

Appendix A: Effects of Environmental Regulations on Economic Growth: A Review of Research

Attempts to assess the impacts of environmental regulation on the economy—including trade flows and foreign investment, Gross Domestic Product (GDP) growth, and productivity—have been going on at least since the early 1970s. These studies differ in methodology, assumptions, and conclusions. This appendix reviews some of the studies.

■ Effect on GDP and Social Welfare

The effect of environmental regulation on the economy and social welfare hinges principally on whether the benefits of regulation outweigh the costs. Unfortunately, few studies have included the benefits, primarily because while estimates of compliance costs are readily available, estimates of benefits are not.¹

Several studies have attempted to evaluate the impact of environmental regulation on GDP. Most studies find that while environmental expenditures may increase economic growth in the short term, particularly in recessionary periods when economic

stimuli are needed, this stimulus is outweighed by the costs in the medium and long term.² Production cost increases lead GDP-producing activities to grow more slowly because an increased share of economic activity is producing effects that GDP measures do not include (e.g., clean air). In part, as discussed below, this reflects a failure of current national income accounting measures to adequately reflect national welfare.

The majority of studies find that environmental regulations have had a negative, but relatively small, impact on GDP growth.³ For example, Denison found that, in the absence of environmental regulation from 1973 to 1982, annual U.S. Gross National Product (GNP) growth would have been 0.07 percent higher.⁴ Jorgenson and Wilcoxon used a more sophisticated model and found that the impact on annual GNP growth to be 0.191 percentage points between 1973 and 1985: real GNP in 1985 would have been 2.59 percent (or **about \$150 billion**) higher.⁵ They contend that new regulations, particularly from the 1990 Clean Air Act Amendments, will slow annual GNP growth

¹If regulations precede a sound scientific foundation (as indeed, they sometimes must), the benefits may not be truly ascertainable, even though the costs may be.

²Ger Klaassen and Andries Nentjes, "Macroeconomic Impacts of an EEC Policy to Control Air Pollution," *Journal of Policy Modeling*, vol. 13, No. 3, 1991, pp. 347-366.

³Measures of gross national product (GNP) or gross domestic product (GDP) are not very different. While some studies have used GNP as a measure, recently, government has adopted the convention of using GDP. GDP plus net receipts of factor income from the rest of the world (e.g., receipts and payments of dividends and interests of foreign affiliates of U.S. corporations and U.S. affiliates of foreign corporations) equals GNP.

⁴E.F. Denison, *Trends in American Economic Growth, 1929-1982* (Washington, DC: The Brookings Institution, 1985), p. 34.

⁵In other words, if GNP grew 2.5 percent a year with environmental regulations, it would grow 2.691 percent a year without them. Dale W. Jorgenson and Peter J. Wilcoxon, "Environmental Regulation and U.S. Economic Growth," discussion paper, Harvard University, Energy and Environmental Policy Center, November 1989.

by another 0.04 percent by the year 2005 and 0.05 percent by 2020.⁶

However, due to simplified assumptions made in modeling the direct effects of environmental regulation on the economy, the results of econometric studies have to be interpreted with caution. First, some studies that measure only compliance costs to business are underreporting the true costs of regulation, since they are not based on a full equilibrium model of how the costs work their way through the economy in the long run. Using these methods, costs are normally higher than simple measurement of compliance costs.⁷ Both Jorgenson and Wilcoxon and Hazilla and Kopp use such full equilibrium models to measure costs.

However, a second and more serious limitation of all the studies is that while they include the costs of environmental regulations, they do not include the benefits, by definition assuring that their models will find that regulation lowers GDP. There are a number of benefits of regulation, both to the polluting firm and to the rest of society, that if measured might increase GDP. The polluting firm may benefit from pollution control, particularly if it involves production process changes that lead to increased productivity, lower energy and materials use, and increased worker welfare. While the extent of the benefits to the industry is not clear (they are probably not large), not including them overestimates economic losses.

More sizable benefits occur outside the firm. For example, increased natural resource productivity from lower levels of pollution (e.g., increased agricultural and fisheries yield), reduced health care costs, maintenance costs, and capital expenditures on environ-

mental controls (e.g., public water treatment plants) would all increase GDP, in part through increased productivity.⁸

Moreover, some benefits are nonmonetary and not included in GDP measures. For example, enjoyment of natural resources, reduced nuisance (e.g., odor) from pollution, and even species diversity might result from a cleaner environment but would not necessarily be measured in GDP. Also, there are important flaws in how national wealth is calculated with respect to natural resources. While depreciation of man-made capital assets (plant, equipment, buildings) is subtracted from GNP to calculate net national product (NNP), depreciation of natural capital (soil, forests, fisheries, minerals), or human capital (illness due to pollution) is not subtracted as these natural and human resources are depleted.⁹ Thus, not all of the results of defensive activities that slow down the degradation of natural and human resources would be measured in GDP, even though they would raise societal welfare.

While it is important to include these benefits in any assessment of the relationship between regulation and economic growth, accurate and comprehensive measures of the benefits of environmental regulation have not been fully developed.¹⁰ Some argue that the U.S. spends significant resources regulating some pollutants that cause little damage to health or environment, while spending little on abating other pollutants that cause greater damage (e.g., indoor air pollution) and that, as a result, regulation lowers GDP.¹¹ In contrast, others argue that on net, the benefits of environmental regulations outweigh the costs.¹² It remains unclear whether environmental regulations impose more costs

⁶ Dale W. Jorgenson and Peter J. Wilcoxon, "The Impact of Environmental Legislation on U.S. Economic Growth, Investment, and Capital Costs," U.S. *Environmental Policy and Economic Growth: How Do We Fare?* Monograph Series on Tax and Environmental Policies and U.S. Capital Costs (Washington DC: American Council for Capital Formation, 1992), pp. 1-39.

⁷ Michael Hazilla and Raymond J. Kopp, "The Social Cost of Environmental Quality Regulations: A General Equilibrium Analysis," *Journal of Political Economy*, vol. 98, No. 4, pp. 853-873.

⁸ For example, lower health care costs could lead to reduced work absences and would also allow revenues formerly going to health care to go to other economic activities. See Organization for Economic Co-operation and Development, *Environmental Policy Benefits: Monetary Valuation* (Paris: OECD, 1989).

⁹ Robert Repetto, "Accounting for Environmental Assets," *Scientific American*, vol. 266, No. 6, June 1992.

¹⁰ Under the 1990 Clean Air Act, EPA was required to prepare a report assessing the benefits of the Federal clean air regulations. The report is scheduled for release in late 1993. Moreover, EPA is considering doing more detailed work to measure the benefits of regulations in all media.

¹¹ Paul R. Portney, "Policy Watch: Economics and the Clean Air Act," *The Journal of Economic Perspectives*, vol. 4, No. 4, fall 1990; also, Robert Crandall, "Why is the Cost of Environmental Regulation So High," policy paper, Center for the Study of American Business, Washington University, St. Louis.

¹² Alvin L. Alm, "Competitiveness and Environmental Quality," *Environmental Science and Technology*, vol. 25, No. 12, December, 1991, p. 1993.

Table A-I—Estimates of the Share of Total Factor Productivity y Decline From Environmental Regulation

Study	Percent share	Period	Industry scope
Gray ¹	12%	1973-78	240 manufacturing sectors
Denison ²	16%	1972-75	Business sector
Christainsen and Haveman ³	8-12%*	1973-78	Manufacturing
Norsworthy, Harper, & Kunze ⁴	12%*	1973-78	Manufacturing
Barbera and McConnell ⁵	10-12%	1970-80	Chemicals; stone, clay, and glass; iron and steel
Barbera and McConnell ⁶	30%	1970-80	Paper
Gallop and Roberts ⁷	44%	1973-79	Electric utilities

* contribution to decline in labor productivity

¹ Wayne B. Gray, "The Cost of Regulation: OSHA, EPA and the Productivity Slowdown," *The American Economic Review*, vol. 77, No. 5, December 1987 pp. 998-1006.

² Edward P. Denison, *Accounting for Slower Economic Growth: The U.S. in the 1970s* (Washington, DC: The Brookings Institution, 1979).

³ Robert H. Haveman and Gregory B. Christainsen, "Environmental Regulations and Productivity Growth," in *Environmental Regulation and the U.S. Economy*, edited by Henry M. Peskin, Paul R. Portney, and Allen V. Kneese (Baltimore, MD: Johns Hopkins University Press/Resources for the Future, 1981).

⁴ J.R. Norsworthy, Michael J. Harper, and Kent Kunze, "The Slowdown in Productivity Growth: Analysis of Some Contributing Factors," *Brookings Papers on Economic Activity*, No. 2, 1979, p. 387-421.

⁵ Anthony J. Barbera and Virginia D. McConnell, "The Impact of Environmental Regulations on Industry Productivity: Direct and Indirect Effects." *Journal of Environmental Economics and Management*, vol. 18, 1990, pp. 50-65.

⁶ *Ibid.*

⁷ Frank M. Gallop and Mark J. Roberts, "Environmental Regulations and Productivity Growth: The Case of Fossil-fueled Electric Power Generation," *Journal of Political Economy*, vol. 91, No. 4, August 1983, pp. 654-674.

than benefits, and until this question is answered, it is not possible to accurately measure the impact of regulations on productivity or GDP.

Finally, even if net benefits from regulations do exceed costs, those costs normally occur in the present while the benefits often occur in the future. If other countries choose to minimize short-term costs by limiting regulation, they may gain a short-term competitive advantage that can also be translated into a long-term advantage. Also costs may be concentrated, affecting certain industries, workers, and communities, while the benefits may be diffuse.

■ Productivity and Environmental Regulation

A number of studies were done to explain the slowdown in manufacturing productivity gains in the

1970s. Virtually all the studies found that environmental regulations contributed a small share to the slowdown in productivity.¹³ Manufacturing productivity growth rates in the 1980s, however, regained pre-1970 levels.¹⁴

There are several reasons why environmental regulations could lower productivity.¹⁵ First, because pollution abatement inputs (e.g., capital, labor, energy) produces pollution reduction, which is not included as an output in conventional productivity measures, by definition compliance costs lower total factor productivity. Conventional output indicators measure only the value of the saleable product and not the negative value of the environmental damage caused by the pollution. Therefore, studies find that environmental compliance expenditures reduce productivity because their outputs (a cleaner environment than otherwise) are not included as part of the firms' outputs.

¹³ Productivity is generally measured in two ways, total factor (or multifactor) productivity, which relates outputs (value of the products the plant or firm produces) to all inputs to the firm, including capital, labor, purchased inputs, energy and raw materials, and single factor productivity (e.g., labor productivity), which relates outputs to the amount of a single factor (e.g., labor).

¹⁴ William Gullickson, "Multifactor Productivity in Manufacturing Industries," *Monthly Labor Review*, October 1992, pp. 20-29.

¹⁵ For example, see Wayne Gray and Ronald J. Shadbegian, "Environmental Regulation and Manufacturing Productivity at the Plant Level," Center for Economic Studies Discussion Paper (Washington, DC: U.S. Bureau of the Census, March 1993).

Gallop and Roberts found that almost half (44 percent) of the productivity slowdown in the electric power industry in the 1970s was attributable to environmental regulations.¹⁶ Repetto has developed a measure to include pollution in productivity measures for the electric power industry,¹⁷ which includes both electricity and economic damages from pollutants (e.g., crop losses, morbidity) as outputs from utilities. Using this expanded measure, Repetto found that between 1970 and 1985 environmental productivity (kilowatt hours per unit of emissions) increased more rapidly than labor, capital, or energy productivity. ¹⁸ As a result, while electric power productivity declined by 0.38 percent a year between 1971 and 1985 when measured in conventional terms, Repetto estimates that it increased by between 0.33 and 0.62 percent a year when the benefits of a cleaner environment are included as outputs.

Second, environmental regulation could lower the productivity of nonabatement resources in producing measured outputs, if it reduces the efficiency of existing inputs into production. For example, firms use large amounts of energy to run smokestack scrubbers and also must expend substantial effort to maintain these devices.

Third, if firms change production practices in response to regulatory demands, these new practices may be less efficient than the old ones. For example, companies may switch from cleaning with solvents to less productive mechanical cleaning. In addition, to avoid liability and present an image as a clean company, larger firms may subcontract out some of their dirtier production processes to smaller firms,

even though it may be more efficient to produce in-house.¹⁹

Fourth, if firms divert funds from spending on productive investments (e.g., new capital equipment) to pay for environmental expenditures, then productivity growth may lag since less new equipment is bought. It is not clear the extent to which this crowding out takes place; in fact, at least one study²⁰ found that among pulp and paper mills, firms that spent more on productive investments as a share of the plant capital stock also spent more on environmental investments.²¹

Fifth, if regulations have a new-source bias, this may discourage investment in new, more efficient technologies and encourage holding on to older facilities. Finally, regulations may divert management time and effort away from issues of production toward issues of compliance and hence might reduce productivity.

However, there are some reasons why regulations might increase productivity. First, as discussed in chapter 8, new production practices developed to comply with regulations might be more productive than old. For example, Barbera and McConnell found that regulations may have resulted in lower production costs in the non-ferrous metals industry because of the introduction of new lower polluting production practices that were also more efficient.²² However, even though aggressive pollution prevention efforts can reduce compliance costs, particularly when compared to the current end-of-pipe approach, in most cases they are not cost effective in the absence of regulation.

Second, regulations could provide a shock to outdated management practices and encourage management to devote increased attention to production processes and work practices. Finally, if regulation

¹⁶ Frank M. Gallop and Mark J. Roberts, "Environmental Regulations and Productivity Growth: The Case of Fossil-fueled Electric Power Generation," *Journal of Political Economy*, vol. 91, No. 4, August 1983, pp. 654-674.

¹⁷ Robert Repetto, "Environmental Productivity and Why It Is So Important," *Challenge*, vol. 33, No. 5, September-October 1990, pp. 33-38.

¹⁸ Environmental productivity is defined as output per unit of emissions.

¹⁹ F.A. Steward Consulting, "Environment and Competitiveness in the Metal Finishing Industry," contractor report prepared for the Office of Technology Assessment, February 1992.

²⁰ Wayne Gray and Ronald J. Shadbegian, "Environmental Regulation and Manufacturing Productivity at the Plant Level," *op. cit.*

²¹ Many analysts assume that this crowding out occurs on a one-to-one basis, that is, that for every dollar spent on pollution control, firms spend one dollar less on productive investments. While the empirical evidence of this is slim, it does seem to suggest that this is not the case, that instead, it crowds out only between 33 and 50 percent. Adam Rose, "Modeling the Macroeconomic Impact of Air Pollution Abatement," *Journal of Regional Science*, vol. 23, No. 4, 1983, p. 449.

²² Anthony J. Barbera and Virginia D. McConnell, "The Impact of Environmental Regulations on Industry Productivity: Direct and Indirect Effects," *Journal of Environmental Economics and Management*, winter, 1990, pp. 50-65.

imposes substantial costs on some sectors and forces some plants to close, it is likely that the plants that close will be those with the lowest productivity and profits.²³ To the extent that the remaining production takes place in U.S. plants with higher productivity, then industrywide productivity will have increased. For example, OTA found that environmental regulations accelerated steel industry modernization.²⁴

On balance though, environmental regulations appear to have dampened productivity (narrowly defined to not include environmental outputs). Most studies suggest that environmental regulation contributed to around 10 to 15 percent of the productivity growth slowdown during the 1970s. Even among industries bearing the highest pollution abatement costs, environmental regulation did not account for the majority share of the slowdown in productivity growth in the 1970s. In other words, while spending on environment has been responsible for some of the deceleration in productivity growth, other factors (such as technology changes, investment, and training) were more impor-

tant. There is some consensus that the impacts of regulation on productivity in the early 1980s were somewhat less.²⁵ In addition, productivity growth rebounded somewhat in the 1980s.²⁶ However, one study examining regulation from 1979 to 1985 found that among industries with the highest compliance costs (pulp and paper mills, steel mills, and oil refineries), environmental costs were associated with lower productivity. On average, environmental regulations in these high compliance cost sectors caused a 3 to 7 percent decline in total factor productivity.²⁷

It is not clear how future environmental regulations will affect productivity. On the one hand, the expected increase in environmental compliance costs could inhibit productivity. On the other hand, firms are much more experienced with implementation of environmental regulations than they were in the 1970s, and new approaches (such as pollution prevention) could reduce compliance costs and lower negative productivity effects.

²³ Kathryn Harrigan, *Strategies for Declining Businesses* (Lexington, MA: Lexington Books, 1980).

²⁴ U.S. Congress, Office of Technology Assessment, *Technology and Steel Industry Competitiveness*, OTA-M-122 (Washington, DC: U.S. Government Printing Office, June 1980), p. 83.

²⁵ U.S. Congress, Confessional Budget Office, *Environmental Regulation and Economic Efficiency* (Washington, DC: CBO, March 1985).

²⁶ William Gullickson, "Multifactor Productivity in Manufacturing Industries," *Monthly Labor Review*, October, 1992, pp. 20-29.

²⁷ For every additional dollar in environmental operating costs, total factor productivity would drop by \$3 to \$4. Wayne B. Gray and Ronald J. Shadbegian, "Environmental Regulation and Manufacturing Productivity at the Plant Level," *op. cit.*