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# The Challenges of Improving the Economic Analysis of Pending Regulations

## *The Experience of OMB Circular A-4*

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## Abstract

Federal regulatory policy and the evaluation of regulations using benefit-cost analysis continue to be quite contentious. Advocates for more regulation claim that benefit-cost analysis loses information and impedes our understanding of the real beneficial consequences of regulatory action. Against this backdrop, economists and advocates of economic analysis have sought to improve the quality and technical content of benefit-cost analysis. This paper examines key changes made by the 2003 guidelines in Circular A-4 for regulatory analysis issued by the U.S. Office of Management and Budget in an effort to strengthen such analysis. This paper discusses the motivation and basis for these changes—the treatment of discount rates and uncertainty and the cost-effectiveness analysis for rules affecting health and safety—and evaluates the EPA's response to the A-4 changes in its analysis of environmental rules.

**Key Words:** benefit-cost analysis, cost-effectiveness analysis, discount rates, environmental rules, uncertainty analysis

## Contents

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Art Fraas and Randall Lutter*

## Introduction

Federal regulatory policy, especially regarding health, safety and the environment, is often quite contentious. Many critics of regulation claim that federal regulations are often ill-founded and unreasoned efforts to expand government oversight and control of private actions, regardless of the costs. Advocates for more such regulations argue that they are essential to protect public health and safety. (Heinzerling and Ackerman, 2004) But, despite this debate, economic analysis, and in particular analysis of the benefits and costs of pending federal regulations, has stood as an accepted means to provide for a systematic and comprehensive accounting of the beneficial and adverse consequences of regulatory action. Within this context, economists and advocates of economic analysis have sought to improve the quality and technical content of benefit-cost analysis.

Here we look into the effectiveness of one important recent effort to strengthen such analysis, the guidelines on regulatory impact analyses (RIAs) issued by the federal Office of Management and Budget (OMB) in 2003, Circular A-4. The OMB's Circular A-4 is the latest in a series of OMB documents intended to improve agencies' analyses of pending regulations.

Circular A-4, which OMB issued after consulting with regulatory agencies, replaced and refined OMB's "best practices" document issued in 1996, subsequently issued as a guidance in 2000, and re-affirmed in 2001. Its purpose was primarily to improve the information conveyed to policy-makers and the public about the likely effects of different regulatory choices.

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Circular A-4, which like its predecessors requires benefit-cost analysis for all major rule-makings, contains several key changes from these earlier guidance documents, including, most significantly:

1. a specific requirement that agencies perform a formal quantitative analysis of uncertainty for rules with annual benefits or costs that exceed $1 billion,[1]
2. a requirement that agencies provide estimates of net benefits using discount rates of three and seven percent,
3. a requirement that agencies prepare a cost-effectiveness analysis (CEA) for all major rulemakings for which the primary benefits are improved public health and safety.

In this paper we review the quality of a key set of recent federal benefit-cost analyses for major environmental rules in the several years since OMB issued Circular A-4 (A-4), focusing on how these analyses adhered to the key requirements of A-4. For comparison purposes, we also evaluate how well these analyses comply with other longstanding requirements of OMB. For this purpose we focus on three such requirements: 1) whether the analysis identifies a market failure, or presents other reasons for government intervention (e.g., equity), 2) whether the regulatory analysis uses a baseline that is internally consistent, and reasonably reflects pending regulations and market trends, and 3) whether the analysis characterizes the benefits and costs of a set of reasonable alternatives to the rule being proposed or issued.

We find that most RIAs conform to those requirements of A-4 that can be met at relatively low cost, (discounting and statements of need); but, there is greater non-compliance for those requirements that are more difficult to meet (formal treatment of uncertainty, estimating a stream of benefits over 30 years). We find that there is mixed adherence to the requirement to conduct a cost-effectiveness analysis. Finally, we also note in passing that the adherence to these requirements is greater for regulations issued under the authority of statutes that direct agencies to assess risks and costs. Of course the impact of these statements is attenuated by the relatively small set of rules that we consider and by an unavoidable element of subjectivity in our analysis.

The following sections provide a quick review of existing literature on benefit cost analysis, a description of the criteria we used to select major rules for review, a discussion of

[1] For rules with annual benefits in the range of $100 million to $1 billion, agencies should use more rigorous approaches with higher consequence rules and where net benefits are close to zero.

agency treatment of these requirements in their RIAs, and a summary of our review. We conclude with remarks on the extent to which these requirements are being met and a discussion of what else to do to improve regulatory impact analyses.

## Recent Reviews of Benefit-Cost Analysis

An extensive literature exists discussing the strengths and limitations of benefit cost analysis. An authoritative and widely cited *Science* article by Arrow et al. (1996) addresses the role for benefit-cost analysis in health safety and environmental regulations. Following more recent criticisms, Adler and Posner (2006) try to provide new foundations for benefit cost analysis, arguing it is best defended as a welfarist decision procedure, i.e., a workable proxy for overall welfare, something that is part of the moral bedrock (see also Graham, JD. 2008). Despite these arguments, some advocates for further regulation claim that benefit-cost analysis is a deeply flawed device that "impedes rather than aids understanding of the concrete consequences of regulations." (Heinzerling, 2008.)

Our focus on the quality in benefit cost analysis is purposefully limited in scope. We do not consider the extent to which agencies economic analysis is independently replicable—whether different researchers applying the same methods to the same data would get identical results. Perhaps surprisingly, careful efforts at independent replication of large econometric models have shown that in many instances they are not independently replicable, even after they have undergone expert peer-review. (Dewald et al. 1986) We also do not consider a second and higher measure of quality: whether a benefit-cost analysis relies on sound supporting methods—which may range from toxicology and epidemiology on the one hand to atmospheric chemistry and engineering on the other. Clearly a benefit-cost analysis that uses flawed epidemiological estimates of the effect of air pollution on health will itself be flawed. While our primary focus is on whether the analysis is sufficiently robust to support rational informed decision-making, we do not consider all aspects of such robustness. We do not consider, for example, whether the regulatory agency has developed quantitative estimates of benefits and costs, instead limiting our sample to only those regulatory analyses with such quantitative estimates. (Hahn & Dudley 2007)

Our primary focus, on agencies' compliance with 6 key provisions of OMB Circular A-4 has two key differences from earlier literature. First these provisions should be seen as an authoritative statement of what agencies should do and in principle can do. Second, departures from these standards illustrate the severity of the principal-agent problem so common in government policy-making.

## Regulatory Impact Analyses Considered

We consider a set of analyses that represents a major part of the costs and benefits of rules covered by the key elements that are new to A-4. We limit our review to final rules issued after January 1, 2005 because A-4 took effect on January 1, 2005 for final rules (and January 1, 2004 for proposed rules). (OMB 2005, 80) We exclude rules promulgated on or after October 1, 2009 and also exclude "budget" rules, i.e., rules whose primary purpose is to manage a program of government spending, like Medicare. For simplicity, we have also decided to exclude rules with RIAs that do not quantify and monetize both benefits and costs. Most of the major environmental rules published since 2004 are EPA rules. We exclude from our review the Department of the Interior's annual Migratory Bird Hunting Regulations every year to establish bag and possession limits for the hunting season for migratory birds. We also exclude the two other major non-EPA rules from other agencies—both of which failed to provide benefit estimates.[2] We did not review the analyses supporting four major DOE rules setting energy efficiency standards for Electric Distribution Transformers, Commercial Refrigeration Equipment, General Service Fluorescent Lamps and Incandescent Lamps, and Residential Furnaces and Boilers., These standards address a very different basic statutory purpose--energy efficiency--and indeed the bulk of the benefits accrue to energy and cost savings, although there may be some associated environmental co-benefits. Finally, DOT-NHTSA issued a major final rule setting Average Fuel Economy Standards for Light Duty Trucks, Model Years 2008-2011. Again, while there may be some environmental co-benefits associated with this rule, the focus of this rulemaking is on reducing light duty truck fuel use and savings in fuel costs dominate the quantitative benefits of the rule.

For these reasons, we have limited our review to RIAs for all final environmental rules issued after the publication of A-4 and through fiscal year 2009, with annual benefits or costs in excess of $1 billion. These EPA rules—particularly rules from the air program--are responsible for the overwhelming majority of estimated benefits and costs for all federal regulatory programs.

[2] These were: Right Whale Ship Strike (DOC-NOAA) and Designate Critical Habitat for 13 Evolutionarily Significant Units (ESUs) of Pacific Salmon and Steelhead in Washington, Oregon and Idaho. A third DOC NOAA rule—Amendments 18 and 19 to the Fishery Management Plan for Bering Sea/Aleutian Islands King and Tanners Crabs-Crab Rationalization Program—was listed in the Report to Congress with the note that while it was not an economically significant rule, it was designated economically significant because the value of the fishery (and the value of the tradable quotas allocated by the rule exceeded $100 million.

Table 1 provides summary information on the rules in our study. One of these regulations, EPA's Clean Air Fine Particle Implementation Rule, had no regulatory impact analysis associated with it. We therefore exclude it from the rest of our review, leaving us with 13 major regulations.

Figures 1 through 4 provide information on how well the analyses adhere to the new elements in A-4. For comparison purposes, Figures 5 through 7 present information on how well these analyses adhere to preexisting elements of A-4.

## Key Elements New to A-4

### *Comprehensive Treatment of Uncertainty*

A-4 specifically requires a formal quantitative uncertainty analysis for rules with benefits or costs that exceed one billion dollars per year. In doing so, Circular A-4 states: "Your analysis should provide sufficient information for decision makers to grasp the degree of scientific uncertainty and the robustness of estimated probabilities, benefits, and costs to changes in key assumptions." (OMB 2003, 40)

Analysis of benefits for environmental rules typically requires a complex chain of analyses, including establishment of baselines, estimates of the change resulting from regulatory action, the effect of this change in terms of improvements in health and welfare, and the resulting value of these changes in the monetization of benefits. Because of the potential compounding of high-end or low-end assumptions in developing benefits estimates, the analyst, decision-makers, and the public cannot know without a quantitative uncertainty analysis whether the estimates provided by a regulatory impact analysis (RIA) are within the ballpark of likely effects—particularly where conservative assumptions or defaults are used. By developing probability distributions for each of the key components and combining these for the primary estimate, a quantitative uncertainty analysis would place EPA's estimates of benefits in the context of a

comprehensive probability distribution. This would provide a better characterization of the EPA estimates and their uncertainty.[3]

The A-4 requirements with respect to the treatment of uncertainty followed a 2002 National Research Council (NRC) report titled *Estimating the Public Health Benefits of Proposed Air Pollution Regulations*. The NRC report raised specific and detailed concerns with EPA's treatment of uncertainty in its health benefits analysis.[4, 5] While previous recommendations varied regarding the best way to address uncertainty, the 2002 report was unequivocal in recommending that EPA conduct a more comprehensive quantitative assessment of uncertainty in its primary regulatory analysis. The NRC report specifically stated that this change would require EPA to conduct probabilistic, multiple-source uncertainty analyses and make available a presentation that would be clear and transparent to decision makers and to other interested readers. (NRC 2002, 7-8) Other recent reports have also urged EPA to make greater progress in the quantitative treatment of uncertainty. (Krupnick et al. 2006; NRC 2007a, 114-117; NRC 2007b, 6-8; Keohane 2009, 45-47; NRC 2009, 6.)

For our evaluation of the quantitative uncertainty analysis, we split the evaluation into three separate components—uncertainty analysis for the concentration-response relationship, exposure, and cost estimates. In the case of our evaluation of the uncertainty analysis for the concentration response relationship, we accepted EPA's approach of presenting a Monte Carlo analysis using standard errors on the effect estimates and the presentation of the array of results for the individual experts from its expert elicitation study as a satisfactory quantitative uncertainty analysis for the concentration-response relationship for the effect of particulate

[3] Throughout this discussion, the term "uncertainty" refers to both "variability" that reflects the statistical variation in estimates as well as to the uncertainty associated with a more fundamental lack of knowledge. Variability comes from the fact that there is variation within a population in terms of differences in exposure and in susceptibility. Variability cannot be reduced, but it can be better characterized with better data. Uncertainty results from a lack of knowledge about key elements or processes in the risk assessment. It can be represented by quantitative analysis—and can be reduced with additional research—but cannot be eliminated. One element of uncertainty is that which exists about the variability of a population estimate—and thus the analyst often cannot be precise about the extent of variability. (For a more complete discussion, see NRC 2009a, 93-99.)

[4] Earlier NRC reports raised similar concerns. These earlier reports found that proper characterization of uncertainty is essential and most have expressed the concern that analyses of health benefits understate associated uncertainties and leave decision makers with a false sense of confidence in the health benefits estimates.

[5] While the 2002 NRC report focused its attention on the uncertainty in the analysis of health benefits of air pollution regulations, the report recommended that EPA should also perform a similar quantitative uncertainty analysis for the valuation of health benefits and for the regulatory cost analysis. (NRC 2002, 127 and 148).

matter exposures on premature mortality. (Industrial Economics, Inc. 2006; Roman et al. 2008) But, this approach represents only an intermediate step in developing the quantitative uncertainty analysis recommended by the 2002 NRC report. Our evaluation for the Clean Air Act RIAs reflects more a "pass" for effort in responding to the 2002 NRC report than for the adequacy of the analysis.

In Figure 1, on quantitative uncertainty analysis, we summarize how the RIAs in question deal with uncertainty in concentration response, as well as in exposure and in costs. Most of the RIAs we reviewed did not provide a quantitative uncertainty analysis for the exposure and cost estimates. In fact the RIAs with no quantitative treatment of uncertainty were as many as those with formal treatment of uncertainty in concentration response, in exposure and in costs.

### *Time Preference and the Use of Discount Rates in Benefit/Cost Analysis*

Benefits and costs do not always occur in the same time period. If benefits and costs are separated in time, the difference in timing should be accounted for by the analysis. A-4 requires agencies to present an annual stream of benefits and costs expected to result from the rule and provide estimates of net benefits calculated using both 3 and 7 percent. (OMB 2003, 31) As A-4 explains (OMB 2003, 34):

- Resources that are invested will normally earn a positive return, so current consumption is more expensive than future consumption, since you are giving up that expected return on investment when you consume today.
- Postponed benefits also have a cost because people generally prefer present to future consumption. They are said to have positive time preference.

There is strong agreement among economists that a discount factor should be used to adjust the streams of benefits and costs to reflect differences in timing. (OMB 2003, 34) There is less agreement, though, on what the appropriate discount rate should be. The preferred approach --often referred to as the “shadow price” of capital approach--would be to adjust all benefits and costs to reflect their value in equivalent units of consumption and use a discount rate that reflects the social rate of time preference. The magnitude of this adjustment is not well-established, however, and any attempt would prove to be challenging. (OMB 2003, 33) As a result, A-4 requires the use of both 3 and 7 percent as discount rates.

The 7 percent discount rate reflects the fact that economic distortions, particularly the taxes on capital, create a gap between the rate of return that savers earn and the rate of return to

private capital. The pre-tax rate of return—roughly 7 percent—provides a better measure of society's gains from investment. (OMB 2003, 33) Thus, A-4 requires the use of this discount rate because the government should be sensitive to the possible effects of regulatory actions on capital allocation and investment.

When regulation primarily affects private consumption, the use of a lower discount rate reflecting the "social rate of time preference", i.e., the rate at which society discounts future consumption, is appropriate. This rate, as measured by the real rate of return on long-term government debt, is on the order of three percent. (OMB 2003, 33)

Many economists believe that this recommended range for the discount rate is too high—especially where regulatory actions to address intergenerational effects (like climate change) would protect future generations. And, some are concerned that the range will not properly reflect the effect of regulation on particularly productive sectors of the economy. To address these concerns, A-4 provides for the use of sensitivity analysis. Thus, for rules that have important intergenerational benefits and/or costs, the analyst may consider using a lower—but positive—discount rate as a sensitivity analysis in addition to presenting net benefits using discount rates of 3 and 7 percent. Alternatively, if there is reason to believe that the regulation would shift resources away from private investment, then the analyst should present as a sensitivity analysis estimates using a higher discount rate that reflects the return of that investment. (OMB 2003, 34-36)

Among the RIAs in our sample, all but two provided benefit and cost estimates using both 3 and 7 percent as discount rates, as shown in Figure 2. (Those two—the national ambient air quality standard for ozone and the performance standards for petroleum refineries, provided cost estimates only at 7 percent.) This high rate of compliance reflects in part the relative ease of adjusting the analysis during OMB review to reflect discount rates of 3 percent and 7 percent.

Only the two drinking water rules provided data on a stream of benefit and cost estimates, as shown in Figure 3. The Clean Air Act rules in our sample generally provide estimates for a single year--often a year 10 to 20 years in the future. This approach neglects the early years of implementation that are likely to be important because of issues associated with timing and phase-in. In addition, it is likely to be problematic because of difficulties projecting both the baseline scenario and compliance with the rule in the distant future. (NRC 2002) Finally, costs and benefits estimates at a future date like 2030 may be irrelevant since a variety of new federal regulations will likely be issued by then to address the environmental problem in question.

### *Cost-Effectiveness Analysis of Health and Safety Rules*

A-4 requires cost-effectiveness analysis (CEA) for all major rulemaking where the primary benefits are improved public health and safety [to the extent that a valid effectiveness measure can be developed]. (OMB 2003, 9) A-4 explains that both benefit-cost analysis (BCA) and CEA provide a systematic framework for evaluating alternative regulatory actions. A-4 explains that CEA can provide a "rigorous way to identify options that achieve the most cost-effective use of the resources available without requiring monetization of all of the relevant benefits or costs. Generally, CEA is designed to compare a set of regulatory actions with the same primary outcome (e.g., an increase in the acres of wetlands protected) or multiple outcomes that can be integrated into a single numerical index (e.g., units of health improvement)." (OMB 2003, 11)

Health economists use CEA to evaluate the effectiveness of alternative health strategies given a fixed level of expenditure. (Gafni 2006, 408) These analyses may use a variety of measures of effectiveness—such as life-years saved—but the Quality-Adjusted Life Year (QALY) is the most widely used measure combining mortality and morbidity outcomes in a single metric of health effects, without requiring the analyst to provide monetary values for mortality and various conditions of morbidity. (Dickie & List 2006, 340)

The use of CEA for evaluation of environmental policy has encountered significant criticism from environmental economists. While recognizing that CEA can be used as a part of environmental policy analysis and that doing so might result in the same policy conclusions, Dickie and List suggest that there are "serious doubts about the suitability of QALY/CEA for analysis of environmental policies, because QALY does not in general appropriately represent preferences for health and because CEA is neither independent of income distribution nor adequate to assess efficiency." (Dickie & List 2006, 344-345)

Only half of the RIAs that we examined included an analysis of cost-effectiveness using a measure of health for effectiveness. (See Figure 4.) Cost-effectiveness analysis--at least one that incorporates injuries and illness with mortality--can be a challenging task that adds cost and time to the regulatory analysis. EPA's Air office made a concerted effort in response to A-4 to develop CEA methods that incorporate injuries and illness along with premature mortality in a single measure of health status. (Hubbell 2006) This basic method was incorporated in the several RIAs for air rules issued in the first years following the issuance ofA-4. But, the initial impetus behind CEA seems to have diminished and fewer of the more recent rules include a CEA. Where an agency develops a benefit-cost analysis and assigns monetary values to the

health effects (like premature mortality), however, it is not clear that the CEA adds value to the regulatory analysis. This observation is consistent with the experience of one author (Lutter), who found that presentations of results of economic analyses at regulatory agencies outside of EPA, were complicated by the need to present both estimates of benefits and costs and estimates of cost-effectiveness.

## Comparison with Three Longstanding Requirements

For comparison purposes, we also explore three longstanding requirements for federal regulatory impact analyses. The first is that the RIA identify the need for a federal regulation, e.g., by identifying a market failure, or presenting other reasons for government intervention (e.g., equity). We accepted general discussion on the problems associated with market failure--generally, indicating the existence of an externality. Anticipating a shortcoming of most RIAs, we did not apply a more demanding test that would require the RIA to show both that existing regulation fails to address adequately the externality and that the selected rule would address it and yield net benefits. This more demanding test reflects the difference between an RIA where the analyst has incorporated in his/her analysis the essence of a benefit/cost analysis rather than just checking off an item on a checklist. As shown in Figure 5, we find that all but two RIAs in our sample included a description of need or market failure that met this test.

A second longstanding requirement of RIAs is that they use as a baseline a scenario that is internally consistent and reasonably reflects pending regulations and market trends. Use of a consistent and reasonable baseline is fundamental to a sound regulatory analysis. Indeed, as shown in Figure 6, we find that all of the RIAs but one used a consistent and appropriate baseline. That one, the national ambient air quality standard for lead, used a baseline that did not incorporate the potentially significant reductions in blood lead concentrations expected to result from a previously issued rule addressing residential lead hazards.

The final requirement is that the RIA includes an evaluation of alternative standards. Again, we used a low hurdle in evaluating this element--that is, whether the analysis provided quantitative monetized benefit and cost estimates for at least one alternative to the selected option. As a practical matter, there are likely to be an array of issues that could be informed by the analysis and a single alternative is not likely to provide much information on at least some of these issues (e.g., the timing or phase-in of the requirements). So an analysis could still be quite uninformative and yet pass our low hurdle. As shown in Figure 7, three regulations (dealing with hazardous air pollutants from mobile sources, interstate transport of fine particulate matter and ozone, and Standards of Performance for Stationary Compression Ignition Internal Combustion

Engines) did not provide monetized estimates of costs and benefits for any alternative to the preferred option.[6]

Conclusions:

Our review shows that there is a somewhat mixed record in terms of compliance with the requirements of A-4 for the regulatory impact analyses among this set of important rules. On average we gave the analyses a score of 5.25, with a range from three to nine. The two best analyses (at least by these measures), the two drinking water regulations, were both issued to comply not only with OMB A-4, but also relevant provisions of the Safe Drinking Water Act. Under the Safe Drinking Water Act (SDWA) Amendments of 1996, when proposing a national primary drinking water regulation that includes a maximum contaminant level (MCL), the Environmental Protection Agency (EPA) must conduct a health risk reduction and cost analysis (HRRCA), which contains seven separate requirements.

Most of these RIAs have conformed to A-4 with respect to the use of 3 and 7 percent as a discount rate. From the Agency perspective, this was probably a welcome change (from earlier guidelines requiring use of 7 percent) because it favors regulation and, as noted above, it is relatively easy to accommodate.

The RIAs from the air program office made some initial progress in terms of providing cost-effectiveness analysis and in taking steps toward improving the quantitative uncertainty analysis of the estimates. But, the effort to make further progress in these areas seems to have dissipated. As a result, the quantitative uncertainty analysis now provided by the air program still falls far short of the analysis called for by the 2002 NRC report and by A-4. In our view, without a quantitative uncertainty analysis that addresses the important sources of uncertainty, it is difficult to know whether the resulting benefits estimates reflect expected values or where these estimates fall within their associated probability distributions. To paraphrase the NRC report (2002), no estimate can be considered best until the quantitative analysis includes the major sources of uncertainty in the analysis producing that estimate.

The argument for continuing to maintain the requirement for cost-effectiveness analysis that is now part of A-4 is more mixed in our view. The use of cost-effectiveness analysis has been promoted as an alternative approach to the analysis of health outcomes in important part

[6] Another regulation, dealing with emissions from nonroad spark ignition engines, provided quantitative information about the costs of an alternative but did not provide such information about the benefits of that alternative.

because of a reluctance to assign monetary values to health outcomes. When agencies monetize health outcomes as a part of their benefit-cost analysis, there seems to be less reason to require cost-effectiveness analysis. Although, where agencies are providing benefit-cost analysis, cost-effectiveness analysis may still serve as a check on whether the agency is undervaluing or overvaluing the health effects (vis a vis the health benchmarks typically used in health economics).

But, there are important downsides to the cost-effectiveness analysis requirement. It is generally not compatible with the basic social welfare framework that underlies benefit-cost analysis. And, it seems to take the use of analysis in the wrong direction—that is, an evaluation of alternatives given a specified outcome rather than evaluating the efficiency of alternative options and outcomes. In addition, it adds to the cost and complexity of the RIA.

In our judgment, compliance with these requirements of A-4 is not likely to increase without strong support from OMB (and also agency) leadership. OMB's most recent Report to Congress on the Benefits and Costs of Regulation has identified a different set of areas--unrelated to the provisions of A-4 discussed above--where RIAs can and should be improved. These other areas include increased transparency and clarity in presenting benefits and costs, distributional effects, and the effects on future generations, and a greater use of retrospective analysis.

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## Tables and Figures

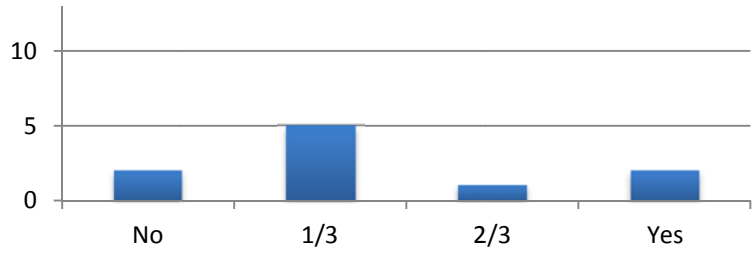
**TABLE 1**

| Agency - Office | Rule | Date Published | Federal Register Notice Reference | Benefits (millions per year) | Costs (millions per year) |
|---|---|---|---|---|---|
| EPA-Water | National Primary Drinking Water Regulations: Long Term 2 Enhanced Surface Water Treatment Rule | January 5 2006 | 71 FR 654 | $262-$1,785 | $80-$132 |
| EPA-Water | National Primary Drinking Water Regulations: Stage 2 Disinfectants and Disinfection Byproducts Rule | January 4 2006 | 71 FR 388 | $598 - $1,473 | $74 – $76 |
| EPA-OAR | Rule To Reduce Interstate Transport of Fine Particulate Matter and Ozone (*Clean Air Interstate Rule*); Revisions to Acid Rain Program; Revisions to the NOX SIP Call | May 12 2005 | 70 FR 25162 | $11,947-$151,769 | $1,716-$1,894 |
| EPA-OAR | Regional Haze Regulations and Guidelines for Best Available Retrofit Technology (BART) Determinations | July 6 2005 | 70 FR 39104 | $2,302 - $8,153 | $314 - $846 |
| EPA-OAR | Review of the National Ambient Air Quality Standards (NAAQS) for Particulate Matter | October 17 2006 | 71 FR 61144 | $3,837-$39,879 | $2,590-$2,833 |
| EPA-OAR | Clean Air Fine Particle Implementation Rule | April 25 2007 | 72 FR 20586 | $18,833-$167,408 | $7,324 |
| EPA-OAR | National Ambient Air Quality Standards for Ozone | March 27 2008 | 73 FR 16435 | $1,581 - $14,934 | $6,676 - $7,730 |
| EPA-OAR | National Ambient Air Quality Standards for Lead | November 12 2008 | 73 FR 66963 | $455 - $5,203 | $113 - $2,241 |
| EPA-OAR | Control of Hazardous Air Pollutants From Mobile Sources | February 26 2007 | 72 FR 8428 | $2,310-$2,983 | $298-$346 |

| | | | | | |
|---|---|---|---|---|---|
| EPA-OAR | Control of Emissions of Air Pollution From Locomotive Engines and Marine Compression-Ignition Engines Less Than 30 Liters per Cylinder | May 6 2008 | 73 FR 25097 | $4,145 - $14,550 | $295 - $392 |
| EPA-OAR | Control of Emissions from Nonroad Spark-Ignition Engines and Equipment | October 8 2008 | 73 FR 59034 | $899 - $4,762 | $196 - $200 |
| EPA-OAR | Standards of Performance for Petroleum Refineries | June 24 2008 | 73 FR 35838 | $176 - $1,669 | $27 |
| EPA-OAR[7] | Standards of Performance for Stationary Compression Ignition Internal Combustion Engines | July 11 2006 | 71 FR 39154 | $679-$757 | $56 |
| EPA-OPPTS | Lead; Renovation, Repair, and Painting Program; Lead Hazard Information Pamphlet; Notice of Availability | April 22 2008 | 73 FR 21691 | $657 - $1,611 | $383 - $417 |

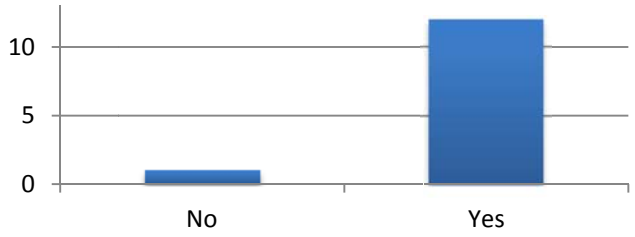
Notes: We report the titles of the rules as they appear in the various *Federal Register* notices. We report estimates of costs and benefits from OMB's annual reports to Congress on the benefits and costs of federal regulations, and expressed in terms of 2001 dollars. We have not rounded the estimates presented in OMB's annual reports.

**Figure 1**
**Quantitative Uncertainty Analysis**

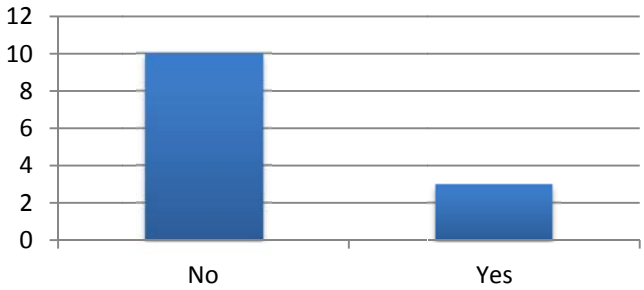



[7] This regulation is not formally required to have a probabilistic treatment of uncertainty because its effects do not exceed $1 billion per year.

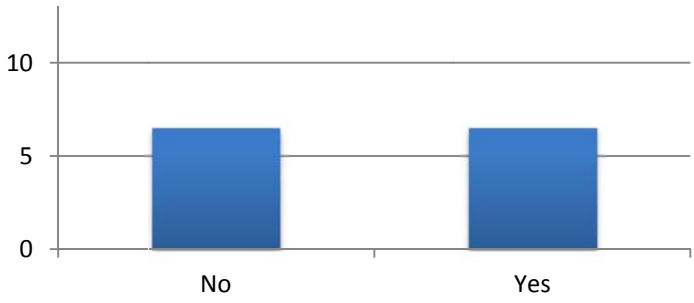
## Figure 2
## Discount at 3% & 7%



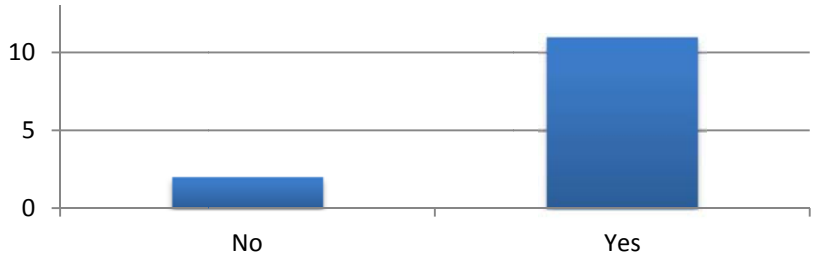

## Figure 3
## Stream of Benefits and Costs



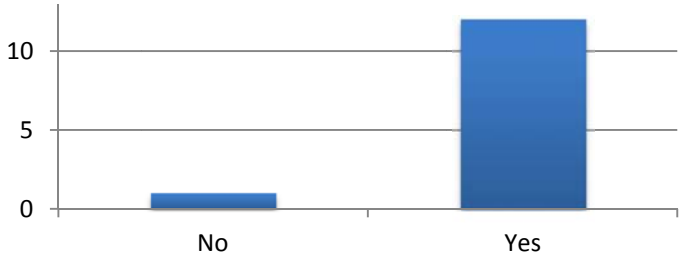

## Figure 4
## Cost-Effectiveness Analysis



## Figure 5
## Need or Market Failure




## Figure 6
## Consistent Baseline




## Figure 7
## Evaluation of Alternatives