

**APPENDIX 1
KATZEN MEMO**

January 11, 1996

Economic Analysis of Federal Regulations
Under Executive Order 12866

After President Clinton signed Executive Order 12866, "Regulatory Planning and Review," the Administrator of the Office of Information and Regulatory Affairs of the Office of Management and Budget convened an interagency group to review the state of the art for economic analyses of regulatory actions required by the Executive Order. The group was co-chaired by a Member of the Council of Economic Advisers and included representatives of all the major regulatory agencies. This document represents the results of an exhaustive two-year effort by the group to describe "best practices" for preparing the economic analysis of a significant regulatory action called for by the Executive Order.

Table of Contents

INTRODUCTION

I. STATEMENT OF NEED FOR THE PROPOSED ACTION

A. Market Failure

1. Externality
2. Natural Monopoly
3. Market Power
4. Inadequate or Asymmetric Information

B. Appropriateness of Non-Federal Regulation

II. AN EXAMINATION OF ALTERNATIVE APPROACHES

1. More Performance-Oriented Standards for Health, Safety, and Environmental Regulations
2. Different Requirements for Different Segments of the Regulated Population
3. Alternative Levels of Stringency
4. Alternative Effective Dates of Compliance
5. Alternative Methods of Ensuring Compliance
6. Informational Measures
7. More Market-Oriented Approaches
8. Considering Specific Statutory Requirements

III ANALYSIS OF BENEFITS AND COSTS

A. General Principles

1. Baseline
2. Evaluation of Alternatives

3. Discounting
 - (a) Basic guidance
 - (b) Additional considerations
 - (c) Intergenerational analysis
4. Treatment of Risk and Uncertainty
 - (a) Risk assessment
 - (b) Valuing risk levels and changes
5. Assumptions
6. International Trade Effects
7. Nonmonetized Benefits and Costs
8. Distributional Effects and Equity

B. Benefit Estimates

1. General Considerations
2. Principles for Valuing Benefits Directly Traded in Markets
3. Principles for Valuing Benefits Indirectly Traded in Markets
4. Principles for Valuing Benefits That Are Not Traded Directly or Indirectly in Markets
5. Methods for Valuing Health and Safety Effects
 - (a) Nonfatal illness and injury
 - (b) Fatality risks
 - (c) Alternative methodological frameworks for estimating benefits from reduced fatality risks

C. Cost Estimates

1. General Considerations
2. Real Costs Versus Transfer Payments
 - (a) Scarcity rents and monopoly profits
 - (b) Insurance payments
 - (c) Indirect taxes and subsidies
 - (d) Distribution expenses

SELECTED FURTHER READINGS

ECONOMIC ANALYSIS OF FEDERAL REGULATIONS UNDER EXECUTIVE ORDER 12866

INTRODUCTION

In accordance with the regulatory philosophy and principles provided in Sections 1(a) and (b) and Section 6(a)(3)(C) of Executive Order 12866, an Economic Analysis (EA) of proposed or existing regulations should inform decisionmakers of the consequences of alternative actions. In particular, the EA should provide information allowing decisionmakers to determine that:

There is adequate information indicating the need for and consequences of the proposed action;

The potential benefits to society justify the potential costs, recognizing that not all benefits and costs can be described in monetary or even in quantitative terms, unless a statute requires another regulatory approach;

The proposed action will maximize net benefits to society (including potential economic, environmental, public health and safety, and other advantages; distributional impacts; and equity), unless a statute requires another regulatory approach;

Where a statute requires a specific regulatory approach, the proposed action will be the most cost-effective, including reliance on performance objectives to the extent feasible;

Agency decisions are based on the best reasonably obtainable scientific, technical, economic, and other information.

While most EAs should include these elements, variations consistent with the spirit and intent of the Executive Order may be warranted for some regulatory actions. In particular, regulations establishing terms or conditions of Federal grants, contracts, or financial assistance may call for a different form of regulatory analysis, although a full-blown benefit-cost analysis of the entire program may be appropriate to inform Congress and the President more fully about its desirability.

The EA that the agency prepares should also satisfy the requirements of the "Unfunded Mandates Reform Act of 1995" (P.L. 104-4). Title II of this statute (Section 201) directs agencies "unless otherwise prohibited by law [to] assess the effects of Federal regulatory actions on State, local, and tribal governments, and the private sector..." Section 202(a) directs agencies to provide a qualitative and quantitative assessment of the anticipated costs and benefits of a Federal mandate resulting in annual expenditures of \$100 million or more, including the costs and benefits to State, local, and tribal governments or the private sector. Section 205(a) requires that for those regulations for which an agency prepares a statement under Section 202, "the agency shall [1] identify and consider a reasonable number of regulatory alternatives and [2] from those alternatives select the least costly, most cost-effective or least burdensome alternative that achieves the objectives of the proposed rule." If the agency does not select "the least costly, most cost-effective, or least burdensome option, and if the requirements of Section 205(a) are not "inconsistent with law," Section 205(b) requires that the agency head publish "with the final rule an explanation of why the least costly, most cost-effective, or least burdensome method was not adopted."

The "Regulatory Flexibility Act" (P.L. 96-354) requires Federal agencies to give special consideration to the impact of regulation on small businesses. The Act specifies that a regulatory flexibility analysis must be prepared if a screening analysis indicates that a regulation will have a significant impact on a substantial number of small entities. The EA that the agency prepares should incorporate the regulatory flexibility analysis, as appropriate.

This document is not in the form of a mechanistic blueprint, for a good EA cannot be written according to a formula. Competent professional judgment is indispensable for the preparation of a high-quality analysis. Different regulations may call for very different emphases in analysis. For one proposed regulation, the crucial issue may be the question of whether a market failure exists, and much of the analysis may need to be devoted to that key question. In another case, the existence of a market failure may be obvious from the outset, but extensive analysis might be necessary to estimate the magnitude of benefits to be expected from proposed regulatory alternatives.

Analysis of the risks, benefits, and costs associated with regulation must be guided by the principles of full disclosure and transparency. Data, models, inferences, and assumptions should be identified and evaluated explicitly, together with adequate justifications of choices made, and assessments of the effects of these choices on the analysis. The existence of plausible alternative models or assumptions, and their implications, should be identified. In the absence of adequate valid data, properly identified assumptions are necessary for conducting an assessment.

Analysis of the risks, benefits, and costs associated with regulation inevitably also involves uncertainties and requires informed professional judgments. There should be balance between thoroughness of analysis and practical limits to the agency's capacity to carry out analysis. The amount of analysis (whether scientific, statistical, or economic) that a particular issue requires depends on the need for more thorough analysis because of the importance and complexity of the issue, the need for expedition, the nature of the statutory language and the extent of statutory discretion, and the sensitivity of net benefits to the choice of regulatory alternatives. In particular, a less detailed or intensive analysis of the entire range of regulatory options is needed when regulatory options are limited by statute. Even in these cases, however, agencies should provide some analysis of other regulatory options that satisfy the philosophy and principles of the Executive Order, in order to provide decisionmakers with information for judging the consequences of the statutory constraints. Whenever an agency has questions about such issues as the appropriate analytical techniques to use or the alternatives that should be considered in developing an EA under the Executive Order, it should consult with the Office of Management and Budget as early in the analysis stage as possible.

Preliminary and final Economic Analyses of economically "significant " rules (as defined in Section 3(f)(1) of the Executive Order) should contain three elements: (1) a statement of the need for the proposed action, (2) an examination of alternative approaches, and (3) an analysis of benefits and costs. These elements are described in Sections I-III below. The same basic analytical principles apply to the review of existing regulations, as called for under Section 5 of the Executive Order. In this case, the regulation under review should be compared to a baseline case of not taking the regulatory action and to reasonable alternatives.

I. STATEMENT OF NEED FOR THE PROPOSED ACTION

In order to establish the need for the proposed action, the analysis should discuss whether the problem constitutes a significant market failure. If the problem does not constitute a market

failure, the analysis should provide an alternative demonstration of compelling public need, such as improving governmental processes or addressing distributional concerns. If the proposed action is a result of a statutory or judicial directive, that should be so stated.

A. Market Failure

The analysis should determine whether there exists a market failure that is likely to be significant. In particular, the analysis should distinguish actual market failures from potential market failures that can be resolved at relatively low cost by market participants. Examples of the latter include spillover effects that affected parties can effectively internalize by negotiation, and problems resulting from information asymmetries that can be effectively resolved by the affected parties through vertical integration. Once a significant market failure has been identified, the analysis should show how adequately the regulatory alternatives to be considered address the specified market failure.

The major types of market failure include: externality, natural monopoly, market power, and inadequate or asymmetric information.

1. **Externality.** An externality occurs when one party's actions impose uncompensated benefits or costs on another. Environmental problems are a classic case of externality. Another example is the case of common property resources that may become congested or overused, such as fisheries or the broadcast spectrum. A third example is a "public good," such as defense or basic scientific research, which is distinguished by the fact that it is inefficient, or impossible, to exclude individuals from its benefits.

2. **Natural Monopoly.** A natural monopoly exists where a market can be served at lowest cost only if production is limited to a single producer. Local gas and electricity distribution services are examples.

3. **Market Power.** Firms exercise market power when they reduce output below what a competitive industry would sell. They may exercise market power collectively or unilaterally. Government action can be a source of market power, for example if regulatory actions exclude low-cost imports, allowing domestic producers to raise price by reducing output.

4. **Inadequate or Asymmetric Information.** Market failures may also result from inadequate or asymmetric information. The appropriate level of information is not necessarily perfect or full information because information, like other goods, is costly. The market may supply less than the appropriate level of information because it is often infeasible to exclude nonpayers from reaping benefits from the provision of information by others. In markets for goods and services, inadequate information can generate a variety of social costs, including inefficiently low innovation, market power, or inefficient resource allocation resulting from deception of consumers. Markets may also fail to allocate resources efficiently when some economic actors have more information than others.

On the other hand, the market may supply a reasonably adequate level of information. Sellers have an incentive to provide informative advertising to increase sales by highlighting distinctive

characteristics of their products. There are also a variety of ways in which "reputation effects" may serve to provide adequate information. Buyers may obtain reasonably adequate information about product characteristics even when the seller does not provide that information, for example, if buyer search costs are low (as when the quality of a good can be determined by inspection at point of sale), if buyers have previously used the product, if sellers offer warranties, or if adequate information is provided by third parties. In addition, insurance markets are important sources of information about risks.

Government action may have unintentional harmful effects on the efficiency of market outcomes. For this reason there should be a presumption against the need for regulatory actions that, on conceptual grounds, are not expected to generate net benefits, except in special circumstances. In light of actual experience, a particularly demanding burden of proof is required to demonstrate the need for any of the following types of regulations:

- price controls in competitive markets;
- production or sales quotas in competitive markets;
- mandatory uniform quality standards for goods or services, unless they have hidden safety hazards or other defects or involve externalities and the problem cannot be adequately dealt with by voluntary standards or information disclosing the hazard to potential buyers or users; or
- controls on entry into employment or production, except (a) where indispensable to protect health and safety (e.g., FAA tests for commercial pilots) or (b) to manage the use of common property resources (e.g., fisheries, airwaves, Federal lands, and offshore areas).

B. Appropriateness of Alternatives to Federal Regulation

Even where a market failure exists, there may be no need for Federal regulatory intervention if other means of dealing with the market failure would resolve the problem adequately or better than the proposed Federal regulation would. These alternatives may include the judicial system, antitrust enforcement, and workers' compensation systems. Other nonregulatory alternatives could include, for example, subsidizing actions to achieve a desired outcome; such subsidies may be more efficient than rigid mandates. Similarly, a fee or charge, such as an effluent discharge fee, may be a preferable alternative to banning or restricting a product or action. Legislative measures that make use of economic incentives, such as changes in insurance provisions, should be considered where feasible. Modifications to existing regulations should be considered if those regulations have created or contributed to a problem that the new regulation is intended to correct, and if such changes can achieve the goal more efficiently or effectively.

Another important factor to consider in assessing the appropriateness of a Federal regulation is regulation at the State or local level, if such an option is available. In some cases, the nature of the market failure may itself suggest the most appropriate governmental level of regulation. For example, problems that spill across State lines (such as acid rain whose precursors are transported widely in the atmosphere) are probably best controlled by Federal regulation, while more localized problems may be more efficiently addressed locally. Where regulation at the Federal level appears appropriate, for example to address interstate commerce issues, the

analysis should attempt to determine whether the burdens on interstate commerce arising from different State and local regulations, including the compliance costs imposed on national firms, are greater than the potential advantages of diversity, such as improved performance from competition among governmental units in serving taxpayers and citizens and local political choice.

II. AN EXAMINATION OF ALTERNATIVE APPROACHES

The EA should show that the agency has considered the most important alternative approaches to the problem and provide the agency's reasoning for selecting the proposed regulatory action over such alternatives. Ordinarily, it will be possible to eliminate some alternatives by a preliminary analysis, leaving a manageable number of alternatives to be evaluated according to the principles of the Executive Order. The number and choice of alternatives to be selected for detailed benefit-cost analysis is a matter of judgment. There must be some balance between thoroughness of analysis and practical limits to the agency's capacity to carry out analysis. With this qualifier in mind, the agency should nevertheless explore modifications of some or all of a regulation's attributes or provisions to identify appropriate alternatives.

Alternative regulatory actions that should be explored include the following:

1. **More Performance-Oriented Standards for Health, Safety, and Environmental Regulations.** Performance standards are generally to be preferred to engineering or design standards because performance standards provide the regulated parties the flexibility to achieve the regulatory objective in a more cost-effective way. It is therefore misleading and inappropriate to characterize a standard as a performance standard if it is set so that there is only one feasible way to meet it; as a practical matter, such a standard is a design standard. In general, a performance standard should be preferred wherever that performance can be measured or reasonably imputed. Performance standards should be applied with a scope appropriate to the problem the regulation seeks to address. For example, to create the greatest opportunities for the regulated parties to achieve cost savings while meeting the regulatory objective, compliance with air emission standards can be allowed on a plant-wide, firm-wide, or region-wide basis rather than vent by vent, provided this does not produce unacceptable air quality outcomes (such as "hot spots" from local pollution concentration).

2. **Different Requirements for Different Segments of the Regulated Population.** There might be different requirements established for large and small firms, for example. If such a differentiation is made, it should be based on perceptible differences in the costs of compliance or in the benefits to be expected from compliance. It is not efficient to place a heavier burden on one segment of the regulated population solely on the grounds that it is better able to afford the higher cost; this has the potential to load on the most productive sectors of the economy costs that are disproportionate to the damages they create.

3. **Alternative Levels of Stringency.** In general, both the benefits and costs associated with a regulation will increase with the level of stringency (although marginal costs generally increase

with stringency, whereas marginal benefits decrease). It is important to consider alternative levels of stringency to better understand the relationship between stringency and the size and distribution of benefits and costs among different groups.

4. **Alternative Effective Dates of Compliance.** The timing of a regulation may also have an important effect on its net benefits. For example, costs of a regulation may vary substantially with different compliance dates for an industry that requires a year or more to plan its production runs efficiently. In this instance, a regulation that provides sufficient lead time is likely to achieve its goals at a much lower overall cost than a regulation that is effective immediately, although the benefits also could be lower.

5. **Alternative Methods of Ensuring Compliance.** Compliance alternatives for Federal, state, or local enforcement include on-site inspection, periodic reporting, and compliance penalties structured to provide the most appropriate incentives. When alternative monitoring and reporting methods vary in their costs and benefits, promising alternatives should be considered in identifying the regulatory alternative that maximizes net benefits. For example, in some circumstances random monitoring will be less expensive and nearly as effective as continuous monitoring in achieving compliance.

6. **Informational Measures.** Measures to improve the availability of information include government establishment of a standardized testing and rating system (the use of which could be made mandatory or left voluntary), mandatory disclosure requirements (e.g., by advertising, labeling, or enclosures), and government provision of information (e.g., by government publications, telephone hotlines, or public interest broadcast announcements). If intervention is necessary to address a market failure arising from inadequate or asymmetric information, informational remedies will often be the preferred approaches. As an alternative to a mandatory product standard or ban, a regulatory measure to improve the availability of information (particularly about the concealed characteristics of products) gives consumers a greater choice. Incentives for information dissemination also are provided by features of product liability law that reduce liability or damages for firms that have provided consumers with notice.

Except for prohibiting indisputably false statements (whose banning can be presumed beneficial), specific informational measures should be evaluated in terms of their benefits and costs. The key to analyzing informational measures is a comparison of the actions of the affected parties with the information provided in the baseline (including any information displaced by mandated disclosures) and the actions of affected parties with the information requirements being imposed. Some effects of informational measures can easily be overlooked. For example, the costs of a mandatory disclosure requirement for a consumer product include not only the cost of gathering and communicating the required information, but also the loss of net benefits of any information displaced by the mandated information, the effect of providing too much information that is ignored or information that is misinterpreted, and inefficiencies arising from the incentive that mandatory disclosure may give to overinvest in a particular characteristic of a product or service.

Where information on the benefits and costs of alternative informational measures is insufficient to provide a clear choice between them, as will often be the case, the least intrusive informational

alternative, sufficient to accomplish the regulatory objective, should be considered. For example, to correct an informational market failure it may be sufficient for government to establish a standardized testing and rating system without mandating its use, because competing firms that score well according to the system will have ample incentive to publicize the fact.

7. More Market-Oriented Approaches. In general, alternatives that provide for more market-oriented approaches, with the use of economic incentives replacing command-and-control requirements, are more cost-effective and should be explored. Market-oriented alternatives that may be considered include fees, subsidies, penalties, marketable permits or offsets, changes in liabilities or property rights (including policies that alter the incentive of insurers and insured parties), and required bonds, insurance or warranties. (In many instances, implementing these alternatives will require legislation.)

8. Considering Specific Statutory Requirements. When a statute establishes a specific regulatory requirement and the agency has discretion to adopt a more stringent standard, the agency should examine the benefits and costs of the specific statutory requirement as well as the more stringent alternative and present information that justifies the more stringent alternative if that is what the agency proposes.

III. ANALYSIS OF BENEFITS AND COSTS

A. General Principles

The preliminary analysis described in Sections I and II will lead to the identification of a workable number of alternatives for consideration.

1. Baseline. The benefits and costs of each alternative must be measured against a baseline. The baseline should be the best assessment of the way the world would look absent the proposed regulation. That assessment may consider a wide range of factors, including the likely evolution of the market, likely changes in exogenous factors affecting benefits and costs, likely changes in regulations promulgated by the agency or other government entities, and the likely degree of compliance by regulated entities with other regulations. Often it may be reasonable for the agency to forecast that the world absent the regulation will resemble the present. For the review of an existing regulation, the baseline should be no change in existing regulation; this baseline can then be compared against reasonable alternatives.

When more than one baseline appears reasonable or the baseline is very uncertain, and when the estimated benefits and costs of proposed rules are likely to vary significantly with the baseline selected, the agency may choose to measure benefits and costs against multiple alternative baselines as a form of sensitivity analysis. For example, the agency may choose to conduct a sensitivity analysis involving the consequences for benefits and costs of different assumptions about likely regulation by other governmental entities, or the degree of compliance with the agency's own existing rules. In every case, an agency must measure both benefits and costs

against the identical baseline. The agency should also provide an explanation of the plausibility of the alternative baselines used in the sensitivity analysis.

2. **Evaluation of Alternatives.** Agencies should identify (with an appropriate level of analysis) alternatives that meet the criteria of the Executive Order as summarized at the beginning of this document, as well as identifying statutory requirements that affect the selection of a regulatory approach. If legal constraints prevent the selection of a regulatory action that best satisfies the philosophy and principles of the Order, these constraints should be identified and explained, and their opportunity cost should be estimated. To the fullest extent possible, benefits and costs should be expressed in discounted constant dollars. Appropriate discounting procedures are discussed in the following section.

Information on distributional impacts related to the alternatives should accompany the analysis of aggregate benefits and costs. Where relevant and feasible, agencies can also indicate how aggregate benefits and costs depend on the incidence of benefits and costs. Agencies should present a reasoned explanation or analysis to justify their choice among alternatives.

The distinction between benefits and costs in benefit-cost analysis is somewhat arbitrary, since a positive benefit may be considered a negative cost, and vice versa, without affecting net benefits. This implies that the considerations applicable to benefit estimates also apply to cost estimates and vice versa.

In choosing among mutually exclusive alternatives, benefit-cost ratios should be used with care. Selecting the alternative with the highest benefit-cost ratio may not identify the best alternative, since an alternative with a lower benefit-cost ratio than another may have higher net benefits. In addition, the internal rate of return should not be used as a criterion for choosing among mutually exclusive alternatives. It is often difficult to compute and is problematical when multiple rates exist.

Where monetization is not possible for certain elements of the benefits or costs that are essential to consider, other quantitative and qualitative characterizations of these elements should be provided (see sections 7 and 8 below). Cost-effectiveness analysis also should be used where possible to evaluate alternatives. Costs should be calculated net of monetized benefits. Where some benefits are monetizable and others are not, a cost-effectiveness analysis will generally not yield an unambiguous choice; nevertheless, such an analysis is helpful for calculating a "breakeven" value for the unmonetized benefits (i.e., a value that would result in the action having positive net benefits). Such a value can be evaluated for its reasonableness in the discussion of the justification of the proposed action. Cost-effectiveness analysis should also be used to compare regulatory alternatives in cases where the level of benefits is specified by statute.

If the proposed regulation is composed of a number of distinct provisions, it is important to evaluate the benefits and costs of the different provisions separately. The interaction effects between separate provisions (such that the existence of one provision affects the benefits or costs arising from another provision) may complicate the analysis but does not eliminate the need to examine provisions separately. In such a case, the desirability of a specific provision may be

appraised by determining the net benefits of the proposed regulation with and without the provision in question. Where the number of provisions is large and interaction effects are pervasive, it is obviously impractical to analyze all possible combinations of provisions in this way. Some judgment must be used to select the most significant or suspect provisions for such analysis.

3. Discounting. One of the problems that arises in developing a benefit-cost analysis is that the benefits and costs often occur in different time periods. When this occurs, it is not appropriate, when comparing benefits and costs, to simply add up the benefits and costs accruing over time. Discounting takes account of the fact that resources (goods or services) that are available in a given year are worth more than the identical resources available in a later year. One reason for this is that resources can be invested so as to return more resources later. In addition, people tend to be impatient and to prefer earlier consumption over later consumption.

(a) Basic considerations. Constant-dollar benefits and costs must be discounted to present values before benefits and costs in different years can be added together to determine overall net benefits. To obtain constant dollar estimates, benefit and cost streams in nominal dollars should be adjusted to correct for inflation. The basic guidance on discount rates for regulatory and other analyses is provided in OMB Circular A-94. The discount rate specified in that guidance is intended to be an approximation of the opportunity cost of capital, which is the before-tax rate of return to incremental private investment. The Circular A-94 rate, which was revised in 1992 based on an extensive review and public comment, reflects the rates of return on low yielding forms of capital, such as housing, as well as the higher rates of returns yielded by corporate capital. This average rate currently is estimated to be 7 percent in real terms (i.e., after adjusting for inflation). As noted in the A-94 guidance, agencies may also present sensitivity analyses using other discount rates, along with a justification for the consideration of these alternative rates. The economic analysis also should contain a schedule indicating when all benefits and costs are expected to occur.

In general, the discount rate should not be adjusted to account for the uncertainty of future benefits and costs. Risk and uncertainty should be dealt with according to the principles presented in Section 4 below and not by changing the discount rate.

Even those benefits and costs that are hard to quantify in monetary terms should be discounted. The schedule of benefits and costs over time therefore should include benefits that are hard to monetize. In many instances where it is difficult to monetize benefits, agencies conduct regulatory "cost-effectiveness" analyses instead of "net benefits" analyses. When the effects of alternative options are measured in units that accrue at the same time that the costs are incurred, annualizing costs is sufficient and further discounting of non-monetized benefits is unnecessary; for instance, the annualized cost per ton of reducing certain polluting emissions can be an appropriate measure of cost-effectiveness. However, when effects are measured in units that accrue later than when the costs are incurred, such as the reduction of adverse health effects that occur only after a long period of exposure, the annualized cost per unit should be calculated after discounting for the delay between accrual of the costs and the effects.

In assessing the present value of benefits and costs from a regulation, it may be necessary to consider implications of changing relative prices over time. For example, increasing scarcity of certain environmental resources could increase their value over time relative to conventional consumer goods. In such a situation, it is inappropriate to use current relative values for assessing regulatory impacts. However, while taking into account changes over time in relative values may have an effect similar to discounting environmental impacts at a lower rate, it is important to separate the effects of discounting from the effects of relative price changes in the economic analysis. In particular, the discount rate should not be adjusted for expected changes in the relative prices of goods over time. Instead, any changes in relative prices that are anticipated should be incorporated directly in the calculations of benefit and cost streams.

(b) Additional considerations. Modern research in economic theory has established a preferred model for discounting, sometimes referred to as the shadow price approach. The basic concept is that economic welfare is ultimately determined by consumption; investment affects welfare only to the extent that it affects current and future consumption. Thus, any effect that a government program has on public or private investment must be converted to an associated stream of effects on consumption before being discounted.

Converting investment-related benefits and costs to their consumption-equivalents as required by this approach involves calculating the "shadow price of capital." This shadow price reflects the present value of the future changes in consumption arising from a marginal change in investment, using the consumption rate of interest (also termed the rate of time preference) as the discount rate. The calculation of the shadow price of capital requires assumptions about the extent to which government actions -- including regulations -- crowd out private investment, the social (i.e., before-tax) returns to this investment, and the rate of reinvestment of future yields from current investment.

Estimates of the shadow price are quite sensitive to these assumptions. For example, in some applications it may be appropriate to assume that access to global capital markets implies no crowding out of private investment by government actions or that monetary and fiscal authorities determine aggregate levels of investment so that the impact of the contemplated regulation on total private investment can be ignored. Alternatively, there is evidence that domestic saving affects domestic investment and that regulatory costs may also reduce investment. In these cases, more substantial crowding out would be an appropriate assumption.

The rate of time preference is also a complex issue. Generally, it is viewed as being approximated by the real return to a safe asset, such as Government debt. However, a substantial fraction of the population does little or no saving and may borrow at relatively high interest rates.

While the shadow price approach is theoretically preferred, there are several practical challenges to its use. Agencies wishing to use this methodology should consult with OMB prior to doing so, and should clearly explain their solutions to the methodological and empirical challenges noted above.

(c) Intergenerational analysis. Comparisons of benefits and costs across generations raise special questions about equity, in addition to conventional concerns about efficiency. One approach to

these questions is to follow the discounting procedures described above and to address equity issues explicitly rather than through modification of the discount rate.

An alternative approach is to use a special social rate of time preference when conducting intergenerational analyses in order to properly value changes in consumption in different generations. For example, one philosophical perspective is that the social marginal rate of substitution between the well-being of members of successive generations may be less than the individual rate of time preference, and that future generations should not have their expected welfare discounted just because they come later in time. Instead, this view suggests that discounting should reflect only the growth of per capita consumption and the corresponding decrease in marginal utility over time. As this approach uses a consumption-based rate of interest, costs and benefits must also be adjusted to reflect the shadow price of capital. As in other cases when agencies seek to use the shadow price of capital approach, they should consult with OMB prior to conducting special analyses of regulations having substantial intergenerational effects.

4. Treatment of Risk and Uncertainty. The effects of regulatory actions frequently are not known with certainty but can be predicted in terms of their probability of occurrence. The term "risk" in this document refers generally to a probability distribution over a set of outcomes. When the outcomes in question are hazards or injuries, risk can be understood to refer to the probabilities of different potential severities of hazard or injury. For example, the risk of cancer from exposure to a chemical means a change in the probability of contracting cancer caused by that exposure. There also are risks associated with economic benefits and costs, e.g., the risk of a financial loss of \$X means the probability of losing \$X.

Often risks, benefits, and costs are measured imperfectly because key parameters are not known precisely; instead, the economic analysis must rely upon statistical probability distributions for the values of parameters. Both the inherent lack of certainty about the consequences of a potential hazard (for example, the odds of contracting cancer) and the lack of complete knowledge about parameter values that define risk relationships (for example, the relationship between presence of a carcinogen in the food supply and the rate of absorption of the carcinogen) should be considered.

The term "uncertainty" often is used in economic assessments as a synonym for risk. However, in this document uncertainty refers more specifically to the fact that knowledge of the probabilities and sets of possible outcomes that characterize a probability distribution of risks, based on experimentation, statistical sampling, and other scientific tools, is itself incomplete. Thus, for example, a cancer risk might be described as a one-in-one-thousand chance of contracting cancer after 70 years of exposure. However, this estimate may be uncertain because individuals vary in their levels of exposure and their sensitivity to such exposures; the science underlying the quantification of the hazard is uncertain; or there are plausible competitors to the model for converting scientific knowledge and empirical measures of exposures into risk units. Estimates of regulatory benefits entail additional uncertainties, such as the appropriate measures for converting from units of risk to units of value. Cost estimates also will be uncertain when there are uncertainties in opportunity costs or the compliance strategies of regulated entities.

Estimating the benefits and costs of risk-reducing regulations includes two components: a risk assessment that, in part, characterizes the probabilities of occurrence of outcomes of interest; and a valuation of the levels and changes in risk experienced by affected populations as a result of the regulation. It is essential that both parts of such evaluations be conceptually consistent. In particular, risk assessments should be conducted in a way that permits their use in a more general benefit-cost framework, just as the benefit-cost analysis should attempt to capture the results of the risk assessment and not oversimplify the results (e.g., the analysis should address the benefit and cost implications of probability distributions).

Risk management is an activity conceptually distinct from risk assessment or valuation, involving a policy of whether and how to respond to risks to health, safety, and the environment. The appropriate level of protection is a policy choice rather than a scientific one. The risk assessment should generate a credible, objective, realistic, and scientifically balanced analysis; present information on hazard, dose-response, and exposure (or analogous material for non-health assessments); and explain the confidence in each assessment by clearly delineating strengths, uncertainties, and assumptions, along with the impacts of these factors on the overall assessment. The data, assumptions, models, and inferences used in the risk assessment to construct quantitative characterizations of the probabilities of occurrence of health, safety, or ecological effects should not reflect unstated or unsupported preferences for protecting public health and the environment, or unstated safety factors to account for uncertainty and unmeasured variability. Such procedures may introduce levels of conservatism that cumulate across assumptions and make it difficult for decisionmakers to evaluate the magnitude of the risks involved.

(a) Risk assessment. The assessment of outcomes associated with regulatory action to address risks to health, safety, and the environment raises a number of scientific difficulties. Key issues involve the quality and reliability of the data, models, assumptions, scientific inferences, and other information used in risk analyses. Analysts rarely, if ever, have complete information. It may be difficult to identify the full range of impacts. Little definitive may be known about the structure of key relationships and therefore about appropriate model specification. Data relating to effects that can be identified may be sketchy, incomplete, or subject to measurement error or statistical bias. Exposures and sensitivities to risks may vary considerably across the affected population. These difficulties can lead, for example, to a range of quantitative estimates of risk in health and ecological risk assessments that can span several orders of magnitude. Uncertainties in cost estimates also can be significant, in particular because of lack of experience with the adjustments that markets can make to reduce regulatory burdens, the difficulty of identifying and quantifying opportunity cost, and the potential for enhanced or retarded technical innovation. All of these concerns should be reflected in the uncertainties about outcomes that should be incorporated in the analysis.

The treatment of uncertainty in developing risk, benefit, and cost information also must be guided by the principles of full disclosure and transparency, as with other elements of an EA. Data, models, and their implications for risk assessment should be identified in the risk characterization. Inferences and assumptions should be identified and evaluated explicitly, together with adequate justifications of choices made, and assessments of the effects of these choices on the analysis.

Informed judgment is necessary to evaluate conflicting scientific theories. In some cases it may be possible to weigh conflicting evidence in developing the overall risk assessment. In other cases, the level of scientific uncertainty may be so large that a risk assessment can only present discrete alternative scenarios without a quantitative assessment of their relative likelihood. For example, in assessing the potential outcomes of an environmental effect, there may be a limited number of scientific studies with strongly divergent results. In such cases, the assessment should present results representing a range of plausible scenarios, together with any information that can help in providing a qualitative judgment of which scenarios are more scientifically plausible.

In the absence of adequate valid data, properly identified assumptions are necessary for conducting an assessment. The existence of plausible alternative models and their implications should be carried through as part of each risk characterization product. Alternative models and assumptions should be used in the risk assessment as needed to provide decisionmakers with information on the robustness of risk estimates and estimates of regulatory impacts. As with other elements of an EA, there should be balance between thoroughness of analysis in the treatment of risk and uncertainty and practical limits on the capacity to carry out analysis. The range of models, assumptions, or scenarios presented in the risk assessment need not be exhaustive, nor is it necessary that each alternative be evaluated at every step of the assessment. The assessment should provide sufficient information for decisionmakers to understand the degree of scientific uncertainty and the robustness of estimated risks, benefits, and costs. The choice of models or scenarios used in the risk assessment should be explained.

Where feasible, data and assumptions should be presented in a manner that permits quantitative evaluation of their incremental effects. The cumulative effects of assumptions and inferences should also be evaluated. A full characterization of risks should include findings for the entire affected population and relevant subpopulations. Assumptions should be consistent with reasonably obtainable scientific information. Thus, for example, low-dose toxicity extrapolations should be consistent with physiological knowledge; assumptions about environmental fate and transport of contaminants should be consistent with principles of environmental chemistry.

The material provided should permit the reader to replicate the analysis and quantify the effects of key assumptions. Such analyses are becoming increasingly easy to perform because of advances in computing power and new methodological developments. Thus, the level and scope of disclosure and transparency should increase over time.

In order for the EA to evaluate outcomes involving risks, risk assessments must provide some estimates of the probability distribution of risks with and without the regulation. Whenever it is possible to quantitatively characterize the probability distributions, some estimates of central tendency (e.g., mean and median) must be provided in addition to ranges, variances, specified low-end and high-end percentile estimates, and other characteristics of the distribution.

Overall risk estimates cannot be more precise than their most uncertain component. Thus, risk estimates should be reported in a way that reflects the degree of uncertainty present in order to prevent creating a false sense of precision. The accuracy with which quantitative estimates are

reported must be supported by the quality of the data and models used. In all cases, the level of precision should be stated explicitly.

Overall uncertainty is typically a consequence of uncertainties about many different factors. Appropriate statistical techniques should be used to combine uncertainties about separate factors into an overall probability distribution for a risk. When such techniques cannot be used, other methods may be useful for providing more complete information:

- Monte Carlo analysis and other simulation methods can be used to estimate probability distributions of the net benefits of alternative policy choices. It requires explicit quantitative characterization of variability to derive an overall probability distribution of net benefits. Parameter or model probability distributions may be derived empirically (for example, directly from population data or indirectly from regression or other statistical models) or by assumption. This approach has the advantage of weighing explicitly the likelihood of alternative outcomes, permitting evaluation of their relative importance. However, care must be taken to consider the entire output of the analysis rather than placing undue reliance on any one statistic. Because of the sensitivity of such simulations to assumptions about correlations between parameters, the likelihood that a particular specification is correct, omitted factors, and assumptions about the distribution of parameters, etc., special care should be taken to address these potential pitfalls. The quality of the overall analysis is only as good as the quality of its components; faulty assumptions or model specifications will yield faulty results.
- Sensitivity analysis is carried out by conducting analyses over the full range of plausible values of key parameters and plausible model specifications. Sensitivity analysis is particularly attractive when there are several easily identifiable critical assumptions in the analysis, when information is inadequate to carry out a more formal probabilistic simulation, or when the nature and scope of the regulation do not warrant more extensive analysis. One important form of sensitivity analysis involves estimating "switch points," that is, critical parameter values at which estimated net benefits change sign. Sensitivity analysis is useful for evaluating the robustness of conclusions about net benefits with respect to changes in model parameters. Sensitivity analysis should convey as much information as possible about the likely plausibility or frequency of occurrence of different scenarios (sets of parameter values) considered.
- Delphi methods involve derivation of estimates by groups of experts and can be used to identify attributes of subjective probability distributions. This method can be especially useful when there is diffuse or divergent prior knowledge. Care must be taken, however, to preserve any scientific controversy arising in a delphi analysis.
- Meta-analysis involves combining data or results from a number of different studies. For example, one could re-estimate key model parameters using combined data from a number of different sources, thereby improving confidence in the parameter estimates. Alternatively, one could use parameter estimates (elasticities of supply and

demand, implicit values of mortality risk reduction) from a number of different studies as data points, and analyze variations in those results as functions of potential causal factors. Care must be taken to ensure that the data used are comparable, that appropriate statistical methods are used, and that spurious correlation problems are considered. One significant pitfall in the use of meta-analysis arises from combining results from several studies that do not measure comparable independent or dependent variables.

New methods may become available in the future as well. This document is not intended to discourage or inhibit their use, but rather to encourage and stimulate their development.

Uncertainty may arise from a variety of fundamentally different sources, including lack of data, variability in populations or natural conditions, limitations in fundamental scientific knowledge (both social and natural) resulting in lack of knowledge about key relationships, or fundamental unpredictability of various phenomena. The nature of these different sources may suggest different approaches. For example, when uncertainty is due to lack of information, one policy alternative may be to defer action pending further study. One factor that may help determine whether further study is justifiable as a policy alternative is an evaluation of the potential benefits of the information relative to the resources needed to acquire it and the potential costs of delaying action. When uncertainty is due largely to observable variability in populations or natural conditions, one policy alternative may be to refine targeting, that is, to differentiate policies across key subgroups. Analysis of such policies should consider the incremental benefits of improved efficiency from targeting, any incremental costs of monitoring and enforcement, and changes in the distribution of benefits and costs.

(b) Valuing risk levels and changes. To value changes in risk arising from variability in expected outcomes as a consequence of regulation, agencies should consider the expected net benefits of the risk change, taking into account the probability distribution of potential outcomes with and without the regulation. The more familiar examples deal with valuing risks associated with incurring possible future costs. When costs are subject to risk, they are generally appraised by risk-averse individuals at more than the expected value. For example, riskier financial instruments must generally earn a higher average rate of return in order to attract investors. Similarly, the owner of a facility may be willing to pay more to reduce the probability of fire than the reduction in expected loss, because of aversion to the risk of the loss. This also explains why property owners are willing to buy fire insurance at a price that exceeds expected losses. To accurately value the net benefits of a regulation, regulation-induced changes in expenditures on self-protection, mitigation, or other risk-reduction measures should be included.

Under the standard assumption in economic theory that individuals make choices among outcomes subject to risks to maximize expected utility, risk aversion is incorporated into net benefits estimates by expressing benefits and costs in terms of their certainty equivalents. Certainty equivalents are defined as net benefits occurring with certainty that would have the same value to individuals as the expected value of an alternative whose net benefits are subject to risk. For risk-averse individuals, the certainty equivalent of such a net benefit stream would be smaller than the expected value of those net benefits, because risk intrinsically has a negative value. The difference between the expected value of net benefits subject to risk and the certainty

equivalent is called the risk premium. Similarly, regulations that reduce the overall variability of net benefits will have a certainty equivalent value that is larger than the expected value of the net benefits by an amount that reflects the value of the variability of outcomes.

Typically total expected net benefits and risk premia are calculated on the basis of a representative set of individual preferences. Agencies should also present available information on the incidence of benefits, costs, and risks where necessary for judging distributional consequences. Where information is available on differences in valuation across income levels or other identifiable criteria, agencies can use this information and information on the incidence of regulatory effects in calculating total net benefits estimates.

The importance of including estimates of individuals' willingness to pay for risk reduction varies. Willingness to pay for reduced risks is likely to be more significant if risks are difficult to diversify because of incomplete risk and insurance markets, or if the net benefits of the regulation are correlated with overall market returns to investment. When the effects of regulation fall primarily on private parties, it is sufficient to incorporate measures of individual risk aversion. For regulatory benefits or costs that accrue to the Federal government (for example, income from oil production), the Federal government should be treated as risk neutral because of its high degree of diversification.

As noted in the previous section, the discount rate generally should not be adjusted as a device to account for the uncertainty of future benefits or costs. Any allowance for uncertainty should be made by adjusting the monetary values of changes in benefits or costs (for the year in which they occur) so that they are expressed in terms of their certainty equivalents. The adjustment for uncertainty may well vary over time because the degree of uncertainty may change. For example, price forecasts are typically characterized by increasing uncertainty (forecast error) over time, because of an increasing likelihood of unforeseen (and unforeseeable) changes in market conditions as time passes. In such cases, the certainty equivalents of net benefits will tend to change systematically over time; these changes should be taken into account in analyzing regulations that have substantial effects over a long time period. Uncertainty that increases systematically over time will result in certainty equivalents that fall systematically over time; however, these decreases in certainty equivalents will mimic the effects of an increase in the discount rate only under special circumstances.

5. Assumptions. Where benefit or cost estimates are heavily dependent on certain assumptions, it is essential to make those assumptions explicit and, where alternative assumptions are plausible, to carry out sensitivity analyses based on the alternative assumptions. If the value of net benefits changes sign with alternative plausible assumptions, further analysis may be necessary to develop more evidence on which of the alternative assumptions is more appropriate. Because the adoption of a particular estimation methodology sometimes implies major hidden assumptions, it is important to analyze estimation methodologies carefully to make hidden assumptions explicit.

Special challenges arise in evaluating the results of an EA that relies strongly upon proprietary data or analyses whose disclosure is limited by confidentiality agreements. In some cases, such data and analysis may be the best, or even the only, means to address an important aspect of a proposed regulation. Nevertheless, given the difficulties that this confidentiality presents to

OMB review and meaningful public participation in the rulemaking, agencies should exercise great care in relying strongly upon proprietary material in developing an EA. When such material is used, it is essential that agencies provide as much information as possible concerning the underlying scientific, technological, behavioral, and valuation assumptions and conclusions. This can be accomplished, for example, by providing information about the values of key input parameters used in a modeling analysis or the implied behavioral response rates derived from sensitivity analysis.

The effectiveness of proposed rules may depend in part upon agency enforcement strategies, which may vary over time as agency priorities and budgetary constraints change. Because an agency usually cannot commit to an enforcement strategy at the time the rule is promulgated, the analysis of a rule's benefits and costs should generally assume that compliance with the rule is complete, although there may be circumstances when other assumptions should be considered as well. The analysis of a new or revised rule should differentiate between its benefits and costs, given an assumed level of compliance, and the implications of changes in compliance with an existing rule.

6. International Trade Effects. In calculating the benefits and costs of a proposed regulatory action, generally no explicit distinction needs to be made between domestic and foreign resources. If, for example, compliance with a proposed regulation requires the purchase of specific equipment, the opportunity cost of that equipment is ordinarily best represented by its domestic cost in dollars, regardless of whether the equipment is produced domestically or imported. The relative value of domestic and foreign resources is correctly represented by their respective dollar values, as long as the foreign exchange value of the dollar is determined by the exchange market. Nonetheless, an awareness of the role of international trade may be quite useful for assessing the benefits and costs of a proposed regulatory action. For example, the existence of foreign competition may make the demand curve facing a domestic industry more elastic than it would be otherwise. Elasticities of demand and supply frequently can significantly affect the magnitude of the benefits or costs of a regulation.

Regulations limiting imports -- whether through direct prohibitions or fees, or indirectly through an adverse differential effect on foreign producers or consumers relative to domestic producers and consumers -- raise special analytic issues. The economic loss to the United States from limiting imports should be reflected in the net benefit estimate. However, a benefit-cost analysis will generally not be able to measure the potential U.S. loss from the threat of future retaliation by foreign governments. This threat should then be treated as a qualitative cost (see section 7).

7. Nonmonetized Benefits and Costs. Presentation of monetized benefits and costs is preferred where acceptable estimates are possible. However, monetization of some of the effects of regulations is often difficult if not impossible, and even the quantification of some effects may not be easy. Effects that cannot be fully monetized or otherwise quantified should be described. Those effects that can be quantified should be presented along with qualitative information to characterize effects that are not quantified.

Irrespective of the presentation of monetized benefits and costs, the EA should present available physical or other quantitative measures of the effects of the alternative actions to help

decisionmakers understand the full effects of alternative actions. These include the magnitude, timing, and likelihood of impacts, plus other relevant dimensions (e.g., irreversibility and uniqueness). For instance, assume the effects of a water quality regulation include increases in fish populations and habitat over the affected stream segments and that it is not possible to monetize such effects. It would then be appropriate to describe the benefits in terms of stream miles of habitat improvement and increases in fish population by species (as well as to describe the timing and likelihood of such effects, etc.). Care should be taken, however, when estimates of monetized and physical effects are mixed in the same analysis so as to avoid double-counting of benefits. Finally, the EA should distinguish between effects unquantified because they were judged to be relatively unimportant, and effects that could not be quantified for other reasons.

8. Distributional Effects and Equity. Those who bear the costs of a regulation and those who enjoy its benefits often are not the same people. The term "distributional effects" refers to the description of the net effects of a regulatory alternative across the population and economy, divided up in various ways (e.g., income groups, race, sex, industrial sector). Benefits and costs of a regulation may be distributed unevenly over time, perhaps spanning several generations. Distributional effects may also arise through "transfer payments" arising from a regulatory action. For example, the revenue collected through a fee, surcharge, or tax (in excess of the cost of any service provided) is a transfer payments.

Where distributive effects are thought to be important, the effects of various regulatory alternatives should be described quantitatively to the extent possible, including their magnitude, likelihood, and incidence of effects on particular groups. Agencies should be alert for situations in which regulatory alternatives result in significant changes in treatment or outcomes for different groups. Effects on the distribution of income that are transmitted through changes in market prices can be important, albeit sometimes difficult to assess. The EA should also present information on the streams of benefits and costs over time in order to provide a basis for judging intertemporal distributional consequences, particularly where intergenerational effects are concerned.

There are no generally accepted principles for determining when one distribution of net benefits is more equitable than another. Thus, the EA should be careful to describe distributional effects without judging their fairness. These descriptions should be broad, focusing on large groups with small effects per capita as well as on small groups experiencing large effects per capita. Equity issues not related to the distribution of policy effects should be noted when important and described quantitatively to the extent feasible.

B. Benefit Estimates

The EA should state the beneficial effects of the proposed regulatory change and its principal alternatives. In each case, there should be an explanation of the mechanism by which the proposed action is expected to yield the anticipated benefits. An attempt should be made to quantify all potential real incremental benefits to society in monetary terms to the maximum extent possible. A schedule of monetized benefits should be included that would show the type of benefit and when it would accrue; the numbers in this table should be expressed in constant, undiscounted dollars. Any benefits that cannot be monetized, such as an increase in the rate of

introducing more productive new technology or a decrease in the risk of extinction of endangered species, should also be presented and explained.

The EA should identify and explain the data or studies on which benefit estimates are based with enough detail to permit independent assessment and verification of the results. Where benefit estimates are derived from a statistical study, the EA should provide sufficient information so that an independent observer can determine the representativeness of the sample, the reliability of extrapolations used to develop aggregate estimates, and the statistical significance of the results.

The calculation of benefits (including benefits of risk reductions) should reflect the full probability distribution of potential consequences. For example, extreme safety or health results should be weighted, along with other possible outcomes, by estimates of their probability of occurrence based on the available evidence to estimate the expected result of a proposed regulation. To the extent possible, the probability distributions of benefits should be presented. Extreme estimates should be presented as complements to central tendency and other estimates. If fundamental scientific disagreement or lack of knowledge precludes construction of a scientifically defensible probability distribution, benefits should be described under plausible alternative assumptions, along with a characterization of the evidence underlying each alternative view. This will allow for a reasoned determination by decisionmakers of the appropriate level of regulatory action.

It is important to guard against double-counting of benefits. For example, if a regulation improves the quality of the environment in a community, the value of real estate in the community might rise, reflecting the greater attractiveness of living in the improved environment. Inferring benefits from changes in property values is complex. On the one hand, the rise in property values may reflect the capitalized value of these improvements. On the other hand, benefit estimates that do not incorporate the consequences of land use changes will not capture the full effects of regulation. For regulations with significant effects on land uses, these effects must be separated from the capitalization of direct regulatory impacts into property values.

1. General Considerations. The concept of "opportunity cost" is the appropriate construct for valuing both benefits and costs. The principle of "willingness-to-pay" captures the notion of opportunity cost by providing an aggregate measure of what individuals are willing to forgo to enjoy a particular benefit. Market transactions provide the richest data base for estimating benefits based on willingness-to-pay, as long as the goods and services affected by a potential regulation are traded in markets. It is more difficult to estimate benefits where market transactions are difficult to monitor or markets do not exist. Regulatory analysts in these cases need to develop appropriate proxies that simulate market exchange. Indeed, the analytical process of deriving benefit estimates by simulating markets may suggest alternative regulatory strategies that create such markets.

Either willingness-to-pay (WTP) or willingness-to-accept (WTA) can provide an appropriate measure of benefits, depending on the allocation of property rights. The common preference for WTP over WTA measures is based on the empirical difficulties in estimating the latter.

Estimates of willingness-to-pay based on observable and replicable behavior deserve the greatest level of confidence. Greater uncertainty attends benefit estimates that are neither derived from market transactions nor based on behavior that is observable or replicable. While innovative benefit estimation methodologies will be necessary or desirable in some cases, use of such methods intensifies the need for quality control to ensure that estimates are reliable and conform as closely as possible to what would be observed if markets existed.

2. Principles for Valuing Benefits Directly Traded in Markets. Ordinarily, goods and services are to be valued at their market prices. However, in some instances, the market value of a good or service may not reflect its true value to society.

If a regulatory alternative involves changes in such a good or service, its monetary value for purposes of benefit-cost analysis should be derived using an estimate of its true value to society (often called its "shadow price"). For example, suppose a particular air pollutant damages crops. One of the benefits of controlling that pollutant will be the value of the crop saved as a result of the controls. That value would typically be determined by reference to the price of the crop. If, however, the price of that crop is held above the unregulated market equilibrium price by a government price-support program, an estimate based on the support price would overstate the value of the benefit of controlling the pollutant. Therefore, the social value of the benefit should be calculated using a shadow price for crops subject to price supports. The estimated shadow price is intended to reflect the value to society of marginal uses of the crop (e.g., the world price if the marginal use is for exports). If the marginal use is to add to very large surplus stockpiles, the shadow price would be the value of the last units released from storage minus storage cost. Therefore, where stockpiles are large and growing, the shadow price is likely to be low and could well be negative.

In other cases, market prices could understate social values, for example where production of a particular good also provides opportunities for improving basic knowledge.

3. Principles for Valuing Benefits That Are Indirectly Traded in Markets. In some important instances, a benefit corresponds to a good or service that is indirectly traded in the marketplace. Examples include reductions in health-and-safety risks, the use-values of environmental amenities and scenic vistas. To estimate the monetary value of such an indirectly traded good, the willingness-to-pay valuation methodology is considered the conceptually superior approach. As noted in Sections 4 and 5 immediately following, alternative methods may be used where there are practical obstacles to the accurate application of direct willingness-to-pay methodologies.

A variety of methods have been developed for estimating indirectly traded benefits. Generally, these methods apply statistical techniques to distill from observable market transactions the portion of willingness-to-pay that can be attributed to the benefit in question. Examples include estimates of the value of environmental amenities derived from travel-cost studies, hedonic price models that measure differences or changes in the value of land, and statistical studies of occupational-risk premiums in wage rates. For all these methods, care is needed in designing protocols for reliably estimating benefits or in adapting the results of previous studies to new applications. The use of occupational-risk premiums can be a source of bias because the risks,

when recognized, may be voluntarily rather than involuntarily assumed, and the sample of individuals upon which premium estimates are based may be skewed toward more risk-tolerant people.

Contingent-valuation methods have become increasingly common for estimating indirectly traded benefits, but the reliance of these methods on hypothetical scenarios and the complexities of the goods being valued by this technique raise issues about its accuracy in estimating willingness to pay compared to methods based on (indirect) revealed preferences. Accordingly, value estimates derived from contingent-valuation studies require greater analytical care than studies based on observable behavior. For example, the contingent valuation instrument must portray a realistic choice situation for respondents -- where the hypothetical choice situation corresponds closely with the policy context to which the estimates will be applied. The practice of contingent valuation is rapidly evolving, and agencies relying upon this tool for valuation should judge the reliability of their benefit estimates using this technique in light of advances in the state of the art.

4. Principles and Methods for Valuing Goods That Are Not Traded Directly or Indirectly in Markets. Some types of goods, such as preserving environmental or cultural amenities apart from their use and direct enjoyment by people, are not traded directly or indirectly in markets. The practical obstacles to accurate measurement are similar to (but generally more severe than) those arising with respect to indirect benefits, principally because there are few or no related market transactions to provide data for willingness-to-pay estimates.

For many of these goods, particularly goods providing "nonuse" values, contingent-valuation methods may provide the only analytical approaches currently available for estimating values. The absence of observable and replicable behavior with respect to the good in question, combined with the complex and often unfamiliar nature of the goods being valued, argues for great care in the design and execution of surveys, rigorous analysis of the results, and a full characterization of the uncertainties in the estimates to meet best practices in the use of this method.

5. Methods for Valuing Health and Safety Benefits. Regulations that address health and safety concerns often yield a variety of benefits traded directly in markets, benefits indirectly traded in markets, and benefits not traded in markets. A major component of many such regulations is a reduction in the risk of illness, injury or premature death. There are differences of opinion about the various approaches for monetizing such risk reductions. In assessing health and safety benefits, the analysis should present estimates of both the risks of nonfatal illness or injury and fatality risks, and may include any particular strengths or weaknesses of such analyses the agencies think appropriate, in order to accurately assess the benefits of government action.

(a) Nonfatal illness and injury. Although the willingness-to-pay approach is conceptually superior, measurement difficulties may cause the agency to prefer valuations of reductions in risks of nonfatal illness or injury based on the expected direct costs avoided by such risk reductions. For example, an injury-value estimate from a willingness-to-pay study may be an average over a specific combination of injuries of varying severity. If the average injury severity in such a study differs greatly from the injury severity addressed by the regulatory action, then

the study's estimated injury value may not be appropriate for evaluating that action. More generally, willingness-to-pay estimates may be unavailable or too tentative to provide a solid base for the evaluation. The agency should use whatever approach it can justify as most appropriate for the decision at hand, keeping in mind that direct cost measures can be expected to understate the true cost. As discussed above (Section III.A.3), costs and benefits should be appropriately discounted to reflect the latency period between exposure and illness.

The primary components of the direct-cost approach are medical and other costs of offsetting illness or injury; costs for averting illness or injury (e.g., expenses for goods such as bottled water or job safety equipment that would not be incurred in the absence of the health or safety risk); and the value of lost production. Possibly important costs that might be omitted by the use of the direct-cost approach are the costs of pain, suffering and time lost (due to illness, injury, or averting behavior) from leisure and other activities that are not directly valued in the market. The present value of the expected stream of costs should be included. For long-term chronic illness or incapacitation the direct-cost approach may be particularly problematic compared to a willingness-to-pay estimate analogous to the valuation of mortality risks (discussed below).

Valuing lost production and other time-related costs gives rise to a number of methodological concerns. For occupational illness or injury, lost production can be measured by losses in workers' value of marginal product. In valuing the effects of broader environmental hazards, however, attention must be given to the composition of the exposed population. For example, some portion of the working-age population may be unemployed, while others will be retired. Still others may have chosen to be homemakers or home caregivers. Valuation of nonfatal illness or injury to these parts of the population presents a greater challenge than valuing the loss of employee services using wage rates. Finally, the valuation of health impacts on children or retirees through the direct-cost approach is especially problematic since their zero opportunity cost in the labor market is not a good proxy for the social cost of illness. The agency should use whatever approach it can justify but should provide a clear explanation of the assumptions and reasoning used in the valuation.

(b) Fatality risks. Values of fatality risk reduction often figure prominently in assessments of government action. Estimates of these values that are as accurate as possible, given the circumstances being assessed and the state of knowledge, will reduce the prospects for inadequate or excessive action.

Reductions in fatality risks as a result of government action are best monetized according to the willingness-to-pay approach. The value of changes in fatality risk is sometimes expressed in terms of the "value of statistical life" (VSL) or the "value of a life". These terms are confusing at best and should be carefully described when used. It should be made clear that these terms refer to the willingness to pay for reductions in risks of premature death (scaled by the reduction in risk being valued). That is, such estimates refer only to the value of relatively small changes in the risk of death. They have no application to an identifiable individual.

There is also confusion about the term "statistical life." This term refers to the sum of risk reductions expected in a population. For example, if the annual risk of death is reduced by one in a million for each of two million people, that represents two "statistical lives" saved per year

(two million x one millionth = two). If the annual risk of death is reduced by one in 10 million for each of 20 million people, that also represents two statistical lives saved.

Another way of expressing reductions in fatality risks is in terms of the "value of statistical life-years extended" (VSLY). For example, if a regulation protected individuals whose average remaining life expectancy was 40 years, then a risk reduction of one fatality would be expressed as 40 life-years extended. This approach allows distinctions in risk-reduction measures based on their effects on longevity. However, this does not automatically mean that regulations with greater numbers of life-years extended will be favored over regulations with fewer numbers of life-years extended. VSL and VSLY ultimately depend on the willingness to pay for various forms of mortality risk reduction, not just longevity considerations.

As described below, there are several ways that the benefits of mortality risk reduction can be estimated. In considering these alternatives, however, it is important to keep in mind the larger objective of consistency -- subject to statutory limitations -- in the estimates of benefits applied across regulations and agencies for comparable risks. Failure to maintain such consistency prevents achievement of the most risk reduction from a given level of resources spent on risk reduction. The valuation of mortality risk reduction is an evolving area in terms of results and methodology. Agencies generally should utilize valuation estimates, either explicitly or implicitly calculated, that are consistent with the current state of knowledge at the time that the analysis is being performed, and should show that their approach to valuation reflects the current state of knowledge. Significant deviations from the prevailing state of knowledge should be explained.

(c) Alternative methodological frameworks for estimating benefits from reduced fatality risks. Several alternative ways of incorporating the value of reducing fatality risks into the framework of benefit-cost analysis may be appropriate. These may involve either explicit or implicit valuation of fatality risks, and generally involve the use of estimates of the VSL from studies on wage compensation for occupational hazards (which generally are in the range of 10⁻⁴ annually), on consumer product purchase and use decisions, or from a limited literature using contingent-valuation approaches. Because these estimates may not be entirely appropriate for the risk being evaluated in some cases (e.g., the use of occupational risk premia for environmental hazards), agencies should provide an explanation for their selection of estimates and for any adjustments of the estimates to reflect the nature of the risk being evaluated.

One acceptable explicit valuation approach would be for the agency to select a single estimate of the value of reductions in fatality risk at ordinarily encountered risk levels, or a distribution of such values, and use these values consistently for evaluating all its programs that affect ordinary fatality risks. Where the analysis uses a range of alternative values for reductions in fatality risk, it may be useful to calculate break-even values, as in other sensitivity analyses. This requires calculating the borderline value of reductions in fatality risk at which the net benefit decision criterion would switch over from favoring one alternative to favoring another (i.e., the value of fatality risk at which the net benefits of the two alternatives are equal). This method will frequently be infeasible because of its computational demands but, where feasible, it may be a useful addition to the sensitivity analysis.

An implicit valuation approach that could be used entails calculations of the net incremental cost per unit of reduction in fatality risk (cost per "statistical life saved") of alternative measures, with net incremental costs defined as costs minus monetized benefits. Alternatives can be arrayed in order of increasing reductions in expected fatalities. Generally this will also correspond to increasing incremental cost. (It is possible that there will be some initial economies of scale, with declining incremental costs. If incremental costs are declining over a broad range of alternative measures, it is likely that there are flaws in the definition of the measures or the estimation of their effects.) The incremental cost per life saved then can be calculated for each adjacent pair of alternatives. With this construction, the choice to undertake a certain set of measures while eschewing others implies a lower and upper bound for the value per life saved; it would be at least as large as the incremental cost of the most expensive measure undertaken, but not as large as the cheapest measure not undertaken. In contrast to explicit valuation approaches, this avoids the necessity of specifying in advance a value for reductions in fatality risks. However, the range of values should be consistent with estimated values of reductions in fatality risks calculated according to the willingness-to-pay methodology, and the method should be consistently applied across regulatory decisions (within statutory limitations), in order to assure that regulation achieves the greatest risk reduction possible from the level of resources committed to risk reduction.

While there are theoretical advantages to using a value of statistical life-year-extended approach, current research does not provide a definitive way of developing estimates of VSLY that are sensitive to such factors as current age, latency of effect, life years remaining, and social valuation of different risk reductions. In lieu of such information, there are several options for deriving the value of a life-year saved from an estimate of the value of life, but each of these methods has drawbacks. One approach is to use results from the wage compensation literature (which focus on the effect of age on WTP to avoid risk of occupational fatality). However, these results may not be appropriate for other types of risks. Another approach is to annualize the VSL using an appropriate rate of discount and the average life years remaining. This approach does not provide an independent estimate of VSLY; it simply rescales the VSL estimate. Agencies should consider providing estimates of both VSL and VSLY, while recognizing the developing state of knowledge in this area.

Whether the VSLs (or VSLYs) are chosen explicitly or are an implicit outcome of a cost-effectiveness approach, the choice of estimates ideally should be based on a comparison of the context of the regulation affecting risks and the context of the study or studies being relied on for value estimates. The literature identifies certain attributes of risk that affect value. These attributes include the baseline risk, the extent to which the risk is voluntarily or involuntarily assumed, and features (such as age) of the population exposed to risk. For regulations affecting some segments of the population (e.g., infants) more than those groups which have served as the basis for most of the information used to estimate VSLs (e.g., working-age adults), the use of VSLs from the literature may not be appropriate. At a minimum, differences in regulatory and study contexts should be acknowledged and a rationale for the choice of the value estimate should be provided.

Based on the literature, both the scale of baseline risks and their degree of voluntariness appear to affect VSLs. However, the risk from an involuntary hazard typically is too small to represent a

significant portion of baseline risk. (For example, average annual mortality risks for men aged 55-64 are about two per hundred, while occupational fatality risk reductions typically achieved by regulations are between two per ten thousand and two per million annually.) In such cases, it may be legitimate to assume that the valuation of risks can be treated as independent of baseline risk.

To value reductions in more voluntarily incurred risks (e.g., those related to motorcycling without a helmet) that are "high," agencies should consider using lower values than those applied to reductions in involuntary risk. When a higher-risk option is chosen voluntarily, those who assume the risk may be more risk-tolerant, i.e., they may place a relatively lower value on avoiding risks. Empirical studies of risk premiums in higher-risk occupations suggest that reductions in risks for voluntarily assumed high risk jobs (e.g., above 10-4 annually) are valued less than equal risk reductions for lower-risk jobs. However, when occupational choices are limited, the occupational risks incurred may be more involuntary in nature.

C. Cost Estimates

1. General Considerations. The preferred measure of cost is the "opportunity cost" of the resources used or the benefits forgone as a result of the regulatory action. Opportunity costs include, but are not limited to, private-sector compliance costs and government administrative costs. Opportunity costs also include losses in consumers' or producers' surpluses, discomfort or inconvenience, and loss of time. These effects should be incorporated in the analysis and given a monetary value wherever possible. (Producers' surplus is the difference between the amount a producer is paid for a unit of a good and the minimum amount the producer would accept to supply that unit. It is measured by the area between the price and the supply curve for that unit. Consumers' surplus is the difference between what a consumer pays for a unit of a good and the maximum amount the consumer would be willing to pay for that unit. It is measured by the distance between the price and the demand curve for that unit.)

The opportunity cost of an alternative also incorporates the value of the benefits forgone as a consequence of that alternative. For example, the opportunity cost of banning a product (e.g., a drug, food additive, or hazardous chemical) is the forgone net benefit of that product, taking into account the mitigating effects of potential substitutes. As another example, even if a resource required by regulation does not have to be paid for because it is already owned by the regulated firm, the use of that resource to meet the regulatory requirement has an opportunity cost equal to the net benefit it would have provided in the absence of the requirement. Any such forgone benefits should be monetized wherever possible and either added to the costs or subtracted from the benefits of that alternative. Any costs that are averted as a result of an alternative should be monetized wherever possible and either added to the benefits or subtracted from the costs of that alternative.

All costs calculated should be incremental, that is, they should represent changes in costs that would occur if the regulatory option is chosen compared to costs in the base case (ordinarily no regulation or the existing regulation) or under a less stringent alternative. Future costs that would be incurred even if the regulation is not promulgated, as well as costs that have already been incurred (sunk costs), are not part of incremental costs. If marginal cost is not constant for any

component of costs, incremental costs should be calculated as the area under the marginal cost curve over the relevant range. A schedule of monetized costs should be included that would show the type of cost and when it would occur; the numbers in this table should be expressed in constant, undiscounted dollars.

The EA should identify and explain the data or studies on which cost estimates are based with enough detail to permit independent assessment and verification of the results. Where cost estimates are derived from a statistical study, the EA should provide sufficient information so that an independent observer can determine the representativeness of the sample, the reliability of extrapolations used to develop aggregate estimates, and the statistical significance of the results.

As with benefit estimates, the calculation of costs should reflect the full probability distribution of potential consequences. Extreme values should be weighted, along with other possible outcomes, by estimates of their probability of occurrence based on the available evidence to estimate the expected result of a proposed regulation. If fundamental scientific disagreement or lack of knowledge precludes construction of a scientifically defensible probability distribution, costs should be described under plausible alternative assumptions, along with a characterization of the evidence underlying each alternative view. This will allow for a reasoned determination by decisionmakers of the appropriate level of regulatory action. That level of action should derive from the decisionmaking process, not from adjusting cost estimates upward or downward at the information-gathering or analytical stages of the process.

Estimates of costs should be based on credible changes in technology over time. For example, a slowing in the rate of innovation or of adoption of new technology because of delays in the regulatory approval process or the setting of more stringent standards for new facilities than existing ones may entail significant costs. On the other hand, a shift to regulatory performance standards and incentive-based policies may lead to cost-saving innovations that should be taken into account. In some cases agencies are limited under statute to considering only technologies that have been demonstrated to be feasible. In these situations, it may also be useful to estimate costs and cost savings assuming a wider range of technical possibilities.

As in the calculation of benefits, costs should not be double counted. Two accounting cost concepts that should not be counted as costs in benefit-cost analysis are interest and depreciation. The time value of money is already accounted for by the discounting of benefits and costs. Generally, depreciation is already taken into account by the time distribution of benefits and costs. One legitimate use for depreciation calculations in benefit-cost analysis is to estimate the salvage value of a capital investment.

2. Real Costs Versus Transfer Payments. An important, but sometimes difficult, problem in cost estimation is to distinguish between real costs and transfer payments. Transfer payments are not social costs but rather are payments that reflect a redistribution of wealth. While transfers should not be included in the EA's estimates of the benefits and costs of a regulation, they may be important for describing the distributional effects of a regulation. Scarcity rents and monopoly profits, insurance payments, government subsidies and taxes, and distribution expenses are four

potential problem areas that may affect both social benefits and costs as well as involve significant transfer payments.

(a) Scarcity rents and monopoly profits. If, for example, sales of a competitively produced product were restricted by a government regulation so as to raise prices to consumers, the resulting profit increases for sellers are not a net social benefit of the rule, nor is their payment by consumers generally a net social cost, though there may be important distributional consequences. The social benefit-cost effects of the regulation would be represented by changes in producers' and consumers' surpluses, including the net surplus reduction from reduced availability of the product. The same conclusion applies if the government restriction provides an opportunity for the exercise of market power by sellers, in which case the net cost of the regulation would include the cost of reduced product provision due both to the government mandate and the induced change in market structure.

(b) Insurance payments. Potential pitfalls in benefit-cost analysis may also arise in the case of insurance payments, which are transfers. Suppose, for example, a worker safety regulation, by decreasing employee injuries, led to reductions in firms' insurance premium payments. It would be incorrect to count the amount of the reduction in insurance premiums as a benefit of the rule. The proper measure of benefits for the EA is the value of the reduction in worker injuries, monetized as described previously, plus any reduction in real costs of administering insurance (such as the time insurance company employees needed to process claims) due to the reduction in worker insurance claims. Reductions in insurance premiums that are matched by reductions in insurance claim payments are changes in transfer payments, not benefits.

(c) Indirect taxes and subsidies. A third instance where special treatment may be needed to deal with transfer payments is the case of indirect taxes (tariffs or excise taxes) or subsidies on specific goods or services. Suppose a regulation requires firms to purchase a \$10,000 piece of imported equipment, on which there is a \$1,000 customs duty. For purposes of benefit-cost analysis, the cost of the regulation for each firm ordinarily would be \$10,000, not \$11,000, since the \$1,000 customs duty is a transfer payment from the firm to the Treasury, not a real resource cost. This approach, which implicitly assumes that the equipment is supplied at constant costs, should be used except in special circumstances. Where the taxed equipment is not supplied at constant cost, the technically correct treatment is to calculate how many of the units purchased as a result of the regulation are supplied from increased production and how many from decreased purchases by other buyers. The former units would be valued at the price without the tax and the latter units would be valued at the price including tax. This calculation is usually difficult and imprecise because it requires estimates of supply and demand elasticities, which are often difficult to obtain and inexact. Therefore, this treatment should only be used where the benefit-cost conclusions are likely to be sensitive to the treatment of the indirect tax. While costs ordinarily should be adjusted to remove indirect taxes on specific goods or services as described here, similar treatment is not warranted for other taxes, such as general sales taxes applying equally to most goods and services or income taxes.

(d) Distribution expenses. The treatment of distribution expenses is also a source of potential error. For example, suppose a particular regulation raises the cost of a product by \$100 and that wholesale and retail distribution expenses are on average 50 percent of the factory-level cost. It

would ordinarily be incorrect to add a \$50 distribution markup to the \$100 cost increase to derive a \$150 incremental cost per product for benefit-cost analysis. Most real resource costs of distribution do not increase with the price of the product being distributed. In that case, either distribution expenses would be unchanged or, if they increased, the increase would represent distributor monopoly profits. Since the latter are transfer payments, not real resource costs, in neither case should additional distribution expenses be included in the benefit-cost analysis. However, increased distribution expenses should be counted as costs to the extent that they correspond to increased real resource costs of the distribution sector as a result of the change in the price or characteristics of the product, or if regulation directly affects distribution costs.

SELECTED FURTHER READINGS

Judith D. Bentkover, Vincent T. Covello, and Jeryl Mumpower, Eds., *Benefits Assessment: The State of the Art*.

Jack Hirshliefer and John G. Riley, *The Analytics of Uncertainty and Information*. An advanced treatment of many issues related to risk and uncertainty.

Myrick Freeman, *The Measurement of Environmental and Resource Values: Theory and Methods*. A comprehensive high-level treatment of environmental valuation issues.

Robert C. Lind, Ed., *Discounting for Time and Risk in Energy Policy*. An advanced treatment of issues related to public and private sector discounting.

E. J. Mishan, *Economics for Social Decisions: Elements of Cost-Benefit Analysis*. Assumes some knowledge of economics. Chapters 5-8 should be helpful on the important subjects of producers' and consumers' surpluses (not discussed extensively in this guidance document).

Robert Cameron Mitchell and Richard C. Carson, *Using Surveys to Value Public Goods: The Contingent Valuation Method*. Provides a valuable discussion on the potential strengths and pitfalls associated with the use of contingent-valuation methods.

V. Kerry Smith, Ed., *Advances in Applied Micro-economics: Risk, Uncertainty, and the Valuation of Benefits and Costs*.

Edith Stokey and Richard Zeckhauser, *A Primer for Policy Analysis*. Chapters 9 and 10 provide a good introduction to basic concepts.

George Tolley, Donald Kenkel, and Robert Fabian, Eds., *Valuing Health for Policy: An Economic Approach*. An excellent summary of methods to value reduction in morbidity and extensions to life expectancy.

W. Kip Viscusi, *Risk By Choice*. Chapter 6 is a good starting point for the topic of valuing health and safety benefits. Other more technical sources are given in the bibliography.