.4 Practical Concerns for the Policymaker and Analyst

The implications of the open economy model and the subsequent reduction in the social cost estimate raise a number of questions that are potentially crucial to the policy assessment. Two particularly important points are raised here.

[8]This is not inconsistent with the views attributed to Blinder (1985) and stated in Lind (1990, p. S-15) that crowding out (in their case due to deficit financing) is more likely to be small, rather than nonexistent when viewed in the context of global capital markets.

- ***Is it reasonable to assume that pollution control will not affect other investment opportunities for the regulated industry?***

  Whether private investment is displaced by pollution control seems, at least, an empirical question worthy of further pursuit, rather than a foregone conclusion by those advocating either the higher or lower discount rate. Macroeconomic studies of the relationship between government deficits and investment suggest that *government deficits* do not crowd out private investment (e.g., Evans, 1985). These findings have supported the notion that open global capital markets work to prevent federal deficits from crowding out investment and raising interest rates. The Lind (1990) article thus implies that the crowding out effect is not a terribly important consideration in the selection of a social discount rate for public expenditures. This has sparked the drawing of similar conclusions for the analysis of pollution control requirements and support for the use of the consumption-based discount rate (i), as described above. However, empirical studies that have looked specifically at mandated pollution control expenditures typically find a relationship between pollution control and other investment. Viscusi (1983) shows that environmental regulation can reduce productive investment due to the uncertainty it implies for investment returns. Gray and Shadbegian's (1997) study of environmental regulation in the pulp and paper industry finds that pollution control expenditures almost fully crowd out "productive" investment.

  The degree of friction in the regulated industry's access to capital markets will largely determine whether investment crowding takes place. If access to credit markets is constrained for pollution control investments, there is a stronger case that other private investments would be displaced and the opportunity cost would be captured by r, rather than i. These issues may be worth further scrutiny in an EIA if the regulated industry is dominated by small companies with limited debt capacity.

  To summarize the point, the potential for fully mobile global capital to mitigate the social costs of public programs is an important theoretical development in the economics literature. However, the application of this principle to the particular environmental regulation being analyzed should be justified empirically.

- ***Even when private investment is not displaced, is it reasonable to assume that tax revenues will be unaffected by pollution control investment?***

  The exact canceling out of tax effects as implied by Eq. (8.13) is unlikely to occur in practice. First, the corporate tax rate (t) will generally differ from the tax rate on investment income (t^{rK}) for U.S. citizens, which itself may differ from the tax rate on foreign investment income.[9] Second, the tax effects on regulated producers will be affected by rules governing cost recovery of depreciable assets. Third, there are state taxes to consider. Finally, the tax outcome is further complicated by the extent to which the funds used for pollution control capital are provided through debt, equity, or retained earnings. While it is possible to address some of these tax complications in an EIA, resource limitations will likely make it impractical to quantify the effect of these factors on the selection of a discount rate.

8.3.5 Empirical Evidence on Discount Rates

At this point, the reader may be misled to the conclusion that once one resolves the conceptual issues surrounding which discount rate to use (consumption rate or return to capital), the entire discounting problem has been solved. Unfortunately this is not the case, because complex capital markets generate a wide range of market rates that vary by factors such as the time commitment of funds and the degree of risk of the investment. As a result, there is no clear consensus about the appropriate rate to use either for the consumption rate of interest or the rate of return of capital. Some empirical evidence is presented below.

8.3.5.1 Consumption Rate of Interest

Market rates of return on relatively risk-free lending (e.g., Treasury bills) are often viewed as the appropriate proxy for the consumption rate of interest. Lind (1990), Moore and Viscusi (1990), and Freeman (1993) all argue for real (inflation-adjusted) rates in the 1 to

[9]Personal and corporate tax rates are probably more similar in the mid-1990s than they have been historically. Corporate tax rates in 1997 ranged from 15 to 38 percent (IRS Form 1120 instructions), while personal tax rates ranged from 15 to 39.6 percent (IRS Form 1040 instructions). However the highest personal income tax rates apply only to very high income households ($271,050 in taxable income). The amount of tax withheld from investment income accruing to foreign entities depends on the status of income tax treaties (or conventions) between the U.S. and the foreign country of interest. Foreign residents (sometimes limited to citizens) of those countries are often taxed at a reduced rate or are exempt from U.S. income taxes on certain income received from within the U.S. (IRS, 1998).

4 percent range for the consumption rate of interest. Lipscomb, Weinstein, and Torrance (1996) recommend a rate of 3 percent as the most reflective of real riskless rates of return. There is precedence elsewhere in EPA for using a 3 percent rate as representative of the consumption rate of interest (EPA, 1996).

8.3.5.2 Rate of Return on Private Capital

The 7 percent rate recommended by OMB (1992) is the point of departure for any discussion of private cost of capital in regulatory analysis. This rate is supposed to reflect the marginal pre-tax rate of return on an average private-sector investment. The OMB circular also stipulates that "analyses should show the sensitivity of the discounted net present value and other outcomes to variations in the discount rate. The importance of these alternative calculations will depend on the specific economic characteristics of the program under analysis" [Section 8(b)(2)]. Therefore, there seems to be some leeway to modify the analysis to reflect industry-specific real rates of return that are lower or higher than percent as part of a sensitivity analysis. For an EIA, knowledge of industry- (and firm-) specific capital cost factors will provide a more accurate analysis of distributional effects. Moreover, if the flow of capital funds is limited to the point that pollution control is thought to displace other forms of investment within the regulated sector (i.e., the "closed economy" assumption holds), then these foregone rates of return represent the magnitude of the social cost. Industry-specific rates of return on capital can be obtained from secondary data sources, such as Dun & Bradstreet.

8.3.6 Discounting Recommendations

The first, and strongest, recommendation is to use the pre-tax rate of return on private capital investment to discount costs for the typical EIA. "Typical" means an EIA for a regulation that mandates control responsibilities for a specific industry.[10] The rationale for this is that the private cost of capital determines the magnitude of these control cost responsibilities and therefore the size of the burden that will be determined by the sum of changes in producer and consumer surplus within the regulated sector, the focal point of an EIA. The OMB-recommended discount rate (7 percent) is the suggested default value for the real private cost of capital. If warranted, industry- and firm-specific rates of return can be used to modify this rate via sensitivity analysis. Also, to the extent that an EIA addresses

[10]Refer to Section 5 for a description of the typical industry-level analysis that is the focus of this document.

compliance requirements for the public sector, government borrowing costs should be considered, rather than the private rates.

A case has been stated that pollution control requirements in general may not displace other private investment in the U.S. economy. If so, then the sector-specific social cost estimate from the EIA, which uses the pre-tax rate of return of capital, must be transformed to a (lower) social cost value for SBCA, one based on the consumption rate of interest. Table 8-1 provides an example for the simplifying case of a regulation whose costs are entirely capital expenditures with an infinite service (i.e., expenditures are annualized into perpetuity).

Table 8-1. Transformation of Social Costs from an EIA to BCA

Type of Analysis	Required Capital Expenditures	Discount Rate	Annual Equivalent Cost
Economic Impact Analysis	$500 MM	7%	$35 MM
Benefit-Cost Analysis	$500 MM	3%	$15 MM

The cost estimate is reduced by more than 50 percent.[11] However, before making this transformation, the analyst should examine the empirical justification for doing so. Most importantly, does the evidence support the case that investment will not be displaced for the regulation in question? This may depend on characteristics of the industry and on the nature of the control responsibilities themselves. It is unlikely that a clear answer will result from this inquiry, so the analyst's most prudent strategy may be to present benefit-cost results both with and without the social cost transformation outlined above. This allows the analyst to determine whether the transformation has a decisive impact on the benefit-cost results and if the issue warrants further scrutiny.

8.4 Addressing Uncertainty

Because they are estimates, the results of an economic analysis of a regulatory action are never precise; however, many EAs present simple point estimates of expected benefits and costs without characterizing the uncertainties surrounding these values. Both EPA and OMB

[11]The magnitude of the cost difference is amplified by the infinite life assumption. If the capital equipment has a useful life of, for example, 15 years, then the annualized cost at 3 percent is only about one-quarter less than the annualized cost at 7 percent.

guidance require that such uncertainties be acknowledged and addressed in an EA. Therefore, the purpose of this section is to identify sources of uncertainty in EAs and to discuss methods available to analysts for characterizing and reducing uncertainty in the results of the analysis.

The term "uncertainty" simply refers to the confidence with which any estimate can be accepted as representing the true result of a process about which the analyst has incomplete knowledge.[12] It is important to note that in this discussion "uncertainty" is *not* used as a synonym for risk. The term "risk" is interpreted to mean the likelihood of a particular event occurring. For example, some OAQPS regulations are expected to result in a change in the probability that an individual or ecosystem will experience an effect as a result of an exposure to air pollution.[13] The level of this change in risk is a truth unknown to the analyst and is independent of the techniques used to estimate the risk. In contrast, uncertainty in the assessment of risk is an artifact of the analysis itself and can often be reduced by further study.

Uncertainty can arise at any stage in the development of a regulatory analysis. Within each stage of the analysis, uncertainty can result from any number of factors, including insufficient data, an incomplete understanding of the physical or economic process being modeled, model specification, and the inherent uncertainty in the results of any statistical analysis. A thorough treatment of all sources of uncertainty in a regulatory analysis is beyond the scope of this document. Therefore, the remainder of this discussion focuses on the uncertainties associated with the *valuation* of changes in environmental impacts.

There are three general sources of uncertainty in the economic analysis of a regulatory action: input uncertainty, model uncertainty, and estimation uncertainty. Each of these sources of uncertainty is described below:

- *Input uncertainty*—This is a general term used to describe two specific sources of uncertainty inherent in the data on which an economic analysis is based. These specific sources include the distribution of possible values of the environmental

[12]Both the OMB EA guidance (OMB, 1996) and the EPA working paper addressing uncertainty in EAs (Hagler-Bailly Consulting, Inc., 1997) include a discussion of certainty equivalents. Certainty equivalents are a theoretical construct for the value that a risk-averse individual places on an uncertain outcome. This type of uncertainty does not represent a lack of knowledge on the part of the analyst but rather a component of an individual's response to risk. Therefore, certainty equivalents are more appropriately addressed in a discussion of the expected benefits of a regulatory action rather than in a discussion of analytical uncertainty.

[13]Risk and risk assessment are discussed in detail in Section 7 of this guidance document.

impact being valued and measurement error. The former source of input uncertainty arises when the impacts being valued are themselves the product of a modeling effort as is often the case when the impact of interest is a change in exposure to a pollutant or a change in the probability of a certain outcome occurring. The latter source of input uncertainty, measurement error, is common when the data used in an economic analysis are incomplete and analyst judgement or proxy measures are used to fill in data gaps. The uncertainty surrounding such inputs will naturally be carried through the economic analysis.

- *Model uncertainty*—This type of uncertainty is typically a result of the fact that any statistical model represents a simplification of a behavioral or economic process. This simplification is often necessary because most behavioral and economic processes are highly complex. In addition, this simplification is necessary if the nature of the behavioral or economic process being modeled is not completely understood. In modeling such processes, analysts must often rely on a series of assumptions and abstractions, each having a potential impact on the precision of the analytical results.

- *Estimation uncertainty*—Economic analyses in which the analyst estimates a parametric model yield results that are variable. In particular, all statistical modeling techniques result in parameter estimates that are not point estimates, but rather probability distributions of likely values for the parameters. This distribution in parameter estimates naturally translates into a distribution of the predicted outcome variable. This *estimation uncertainty* requires that the analyst take care to assign the appropriate probability ranges around each estimated parameter or prediction.

Because of the uncertainties described above, the results of an EA must be presented in such a way that the full range of uncertainty is transparent. There are five basic methods for characterizing uncertainty:

- scenario analysis—estimating a range of possible outcomes, such as worst-case and best-case scenarios, in addition to the most likely outcome

- Delphi methods—using input from a group of experts to characterize the potential likelihood of possible outcomes

- sensitivity analysis—identifying assumptions made about key input variables (e.g., the level of exposure or the discount rate) and conducting the analysis over a range of plausible values for these variables to determine the effect of each assumption on the resulting point estimates

- meta-analysis—combining data or results from a number of different studies to estimate a more general model or to characterize the range or distribution of key input variables
- Monte Carlo and other probabilistic methods—simulating a distribution of the results by randomly drawing from the probability distributions of input variables and repeating the analysis numerous times

The draft EPA white paper on uncertainty recommends that, at a minimum, the analyst identify the key assumptions and qualitatively assess the potential impact of each assumption on the results of the analysis (Hagler-Bailly Consulting, Inc., 1997).

In addition, sensitivity analysis should be conducted to further characterize the impact of alternative values of key variables whenever possible. Scenario analysis and Delphi methods are useful when sensitivity analysis fails to adequately characterize the range of possible outcomes, particularly in situations in which there is a small risk of an extreme outcome. Meta-analysis and probabilistic methods are often superior to the other methods. Meta-analysis provides a more complete characterization of key input variables, and probabilistic methods provide a probability distribution for the full range of possible cost and benefit values.

Because Delphi methods, meta-analysis,[14] and probabilistic methods[15] often require substantial time and financial resources, the analyst should determine their likely contribution to the policy implications of the EA results. For analyses in which benefits unambiguously exceed costs, a sensitivity analysis should be adequate. However, in cases in which the results vary significantly depending on the underlying assumptions, other methods of characterizing the range and distribution of both input variables and results should be considered.

[14]For an example of the use of meta-analysis in determining the value of a statistical life to use in the analysis of environmental programs, readers are referred to EPA's analysis of the benefits and costs of the CAA (EPA, 1996a). Analysts interested in conducting meta-analyses are referred to Hedges and Olkin (1985) and Cook et al. (1992).

[15]An example of the use of Monte Carlo simulation in the analysis of a regulation is the CAA retrospective analysis (EPA, 1996a). More detailed discussions of probabilistic methods, including Monte Carlo simulations, can be found in most intermediate or advanced statistics and econometrics texts.

SECTION 9

COMMUNICATING THE RESULTS OF THE ECONOMIC ANALYSIS

The ultimate purpose for conducting the economic analyses described in this document is to inform decisionmakers of the social welfare consequences of the regulatory actions under OAQPS's consideration. One responsibility of the ISEG analyst is to develop a sound, comprehensive analysis that addresses these concerns. Toward that end, sound analytical methodology has been the primary focus of the document up to this point. However, another equally important responsibility is to communicate the results of the analyses in a manner that effectively influences decisionmaking. Without proper communication, the most well-conducted analysis will fail to guide decisions. Therefore, communicating the results of economic analysis to decisionmakers frequently, in a complete and understandable form, is an important part of the development of well-reasoned environmental policy.

The purpose of this section is to provide some general guidance and specific tips for communicating the results of economic analysis throughout the regulatory process. The primary focus is not the EA or EIA document itself—that is addressed throughout the other sections, especially in Section 4. Rather, this section focuses on the various opportunities that ISEG analysts have to bring the economic analysis to bear in making decisions throughout the regulatory process. A comprehensive treatment of communication issues is beyond the scope of this chapter. For more on this topic, the reader may wish to refer to the following sources:

Written Communication

Barzun, Jacque. 1976. *Simple and Direct: A Rhetoric for Writers*. Harper and Row.

Zinsser, William. 1985. *On Writing Well.* Harper and Row. Third Edition.

Strunk, William, and E.B. White. *The Elements of Style*. MacMillan. Various editions.

The Chicago Manual of Style. University of Chicago Press. Various editions.

Visual Communication

Booth, Wayne C., Gregory G. Colomb, and Joseph M. Williams. 1995. *The Craft of Research*. University of Chicago Press. (See especially Chapter 12: Communicating Evidence Visually).

Tufte, Edward R. 1997. *Visual Explanations*. Cheshire, CT: Graphics Press.

Tufte, Edward R. 1983. *The Visual Display of Quantitative Information*. Cheshire, CT: Graphics Press.

Oral Communication

Beebe, Steven A., and Susan J. Beebe. 1997. *Public Speaking: An Audience-Centered Approach.* Prentice-Hall.

Krannich, Caryl Rae. 1998. *101 Secrets of Highly Effective Speakers*. Impact Publications.

9.1 Communication Goals, the Audience, and Challenges

It is important to keep in mind that ISEG performs economic analysis not only to satisfy the various statutes and EOs by which the Agency is required to analyze the effects of its regulations, but also to ensure that decisionmakers (both within and outside the Agency) understand the full range of effects that Agency action (or inaction) will have on society. Thus, any strategy for communicating analytical results should hold improved decisionmaking as a central goal.

The opportunities ISEG analysts have to communicate analytical results throughout the regulatory process range from workgroup meetings to stakeholder interactions to formal presentations for senior Agency management. These exchanges may involve delivering written summaries of the EA/EIA results (preliminary, proposed, final) and making oral presentations. With either written or oral communication, it is important to target the audience in determining both the content and the method of delivery. Different objectives guide presentations to senior management, workgroup members, and stakeholders, so written and oral communications to those groups should differ as well.

The analyst must determine the information that the audience needs to know, either to make their decision (in the case of workgroup members or senior management) or to understand the impact of the regulation on their particular constituency (in the case of

stakeholders). If the audience is overwhelmed with needless detail, they may miss an important point.

ISEG analysts must consider the extent of the audience's background in economics. If the audience is not familiar with economics principles and methods, the ISEG analyst must present the analysis in a manner that is clear to a noneconomist. The audience should be able to deduce the logic of the underlying analysis without relying on terms and concepts outside their area of expertise. In this situation, the analyst should avoid excessive use of jargon. Also, the analyst should consider what elements of economics noneconomists often find either difficult to understand or, sometimes, difficult to accept: these include the concepts of opportunity cost, values of statistical lives saved, and discounting future benefits and costs, among others.

The basic principles of effective communication should be a guiding force, regardless of the medium in which the information is being exchanged. The next section identifies key principles relevant to communicating economics results.

9.2 Key Principles of Clear and Effective Communication[1]

To help the analyst present the results of economic analysis, six principles of communication are identified and briefly described below.

- **Use Clear and Transparent Language**: As indicated above, the ultimate objective of ISEG's economic analyses is to provide information to decisionmakers. Therefore, all aspects of the analysis should be presented in such a manner that the decisionmaker can completely understand the results of the analysis and the methods by which the results were derived. Analytical results should be able to withstand close scrutiny by the decisionmakers themselves and by external parties. Making the analytical results clear helps achieve that goal. On June 1, 1998, President Clinton issued a memorandum directing Federal executive departments and agencies to use "plain language" in the development of all Federal rulemaking activities. While the directive applies specifically to the publication of *FR* notices (see Chapter 3), the spirit of the memorandum is to encourage clear, understandable writing wherever possible.

[1]This discussion of communication principles borrows heavily from the draft guidance document *Guidelines for Preparing Economic Analyses*, prepared by EPA's Office of Policy. As of this writing, a preliminary draft of this document (July 1998d) is being circulated throughout the Agency for review and comment.

- **Identify Data Sources and Assumptions**: The EA/EIA document should always include a description of all data sources and references used in the analysis, subject to confidentiality constraints imposed by CBI agreements. This information should be presented in such a way that decisionmakers and other analysts can obtain these data and other source materials with relative ease. In addition, the analyst should clearly identify all relevant assumptions made in the course of the analysis.

- **Describe the Modeling**: For those not trained in economics and other quantitative disciplines, econometric and other economic models can often appear unapproachable. Therefore, it is important that the analyst describe the modeling techniques used in the analysis in clear and understandable terms. The level of detail of such a discussion will depend on the technical expertise of the audience. Analytical detail may be appropriate for an audience of economists but not for the wide range of disciplines typically represented in the workgroup or senior management. The discussion needs to be targeted to the audience. Providing the basic reasoning underlying the modeling framework not only bolsters the credibility of the results among noneconomists, but it also ensures that decisionmakers correctly interpret the results of the model.

- **Characterize Uncertainty**: As discussed at length in Section 7 of this manual, all EAs are subject to uncertainty. Uncertainty may arise from data, models, or general lack of information. When summarizing results for decisionmakers, the analyst should identify uncertainties that could alter a decision and explain the implications of plausible alternative assumptions.

- **Make Alternatives Comparable**: Because several regulatory alternatives are often evaluated at different stages in the regulatory process, the process of narrowing the field to a preferred alternative requires some form of direct comparison. The ideal way to communicate the full range of consequences of a regulatory option is to convert all of these consequences to a single metric. From the perspective of welfare economics, the most sensible metric is monetary, because it provides a platform for comparing the benefits of the action with its costs (i.e., the benefits that society foregoes to obtain the benefits of the regulation) in a manner that is consistent with the tradeoffs that members of society make all the time—the exchange of dollars for goods and services.

- **Clearly Identify Nonmonetized and Nonquantified Effects**: Often some of the consequences of a regulatory action are not able to be quantified or monetized. To the extent that the regulatory action being analyzed is expected to result in such costs or benefits, monetized benefits and costs may misrepresent the full range of impacts of the regulation. Therefore, it is important to clearly present the full range of benefits and costs that cannot be quantified or monetized. One way to

present these is through a table structured similarly to Table 9-1. Potential health effects of the regulatory action are identified, a subset of those identified are shown to be quantified in the analysis, and a subset of those quantified are shown to be monetized. This presentation provides some sense of the extent and nature of the omissions from the monetary estimate of benefits. This may become critical information if the monetized costs exceed the monetized benefits, in which case the decisionmakers must evaluate whether the implicit value of the nonmonetized benefits is high enough to favor regulatory action.

The method of presentation is particularly important for two types of economic results:

- net social benefits, and
- equity effects and economic impacts.

Table 9-2 provides an example of how net benefits results can be presented in an understandable manner. Eight different regulatory options are evaluated, starting with the least stringent option at the top of the table and working down to the most stringent

Table 9-1. Identified, Quantified, and Monetized Health Effects

Identified Health Effect	Quantified	Monetized
Children Health Effects		
Neonatal mortality	✔	
Fetal developmental effects		
Reduced intelligence	✔	✔
Growth interference	✔	
Adult Health Effects		
Premature death	✔	✔
Hypertension	✔	
Nonfatal heart attack	✔	✔
Reproductive effects		

Table 9-2. Sample Table of Net Benefits Estimates—Annual Net Benefits of Regulatory Options[a]

	Option	Annual Benefits[b,c] ($ million)	Annual Costs ($ million)	Total Net Benefits Per Year ($ million)
1.	Performance Standard A	10	7	3
2.	Performance Standard B	33	12	21
3.	Performance Standard C	40	20	20
4.	Performance Standard D	50	38	12
5.	Incentive Option A	75	35	40
6.	Incentive Option B	85	50	35
7.	Incentive Option C	100	75	25
8.	Incentive Option D	120	115	5

[a] Options are listed in order of increasing total benefits.
[b] The following effects on children could not be quantified and are not included in the benefits estimates: interference with growth, interference with nervous system development, impaired hearing, behavioral changes, metabolic effects, impaired heme synthesis, and anemia.
[c] Blood-pressure related effects could not be quantified for adult women and for selected age groupings of adult men and are therefore not included in the above benefits estimates. Similarly, reproductive effects in women could not be quantified.

option. Monetized benefits and costs are presented in separate columns. This presentation allows the reader to trace results presented in the table back to the respective cost or benefits chapter or section. The far right column presents the results (monetized net benefits). It is transparent to the reader that the net benefits estimate equals benefits less costs. For external comparisons, the table could include the year in which the dollars are denominated. If there are significant nonquantified or nonmonetized benefits or costs to consider, another column might be added to the right of the monetized net benefits column to identify these factors.

As discussed throughout this document, the focus of equity/impacts analysis is on the distributional consequences of rulemakings. The general analytical requirements for these analyses are outlined in Section 6. The key point in terms of presenting the results of these

analyses is to ensure that the results are sufficiently disaggregated to show impacts separately for the groups and sectors of interest.

9.3 A Note on Visual Communication

When the audience represents a diverse group of backgrounds and disciplines and particularly when the venue for communication is constrained by space or time, visual communication (graphs, charts, illustrations) often helps make the key points to the reader or audience. Supplementary to the age-old counsel that "a picture is worth a thousand words" is a telling passage found in one of the communications texts referenced at the beginning of this section:

> If displays of data are to be truthful and revealing, then the logic of the display design must reflect the logic of the analysis … Clear and precise seeing becomes as one with clear and precise thinking. (Tufte, 1997, p. 53)

Following this advice will help strengthen the link between sound analysis on the one hand and sound regulatory decisionmaking or a clear understanding of stakeholder impacts on the other. Not only should visual communication reflect the logic of the analysis, but the need to display results visually can also lead to a more logical analytic design.

Again, the reader can turn to the texts referenced at the beginning of the chapter for a more thorough treatment of the use of visual aids in reports and presentations. An example here can elucidate some key points. Tables such as Table 9-2 are ideal for reports, when the reader can take some time to inspect the detail. However, in an oral presentation, the audience might be distracted in their attempt to interpret the tabular data. Charts can provide a solution to this problem. Figure 9-1 translates the net benefits data from Table 9-2 to bar charts, where the apparent dominance of Incentive Option A and Incentive Option B becomes immediately apparent. Of course, information is lost in the translation—in this case, the underlying levels of benefits and costs. In each case, the presenter should evaluate whether the benefits of the simpler graphic approach (ease and speed of interpretation) outweigh the costs (lost information) in terms of meeting the information needs of the audience.

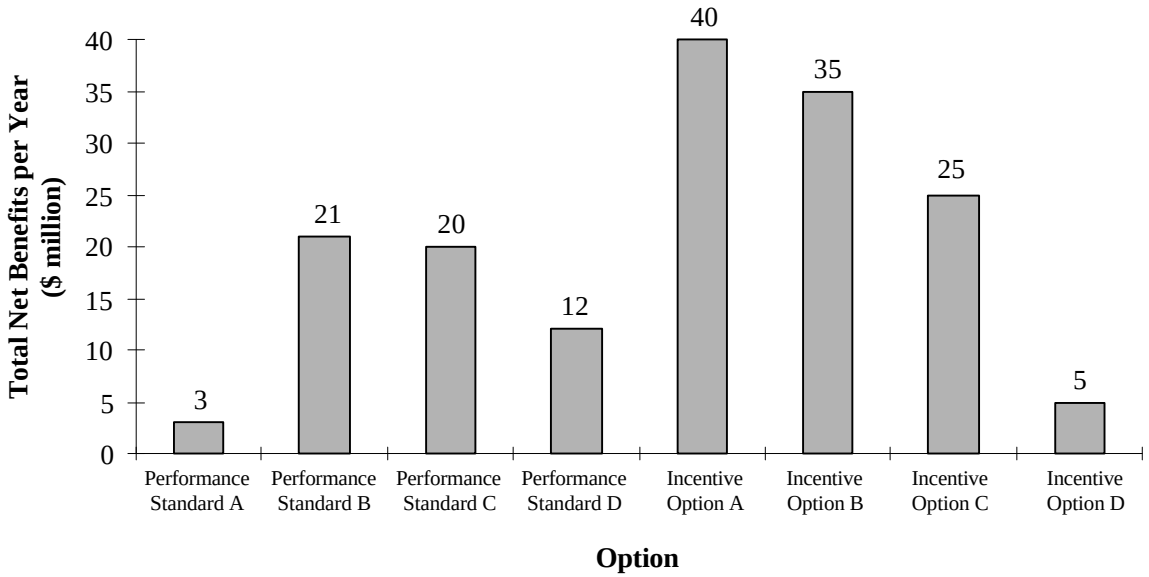

Figure 9-1. Net Benefits of Regulatory Alternatives

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