CHAPTER TWO

Economy and Environment

Over the past several decades, a great deal has been learned about the linkages between environmental policy and economic activity in the United States.

In the 1970s, when many federal environmental laws were first enacted, the main emphasis was on "command-and-control" mechanisms. Command-and-control meant three primary approaches:

- Ambient standards, which specify a minimum level of environmental quality that would be achieved through limits on sources, products, or other sources of pollution. For example, the Clean Air Act required EPA to set national ambient air quality standards to protect human health without regard to cost.
- Emission or effluent limits, which apply to individual sources as a means of achieving health or environment-based ambient standards.
- Technology requirements, which specify the techniques or equipment that sources must use to control pollution, i.e., the requirement that automobiles must be equipped with catalytic converters.

Over several decades, these approaches generally succeeded in reducing pollution. In the case of air quality, for example, national emissions of five of the six major air pollutants have fallen dramatically since 1970.

While admittedly successful in terms of results, command-and-control approaches have been criticized as economically inefficient. In the case of national ambient air quality standards, for example, EPA is required to set standards to protect human health with an adequate margin of safety. In many cases, relatively small amounts of some air pollutants can be shown to have measurable effects on health or the environment. Critics say standards that require eliminating such pollutants may incur large costs for relatively small incremental improvements in environmental quality.

Furthermore, command-and-control approaches generally provide no mechanism for focusing emissions reductions where they are cheapest. In addition, they generally do not provide strong incentives to search for more cost-effective ways to reduce emissions or for new methods to reduce emissions *below* the current standard.

As noted in the *1999 Economic Report of the President*, some technology and performance standards have led to cost-effective innovations. For example, one way to increase the incentive to innovate under

performance standards is for regulators to adopt a strict standard for the future. Such "technology-forcing" performance standards raise the value of innovations that lower pollution control costs, in addition to providing time for the development and adoption of new technologies. For example, in 1970 the California Air Resources Board adopted stringent air emissions standards for new cars that took effect in 1975. This contributed to the development of an emerging technology, the catalytic converter, which cut automobile emissions dramatically and is widely used today.

In the case of environmental regulations requiring the phaseout of chlorofluorocarbons (CFCs) to protect the stratospheric ozone layer, a new method was found for cleaning electronic circuit boards that not only eliminated the use of CFCs but increased product quality and lowered operating costs as well.

Nevertheless, over the past 10 to 15 years the federal government has moved toward a new regulatory approach, known as incentive-based mechanisms. Examples of incentive-based approaches include tradable permit systems, emissions taxes, subsides to reduce pollution, and liability rules.

Tradable Permit Systems

Tradable permit systems take advantage of the fact that the cost of reducing emissions by a given amount differs from firm to firm. A tradable permit system caps total emissions from all firms. After an initial allocation, firms may freely buy or sell permits among themselves. Firms that can reduce emissions for less than the going price of a permit thus have an incentive to do so and then sell their unused permits to other firms facing more costly emissions reductions.

Emissions trading also gives firms an incentive to innovate. Firms that develop effective and cheaper pollution control measures can sell not only their unused permits but the technology itself.

EPA's sulfur dioxide ($SO_{2)}$ emissions reduction program is a significant example of this new approach. The 1977 Clean Air Act Amendments required new fossil fuel-fired electrical generating plants to remove 90 percent of SO_2 from their smokestack emissions (70 percent if the plants used low-sulfur coal). This policy effectively mandated the use of scrubbers, devices that remove SO_2 from the exhaust gases produced by burning coal.

The 1990 Clean Air Act Amendments established a tradable permit program for SO_2 emissions. Under Phase I, which began in 1995, permits were allocated to 110 electric utility plants around the country. Under Phase II, which begins in 2000, the program will be extended to cover virtually all fossil-fuel-burning electric generating plants. Plants that can reduce emissions cheaply, such as by switching to low-sulfur coal, can sell permits to plants that face more expensive emissions reductions. The program is expected to reduce SO_2 emissions to 50 percent of 1980 levels.

It is estimated that the trading system may produce cost savings of 25 to 43 percent. In addition, the tradable permit system may spur innovation that results in additional savings. There is already evi-

dence of dramatically falling costs. In 1990, EPA forecast that the total annual compliance cost for SO_2 emissions reduction in 2010 would be in the range of $2.6 billion to $6.1 billion (in 1995 dollars), whereas a 1998 study estimated costs at just over $1 billion (also in 1995 dollars).

Several factors help explain the rapid decline in costs. One contributing factor was a greater-than-expected decline in rail freight rates, which made low-sulfur coal from the Powder River Basin in Wyoming more competitive with locally mined, high-sulfur coal in Midwestern markets. Switching to low-sulfur coal proved to be substantially less costly than installing smokestack scrubbers. A second factor was lower-than-predicted costs of using scrubbers, in part because of unexpectedly high utilization rates.

Another example of incentive mechanisms is the federal government's efforts to reduce ground-level ozone concentrations. Studies have found that ozone and nitrogen oxides (NO_X) can travel hundreds of miles and contribute to nonattainment of air quality standards in downwind areas. Under traditional regulatory approaches, nonattainment areas had to make costly emissions reductions within their borders even if comparable upwind reductions were available at lower cost.

To address this problem, EPA in 1998 announced a program to reduce NO_X in 22 states and the District of Columbia by an average of 35 percent during May through September (when ozone levels are highest) by 2007. The program allows for emissions trading among electric utilities that are sources of NO_X emissions.

An important distinction between the SO_2 and NO_X programs is that utilities currently account for only about 30 percent of NO_X emissions, compared with about 65 percent of SO_2 emissions. Since the increased opportunity to trade emissions permits tends to lower costs, it would appear desirable to consider expanding the scope of the program to include transportation or nonutility combustion sources. However, the scope of the program may be limited by the need to ensure accountability.

In the area of water pollution, several state and local governments have experimented with programs that are similar in principle to the air pollution trading programs. For example, it may be considerably less expensive to improve water quality by reducing pollution from nonpoint sources than from point sources. Trading programs would allow point sources of pollution to meet environmental standards by paying non-point sources (such as farms) to adopt practices to reduce pollution. Agencies administering these programs rely on verifying that nonpoint sources have adopted land management practices that are linked with pollution reduction. Experience with such programs is still limited, but cost savings could be substantial.

Other Incentive Programs

Over 3,400 communities in 37 states have instituted new variable pricing programs for household waste in recent years. These programs take several forms. For example, pre-paid garbage bags or stickers to affix to bags can be required for collec-

tion, or collection fees can be based on the number and/or size of cans. Such systems are relatively easy and inexpensive and provide a stable source of revenue for collection services.

Education and recycling programs have been important contributing factors in the success of many variable pricing programs. Many communities implement public education, curbside recycling, yard waste, and holiday greenery programs as well. For example, an estimated 8,937 curbside recycling programs were in operation in 1997—a roughly ninefold increase since 1988. Over the same period, there was a similarly dramatic increase in the number of facilities handling "yard trimmings" (grass, leaves, and brush). These complementary programs can be an important factor in the success of variable rate pricing efforts.

In most areas where variable rate programs have been introduced, amounts of waste collected have declined. A 1992 survey of 14 cities with variable rate programs found that the amount of waste destined for disposal decreased by an average of 44 percent. A study in Maine found that cities and towns with variable rate systems disposed of less than half as much waste per capita as cities and towns without such systems. Other studies have found that variable rate programs encourage consumers to think of ways to reduce waste generation, including altering their purchasing habits.

Assessing Costs and Benefits

An important issue connected to economic efficiency policies concerns whether the benefits of environmental protection laws outweigh their costs.

In the case of the Clean Air Act, Congress added to the 1990 amendments a requirement that EPA conduct periodic, scientifically reviewed studies to assess the benefits and the costs of the act.

The first report in this series, *The Benefits and Costs of the Clean Air Act: 1970 to 1990*, examines the benefits and costs of the original 1970 act and the 1977 amendments. Estimates are derived by examining the differences in economic, human health, and environmental outcomes under two alternative scenarios. The "control" scenario reflects actual historical implementation of clean air programs and is based largely on historical data. The "no-control" scenario assumes that no air pollution controls would be established beyond those in place prior to enactment of the 1970 amendments.

The study includes a detailed discussion of two difficult aspects of cost-benefit analysis—quantifying non-market benefits and health benefits.

The study found that:

- The total monetized benefits of the Clean Air Act realized during the period from 1970 to 1990 range from 5.6 to 49.4 trillion dollars, with a central estimate of 22.2 trillion dollars.
- By comparison, the value of direct compliance expenditures over the same period equals approximately 0.5 trillion dollars.
- Subtracting costs from benefits results in net, direct, monetized benefits ranging from 5.1 to 48.9 trillion dollars, with a central estimate of 21.7

trillion dollars, for the 1970 to 1990 period.

- The lower bound of this range may go down and the upper bound may go up if analytical uncertainties associated with compliance costs, macroeconomic effects, emissions projections, and air quality modeling could be quantified and incorporated in the uncertainty analysis. While the range already reflects many important uncertainties in the physical effects and economic valuation steps, the range might also broaden further if additional uncertainties in these two steps could be quantified.

These results indicate that the benefits of the Clean Air Act and associated control programs substantially exceeded costs. Even considering the large number of important uncertainties permeating each step of the analysis, it is extremely unlikely that the converse could be true.

The study also found that a large proportion of the monetized benefits of the Clean Air Act derive from reducing two pollutants: lead and particulate matter. The study provided no evidence to support or reject the possibility that other Clean Air Act programs and standards might not have exceeded measurable costs. It did note, however, that most control programs yielded a variety of benefits, many of which included reductions in other pollutants such as ambient particulate matter.

The report notes that, in a final brief interagency review organized in August 1997 by the Office of Management and Budget, several agencies held different views pertaining to several key assumptions in the study. The concerns included: 1) the extent to which air quality would have deteriorated from 1970 to 1990 in the absence of the Clean Air Act; 2) the methods used to estimate the number of premature deaths and illnesses avoided due to the Clean Air Act; 3) the methods used to estimate the value that individuals place on avoiding those risks; and 4) the methods used to value non-health related benefits. These concerns were not resolved during this review. Therefore, the report reflects the findings of EPA and not necessarily other agencies in the Administration.

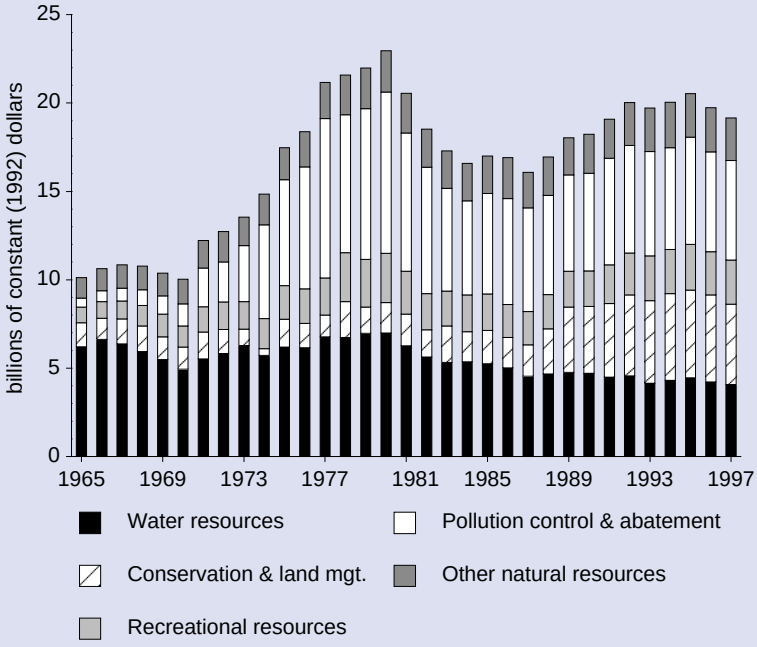
TRENDS

The United States' economy has grown impressively for several decades. In 1997, U.S. gross domestic product (in constant 1992 dollars) stood at $7.27 trillion, which is about 36 percent higher than the 1985 total. (Part III, Table 2.1)

Federal spending on natural resources and environment (in constant 1992 dollars) grew from $10 billion in 1970 to $20 billion in 1992, but since then has remained at about the $20 billion level (Figure 2.1). This represents about 1.3 percent of total federal outlays. Of the $19 billion spent in 1997, 30 percent was for pollution control and abatement, 24 percent for conservation and land management, and 21 percent for water resources. (Part III, Table 2.2)

State and local governments are spending substantially more on natural resources and environment than the fed-

Figure 2.1 Federal Government Expenditures on Natural Resources and Environment, 1965-1997



Source: Executive Office of the President, Office of Management and Budget, *The Budget of the United States Government, Fiscal Year 1999* (OMB, Washington, DC, 1998).

eral government, and spending has continued to rise in the 1990s. Total spending (in constant 1992 dollars) more than doubled between 1970 and 1995 (Figure 2.2). Of the $66.7 billion spent in 1995, sewerage accounted for one third and parks and recreation for one fourth of the total. (Part III, Table 2.3)

Including private sector spending, total U.S. pollution abatement and control expenditures (in constant 1992 dollars) were estimated at $115.9 billion in 1994, the last year for which estimates are available. (Part III, Table 2.4) By type, spending for air pollution controls, water pollution controls, and solid waste management each accounted for roughly one third of the total. (Part III, Table 2.5) Business accounted for about 63 percent of the total, followed by government at 25 percent. (Part III, Table 2.6) Figure 2.3 shows pollution abatement expenditures by selected industries through 1994; the chemical and petroleum/coal sectors accounted for the largest shares of pollution abatement spending in 1994. (Part III, Table 2.7)

U.S. environmental industries generated $168 billion (in constant 1992 dollars) in revenues in 1996, more than triple the 1980 amount. Solid waste management, water treatment works, and water utilities

are the largest revenue generators. Solid waste management also is the largest employer (234,600 people in 1996), followed by consulting and engineering (160,000 people). (Part III, Table 2.8)

In 1995, environmental companies generated over $95 billion (in constant 1992 dollars) in products and services for environmental purposes, led principally by the solid waste and water/wastewater treatment sectors. (Part III, Table. 2.9)

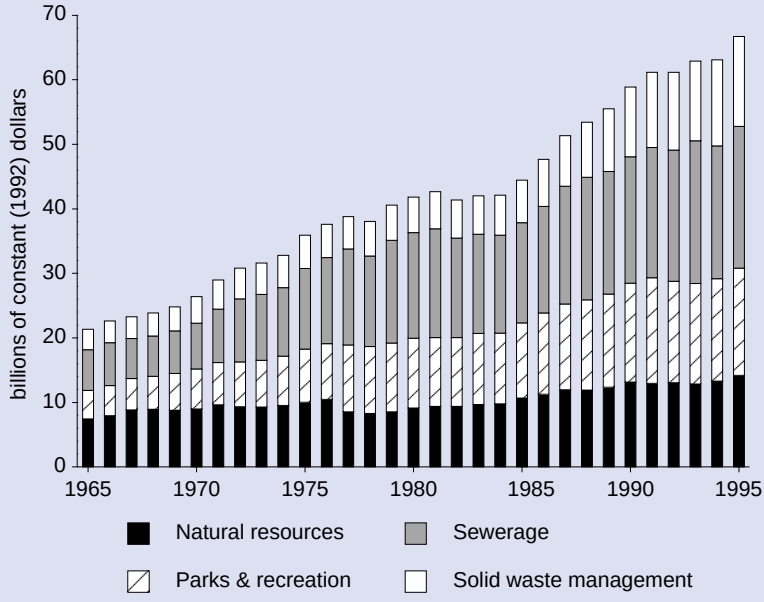
According to an EPA report, expenditures for air pollution controls for stationary sources, mobile sources, and other expenditures (less recovered costs) totaled $20 billion (in constant 1992 dollars) in 1990. (Part III, Table 2.10)

ONLINE RESOURCES

A good place to begin exploring online resources is EPA's Economy and the Environment website (http://www.epa.gov/economics).

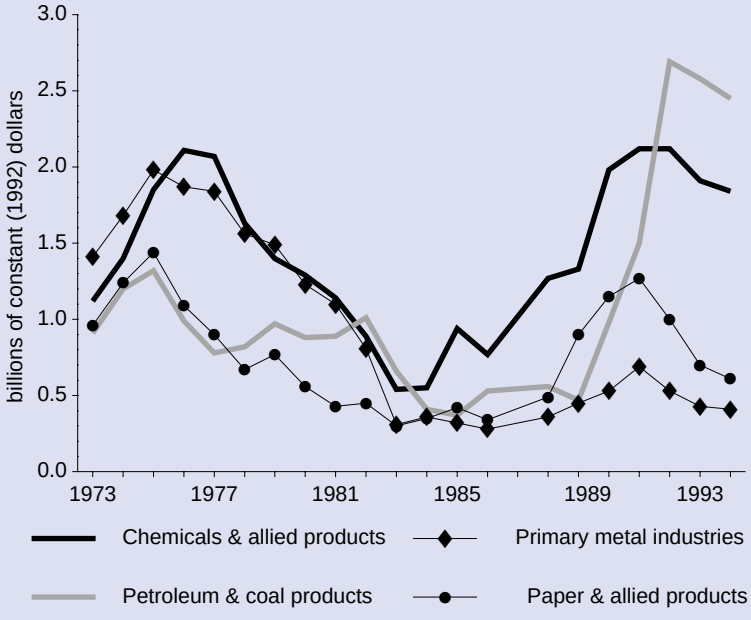
The website includes a Report Inventory of over 500 economic research reports done by or for EPA. These are organized by author, title, subject, research organization, and media, includ-

Figure 2.2 State and Local Government Expenditures on Natural Resources and Environment, 1965-1995



Sources: U.S. Department of Commerce, Bureau of the Census, *Historical Statistics on Government Finances and Employment* (data for years 1965 to 1981), *Government Finances* (data for years 1982 to 1987), and *United States State and Local Government Finances by Level of Government* (Internet accessible data for years 1988 to 1995).

Figure 2.3. Capital Expenditures for Pollution Abatement by Selected U.S. Industries, 1973-1994



Source: U.S. Department of Commerce, Bureau of the Census, *Pollution Abatement Costs and Expenditures*, Current Industrial Reports (GPO, Washington, DC, annual).
Note: This survey was discontinued after 1994.

ing eight reports that can be read online, over 135 that can be downloaded by title and subject, and about 500 that can be ordered in hard copy form. In addition, the site houses a Working Papers Inventory of unpublished papers on the economics of environmental pollution control, which is organized by author, title, institution, media, and subject. The Inventory includes over 125 downloadable working papers. Finally, the site has an inventory of over 1200 Regulatory Impact Analyses and similar cost-benefit analyses of EPA regulations organized by media, title, EPA office, document type, and assessment topic, with over 10 that can be downloaded.

The eight online reports include titles on estimating benefits of environmental regulations, an introduction to environmental economics research at EPA, a Resources for the Future (RFF) report on measuring the benefits of clean air and water, a report on methods development for assessing air pollution control benefits, an Environmental Law Institute (ELI) report on the United States' experience with economic incentives in environmental pollution control policy, and a summary of a report on valuation of reductions in human health symptoms and risks. The eight online reports can be reached through the Report Inventory under Resources.

The site's "Internet Links" is a selection of primarily non-EPA sites that are particularly relevant to the environmental economics field. The sites can be sorted by titles, categories, subjects, or by media.

The site's Internet Links also include links to a number of journals, including the *Journal of Environment and Development*, *Journal of Environmental Economics and Management*, *Environmental Economics Abstracts, Environmental and Resource Economics*, *Environment and Development Economics,* and *Agricultural and Resource Economics Review*. It is also linked to some annual surveys conducted by the U.S. Census Bureau. The *Industrial Air Pollution Control Equipment Survey* (http://www.census.gov/ftp/pub/econ/www/ip3100.html) provides detailed annual data since 1971 on new orders, shipments, and backlog orders of air pollution control equipment. The *Survey of Pollution Abatement Costs and Expenditures* (http://www.census.gov./econ/www/mu1100.html) was conducted annually from 1973 to 1994 and provides comprehensive data on pollution abatement control expenditures, operating costs, and costs recovered by private industries.

The Commerce Department's Bureau of Economic Analysis provides a list of articles on national economic accounts (http://www.bea.doc.gov/bea/an1.htm). The list includes the last report on the pollution abatement and control expenditures survey in the *Survey of Current Business*. Other reports focus on accounting for mineral resources and on alternative measures of gross product by industry.

The Agriculture Department's Economic Research Service has an article entitled "Exploring Linkages Among Agriculture, Trade, and the Environment: Issues for the Next Century" (http://www.econ.ag.gov/epubs/pdf/aer738).

Basic material on budget issues can be found at the Office of Management and Budget site (http://www.whitehouse.gov/OMB/), including descriptions and analysis of the fiscal 1998 federal budget. The site includes OMB's circular on discounting and benefit-cost analysis.

The 1998 and 1999 issues of the *Economic Report of the President* prepared by the President's Council of Economic Advisers have provided detailed assessments of policies designed to promote economically sound environmental protection (http://www.access.gpo.gov/eop/index.html#page1).

Several policy research institutes maintain large websites with material on economy/environment issues. The World Resources Institute (WRI) (http://www.wri.org) has published several studies on natural resource accounting. Recent reports have assessed the relationship between environmental protection and productivity growth, sustainable trade expansion in Latin America, how a tax shift can work for the environment and the economy, and the linkages between population, poverty, and environmental stress. Another significant WRI study is devoted to resource flows—the total use of natural resources that national economic activity requires.

Resources for the Future (http://www.rff.org) has published numerous studies on non-market valuation and cost-benefit analyses. One 1997 RFF study is entitled

Cost-Benefit Analysis and Regulatory Reform: An Assessment of the Science and Art.

An overview of the modeling and estimates of the economic values of environmental resources—*Pricing What is Priceless: A Status Report on Non-Market Valuation of Environmental Resources*—is available through the Duke Economics Working Paper series (http://www.econ.duke.edu/Papers/Abstracts96/abstract.96.30.html).

Many sites focusing on global environmental issues include materials on environmental accounting, linkages, and costs and benefits.

The World Bank Environmental Economics and Indicators Unit (http://www-esd.worldbank.org/eei/) serves as an electronic focal point for new thinking on measuring and valuing the environment. A major focus has been development of indicators, including new estimates of national wealth and savings. New initiatives include a multi-year program on trade, macro-reform and the environment, and work on the development of indicators of rural sustainability. Major publications include *Expanding the Measure of Wealth*, which continues and expands the work on environmental indicators begun in the 1995 report *Monitoring Environmental Progress*.

New Ideas in Pollution Regulation, sponsored by the World Bank (http://www.worldbank.org/nipr), is another site with useful material on economy-environment relationships.

The United Nations Environment Programme's Environment and Economics Unit has a publications database (http://unep.unep.org/unep/products/eeu/eeupub.htm) with the following categories: environmental impact assessments, valuation of environment and natural resources, environmental and natural resource accounting, economic policy instruments, and trade and environment.

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CORE DATA

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