ASSESSING THE COSTS OF ENVIRONMENTAL LEGISLATION

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PREFACE

This Congressional Budget Office staff working paper presents a taxonomy of definitions regarding the costs of environmental regulation. These various cost concepts are illustrated with examples based on cost estimates for legislative proposals relating to ozone attainment requirements under the Clean Air Act. The study was prepared in response to requests from the House Committee on Energy and Commerce, the majority and minority staffs of the Senate Environment and Public Works Committee and its Subcommittee on Environmental Protection, and a separate group of 34 Senators.

The paper was prepared in CBO's Natural Resources and Commerce Division under the supervision of Everett M. Ehrlich and Roger C. Dower, who wrote the report together with Douglas Kendall. Computational and analytical support was provided by Thomas Lutton. Valuable comments and assistance were provided by Robert Dennis, Matthew Salomon, Deborah Reis, and Robert Sunshine of CBO, Larry Parker and David Gushee of the Congressional Research Service, Robert Friedman of the Office of Technology Assessment, and Eric A. Hanushek of the University of Rochester. The paper was edited by Francis Pierce and typed by Patricia P. Joy.

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SUMMARY

As the Congress moves toward reauthorizing the Clean Air Act, it is increasingly asked to consider explicitly the costs of alternative legislative proposals. In response to members' requests, Congressional support agencies have provided several detailed economic analyses of Senate and House bills to control acid rain, attain national ambient levels of ozone, and address other forms and sources of air pollution. In addition, other federal agencies and private organizations have conducted economic analyses of legislative proposals and made them available to the Congress. Taken together, these studies offer often widely differing definitions and estimates of so-called "costs of environmental regulation."

To assist the Congress in interpreting these estimates, this paper sets out a taxonomy of cost definitions and assesses their meaning and application. To illustrate these different definitions, existing government estimates of Congressional proposals to reduce ozone concentrations (for example, as found in H.R. 3054 and S. 1894) are evaluated. Although these estimates differ in scope and measurement, they all tend to reflect the first-order cost burden of regulation and rarely consider how these cost burdens are translated into the changes in prices and output that ultimately determine the impact of regulation on the overall economy. Previous estimates of the impact of pollution control spending on the macroeconomy have found that a dollar of pollution control spending is expected to result in a one- to three-dollar loss in measured national output. Estimates obtained in this report fall into this range. Thus, a $10 billion annual pollution abatement requirement is likely to reduce real national output by $10 billion to $30 billion yearly.

TYPES OF ENVIRONMENTAL REGULATORY COSTS

Most estimates of the cost of environmental regulation are based on the initial cost to pollution sources of installing certain control technology or undertaking some other specific type of reduction program. **Compliance cost** estimates such as these may be useful for identifying the initial cost burden to affected firms, but say very little about how firms might respond to this potential increase in costs. By changing inputs and outputs, increasing prices, or reducing other production costs, firms are likely to reduce their first-order impact and shift some of the burden to suppliers, workers, and consumers. **Industry-level cost** estimates, properly constructed, will tend to demonstrate how compliance costs might be translated, by the decisions of individual firms, into effects on industry performance.

Industry-specific effects or cost burdens do not, however, provide a complete picture of the aggregate effects, or **macroeconomic impacts**, on the economy as a whole. Losses in one industry may be offset, in part, by gains in another (for example, in pollution abatement industries) or within the industry itself, leaving the aggregate economy less worse off than would be suggested by the compliance or industry-level cost estimates alone. Finally, estimates of macroeconomic impact may not reveal possible changes in **social welfare**, to the extent that the estimates do not reflect the value that producers and consumers place on the economic changes resulting from environmental regulations. Moreover, these economic changes would include both measurable and nonmeasurable costs. Of course, all of these measures should be viewed as gross rather than net costs, since they do not include the increased production of such goods as pollution-abating equipment or environmental control benefits such as improved health.

OZONE ATTAINMENT PROPOSALS: A CASE STUDY OF REGULATORY COSTS

The Senate is currently considering a comprehensive set of amendments to the Clean Air Act. The House is reviewing a more limited set of revisions. Both bills would address the failure of many urban areas to achieve the national air quality standard for ozone. The existing cost analyses of Congressional proposals illustrate several of the more important characteristics of regulatory cost analyses. Virtually all estimates of costs to the private sector fall into the category of compliance costs and are predicated heavily on assumptions concerning control technologies and the cost per ton of emissions reduced. The range in existing estimates of ozone compliance costs is quite large, from a low estimate of around $4 billion per year to a high estimate of approximately $13 billion. There are many reasons for the difference, ranging from uncertainty concerning control costs as they might apply to different industrial sources to different interpretations of how the bills would be implemented.

No government agency has formally estimated the industry-level costs or small business impacts. This lack of analysis limits a full understanding of the economic effects of ozone attainment provisions. Moreover, all of the existing analyses restrict the type and scope of potential economic responses to increased control requirements, and by ignoring any attendant benefits overestimate the long-run total net social costs.

Estimates of the cost of regulation to the public sector (state, local, and federal governments) are distinctly different from the private-sector cost estimates but share some of the underlying causes of uncertainty. Specifically, it is difficult to predict how state and local governments will actually go about meeting the new regulatory requirement deadlines for attaining the national ozone standards. Further, the actual impact on state or federal budgets will in the end be a function of how the requirements are financed: polluters may pay many of these costs through fees and other charges, or the burden may be placed on general taxpayers.

MACROECONOMIC EFFECTS

The macroeconomic effects of environmental regulation are almost always presumed to be negative. Increased costs of production stemming from increased regulatory costs are assumed to lower output, raise prices, and lead to lower productivity. Part of the reason for this presumption is that discussion focuses on the industries that are hurt by environmental regulation and not on those that may benefit. The manner in which regulation is modeled (as a series of cost burdens for specific industries) limits the ability to consider benefits in the calculation. But the negative bias is also a function of how accurately long-term responses to increased compliance costs are approximated. If the economy is viewed as relatively inflexible with little opportunity for trade-offs between products and industries, macroeconomic effects are likely to be seen as large. An alternative view could produce significantly different results. Even the macroeconomic impacts themselves, however, cannot be taken as a final indicator of whether the country is better or worse off as a result of environmental regulation.

Illustrative estimates of potential macroeconomic impacts derived by the Congressional Budget Office (CBO) also find the economic effects of environmental regulations to be negative. (There are no existing formal analyses of the House or Senate proposals to amend the Clean Air Act.) But the CBO estimates and other research suggest lower impacts than might be expected on the basis of at least one recent macroeconomic study conducted on another environmental program. One dollar of pollution control expenditure lowers economic output by between one dollar and three dollars. While these results are partly determined by the structure of the model and by underlying assumptions, they show that the short-run, worst-case situation depicted by some existing estimates of simple compliance costs may be exaggerated.

Precise estimates of the economic consequences of environmental regulation are probably impossible to make. Measurement errors, data gaps, and other shortcomings limit the overall accuracy of any analysis. All economic models oversimplify reality and are subject to various biases. It is convenient to equate changes in economic variables such as output or prices with social welfare, but social welfare is a composite of the goods and services people value. Some of these can be measured, while others lie outside the economic model.

CHAPTER I

COSTS OF ENVIRONMENTAL REGULATION: AN OVERVIEW

Environmental pollution poses a problem for the economy; absent corrective policies, polluters--whether the owners of factories or the operators of motor vehicles--have little incentive to stop polluting because the costs are borne by others while the polluters themselves profit. As long as the costs created by pollution remain "external" to the polluter, society effectively subsidizes polluters and their activities. If regulation reflects the extent of these external costs, it can lead all economic actors to incorporate the true costs and consequences of their activities into their economic decision making and, therefore, improve the well-being that society derives from its resources.

Even if regulators correctly assess the potential damage caused by pollution and dictate compliance and enforcement procedures that minimize disruptive effects, regulation will still require significant economic adjustments. Regulation ultimately will raise the prices of goods associated with pollution (relative to those that are more environmentally benign) and by so doing will change the composition of goods and services demanded by households and firms. Production of goods and services that lead to pollution will contract, and with it employment and affluence in some communities or regions. At the same time, production of substitutable goods and services, and of goods and services used in abating pollution, will increase.

Indeed, any major regulatory initiative, by influencing so many different goods, production sites, individuals, and economic decisions, cannot help but have broadly cast and important economic effects. Some of these effects will be local and some national; some will be immediately translated into measurable wealth or income changes (such as employment gained or lost) and some may never be "monetized" or captured directly in conventional economic measures. And what are perceived as economic losses to some will be experienced as important benefits to others. Thus, regulation may improve society's overall well-being (as measured by its subjective appraisal of its own welfare) while still lowering such purely material measures as gross national product.

The inherent complexity of the economy's response to regulation suggests the difficulty of finding a single answer to the question "what does a particular set of environmental regulations cost?" Possible answers could range from a very large amount (if every economic adjustment induced by a regulation were regarded as a cost and any associated benefit disregarded) to a very small or even negative amount (that is, if net rather than gross costs were considered and if regulation led, on balance, to increases in social welfare). Thus, while an analysis of the gross social costs of environmental regulation (focusing only on the negative economic adjustments) would show society worse off, a net social cost study (where positive adjustments are also included) might show

strikingly different results. As the Congress has been considering environmental legislation, many analysts have presented it with different estimates and analyses of economic costs that vary across this range. This paper, using current proposals to address the problem of ozone control, attempts to explain the strengths and weaknesses of different perspectives on cost and how these perspectives relate to each other.1/ It then evaluates some existing estimates of ozone attainment and considers different types of cost impacts of these estimates.2/

PERSPECTIVES ON THE COST OF REGULATION

Four definitions of "costs" are often used in analyses of environmental regulations. The definitions are not mutually exclusive--in fact, they may be thought of as being sequentially more inclusive, with each definition subsuming the effects incorporated into the previous one. The four definitions are: **compliance costs**, or estimates of the expenditures on equipment and services needed to comply with a given regulation; **industry-level costs**, which include compliance costs for an industry and may also include the value of an industry's lost output, revenues, or profits when these are relevant; **macroeconomic costs**, or the change in real economic activity that results from regulation; and **changes in social welfare**, or the value of the change in people's perceptions of their welfare after the compliance costs of a regulation have worked their way through the economy. Each of these is addressed in turn in the following discussion.

Compliance Costs

Firms responding to regulation must often purchase, operate, and maintain new equipment or must substitute materials or other production inputs. Typically, engineering studies of **compliance costs** attempt to estimate these expenditures on a plant-by-plant or industry-specific level before regulations are implemented.

Such studies generally superimpose a pollution-abating "end-of-pipe" technology over a prototypical plant or production technology. The cost of this equipment and its maintenance is treated generally as a pure addition to the cost of production (save for those instances where effluent recovery may lead to a usable by-product). These studies will often multiply the expenditure estimates for the prototypical plant by the number of such plants it would take to produce the relevant industry's current output. This procedure gives a useful approximation of the immediate cost effect of a regulation on an industry.

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1. The potential benefits of ozone attainment proposals are discussed more fully in Office of Technology, *Urban Ozone and the Clean Air Act: Problems and Proposals for Change* (April 1988).

2. This chapter deals with private-sector costs. Chapter III addresses corresponding public-sector costs.

Such engineering studies may overstate or misstate compliance costs for several reasons. First, technological advances allow firms to comply with regulations at lower cost in the long term. Firms may also be able to shift their productive inputs so as to minimize their expenditures or cost burden. Moreover, as new plants replace old ones in an industry, environmental concerns will be incorporated into their design, further lowering the cost of emission reductions. Thus, the "state of the art" that engineering studies seek to apply will change. Second, not all firms in an industry face the same costs when complying with a regulation: smaller firms may be exempted, larger firms may enjoy lower costs associated with larger size, and site-specific factors will always influence costs. Whether this influence leads to overestimates or underestimates of total industry costs depends on the sample chosen for the prototype and on the industry in question. Finally, not all firms comply with regulations, and the assumption that they all will leads to higher estimates of costs. A study performed in 1980 confirmed all of these tendencies, noting that engineering estimates of both the industry and the Environmental Protection Agency tended to overstate the actual costs of complying with various regulations.3/

Further, these studies implicitly assume that complying with environmental regulations will not reduce the output of an industry (since the costs of the "prototypical" plant are extrapolated to the industry's existing level of output). They also ignore how these compliance costs might be distributed between an industry's producers and the consumers of its product as prices adjust to the new costs. Such economic adjustments are not addressed in engineering cost studies.

An alternative basis for estimating past compliance costs for an industry involves the use of surveys that ask firms to report their actual compliance costs. This technique may lead to other kinds of misestimation. First, the respondents to these surveys are often unsure as to whether the expenditures they incurred were a response to federal or to state and local regulations. This "choice of a baseline" issue has grown more serious over time as state and local governments have added to federal regulatory requirements. Second, many production sites may not segregate the expenditures incurred in complying with regulations from other expenditures, and therefore their responses may at best be educated guesswork. Finally, it may be difficult to distinguish between environmental and other expenditures over time, both because effluent abatement strategies may shift from the installation of "end-of-pipe" equipment to incorporating abatement features into plant design, and because expenditures to maintain pollution-abating equipment are often indistinguishable from those that maintain other equipment.

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3. See Putnam, Hayes, and Bartlett, "Comparisons of Estimated and Actual Pollution Control Capital Expenditures for Selected Industries," Cambridge, Mass., 1980.

It is not surprising, then, that different surveys of compliance costs regularly produce widely disparate results.4/ Much the same is true of more aggregative measures, such as total private non-farm pollution control expenditures, although these vary by somewhat less than do industry-level data.5/

Industry-Level Costs

While compliance costs are generally depicted as borne by individual firms in specific industries, **industry-level costs** also include the cost of economic dislocations associated with regulation.

Regulation may have a variety of effects on an industry beyond compliance expenditures. For example, some firms may find it more cost-effective to reduce their output than to reduce the pollution associated with that output. In cases where no cost-effective technique for responding to regulation can be found (although this is rare), some older plants may close entirely. And if firms attempt to pass the cost burden of regulation forward to consumers, the quantity demanded of their product may fall, lowering output and perhaps profits. Alternatively, foreign competition may limit the ability of firms in an industry to pass these costs through. All of these effects pose costs to an industry of a different sort than the simple costs of compliance activities.

It is fairly common in studies of regulatory compliance costs to be presented with analyses of industry-level costs and impacts that derive from two main sources. The more formal assessments will be obtained from quantitative financial models on a firm-level basis that relate empirically additional pollution control expenditures to various measures of financial performance such as discounted cash flow. Plant-level financial analyses are then aggregated to the industry level to determine the impact on performance variables such as prices, profits, growth, or employment. Properly conducted, these analyses should give explicit consideration to demand and supply factors that define the ability of specific firms to pass cost increases forward or backward. Alternatively, industry-specific cost estimates are sometimes shown as a percentage or fraction of various indicators that are assumed to indicate the relative ability of an industry to absorb the initial cost burden or to show the impact of the additional expenditures on industry performance.

The more formal modeling approaches seem more likely to provide some insight into potential economic responses to an increased cost burden--to the extent that the industry has been appropriately modeled. On the other hand, the formal techniques are costly and require complex, plant-specific modeling.

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4. See P. Portney, "The Macroeconomic Impacts of Federal Environmental Regulation," in H.M. Peskin, P. Portney, and A.V. Kneese, eds., *Environmental Regulation and the U.S. Economy* (Baltimore: Johns Hopkins University Press, 1981).

5. See Congressional Budget Office, *Environmental Regulation and Economic Efficiency* (March 1985), pp. 55-56.

The other approach reveals much less concerning the ultimate impact of costs. The statement that the direct costs of a particular regulation or legislative proposal would be equivalent to X percent of total industry sales or net revenues is almost impossible to interpret. It may help to highlight specific industries that bear a relatively large cost burden. It may also be useful in understanding how the impact of costs varies for firms of different size within an industry.6/

A variety of studies have been performed through the years that chronicle the expected effects of regulation on an individual industry or on a cross-section of all industries.7/ These studies, while often valid, tend to concentrate on those industries that face the most onerous burdens under a proposed regulation, and therefore may overstate net costs if other industries benefit from the regulation. While such studies address an industry's gross costs, they do not inform as to society's net costs. For example, studies of air pollution regulations have characteristically linked them to the electric utility or ferrous and nonferrous metals industries; studies of water quality may look at the chemical and paper industries; studies of toxic and hazardous waste may focus on the chemical industry as may studies of hazardous air emissions. These studies are of obvious value in that they describe the set of firms (and, therefore, of workers or regions) that would be most dramatically affected by a regulation, but they present a one-sided view of the costs to society. On the other hand, industry-level cost studies such as these can serve to illustrate another important characteristic of industry cost burdens. Cost burdens rarely fall equally on all firms within an industry. For example, acid rain control legislation is likely to impose substantially higher costs on aluminum smelters that use coal-fired electricity than on smelters that use hydropower electricity. Even within an industry there will be winners and losers from environmental legislation.8/

Moreover, some industries will benefit from environmental regulation--industries that use environmental resources as inputs (such as agriculture, forestry, fisheries, or tourism) and industries that manufacture the inputs needed to comply with regulations (such as instrumentation). If regulation results in reduced health care costs or property damage costs, it may also expand the

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6. For example, EPA analyzes small business impacts by estimating the percent of production costs of small businesses associated with the additional costs of a regulation. Compliance costs over 10 percent of total production costs are considered a significant impact.

7. See L.B. Parker and A. Holt, *Acid Rain Legislation and Mid-Western Industries: A Mountain or a Mole Hill?* Congressional Research Service Report, June 6, 1985; Congressional Budget Office, *The Clean Air Act, The Electric Utilities, and the Coal Market* (April 1982); Robert W. Crandall, *Controlling Industrial Pollution: The Economics and Politics of Clean Air*, (Washington, D.C.: The Brookings Institution, 1983); W. B. Gray, "The Cost of Regulation: OSHA, EPA, and the Productivity Slowdown," *American Economic Review*, vol.77 no.5 (December 1987), pp. 998-1006.

8. See Parker and Holt in *Acid Rain Legislation and Mid-Western Industries: A Mountain or a Mole Hill?* for other examples.

demand for other goods and services or reduce their production costs. Neither of these effects is taken account of in the industry-level approach. Studies of industry-level costs, therefore, unless presented within a larger framework of regulatory costs and benefits, tell us more about the need for adjustment programs within the industry than they do about the final "cost" of a regulation or its desirability.

Macroeconomic Costs

Regulation may also change the levels of income, employment, and final prices for the whole economy. When the many production and consumption decisions resulting from the initial compliance costs are summed and their interactions taken account of, they may lead to changes in such macroeconomic variables as real output (measured by gross national product), the price level, and employment. While industry-level costs are "gross" costs (for a given industry), macroeconomic costs generally represent the "net" material cost of a regulation to society, over the long run.

A more neutral term would be macroeconomic "effects," since macroeconomic "costs" presumes that a regulation's depressing effects on economic activity will outweigh its output-enhancing effects and its net effect will be negative. There is some basis for this presumption, however, since some of regulation's benefits do not enter the calculation of GNP. Any analysis that deals only with measurable economic costs and benefits will neglect these effects.

But even measurable benefits may be undervalued in macroeconomic models, which--like the models of specific industries discussed above--are more sensitive to the cost burden associated with a regulation than to its benefits. This is a bigger problem at the macroeconomic level than at the industry level, where omitting benefits may not always bias the result. Proposals to lower air emissions, for example, must of necessity place a significant burden on the electric utility, automobile, metals, and petroleum refining industries. And even if they also generate economic cost savings, not all of the savings will be experienced by those industries. Treating regulation as a "cost burden" problem, therefore, may sometimes be appropriate when investigating specific industries.

But if the macroeconomic effects of regulation are estimated by representing regulation solely as a set of higher production costs, the biases found in industry studies will be compounded. This is the way regulation has generally been modeled.9/ It reflects the difficulty of identifying the dispersed and sometimes intangible benefits of regulation. One attempt to incorporate these benefits was made by Data Resources, Inc., which took all industry expenditures for operating and maintaining pollution-abating equipment and divided them by the average wage in manufacturing to reflect the employment generated by pollution-abating activities. (Doing so led to higher estimates for

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9. For a survey of macroeconomic studies of environmental regulation, see Congressional Budget Office, *Environmental Regulation and Economic Efficiency* (1985), pp. 59-75.

employment, output, and inflation, and lower estimates of productivity growth, as would be expected when employment is directly increased but measured output is not.)10/

Changes in Social Welfare

The ultimate measure of the cost of environmental regulation would be one that included the subjective value to consumers of goods and services forgone as a result of regulation. It would also include subjective losses through delay or inconvenience should regulation force people to change their living patterns. Such a measure would go beyond the macroeconomic costs and measure **changes in social welfare.**

The welfare measure is theoretically the most satisfactory since it would include all of the conceivable benefits of regulation. Its very breadth makes it the most difficult to apply. The ideal procedure for measuring changes in personal welfare is that of "compensating variation." This procedure identifies the amount of money that a person would require after a regulation is imposed in order to be subjectively "as well off" as before (or, in the case of benefits, the amount that a person would be willing to surrender). This would be the amount by which that person's welfare had changed. By summing individual responses, a social compensating variation can be obtained. This is the dollar value of the change in society's perception of its own well-being because of a regulation, and is probably the best theoretical measure of the ultimate "cost" of the regulation. A number of studies have used compensating variation techniques to assess such unmonetizable environmental benefits as the value of increased longevity, or the preservation of scenic vistas.11/

The difficulties of estimating this measure are obvious. Individuals may not report their perceptions accurately, and they may not have correct perceptions of the changes resulting from regulation. Moreover, some regulations have such wide-ranging effects that it is impossible to present people with a complete list of them. Efforts to use this technique to measure the costs of regulation must, therefore, employ a shorthand approach.

The first and foremost study to devise such a shorthand did so by calculating the payment needed to compensate society for the estimated losses in

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10. See Data Resources, Inc., "The Macroeconomic Impact of Federal Pollution Control Programs, 1978 Assessment," submitted to the Environmental Protection Agency and the Council on Environmental Quality, January 29, 1979.

11. See, for example, M. Cropper and F. Sussman, "Families and the Economic Risks to Life," *American Economic Review*, vol. 78, no. 1 (March 1988), pp. 255-260; or, for a broader perspective, A.J. Kneese, *Measuring the Benefits of Clean Air and Water* (Washington, D.C.: Resources for the Future, 1984).

output resulting from environmental regulation.12/ This provided a more sophisticated estimate of the cost of regulation. The authors note, however, that their estimates of the "cost" of environmental regulation must be balanced against estimates of benefits (in other words, they have estimated gross but not net costs). But for as pervasive a policy as environmental regulation, it is not clear that "costs" and "benefits" can be separated into distinct groups. Rather, regulation brings adjustments that are often costs to some and benefits to others.

As a practical matter, none of the cost-estimation approaches discussed here adequately captures this mixed character of most environmental regulation. Consequently, most of the methods tend to overestimate net economic costs. This is because the approaches rarely consider regulatory benefits, because benefits are difficult to measure, and because certain industrial responses to the cost burden of regulation--such as technological progress or input switching--may not be correctly anticipated.

OTHER COSTS

Much of the preceding discussion has been in terms of expenditures by firms or other industrial sources of pollution. These are by no means the only costs. Although industrial control costs are often the largest component of overall regulatory costs, compliance may also require expenditures on the part of federal, state, and local governments and by the general public directly (as distinct from consumer costs resulting from price increases). Governmental expenditures are treated in this study as public costs and are discussed more fully in Chapter III. Like any other type of public expenditure, federal, state, or local spending on pollution control programs can be expected to have a stimulative short-term effect on the economy, but could result in adverse international trade effects or decreased domestic private savings. Given the relatively small level of public expenditures for pollution control programs, these effects are likely to be minimal and difficult to detect.

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12. See H. Hazilla and R. J. Kopp, *The Social Cost of Environmental Quality Regulations: A General Equilibrium Analysis* (Washington, D.C.: Resources for the Future, 1986). The authors first estimated, using a family of over 600 mathematical "preference functions" that they constructed to represent society as a whole (as does any random sample), the level of social welfare derived from the bundle of goods and services that society would produce were there no environmental regulation. They then added the cost burdens resulting from regulation and observed the change in the level and composition of the production of all goods and services. Using their family of representative "preference functions," they then estimated the level of well-being derived from this "post-regulatory" bundle of goods and the minimum feasible cost of raising social well-being from the lower, "post-regulatory" level to the higher, "pre-regulatory" level. This minimum feasible cost is the compensating variation that defines the value of the loss in well-being associated with regulation.

Costs incurred directly by the general public are included as private costs, and many have been taken account of in the earlier discussion. One category of costs borne directly by the general public deserves special attention, however. Many environmental control programs require changes in the public's consumption patterns and other daily habits. For example, leaf burning is banned in many localities, and some cities have restricted automobile commuting because of air pollution problems. Requirements such as these impose what might be called "consumer inconvenience" costs to the extent that the general public would be willing to pay some positive amount to avoid the required changes. These are real costs and should directly enter the calculation of social welfare losses. On the other hand, they are extremely difficult to measure since they are not usually reflected in market prices. Like other types of costs, moreover, consumer inconvenience costs are not static over time, but are likely to change as consumer preferences change. It is conceivable that some inconvenience costs associated with pollution control programs would decrease over time as the general public adjusted to and became more comfortable with the restrictions.

CHAPTER II

PRIVATE ECONOMIC COSTS OF OZONE ATTAINMENT

Existing estimates of the costs associated with current legislative proposals to reauthorize the Clean Air Act share most of the limitations and uncertainties discussed in Chapter I. Any economic analysis is further complicated by the fact that the precise regulatory requirements of the proposals must be constructed from the statutory language. The Congressional Research Service (CRS) and the Office of Technology Assessment (OTA) have, nevertheless, estimated the private costs of some of the key provisions of Congressional proposals that would revise the attainment schedules and requirements for the national ozone standard. These and other cost estimates are reviewed here to illustrate the types of concerns and issues raised in Chapter I. The proposals' costs to federal, state, and local governments will be examined in Chapter III.

Existing estimates of ozone attainment control costs tend to focus only on the negative consequences of the proposals. In this regard, they tend to overestimate actual cost burdens. This is particularly true since most of the estimates fall into the "compliance cost" category and may not depict explicitly the full range of possible technological and economic responses, nor the benefits of reducing ozone concentrations. One final general point concerning the estimates reviewed below is that all of them relate to the provisions of the Senate bill (S. 1894). To the extent that the existing House bill (H.R. 3054) adopts different approaches, its costs may vary from those reported here.1/ OTA argues that the costs of the two bills (or of the Environmental Protection Agency's proposal, for that matter) are unlikely to differ substantially because meeting the similar attainment deadlines will require most areas now out of compliance to implement all available control methods. Even then, OTA questions whether the reductions required for attainment can be achieved in all areas.

OVERALL ESTIMATES OF PRIVATE-SECTOR COMPLIANCE COSTS

Table 1 presents estimates of the cost of meeting the major ozone attainment provisions in H.R. 3054 and S. 1894, made by CRS, OTA, and the Environmental Protection Agency (EPA).

All of these estimates involve different sets of assumptions and different methods of calculation, but they share several common characteristics that are worth noting in order to better understand the differences between the estimates:

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1. In addition, at the time of this writing, at least one other House proposal concerning ozone attainment revisions was being developed. This proposal was not incorporated explicitly in this analysis.

TABLE 1. GOVERNMENT AGENCY ESTIMATES OF THE ANNUAL COST OF SELECTED OZONE ATTAINMENT PROVISIONS (In billions of 1988 dollars)a/

Provision	CRS Low (Costs in 2000)	CRS High (Costs in 2000)	EPA Low (Costs in 1992)	EPA High (Costs in 1992)	OTA (Costs in 2003)
Stationary Source VOC	3.91	6.39	n/a	n/a	2.42
Area Sources	--b/	--b/	--	--	0.96
Tailpipe Standards	1.20	3.10	1.24c/	1.24c/	2.51
Enhanced Inspection and Maintenance	0.46	2.05	1.35	1.35	3.38
Stage II	0.08	0.12	0.05	0.09	0.26
Alternative Fuels	0.14	0.38	--	--	0.88
TCMs	0.00	0.23	--	--	--
Onboard	0.20	0.80	0.19	0.19	0.79
RVP Control	0.45	0.45	0.21	0.77	0.27
Total	6.44	13.52	4.23	4.83	11.48

SOURCES: Compiled by the Congressional Budget Office from publications of the Congressional Research Service, the Office of Technology Assessment, and the Environmental Protection Agency. CRS estimates of costs in 2000 are reported in CRS reports 87-751S and 88-297S. OTA estimates of costs in 2003 are reported in Office of Technology Assessment, "Urban Ozone and the Clean Air Act: Problems and Proposals for Change," April 1988. EPA estimates of costs in 1992 are reported in "Detailed Documentation of Costs of Senate Clean Air Act Amendments," with the exception of the estimates for Stage II and Onboard Control that are reported in Federal Register, vol. 52, no. 160, Wednesday, August 17, 1987.

NOTE: n/a = not applicable

a. None of the totals should be viewed as representing the full cost to any area of attaining the ozone standard. The CRS and EPA numbers are estimates of some specific provisions of S. 1894. OTA's estimates assume that all non-attainment areas will have to implement all available emissions reduction strategies to reach attainment, and many areas will still exceed the standard after implementing these controls.

b. CRS includes the cost of area sources in its stationary source estimate.

c. EPA does not estimate the cost of heavy-duty diesel trucks meeting the bill's NO_x standard because it considers the standards to be technically infeasible.

- The cost estimates are predicated on the analysts' interpretation of the bills' requirements, and on assumptions concerning how the requirements would be implemented by EPA and the states. Some of the provisions are relatively straightforward in this regard; others are subject to greater uncertainty. For example, the House bill may allow states close to attainment relatively more flexibility than does the Senate bill in terms of actions required to meet the air quality goals. Thus, the cost analysis has to adopt assumptions concerning state responses that may or may not be realized.

- The analyses use somewhat different baselines for estimating costs. For example, current EPA estimates of the Senate bill assume that some proposed legislative requirements will be implemented by EPA regardless of Congressional action. Specifically, EPA already has proposed changes in onboard and RVP controls. The different baselines confuse simple comparisons of the estimates and can lead to large variations.

- While the House and Senate bills include a number of relatively similar requirements, there are significant differences. These include the numbers of cities or areas to which specific requirements would apply and the time frames in which they would take effect. It is not clear whether these differences are likely to affect the cost estimates.

- All of the estimates fall into the general category of engineering costs. They reflect principally the bills' first-order additional capital and operating maintenance requirements, and do not attempt to predict economic responses to these increased costs.

- All of the estimates in Table 1 assume that the same level of costs will be incurred year after year. For example, technology-based controls on stationary sources are estimated to cost the same on an annual basis regardless of the length of time before such controls are required. Given the deadlines for meeting the bills' various requirements, however, costs are likely to vary substantially over time if states delay certain types of control requirements until absolutely necessary. Table 2 shows OTA estimates of this time variance. The overall impact of timing on the total costs of the requirements could be significant.2/

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2. In general, as costs are pushed forward in time, the total costs over the period of the analysis expressed in terms of present values are lower. The is true for two important reasons. First, a dollar spent today is more expensive than a dollar spent at some point in the future. Further, a longer compliance period generally will allow expanded opportunities for the development of less costly technology or the adoption of other, potentially less expensive, control options such as product or input substitution or process change.

TABLE 2. ESTIMATED ANNUAL COSTS OF SPECIFIC OZONE ATTAINMENT PROVISIONS OVER TIME
(In billions of 1988 dollars)

Provision	1993	1998	2003
Stationary Source Controls	2.07	2.19	2.42
Area Sources	0.88	0.92	0.96
Tailpipe Standards	0.63	1.75	2.51
Enhanced I/M	2.73	3.05	3.38
Stage II	0.21	0.24	0.26
Alternative Fuels a/	0.94	0.84	0.88
Onboard	0.21	0.53	0.79
RVP Control	0.26	0.26	0.27
Totals	7.93	9.79	11.48

SOURCE: Office of Technology Assessment, "Urban Ozone and the Clean Air Act: Problems and Proposals for Change," April 1988.

a. Based on costs of methanol use.

- The bases for the cost analyses reviewed here are sometimes unclear, but it is presumed that all costs are in 1988 dollars unless stated otherwise--that is, in terms of the value of a dollar in 1988 incurred in each year the provisions are in effect.

The following pages provide additional detail on some of the specific assumptions and issues underlying the estimates for individual provisions.

COSTS OF SPECIFIC PROVISIONS

The various strategies adopted by the proposed legislation to extend ozone attainment deadlines result in a wide assortment of cost estimates. The underlying methods or protocols for a selected set of these estimates are evaluated below. While some of these are predicated on formal cost models, others might best be regarded as educated guesses--particularly the cost estimates associated with technology-forcing provisions and control measures affecting smaller, currently unregulated sources.

Industrial Stationary Source Controls

The House and Senate bills place certain VOC and NO_x reduction requirements on a wide range of industrial sources in various regions.3/ Given the new threshold emission levels adopted by the bills, affected sources could include both large chemical or petroleum production facilities and relatively small dry cleaning or bakery firms. In general, these sources will be required to adopt specific control technologies (referred to as "reasonably available control technologies" or RACT) to reduce their emissions. These costs are estimated to range from $2.4 billion to $6.4 billion annually for the Senate bill.

Most of the estimates for the stationary source controls are based on estimates of emission reduction levels (in millions of tons) necessary to meet attainment deadlines, multiplied by an estimate or range of estimates of the average dollar cost per ton of doing so. The OTA analysis of the Senate bill is one important exception. OTA estimates the emission reductions that could be achieved through the application of RACT in 43 industrial categories, and then multiplies these estimates by cost-per-ton control estimates specific to each category.

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3. Volatile organic compounds (VOCs) are a class of substance that vaporize at certain temperatures and atmospheric conditions. In combination with nitrogen oxides (NO_x), emitted from the combustion of fossil fuels and sunlight, VOCs can react to form lower atmospheric ozone. VOCs are emitted from a diverse set of mobile and stationary sources, including house paints, automobile engines, pesticides, and petroleum refineries. Mobile source controls include tailpipe standards, onboard refueling controls, etc. Stationary source controls can be directed toward point stationary sources such as commercial or industrial facilities, or area sources including pesticide applications, architectural coatings, and solvents.

The accuracy of these estimates in terms of actual compliance costs depends on the degree to which the cost-per-ton estimates reflect the specific characteristics of the regulated sources. Properly constructed or specified, the per-ton costs would take account of:

- The degree to which any specific source or category of sources is already controlling VOC emissions;

- Differences in the industrial processes that emit VOCs;

- Options available to sources to control emissions--from technological controls to product or input substitutions; and

- Differences, if any, between the control options available to smaller firms and those available to large firms.

The OTA analysis appears to be the best in addressing at least some of these considerations. By taking account of existing levels of control and differences among emission sources in the cost of control, the OTA study acknowledges that not all sources of VOC are alike. The total estimates for stationary-source VOC control appear, however, somewhat invariant to the use of an average versus a source-specific control cost. The more important consideration may be differences in cost of control between large VOC emission sources, say those emitting over 100 tons, compared to smaller sources--those down to 25 tons in the Senate bill. Although some RACT standards are in place for this size of source, there has been relatively little experience with the kinds of controls that would be appropriate and effective for these source categories. It is possible that many of them would have fewer and relatively more expensive reduction options than the larger sources. For example, a large emission source may find it less expensive on a per-ton basis to vent several VOC emission points to a single control device. A single smaller source, on the other hand, may be forced to adopt a more expensive strategy. The analyses conducted so far throw little light on this potential problem. Given that the House and Senate bills bring a potentially large number of small, relatively uncontrolled, sources into the regulatory system, this is an important concern.

Compliance costs provide limited insight as to the responses of firms when faced with the prospect of increased cost burdens. For one thing, as already noted, the technologies that serve as the basis for cost estimation are unlikely to reflect the full range of control options available to any specific firm. Moreover, a host of economic responses is also possible and likely.

National Standards for Stationary and Area VOC Sources

In addition to the technology-based control required in specific nonattainment regions, the House and Senate bills require developing and implementing national emission standards for specified classes of VOC sources. Over and above the RACT provision, these requirements will ultimately direct emission reduction efforts at large and diverse classes of point and area VOC sources that could include degreasing operations, automobile body paint facilities and shops, and

other small facilities. OTA has provided an estimate of the engineering cost burdens of the Senate version of standards but only for two of the five source categories: solvents and architectural coatings. Assuming a cost-per-ton control of $2,000, OTA arrives at a cost for these standards of around $960 million per year. Although these estimates were made on the basis of the Senate bill, the House requirements are quite similar.

The accuracy of the OTA estimates hinges on the same kinds of concerns expressed above: the degree to which these sources are already controlled; the possibility of relatively low-cost production substitution (for example, switching to water-based paints); and the other available technological control options. The potential impact of these issues is particularly acute given the wide diversity of sources affected by these provisions. Presumably many of the sources, because of their size, have generally not been subject to controls. This would suggest that reductions might be achieved relatively inexpensively. On the other hand, because some of the sources are small they may not be able to avail themselves of technology-based controls, limiting their overall flexibility to achieve cost-effective reductions.

Stage II Controls

The costs of installing and maintaining "at-the-pump" gasoline vapor recovery devices or Stage II controls, as required by the House and Senate bills, have been estimated by several organizations. These estimates all assume that every nonattainment region will implement this control. This assumption seems reasonable given the Senate bill requirements. The House bill, however, requires Stage II only in severe areas, suggesting lower overall costs. If, as OTA suggests, most nonattainment regions will have to implement every available control strategy regardless of specific legislative requirements, costs are likely to be the same under either bill.

In general, the basis for these engineering cost estimates is either the cost per gasoline pump or station for the required technology (multiplied by the number of affected pumps or stations) or an estimate of the cost-per-ton control (multiplied by the expected emission reductions). The relatively small range of costs associated with these controls reflects probably the relatively homogeneous nature of the technology and control sources.

One somewhat controversial element of Stage II costs concerns the inconvenience costs to car drivers of having to use a Stage II-equipped pump. EPA has argued that, everything else being equal, car drivers would be willing to pay some amount of money to avoid having to follow the special handling procedures of the stage II pump apparatus. Such inconvenience costs are difficult to measure, since they are not reflected in market transactions. EPA has provided an estimate of 10 cents per refueling event as an approximation of the inconvenience costs to car drivers. The basis for this estimate is unclear, and there is little in the way of an analytical baseline for comparison. If Stage II was implemented in all nonattainment areas, even this small unit cost would result in relatively large aggregate costs of approximately $141 million to $209 million annually.

Alternative Fuels

Under both the House and Senate bills, new vehicles in fleets of a certain size and in certain areas will have to be capable of using alternative fuels such as methanol, ethanol, or natural gas. In addition, the House bill requires that at least 30 percent of all new vehicles in severe areas be capable of using these same fuels by 1997. The primary determinants of total direct costs to fleet owners (public or private) are the number of areas in which the requirement holds, the type of fuel selected for alternative use, the size of the fleet to which the requirement applies, the cost of designing vehicles capable of using those fuels, and, most important, whether the redesigned vehicles actually use alternative fuels. This last point is important given the current price differential between gasoline and most alternative fuels. The CRS estimated a range of $140 million to $380 million as the cost of the Senate bill's fleet requirement for converting fleets of 50 or more units to methanol or natural gas.

Enhanced Inspection and Maintenance (I/M) Programs

These provisions are discussed in Chapter III. It is worth noting, however, that a substantial portion of the costs are likely to be passed on to owners of vehicles (through inspection or registration fees and repair costs).

Offset Requirements

Current law requires new sources in nonattainment areas to obtain offsetting reductions in emissions at a ratio of greater than 1 to 1. EPA's current policy requires a 1.2 to 1 offset ratio for all major sources (over 100 tons) in some instances. H.R. 3054 requires an offset ratio of 1.2 to 1 for all new sources over 25 tons in serious areas, and an offset ratio of 1.5 to 1 for all new sources over 10 tons in severe areas. S. 1894 requires offset ratios of 2 to 1 for new sources over 25 tons in severe or most severe areas. The key issue affecting the costs of the proposed offset requirements is whether they are particularly binding given the percentage reduction requirements. The Senate bill, for example, already requires that severe nonattainment areas reduce overall emissions of VOCs by 65 percent by 1997. These reduction requirements may, in some areas, force nonattainment regions to adopt even more stringent offsets than those in the proposed legislation.

Fees

Both H.R. 3054 and S. 1894 require that severe areas impose a per-ton fee on stationary sources emitting over 25 tons of VOCs or NO_X. The Senate bill requires that the fee be at least $100 per ton and be imposed beginning in 1993; the House bill leaves the fee unspecified, but requires that it be imposed beginning in 1990. CRS estimates that if the fee was set at $100 per ton and affected 15 areas, it would generate roughly $100 million per year. But this estimate assumes that emissions would actually increase in these areas between now and 1993, an unlikely assumption given the required percentage reductions

and the stringent requirements for new sources. The estimate also assumes 15 areas would be affected. This appears to overstate the cost given that only four areas fall into the category of severe or most severe areas according to the most recent data. This bias may be partially offset by the difficulties areas have had attaining a specific deadline in the past.

H.R. 3054 also authorizes the EPA Administrator to promulgate regulations imposing a fee of not more than \$.05 per gallon on the sales of gasoline and diesel fuel in severe areas. The revenues of this fee are to be available for making grants to states and local governments in those areas to implement transportation control measures.

Fuel Volatility

To limit gasoline volatility during warm months, both H.R. 3054 and S. 1894 would require that the Reid Vapor Pressure of gasoline be reduced to 9.0 pounds per square inch, or approximately 80 percent of its current level, by 1992 (the Senate bill requires this standard by 1990). Cost estimates of this provision range from \$210 million to \$770 million per year. The primary method for lowering gasoline volatility is to reduce the butane content of the fuel. This process would increase the cost to refiners to the extent they have locked into contracts for butane or would have to make changes in the refining process to alter fuel composition. Economywide costs could be substantially lower, however, if reducing butane content increased the fuel economy of vehicles. Lower-volatility fuels might also increase the drivability of some cars. All of these costs are considered in a range of costs estimated by EPA in its proposed rules on volatility.4/ The EPA estimates are the basis for all CRS and OTA estimates of this provision. The reason for the differences between the CRS and OTA estimates is unclear, but they appear to reflect differing assumptions about refiners' ability to break contracts or the value of reducing RVP in attainment areas.

None of the existing estimates takes account of the incremental cost of the earlier deadline for S. 1894. The less time refiners are allowed to meet these requirements, the more significant the short-term cost increase. For example, the EPA estimate of the S. 1894 RVP requirement reflects the approximate annual cost in 1992. EPA notes, however, that the RVP reduction deadline of April 1990 would be possible to meet only through large-scale short-term product switching, which could add an incremental cost of \$2 billion during 1990 and 1991.

Onboard Controls

The House and Senate bills would require that onboard controls (VOC collection canisters in the trunks of cars) be installed on all vehicles sold after 1990 and 1991, respectively. The range of cost estimates reflects the different views on

4. 52 FR 31274, August 19, 1987.

the difficulty of fitting onboard canisters into current car designs. EPA argues that the onboard controls would be small enough to fit onto current car designs without major retooling, and estimates the per-vehicle cost as ranging from $14 to $19 per vehicle. Some auto manufacturers dispute this view, arguing that fitting even small canisters into some small vehicle designs would be impossible without substantial retooling, at a cost of between $80 and $110 per vehicle, or around 1 percent of the average price of a new car.5/

Three additional arguments cloud the debate about onboard controls. Opponents of these canisters argue that they would increase the likelihood of fire in the event of a crash. This argument is based more on the premise that any control that complicates the fuel line will increase the chance of failure than on evidence that such controls are particularly dangerous. Opponents also argue that positioning the canisters will require manufacturers to reduce either trunk size or fuel tank size. In either case, they argue that the design change would result in consumer inconvenience costs of up to $25 per car in the case of reduced trunk size. (Larger cars might enjoy a relative cost advantage in this respect.) Finally, the EPA argues that onboard controls would increase fuel economy, and therefore, it includes a $5 credit for fuel recovery in the $14 per car estimate.

Tailpipe Standards

One of the controversial provisions of both bills involves the tightening of mobile source emission standards for carbon monoxide (CO), nitrogen oxides (NOx), and hydrocarbons. Although the bills set similar standards, they differ in the year by which compliance must be met and in the type of vehicle concerned. These differences aside, the costs to automobile manufacturers of these requirements appear to be primarily determined by their technological feasibility and the costs of increased automobile recalls and expanded warranty claims. CRS, EPA, and OTA have estimated the costs of the Senate provisions as ranging from $1.2 billion to $3.1 billion annually.

Some general observations concerning the estimates are in order. First, the hardware cost estimates assume that automobile manufacturers would be able to design a technology capable of meeting the requirements. CRS states that virtually all domestic manufacturers have testified that they are unable to meet these standards. CRS does, however, suggest a range of $50 to $150 as the cost per car, based in part on estimates used by EPA. OTA uses an estimate of around $140 per car (including NO_x control). Other observers have noted that the automobile industry made the same claim in regard to earlier emission control standards, but was ultimately able to meet them. At the same time, the proposed new standards involve more than a simple marginal improvement in

5. See testimony of Teiji Iida, Manager, Toyota Motor Corp. before the Subcommittee on Environmental Protection of the Senate Committee on Environment and Public Works, April 9, 1987.

emissions: they may require new technological developments. It is beyond the scope of this paper to resolve the dispute, but the uncertainty associated with the estimates should be noted.

The other cost elements contained in the CRS study relate primarily to the increased costs to automobile manufacturers of ensuring that the tailpipe emission control technology continues to operate properly over its warranty period. This period has been expanded under the Senate bill to 10 years or 100,000 miles. The CRS estimates assume that certain percentages of cars would have to be recalled during the 10-year/100,000-mile time period for manufacturer repair, and that a doubled warranty period would result in doubled warranty costs. These assumptions are based at least in part on the industry's claim that it will be difficult to guarantee continued performance of emission control equipment, particularly in larger six- or eight-cylinder vehicles. Again, it is only possible to record the uncertainty associated with these estimates. Other potential consequences of these provisions are discussed in a later section on industry impacts.

INDUSTRY-LEVEL COSTS

The compliance cost estimates for the various ozone attainment provisions presented earlier are not specific to any particular industry except for some of the mobile source controls. Obviously, however, these costs will be distributed differently across industries, depending on their relative emission levels, the existing levels of control, and the various technological options available in each industry. The translation of these costs into specific measures of industry performance (such as profits, employment, etc.) will depend on how the individual firms in an industry respond to the engineering cost burdens imposed by the regulations.

Ideally, industry compliance costs would be constructed from an aggregation of firm-level costs, and would explicitly allow for individual firm responses to engineering cost burdens that would minimize the costs to each firm. Unfortunately, none of the existing ozone attainment cost estimates have been assembled in this manner.6/ In fact, there is a relative dearth of empirical analyses relating to industry-specific costs and impacts. It is possible, nevertheless, to put at least some of the estimated cost burdens into the context of industry-level costs and impacts.

Distribution of Costs by Industrial Sector

Lacking a formal analysis of industry-level costs associated with the House or Senate ozone attainment proposals, this paper can offer only a crude assessment

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6. Several industry-specific cost studies have been prepared by industrial organizations. These are not reviewed here except for comparative purposes.

of the cost burden on specific industries. Tables 3 to 5 break down estimated 1985 emissions of VOCs by various major source categories and by various industrial processes. The initial cost burden of H.R. 3054 to these sectors can be roughly approximated by allocating the estimated total ozone control costs on the basis of each sector's estimated emissions. In the case of transportation, storage, and marketing, the emissions and the associated control costs are allocated to petroleum refining. Emissions and associated control costs for industrial processes and industrial surface coating are allocated across the remaining industrial processes in Table 5. On this basis, the organic chemicals, petroleum, and polymers and resins sectors bear the greatest absolute cost burdens. The distribution of the burden is roughly similar to industries' value of shipments (Table 6), a dollar measure of industry output, although larger relative impacts are shown for vegetable oil processing facilities, petroleum refineries, and synthetic rubber manufacturing. In only one industry is the initial cost burden greater than 1 percent of the 1987 value of shipments.

These industry-level cost burden estimates should be viewed with extreme caution. They assume that all sources face roughly the same level of per-unit control costs. In fact, the average per-ton control cost implied by these tables is substantially less than those estimated by OTA for the individual industries. Further, the estimates assume that the industrial processes considered will not bear any other emission reduction costs from other major sources not included (for example, other solvent use and other miscellaneous sources). Finally, the estimated cost burdens are really compliance costs and do not really match the definition of industry-level costs given earlier, since they do not take account of possible economic responses on the part of the affected sources. At best they should be viewed as crude first-order estimates showing which industrial sectors may be most adversely affected. They say very little about the potential ability of these industries to pass on price increases, hold market share, or realign production processes.

A similar exercise was conducted in a study prepared for The Business Roundtable (BRT).7/ It estimated that 300,000 to 600,000 jobs in the primary manufacturing industries (approximately 1.5 percent to 3.0 percent of their total work force) could be lost as a result of annual incremental expenditures of $20 billion under selected provisions of the Senate bill. The BRT estimates, however, like those in Tables 4 through 6, are not derived from an explicit model of the industries that make up the primary manufacturing sector. Rather, they appear to be based on a set of "rules of thumb" relating compliance costs to production cost changes, losses in domestic market shares, and job losses. As a consequence, they are completely static, making no allowance for cost-reducing technological or economic responses. They are also sector-specific in that they ignore potential employment increases in other sectors. The BRT estimates may best be viewed as an extreme worst-case scenario. While pollution control costs of the magnitude considered by BRT could reasonably be expected to have deleterious effects if imposed on this one sector, exacerbating the current

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7. The Business Roundtable, *Analysis and Impact of S. 1894: "The Clean Air Act Standards Attainment Act of 1987,"* prepared by R.M. Dodd and Company (March 1988).

TABLE 3. SUMMARY OF 1985 U.S. VOC EMISSIONS
(In thousands of tons per year)

Source Category	Point Source Emissions	Area Source Emissions	Percent of Total Emissions
Storage, Transportation, and Marketing of Petroleum Production	324	1,000	7
Industrial Processes	1,052	--	6
Industrial Surface Coating	525	--	3
Other Solvent Use (degreasing, dry cleaning, graphic arts, adhesives, solvent extraction processes, etc.)	268	4,700	26
Other Miscellaneous Sources (fuel combustion, solid waste disposal, open burning, waste solvent recovery processes, and stationary internal combustion engines)	242	3,600	20
Mobile Sources	--	7,300	38
Total	2,412	16,700	100

SOURCE: Environmental Protection Agency, *National Emissions Data System*.

TABLE 4. ESTIMATED ANNUAL OZONE COMPLIANCE COSTS BY VOC SOURCE CATEGORY (In millions of 1988 dollars)

Source Category	Cost
Storage, Transportation, and Marketing of VOCs	800
Industrial Processes	690
Industrial Surface Coating	340
Other Solvent Use (degreasing, dry cleaning, graphic arts, adhesives, solvent extraction processes, etc.)	2,980
Other Miscellaneous Sources (fuel combustion, solid waste disposal, open burning, waste solvent recovery processes, and stationary internal combustion engines)	2,300
Mobile Sources	4,360
Total	11,480

SOURCE: Congressional Budget Office, based on OTA compliance costs estimates allocated to source category on the basis of emission levels.

TABLE 5. ESTIMATED ANNUAL CONTROL COSTS OF 1985 VOC EMISSIONS BY MAJOR INDUSTRIAL POINT SOURCES (In tons per year and millions of 1988 dollars)

Industry	Emissions a/	Costs
Petroleum Refining	200,470	196
Lube Oil Refining	2,507	--
Organic Chemicals	255,803	250
Inorganic Chemicals	12,836	13
Fermentation Processes	24,787	24
Vegetable Oil Processing	8,555	8
Pharmaceuticals	4,848	--
Plastic Products	9,244	9
Rubber Tires	20,185	20
SBR Rubber	52,129	51
Polymers and Resins	112,378	110
Synthetic Fibers	27,073	27
Iron and Steel	48,096	47
Others	273,248	267
Total	1,052,166	1,030

SOURCE: Congressional Budget Office, based on OTA cost estimates allocated on the basis of 1985 emission levels.

a. May not sum to total because of rounding.

TABLE 6. ESTIMATED OZONE CONTROL COSTS AS A PERCENTAGE OF SELECTED INDUSTRIES' 1987 VALUE OF SHIPMENTS

Industry	Value of Shipments a/	Costs
Petroleum Refining	117,243	.85
Lube Oil Refining	--	--
Organic Chemicals	47,290	.53
Inorganic Chemicals	18,570	.07
Fermentation Processes	20,386	.12
Vegetable Oil Processing	605	1.38
Pharmaceuticals	--	--
Plastic Products	67,218	.01
Rubber Tires	11,199	.18
SBR Rubber	9,505	.54
Polymers and Resins	23,854	.46
Synthetic Fibers	10,991	.24
Iron and Steel	53,091	.09

SOURCE: Congressional Budget Office control cost estimates, based on OTA cost estimates allocated on the basis of 1985 emission levels. Value of shipments is estimated for 1987, taken from U.S. Department of Commerce, Office of Business Analysis, Industrial Outlook data base.

a. In millions of 1987 dollars.

downward trend of employment in primary manufacturing, they should not be taken as indicating a corresponding loss in national economic performance.

The lack of industry-level cost information is one of the major barriers to a better understanding of the economic implications of the ozone attainment provisions. Even more troublesome is the lack of information on the size distribution of affected industrial sources, and on their control options. The bulk of current VOC emissions come from relatively small area sources of which very little seems to be known, and the costs associated with controls on these sources could far exceed the industry costs estimated here.

Automobile Manufacturing

Motor vehicles contribute roughly one-third of the ozone precursors emitted nationally. Attempts to control ambient ozone levels, therefore, inevitably require stringent controls on automobiles (so-called "tailpipe standards") and, in turn, lead to losses of output, employment, and profits in the automobile industry. The existing analyses of the cost burdens to the domestic automobile industry provide a basis for a case study of industry-level costs that illustrates some of the more important economic issues.

Both S. 1894 and H.R. 3054 would impose stricter standards on vehicles for emissions of hydrocarbons, nitrogen oxides, particulate matter, carbon dioxide, and (for nongasoline-powered vehicles) formaldehyde. In addition, both bills would require that 90 percent of the vehicles sampled as they come off a production line meet these standards (an increase from the current 60 percent); that entire fleets of vehicles could not be averaged to meet this requirement; that an idle test be added for all cars; and that pollution abating equipment be guaranteed by manufacturer's warranty under "normal" maintenance (as opposed to the current norm of "proper" maintenance) for 5 years or 50,000 miles. The Senate bill goes further, increasing the warranty period to 10 years or 100,000 miles and adding a cold-start test for carbon monoxide and separate high-altitude standards for light trucks.

At issue is whether the automobile industry can achieve these requirements. Industry representatives have expressed their concerns that the combined burden of these standards and tests might diminish the performance of their cars, much as similar regulatory standards are agreed to have done in the mid-1970s. They also note that no new technology exists that could be applied to automobile design to meet all of these requirements, and that bringing cars up to these specifications would require "fine tuning" of existing design features, perhaps by including additional catalyst loadings in converters and other changes. Studies by both CRS and OTA suggest that these problems are not insurmountable, although they would require forcing technology beyond its present limits, and that automobile manufacturers can meet these requirements, at a cost.8/

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8. Congressional Research Service, *Emission Controls and Motor Vehicles and Fuels*, CRS 88-297 S, April 13, 1988. Sierra Research, Inc., *The Feasibility and Costs of More Stringent Mobile Source Controls*, prepared for the Office of Technology Assessment (January 20, 1988).

The CRS report attempts to estimate the cost to the U.S. automobile industry of meeting the more stringent Senate requirements.9/ The report finds that meeting emission standards and their associated warranty costs for passenger vehicles, light trucks, and heavy trucks would cost between $1.40 billion and $3.9 billion (in 1988 dollars) annually.10/ In addition, required changes in the performance of fuels (for example, with respect to volatility or sulfur or oxygen content), would increase the cost of buying fuels (and, therefore, of operating vehicles) by between $1.29 billion and $2.97 billion annually. The total annual cost of buying and operating cars, trucks, and motorcycles manufactured in the United States would rise by between $2.69 and $6.87 billion (again in 1988 dollars)--the midpoint of this range being $4.78 billion.

This is an estimate of compliance costs and, as such, is unrelated to final economic effects on the automobile industry. These costs would add to the cost of producing domestic automobiles and, therefore, raise the price and lower the quantity of U.S. vehicles sold. CRS estimates that these proposed regulations would lead to a loss of output in the auto (including trucks) industry of up to $10.6 billion annually. But its calculations are not based on the effect of compliance costs on vehicle prices and sales. Instead, CRS takes a "worst case" approach and calculates losses on the basis of assumptions regarding how many newly produced vehicles would go out of production for failure to meet the environmental standards. For example, CRS assumes that 300,000 six- and eight-cylinder cars would go out of production for this reason. Some buyers might prefer to buy smaller U.S. cars or to buy the same larger car later; in addition, the output lost to imports would total 75,000 of the 300,000 units. Assuming that these larger cars had an average wholesale price of $20,000 (an admittedly "worst case" assumption), lost output would total $1.5 billion and employment losses would total 30,000 assuming a ratio of one job to every $50,000 in output.

The estimates made by CRS represent a technological view rather than an economic calculation of impact. Elsewhere in its report, for example, CRS assumes that the average cost per passenger vehicle of installing new equipment would be $100. Losses in sales of all passenger vehicles, therefore, should be roughly equal to the extent to which the demand for them would decline if their price were to rise by this amount. Given an average sticker price of $10,000, the price of a car would rise by 1 percent. Using commonly assumed levels of the sensitivity of demand to the price of cars, this would lead to a decline in domestic sales of about 54,000 units annually.11/ At $10,000 per unit, this yields total sales losses of $540 million. The CRS report suggests passenger vehicle output losses between zero and $3.0 billion.

The CRS estimates of output and employment losses in the automobile industry are at best a partial description of the economy's adjustment to ozone

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9. Ibid.

10. This estimate includes the cost of an on-board vapor recovery system, an estimate for which is provided separately in the CRS report.

11. A demand elasticity of 0.8 was used for this calculation.

regulations. The study concludes that output losses would range from zero to $10.6 billion: using its ratio of one job for each $50,000 in output, an estimated employment loss of 212,000 would result, or roughly 20 percent of total automobile employment. But if $10.6 billion worth of automobiles and trucks were not sold, those dollars would find some alternative use. Households would purchase mass transportation, or choose to spend the income not spent on cars on other purposes. Businesses would substitute other forms of freight services for trucks. Thus, the estimated effects on the automobile industry are not economywide effects. While they are important for automobile-producing regions, communities, and workers, they do not show whether a proposed regulation is beneficial in the aggregate.

Impacts on Small Business

The ozone attainment proposals raise the possibility that VOC control expenditures will be imposed on a large category of relatively small emission sources. To the extent that small sources are correlated with small businesses, the likelihood of a disproportionately large burden on small businesses increases. For example, New Jersey's emissions inventory shows that 24 times as many sources would be included in a VOC control program that adopted a 25-ton emission threshold as would be included in a 100-ton program. It is often argued that small businesses may suffer under a pollution control program that does not make allowance for the limited ability of small firms to raise the necessary capital for purchasing pollution control equipment, as well as their limited ability to take cost-minimizing actions. Government data on the costs and effects of the ozone attainment proposals do not permit a detailed assessment of this issue. Given the potential costs to small businesses under the Senate and House bills, this lack of data and analysis is problematic.

TRADE EFFECTS

A common concern with domestic environmental regulatory programs is that they may place certain domestic industries at a competitive disadvantage relative to foreign producers. This concern is predicated on the assumption that foreign producers are able to sell products in this country at lower prices than domestic products because they are not forced to incur the same level of environmental pollution control costs. To the extent that this assumption is valid, domestic purchases of imported goods would be favored over their U.S.-produced counterparts, and domestic goods would be more difficult to market abroad, resulting in domestic employment losses and a widening of the U.S. trade deficit.

Several historical studies of pollution control cost impacts suggest that international differences in environmental policies have only marginal effects on the overall competitiveness of domestic industries.12/ The reasons are several:

12. See especially, Congressional Budget Office, *Economic Efficiency and Environmental Regulation* (1985) and Congressional Budget Office, *How Federal Policies Affect the Steel Industry* (1987).

- o Environmental regulations do not differ much in stringency among most major developed countries. In less developed countries the differences may be greater, although most analyses have not carefully investigated this possibility.

- o The effect of other cost and policy variables on the prices of imported versus domestic products far exceed those associated with environmental regulations. Differences in raw material costs, labor costs, and government trade policy, for example, are much more likely to affect domestic and foreign costs of production than are environmental cost differentials.

- o Finally, in the case of several specific industries, changes in world-wide demand and supply appear to have more impact on U.S. production than do cost differences alone.

While a strong case can be made that past environmental pollution control expenditures did not have a significant impact on aggregate domestic trade flows, it is possible that the additional expenditures associated with the new ozone attainment provisions would affect certain industries and certain firms that are already feeling import pressures. It has been argued that the mobile source provisions would lead to increased sales of smaller imported vehicles. Without detailed industry-specific data, or a formal analysis of ozone controls in other countries, it is difficult to address this possibility. But certain industries would be more likely than others to experience some additional import pressure, particularly if the pollution control costs constituted a significant portion of their costs of production. Table 7 shows current levels of import penetration for selected industries that are likely to bear a significant burden of ozone compliance costs.

IMPACTS ON CONSUMERS

Most of the ozone attainment proposals call for VOC reduction strategies that will impose some costs directly on consumers or the public. Although the public bears the ultimate costs of most environmental programs through increased prices, reduced returns to stockholders, and increased taxes or fees, several provisions of H.R. 3054 and S. 1894 would affect consumers directly. Two potential classes of costs stand out in this regard: direct costs in the form of fees or charges--for example, those associated with inspection and maintenance requirements; and inconvenience costs related to Stage II and transportation control programs. A third category, that has recently received some attention, incudes direct and inconvenience costs associated with controls on VOC emissions from consumer products.

Direct Consumer Costs

Several analyses of the costs of vehicle inspection and maintenance programs have argued that they would result in increased repair costs to consumers. Most

TABLE 7. IMPORT INDICATORS AND ESTIMATED OZONE ATTAINMENT COSTS FOR SELECTED INDUSTRIES

Standard Industrial Classification	Industry	Import Penetration Ratio a/ (In percents) 1982	1983	1984
1311	Oil and Gas Extraction: Petroleum	27.5	24.6	23.4
20	Food and Kindred Products	3.6	3.8	4.2
22	Textile and Mill Products	5.4	5.5	7.2
26	Paper and Allied Products	6.1	6.1	6.9
28	Chemical and Allied Products	4.5	5.2	6.1
2911	Petroleum Refining	7.3	8.7	10.4
30	Rubber and Miscellaneous Plastic Products	5.1	5.4	5.9
33	Iron and Steel	14.9	11.5	15.2
37	Transportation Equipment	15.4	14.9	16.6
5541	Motor Vehicles	20.6	19.7	20.7

SOURCE: Congressional Budget Office. Import penetration ratios from the Department of Commerce, U.S. Industrial Outlook data base.

a. Ratio of imports to new supply, where new supply equals product shipments plus imports.

of the proposals provide for a repair-cost waiver, under which the owner of a vehicle that fails an inspection can pass by spending a certain amount to tune or repair the car. The required expenditure level is $200 under both the House and Senate bills. It is likely that many car owners would eventually incur these costs anyway. The true impact of the inspection and maintenance programs would be the extent to which the costs were incurred earlier than they would have been without such a requirement. The cost should be estimated by comparing the present value of vehicle repair costs in the absence of legislation with the present value of repair costs under inspection and maintenance programs. This method of assigning a repair cost to the bills would probably lead to a significantly lower estimate than has been made in the analyses mentioned above.

Inconvenience Costs

It has been argued that the use of Stage II equipment would require greater effort and attention on the part of consumers who fill their own gasoline tanks. Similarly, the transportation control plans, depending on their extent and design, might require car drivers to adopt different commuting patterns or driving habits. In addition, requirements for periodic inspection and maintenance of vehicles might also be associated with consumer inconvenience if drivers would prefer to forgo the inspection process.

To the extent that consumers would be willing to pay some amount to avoid having to change their current behavior, these provisions would impose real costs that are not taken account of in the compliance cost estimates presented earlier. This class of costs is very difficult to estimate, however. Such costs are not generally reflected in any set of market prices, and cannot be directly observed. Some estimates of potential consumer inconvenience cost have been developed, as shown in Table 8. The estimate of $25 per car for onboard controls was derived by an automobile company using existing customer service data; it assumed that the requirement would force car manufacturers to reduce the trunk size of vehicles with onboard canisters (an assumption that EPA disputes). The EPA estimate of $0.01 per gallon for Stage II is best described as a guess, but appears to be based on the level of consumer resistance in areas where Stage II controls have been implemented. The uncertainty that accompanies both the basis for and the techniques used in deriving these estimates suggests that they should be viewed as rough attempts to assign some cost to these categories, rather than as an accurate representation of consumers' willingness to pay.

Consumer inconvenience costs are analagous to many of the unmeasurable benefits of environmental regulation except that they affect the cost side of the analysis. Ideally, such costs would be included in any measure of the social welfare effects of the legislative proposals. Unfortunately, these costs--like the benefits--are excluded from the following discussion of macroeconomic effects. The importance of this omission is difficult to assess, given the uncertainty over the absolute level of inconvenience costs. The EPA estimates of Stage II inconvenience costs suggest that they might be significant. On the other hand, inconvenience costs may diminish as consumers come to accept the new requirements after an initial learning period. Several states have noted that consumer resistance tends to fall over time.

TABLE 8. AVAILABLE ESTIMATES OF THE ANNUAL CONSUMER INCONVENIENCE COSTS OF SELECTED OZONE ATTAINMENT PROVISIONS (In millions of 1988 dollars)

Provision	Estimated Costs Low	High
Stage II	141	209
Onboard	309	309
Enhanced Inspection and Maintenance	a/	a/
Transportation Control Measures	a/	a/

SOURCE: The Stage II costs are EPA estimates reported in 52 FR 31162, August 19, 1987. The onboard estimates were based on an estimate of $25 per car used by the Motor Vehicle Manufacturers Association multiplied by an estimated 12 million new cars annually. The estimate is reported in "EPA: Ozone and the Clean Air Act," serial #100-25, Subcommittee on Oversight and Investigation, April 27, 1987, p. 1607.

a. No estimate.

MACROECONOMIC IMPACTS

Beyond its effects on specific industries or sectors, environmental legislation is presumed to have a negative impact on the national economy. This presumption is supported by most of the economic literature on the subject. Nevertheless, studies conducted during the 1970s and 1980s showed that the effects on specific indicators of economic performance varied widely in magnitude and were not always negative. The most recent studies tend to confirm a depressing effect, although the estimated levels of impact still vary considerably. Most macroeconomic and growth accounting analyses suggest that expenditures on pollution control plant, equipment, and maintenance are likely to displace national output on a 1:1 to 1:3 ratio.13/ That is, one dollar of required pollution compliance expenditures results in a one- to three-dollar loss in real gross national product. More recent estimates derived by the Congressional Budget Office also fall into this range.

Previous Studies of the Macroeconomic Impact

Empirical investigations of the net economic impact of pollution abatement compliance expenditures over the past two decades present an array of possible outcomes ranging from small expansionary effects to quite large negative impacts; some studies report losses in real output and employment, and increases in prices, while others report opposite effects on these same variables. A brief review of the principal studies will highlight some of the more important issues.

Expansionary Effects. At first glance, the results of a few studies that find environmental regulatory requirements to have a positive effect on overall economic performance would appear counterintuitive.14/ Pollution abatement expenditures are generally seen as increasing the costs of producing any given level of output, thus increasing prices and decreasing productivity. An opposite effect would seem to require that pollution control spending actually enhance the ability of the economy to produce goods and services. For this to be true, environmental regulation would have to result in a new mix of output that is more valuable than the preregulatory mix. Alternatively, environmental regulation might lower the costs of producing a given output mix by increasing the supply of inputs (such as clean water or more forests) to the production of goods and services.

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13. Paul Portney, "Macroeconomic Impacts of Environmental Regulations," in Henry Peskin, Paul Portney and Allen Kneese, eds., *Environmental Regulation and the U.S. Economy* (Baltimore: Johns Hopkins University Press, for Resources for the Future, 1981). See also Adam Rose, "Modeling the Macroeconomic Impact of Air Pollution Abatement," *Journal of Regional Science*, vol. 23, no. 4 (1983). See also Congressional Budget Office, *Environmental Regulation and Economic Efficiency* (1985).

14. Rose, in "Modeling the Macroeconomic Impact," cites six studies that suggest expansionary effects, eight that suggest contractionary effects.

It is possible that some industries may enjoy cost savings stemming from environmental pollution control requirements.15/ These effects alone, however, are unlikely in themselves to generate macroeconomic expansion. Existing macroeconomic models are unlikely to capture improvements in economic efficiency that might arise from regulation intended to correct environmental market failures. Further, the economic data upon which these studies rely do not include many of the potential benefits upon which the cost-saving argument relies. For example, one analysis of environmental benefits found that over 90 percent of the benefits, including productivity gains, resulting from two air pollution control programs were not included in the national economic accounts.16/

The more likely reason for the expansionary findings of certain studies lies in the assumptions they used. Some of these studies rely on a model structure with fixed production coefficients that treat pollution control spending as simply increasing aggregate demand for goods and services. Alternatively, other studies employ a model approach that assumes (or generates internally) an economy that is at less than full employment. In these circumstances, spending on environmental pollution control can have a directly stimulative effect on the economy, and pollution abatement expenditures need not displace other "productive" spending--at least in the short run. This is not to say that environmental regulatory programs cannot have a net positive impact on the economy, since it is possible that beneficial impacts could outweigh negative ones. Rather, it is more reasonable to assume that long-run gross macroeconomic impacts would be negative even though short-run effects might be expansionary.

Negative Macroeconomic Impacts. Most recent studies using econometric techniques show that mandated increases in environmental pollution control compliance expenditures produce negative, or contractionary, measured macroeconomic effects. In very general terms, pollution control spending is found to increase the costs of producing national output, thus resulting in reduced output, reduced employment, and higher prices. These negative consequences, over time, outweigh the short-term increases in investment and consumption that may accompany increased regulatory requirements.

Using the net impact of pollution abatement expenditures on real output (GNP) as one indicator of macroeconomic impact, it is possible to construct a relationship or "multiplier" between a dollar expended on pollution control and the dollar value of output loss. One survey of past studies suggests that this ratio may be in the range of 1:1 to 1:3.17/ This means that one dollar in

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15. John Jenarich, "Environmental Control," *Nation's Business*, vol 67 (1979) and Michael Royston, "Making Pollution Prevention Pay," *Harvard Business Review*, vol. 58 (1980).

16. Myrick Freeman, "Some Issues in the Estimation and Use of Benefit Measures," report prepared for U.S. Council on Environmental Quality (February 1980).

17. Rose, "Modeling the Macroeconomic Impact."

additional pollution control spending would result in a one- to three-dollar loss in national output--that is, an environmental program with compliance expenditures of $10 billion might be associated with a real output loss of $10 billion to $30 billion.

A recent study conducted for the National Association for Manufacturers by Data Resources, Inc., paints a significantly different picture. Using a large-scale econometric model of the U.S. economy, the study finds that previous Congressional proposals to curb acid rain would result in economywide output losses of 4.1 dollars to 5.8 dollars for every dollar spent on control. According to the DRI study, a $53 billion dollar investment in acid rain controls over a five-year period would elicit a cumulative $222 billion loss in GNP by the year 2000. Job losses associated with this output effect would be in the tens of thousands. Interestingly, the DRI study shows expansionary effects in the first few years, followed by increasingly large negative effects that keep the economy below its original growth path.

The magnitude of the impacts suggested by DRI are outside the bounds established by most other studies--up to several times larger for the worst case. More important, DRI finds that pollution control costs incurred over a limited number of years could have continuing and presumably permanent negative effects on the economy from which it would never recover. While it would not be surprising for the economy to experience negative effects during a circumscribed transition period, the negative effects ought to lessen as the economy adjusted to a new set of prices (for example, to increased energy prices). One possible explanation of the DRI estimates may be the model's response to electricity price increases resulting from acid rain control legislation (the subject of DRI's analysis). It may also be that the model had not yet reached long-run equilibrium in the reported simulation period. Nevertheless, this would appear to represent a severe worst case at the very least, even though DRI describes the estimated impacts as representing lower bounds.

Alternative Macroeconomic Impact Estimates

It is not within the scope of this paper to reconcile the differences between the DRI results and those of earlier analyses. It is possible, however, to construct a set of comparative estimates in the hope of narrowing the range of potential output effects associated with environmental compliance costs. To this end, the paper has used two different approaches, selected for their computational simplicity and accessibility, to illustrate the potential impact of pollution control expenditures on economic output.

The first approach employs a very simple model to address the hypothetical question, "What might real national output have been if the labor and capital devoted to pollution abatement had been available for other uses?" As illustrated by the work of Denison and others, this method--called growth accounting--assumes that the entire output of the economy can be represented

by a single equation relating capital and labor to output.18/ In these models, capital and labor expenditures on environmental control are assumed to perfectly displace other "productive" expenditures. By subtracting environmental expenditures from total expenditures on capital and labor over an historical time period, these models have been used to estimate the impact of regulation on output (and productivity). If the historical relationship between labor, capital, and output can be assumed to remain unchanged in the future, these models provide a crude basis for predicting the impact of new pollution control expenditures on future output. For example, if in the past, a 1 percent increase in capital expenditures has resulted in a 0.5 percent gain in output, a growth-accounting framework would assume that a 1 percent increase in pollution capital expenditures would result in a 0.5 percent loss in output. Of course, this multiplier would increase when the effects of environmental labor expenditures are added into the calculation.

By design and assumption, environmental expenditures can only have a negative impact on output in a growth accounting framework. By assuming that production costs are not affected by pollution control requirements, growth accounting models cannot reflect the wide range of possible consumer and producer responses that would be considered in a more sophisticated analysis. As a result, these models are generally considered to provide upper bound estimates of the economic effects of environmental spending. For the purposes of this paper, the growth accounting perspective offers a relatively simple way to represent the potential macroeconomic impact of environmental regulation under a very confining set of assumptions.

The second approach involves the use of a PC version of the DRI macro model to simulate the effects of a $10 billion pollution abatement program. The DRI model is a multiequation forecasting model that treats the economy in substantially more detail than the simple growth-accounting framework. Expenditures on labor and capital were increased for any given level of output to account for the required pollution abatement costs. Because the manner in which new pollution control expenditures are introduced differ from their counterparts in the DRI study discussed earlier, they may not be directly comparable.

The results of these two comparative analyses confirm the consensus findings of the earlier studies: pollution control expenditures reduce measured national output. The expenditures result in higher prices, in response to increases in the costs of producing the new output levels. The impact on employment is less determinate, but small losses are indicated. The magnitude of the estimated output losses is smaller than that suggested by the DRI acid rain study. Under the growth-accounting model, the ratio of a dollar of

18. Edward Denison, *Accounting for Slower Economic Growth: The United States in the 1970s* (Washington, D.C.: The Brookings Institution, 1979). See also Congressional Budget Office, *Environmental Regulation and Economic Efficiency*, for a brief review of growth accounting models as well as other possible approaches for estimating macroeconomic effects.

pollution control expenditures to a dollar of output loss is in the range of 1:1 to 1:1.8 over the period 1972-1985.19/ Using the PC version of the DRI macro model over the period 1990-2000, the ratio ranges from 1:1.3 to 1:3, depending on assumptions concerning the manner in which labor and capital are affected by pollution control spending. This appears to be a likely range for the effects of pollution abatement expenditures on measured economic output.

Limitations of the Macroeconomic Analyses

All of the empirical analyses discussed here share some common limitations and uncertainties, although in varying degree. Two of these are most important from a broader policy perspective:

- None of the available analyses captures fully the potential for changes in production or consumption. To the extent that producers and consumers react to environmental regulatory constraints by adopting new production methods, new goods and services, or new consumption patterns, the costs and impacts of regulation are likely to be substantially less than those presented here.

- None of the available studies includes, in any substantial way, the benefits of environmental regulation. Because many of these benefits cannot be directly measured in an economic sense, they do not enter the national economic accounts. Hence the output losses estimated by these studies cannot be interpreted as real changes in social welfare. Although the macroeconomic results are important, they do not show whether society is better off or worse off as a result of environmental regulation.

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19. These results are based on an exponential relationship between output and capital and labor inputs over the period 1972-1985. It was assumed that 56 percent and 44 percent of all pollution abatement expenditures were devoted to capital and labor, respectively, in that period.

CHAPTER III

PUBLIC COSTS OF ENVIRONMENTAL REGULATION

Pollution control requirements lead to expenditures by federal, state, and local governments. Broadly speaking, these are associated with the design, implementation, and enforcement of environmental programs as well as with the direct costs to various levels of government of complying with regulations. While the public-sector costs are generally much smaller than the private-sector costs, they can be substantial enough to affect the allocation of social resources. Further, while analyses of public-sector costs share several characteristics with analyses of private-sector costs, their interpretation may differ. This chapter explores some of the key issues surrounding the assessment of public environmental costs within the context of the current Congressional proposals relating to ozone.

PUBLIC-SECTOR AND PRIVATE-SECTOR COSTS

From a broad perspective, the public-sector costs of environmental regulation resemble private costs: social resources are diverted by legislative specifications. The level and type of government expenditures on regulatory programs, like those of the private sector, are dictated by the specific requirements of the programs. In addition, public-sector cost analyses share some of the same general estimation characteristics as private-sector analyses--they are largely extrapolated from past compliance activities and are subject to uncertainties concerning the estimation baseline.

Because environmental regulation reflects the desire to shift the costs of environmental protection to polluters, some would argue that environmental legislation should not result in any increased public costs. Under this view, all the costs for developing, implementing, and enforcing these programs should be passed on to polluters in the form of fees, tolls, or excise taxes (unless, of course, the public sector itself is responsible for the pollution). In this sense, defining costs as "public" is more a matter of the type and nature of the regulatory activity involved than of who ultimately pays or should pay.1/ Public costs, therefore, are those that originate in the public sector, rather than just those that are financed by general taxes.

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1. This discussion ignores the issue of differing efficiencies between levels of government--whether one level of government may be better able than another to carry out a specific regulatory requirement. It also ignores the question whether in some instances the private sector could do a better job.

ESTIMATING PUBLIC COSTS OF ENVIRONMENTAL REGULATION

Estimates of public costs share many of the same characteristics, limitations, and uncertainties as private-sector compliance cost estimates. They tend to be based on best before-the-fact judgments concerning activities that are likely to be carried out by various levels of government. These judgments often rely on past experience of the Environmental Protection Agency (EPA) and on estimates of the cost of developing similar regulations and programs, or on the experience of one or more states that have already implemented a particular control measure. This approach may overestimate actual public costs to the extent that EPA and the states may learn from past experience and develop or implement subsequent programs more effectively. Alternatively, costs may be understated if past regulatory activities were addressed to lower-cost opportunities. Also important is the degree to which certain program requirements can be handled by existing government activities without requiring new resources or reductions in other program activities. States or localities may find that existing activities satisfy new legislative requirements; thus, the "choice of a baseline" is a crucial issue in defining public costs.

Public cost analyses of environmental regulation are perhaps most affected by assumptions concerning the baseline from which costs will be incurred. The baseline used in many analyses reflects current law; specifically, the assumption is made that the states and EPA will implement only those controls currently mandated by law. This could be misleading for two opposing reasons. First, it is quite likely that some states will pass new laws, or EPA will issue new requirements even if a legislative proposal is not enacted. Second, uncertainty about the pending Congressional legislation could slow states' implementation of current programs and delay EPA enforcement of various sanctions or penalties. In either case, there is often no certainty as to what would happen in the absence of legislation, suggesting that some costs commonly associated with the legislation could be incurred anyway.

A related problem is that of mapping out definitively what kinds of similar environmental programs have already been put in place at various levels of government. Many current environmental legislative proposals, such as the Senate and House Clean Air Act proposals, are amendments to or reauthorizations of established pollution control programs that have been implemented to various degrees in each state. The progress of the states in responding to past legislation is often far from uniform, creating uncertainty as to the regulatory "baseline" currently in effect in each state. In addition, many states may have programs in place even without federal legislative guidance, such as programs to control emissions of air toxics. Uncertainty as to the future nature and extent of existing programs, therefore, complicates the estimation of the incremental public cost of new legislation, particularly at the state and local level.

A further characteristic of public cost analyses is that they often represent, like private-sector compliance cost estimates, the first-order cost burden of regulation to government. But not all of these costs will be paid directly by federal, state, or local tax revenues. While many past environmental public-

sector costs were paid from general revenues, state and local governments have increasingly looked to alternative funding mechanisms that place more of the cost burden on those responsible for the pollution, or on other sources outside their tax bases. While the EPA is faced with statutory and programmatic restrictions in its ability to charge fees to recover costs, state and local agencies typically have much more flexibility. Although some are limited in their ability to pass costs along by state law or public opinion, many state agencies are increasingly willing to pass on incremental public costs through increased permit and user fees. The percentage of public costs that might be passed on to other parties is difficult to predict and might have little impact on the actual level of total environmental control costs, but it is critical to understanding how pollution control costs are distributed.

Public-sector costs may also ultimately deviate from these "first-order" estimates because of economic "feedback." If a jurisdiction finds that it must curtail economic growth to attain national ambient standards, it faces lower tax receipts and greater spending requirements. As regulations grow more strict, this effect becomes increasingly important as a source of public-sector costs.

OZONE ATTAINMENT--A CASE STUDY IN PUBLIC COSTS

Many of the current proposals to reauthorize the Clean Air Act provide examples of public costs that illustrate the general characteristics of the public costs of most environmental control programs. The ozone attainment provisions of these proposals specifically contemplate a rather wide range of government programs and activities raising these issues. A brief review of several of these proposals provides a basis for better understanding the nature of public costs.

Most of the existing analyses of the public costs associated with ozone attainment proposals have focused on the Senate bill. CBO has previously prepared a formal cost estimate for S. 1894 that includes its ozone attainment provisions and the impact of the bill on state and local costs.2/ The uncertainties and limitations associated with estimates of state and local cost estimates made a precise estimate of the budgetary impact of some of these provisions difficult.

While the Congressional Research Service (CRS) and the Office of Technology Assessment (OTA) have not attempted to estimate the effect of these bills on state, local, or federal government budgets, they have analyzed several provisions the costs of which would initially be the burden of state and local governments--for example, inspection and maintenance programs. The CRS and OTA estimates say very little about how these costs will be distributed or their

2. For a full discussion of the federal costs of these bills see: Congressional Budget Office, cost estimate included in *Clean Air Standards Attainment Act of 1987*, Report No. 100-231, Senate Committee on Environment and Public Works, to accompany S. 1894, pp. 308-317.

final budgetary impact, but indicate some of the cost burdens that will be placed initially on state and local governments.

Costs of Selected Ozone Attainment Provisions

The public costs of environmental programs are usually considered in three major categories: research and development, abatement and control--which includes regulation and standards development and implementation--and enforcement. All of the cost elements discussed below, with the exception of stationary source inspection costs, fall into the abatement and control category. This is not to ignore the other public cost categories as they may apply to ozone attainment proposals, but to focus on the broader characteristics. In addition, all of the public costs reviewed here are incurred by state and local governments except for federal compliance costs and the federal costs of reviewing state plans; state and local costs constitute probably the bulk of the public costs associated with ozone and are the most difficult to assess. Finally, while the list of specific ozone attainment provisions discussed here is by no means exhaustive, it encompasses the provisions that are most likely to lead to significant public costs and reflects most of the issues presented earlier.

State Implementation Plan (SIP) Revision and Review. Under the Clean Air Act, efforts to attain national ambient air quality standards are coordinated through a system of federally approved state programs set out in State Implementation Plans (SIPs). This program is ongoing; even in the absence of new legislation, states are required to move forward with attainment initiatives. Thus, current law and the legislation now before Congress would require states to develop and submit revised SIPs for nonattainment areas. Under the provisions of both H.R. 3054 and S. 1894, extensive federal involvement would also be required in all phases of the SIP process including plan development, review, and implementation. These requirements illustrate the difficulties involved with choosing a baseline. States are already incurring the costs of SIP revision and review. In fact, states continuously update their SIPs as new regulations are developed or on the basis of new information. For example, an EPA study of selected state air agencies showed that 1987 state expenditures for SIP review ranged from 2 percent to 34 percent of their air pollution control budgets.3/ EPA also incurs costs continuously in reviewing the many SIP revisions that are submitted each year, and provides guidance and technical support. The range of current SIP activities makes determining whether federal and state costs would increase, decrease, or remain the same under each bill difficult.

For example, H.R. 3054 would not require that states update their inventories or run new air dispersion models in revising their SIPs. As these are normally the most time-consuming and costly parts of SIP revision, it is likely

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3. See the 1987 pilot exercise to define state/local program activities and resource costs, Regional Programs Office, Office of Air Quality and Standards, EPA, Research Triangle Park, North Carolina. (Updated draft, November 6, 1987, Table III.)

that state expenditures for SIP revision will, on average, stay the same. EPA expenditures are likely to rise, however, as the agency attempts to inventory emissions and run the necessary model for the states in carrying out SIP review and attainment monitoring.

S. 1894 would have similar effects on federal and state SIP expenditures, but for a different reason. The bill would likely increase the amount states would need to spend on SIP revision by requiring that states improve their inventories and run more sophisticated models, but it would authorize a one-time appropriation to the states of $75 million to complete this SIP revision process. CBO estimated that, if appropriated, this amount would be sufficient to cover all incremental state costs, thereby distributing the initial cost of revising SIPs to federal taxpayers rather than to specific nonattainment area tax bases.

Enhanced Inspection and Maintenance (I/M). Motor vehicle emission inspection and maintenance programs have been introduced in many areas of the country as part of state implementation programs to control ozone. Both bills would expand the number of jurisdictions that would be required to have vehicle I/M programs. They would also expand the scope of these programs beyond what is required by current law. Based on information provided by EPA, CBO estimated that the added annual cost of this provision could reach $900 million for S. 1894 with some additional cost for the initial investment in new equipment. Using the same information, the annual costs under H.R. 3054 would probably be about $100 million to $150 million less than under the Senate bill. Most of the cost difference between the bills results from the inclusion of more states within transport areas in S. 1894. While both bills require that cities in attainment in regions where transport of ozone is a problem implement some controls, including I/M, the Senate bill defines the transport area to include five Midwestern states (Ohio, Indiana, Illinois, Michigan, and Wisconsin) that are not included under H.R. 3054. This difference would extend coverage of I/M programs to 34 additional attainment cities with approximately 7 million vehicles.

These costs are based on a per-car estimate of $13 for establishing an enhanced program and $5 for enhancing an established program. Other Congressional agencies have used per-car estimates ranging from $4 (CRS) to $20 (OTA) for establishing an enhanced program. The CRS estimate is derived from an earlier EPA draft study, while the OTA estimate uses data from a more recent study of California's I/M program. Based on fees currently charged by some states with nonenhanced programs,4/ the CBO estimates seem reasonable, but the range associated with per-car estimates reflects the margin for error that must accompany this and most other cost estimates. More information is available concerning the cost of establishing an I/M program than for virtually any other provision involving public costs of these bills, and yet estimates still vary by up to 500 percent.

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4. "Air Permits and Emissions Fees," State and Territorial Air Pollution Program Administrators (STAPPA) and Association of Local Air Pollution Control Officials (ALAPCO), April 1987.

The I/M provisions also highlight the uncertainty over how much of the initial cost burden will be incurred by the states or passed on to the public through fees. State air agencies' budgets currently total approximately $270 million. If these agencies were forced to bear all the costs of even the lowest I/M estimate by CRS, $280 million (not including repair costs), their current budgets would double--an extremely unlikely result. A more likely result is that many states would set fees high enough to cover a large proportion of these costs. Some state legislatures, however, do not allow I/M fees or else set fee limits at levels insufficient to cover the costs of enhanced programs.

Transportation Control Measures (TCM). Under S. 1894, jurisdictions in severe areas are required to use TCMs to offset any projected growth in vehicle-miles traveled. These measures may include requiring the use of methanol-powered vehicles, imposition of commuting restrictions, or development of mass transit systems. Severe nonattainment regions must adopt a list of TCMs or obtain offsetting reductions elsewhere. Because of the long list of controls already required by S. 1894, these areas would probably adopt many of these measures, but it is impossible to be certain. CRS has estimated that if 15 areas used TCMs to reduce areawide VOC emissions by 1 percent, the costs to these jurisdictions would be approximately $220 million a year.5/ CRS suggests that the actual public cost of these measures could be as low as $0 or as high as $5 billion annually. The high cost would apply if the 10 worst areas were forced to install a major new mass transit system. No costs would result if areas chose alternative strategies or only adopted measures with costs that could be offset by increased revenues (such as from tolls).

Compliance Costs. In addition to incurring expenditures to design and implement ozone reduction programs, all levels of government may also be subject to costs of complying with these programs. For example, both S. 1894 and H.R. 3054 require that some percentage of new vehicles in certain areas be capable of using alternative fuels with lower emission characteristics. CRS estimated that complying with the provisions in S. 1894 could result in between 150,000 and 600,000 federal, state, and local government vehicles converting to use compressed natural gas or methane, at a cost ranging between $11 million and $99 million annually.

Other ozone attainment provisions that might impose governmental compliance costs include the national standards on traffic and military coatings (such as road and ship paints), and the requirement that smaller sources be required to obtain permits and be subject to reasonably available control technology (RACT) requirements. The national standards would certainly effect the Departments of Defense and Transportation to the extent they increased the cost of these coatings. Including smaller sources in the control system would be likely to increase the number of government-owned facilities subject to emission reduction requirements. California for example, estimates that of the 1,085

5. Congressional Research Service, "Ozone and Carbon Monoxide Nonattainment, An Analysis of Title I of the Proposed Clean Air Standards Attainment Act." Report No. 87-7515, September 10, 1987, pp. 10-11.

existing sources of VOC and NO_X that would be subject to regulation under S. 1894, 70 are government-owned.

Stationary Sources: Permits and Inspections. In order to ensure compliance with federal and state environmental laws, regulations, and standards, the EPA coordinates and oversees enforcement efforts with state and local agencies. In the case of air pollution from stationary sources, enforcement takes the form of issuing permits and making periodic inspections. EPA currently requires that states issue permits to major sources of VOCs and NO_X. The permits specify technology requirements and allowable emission levels over time. Since many of the enforcement methods and activities that might be associated with the proposed legislation would probably resemble those currently in use, additional costs to states might be minimal. An important exception, however, involves a change in the definition of a major source, under S. 1894, from a unit with the potential to emit 100 tons or more to a unit with the potential to emit 25 tons or more per year. EPA estimates that if states were required to issue permits to these smaller facilities and inspect them even every fifth year, it would take 1,500 new man-years nationally, roughly doubling states' current expenditures on these activities.

WHAT IS EXCLUDED?

Besides focusing solely on the public costs of selected provisions of ozone attainment proposals (and thus overlooking other possible public costs, such as research and development), this chapter has excluded an important potential public cost element that is not captured by the three major categories. Just as most estimates of private costs do not consider the macroeconomic effects that legislation may have, most estimates of public costs do not consider the total public costs of bringing an area into attainment with the ozone standard. Beyond the costs of the specific set of controls that would be necessary in each nonattainment area, public costs are affected by how the area-specific controls would affect local tax bases, unemployment benefits, and so on.

While such an analysis is beyond the scope of this paper, the link between public-sector costs and economic feedbacks is worth mentioning. It is often assumed that because H.R. 3054 requires fewer specific controls than S. 1894, thereby allowing greater state flexibility, the bill would impose significantly lower public costs. There is no reason to suppose, however, that the ultimate state and local effects of the two bills would be significantly different. Both the Senate and House bills are dominated by the same ultimate enforcement mechanism--jurisdictions must attain the standard within a given time period or be subject to very damaging sanctions, including severe limitations on economic growth. Unless the specific requirements in the Senate bill result in more control than actually necessary to reach attainment, or states are willing to risk the imposition of sanctions, it is likely that states will choose to implement similar control measures under either proposal and will bear similar costs.