Environmental Requirements and U.S. Manufacturing Industry Competitiveness

7

Environmental regulations can produce substantial benefits in the form of improved human health and a healthier ecosystem, with reduced costs in these areas. However, these benefits accrue to society as a whole, while individual firms that bear the higher compliance costs experience higher production costs as a result.[1]

Total U.S. spending (both public and private) on pollution control and abatement (including local solid waste collection costs) rose from approximately $52 billion in 1972 (1990 dollars) to $108 billion in 1990. As a share of gross national product (GNP), these expenditures grew more slowly, from 1.52 percent of GNP in 1972 to 1.95 in 1990. Expenditures could increase to between $133 and $147 billion (1990 dollars) by the year 2000, or between 2.0 and 2.2 percent of GNP.[2]

Relative to total production costs, the cost of pollution control to U.S. manufacturers is small-amounting, by one estimate, to $21 billion or about 1.72 percent of manufacturing value added in 1991. Moreover, the differential in compliance costs borne by U.S. firms compared to foreign fins, especially in advanced industrial nations, is not great. Factors other than environmental regulations, such as market access, management capability, financing, work force skills, labor costs, and technology, play more prominent roles in determining competitive advantage. Also, pollution control costs have not increased significantly

[1] **For discussion of** the **many factors that** contribute **to a firm or muon's competitive ness see Michael Porter,** *The Competitive Advantage of Nations* (*New* York, **NY: The Free** Press, 1990); **and U.S. Congress, Office of Technology Assessment,** *Competing Economies: America, Europe, and the Pacific Rim,* OTA-ITE-498 (Washington, **DC: U.S. Government Printing Office, October 1991).**

[2] **U.S. Environmental Protection Agency,** *Environmental Investments: The Cost of A Clean Environment* (Washington, **DC: Island Press, 1991).**

since the mid-1970s as a share of sales. However, these costs may be more troublesome to U.S. manufacturers now, due to intensifying demands of international competition. In an era when U.S. firms face increasing competition from able and effective competitors from both advanced and developing nations, even relatively small cost differences can affect relative competitive advantage.

Pollution control expenditures by manufacturers in the United States differ significantly by sector. For some industries, particularly process industries (e.g., chemicals, petroleum, pulp and paper, primary metals), pollution control expenditures can be a relatively large share of total capital expenditures and a small but significant share of value added. For example, as a share of value added, the petroleum industry spends over 15 percent on pollution control, primary metals and pulp and paper each spend over 4 percent, and chemicals spends over 3 percent. Most other industries, particularly discrete parts manufacturers and assemblers, spend much less. (It is possible, moreover, that these expenditures on pollution control by manufacturers are underreported, perhaps by as much as 20 to 30 percent. See app. 7-A.)

Expenditures are only part of the picture. As U.S. manufacturers seek to continuously improve production processes and rapidly introduce new products, complex and time-consuming permitting procedures and regulatory inflexibility can present serious obstacles. Many analysts argue that the U.S. regulatory system is more adversarial and rigid than those of most other nations.

While it is difficult to accurately compare pollution abatement and control costs among nations, it appears that compliance costs for U.S. industry are among the highest in the world. Manufacturers in western Germany and perhaps a very few other Northern European countries incur comparable costs; elsewhere in Europe costs are lower. Japanese pollution control costs for manufacturers have been lower than those for the United States since 1977, and that gap has been growing. For example, compared to firms in Japan, in 1990 automobile manufacturers in the United States spent over five times more as a percent of total capital investments and three times more as a percent of sales to control pollution from the production of automobiles. Pollution control and abatement costs in newly industrialized and developing nations are significantly lower than in the United States.

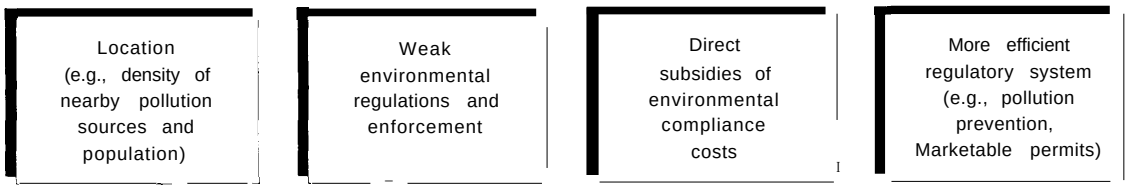
Some of these cost differentials might be due to more efficient regulatory systems. However, the major source of difference appears to stem from variances in regulatory requirements and the intensity of their enforcement (or the degree of compliance). Finally, U.S. firms often receive less government financial and technical help (e.g., tax deductions, loans, and R&D grants) than their counterparts in Japan, Germany, and some other countries.

Several attempts to assess the competitive impacts of environmental regulation on the economy have been conducted since the early 1970s. These studies differ in methodology, assumptions, and conclusions, and, because of the complexity of the research question, offer limited insight. The little research on employment effects suggests that in the medium to long-term, the impact on jobs from pollution and waste control requirements is likely to be minimal. However, it appears that pollution and waste control regulations had a small negative impact on manufacturing productivity, industrial innovation, balance of trade, and the location of industrial investment. While the effects are small, this does not mean that they are insignificant and should not be

[3] Compared to the United States, much of the private sector spending for pollution control in Japan is not by manufacturers, but rather by electric utilities to control nitrogen oxides (NO_x) and sulfur dioxide (SO_2). Moreover, regulations of many pollutants, including volatile organic compounds and hazardous wastes, are much stronger in the United States than in Japan.

[4] Japanese automobile firms maintain higher capital investment rates as a percent of sales than do U.S. automakers,

Figure 7-l—External Determinants of Environmental Compliance Costs



SOURCE: Office of Technology Assessment, 1993.

addressed+ specially if analysis could point the way to more effective and less burdensome methods of achieving environmental goals. This is particularly true given stricter pollution control requirements which will come into effect in the mid and late 1990s.

This chapter first discusses the costs of complying with U.S. pollution control regulations for manufacturers in the United States. It then discusses costs and regulatory requirements for manufacturers in other nations, including Japan, Germany, and Holland. Finally, it discusses research on the effects of regulation on technology innovation and foreign trade and investment. Appendix A discusses effects of regulation on GDP and productivity.

OVERVIEW

Externally imposed environmental compliance costs are determined in at least four ways (see figure 7-1).

First, geographic location and density of pollution sources can be a factor. Firms located in sparsely populated areas with very low levels of pollution from other sources, may not have to control pollutants as strictly to meet overall ambient standards (unless, of course, requirements are in place to prevent any significant deterioration of existing environmental conditions).

Second, companies may bear few costs if they are located in nations or regions that allow them to pollute heavily, even where there are high pollution loads. Moreover, while few data compare worker health and safety costs in different nations, U.S. firms may carry higher costs in this area compared to those in many competing countries, particularly newly industrialized and developing countries.[5]

In the long term, nations may pay more for these implicit subsidies (e.g., through increased health costs and reduced natural resource productivity). In some cases this penalty maybe so large as to impede economic growth, as the current situation in Eastern Europe and the former Soviet Union illustrates. However, just as other subsidies can create industrial competitive advantages,[6] so can environmental subsidies, whether in the form of lax regulations or direct assistance.

Some argue that strict environmental regulations can lead to increased competitive advantage.[7] Firms in countries with strict regulations on industrial processes might find that aggressive environmental actions, particularly pollution pre-

[5] See Lawrence J. MacDonnell, "Government Mandated Costs: The Regulatory Burden of Environmental, Health and Safety Standards," *Resources Policy*, March 1989, pp. 75-96.

[6] U.S. Congress, Office of Technology Assessment op. cit., footnote 1.

[7] A number of analysts use Michael porter's, article, "America's Green Strategy" *Scientific American*, April 1991, vol. 264, No. 4, p. 168 as evidence of this relationship. Porter's writings on this relationship suggest a more limited view (see box 3-2).

vention, make them more competitive relative to other *domestic* competitors having to comply with the same standards. However, as a group, firms within countries with stringent environmental regulations may often face a competitive disadvantage in a global marketplace where they must compete with firms in *foreign* countries with more lax standards. When waste disposal costs are high and regulatory requirements are stringent, firms can sometimes save money by controlling pollution and reducing wastes. However, these actions are seldom financially justifiable in the absence of waste treatment or pollution control requirements.

The third factor in determining compliance costs is the degree to which nations or regions provide financial or technical assistance to meet pollution control regulations. Although the Organization of Economic Cooperation and Development (OECD) has adopted the polluter pays principle, which states that the polluter should bear the expenses of carrying out measures to protect the environment, the principle is not strictly adhered to in any developed or developing country. However, there is significant variation in the degree to which governments provide both financial and nonfinancial assistance to help industry meet environmental requirements. Relative to some countries, the United States provides little help to its industries to comply with pollution abatement requirements.

Fourth, firms in nations that structure their regulatory systems more efficiently (e.g., fewer delays, more flexibility) while maintaining similar levels of protection, may face lower costs than firms in nations that achieve the same level of protection in less efficient ways. To some extent, market incentives (e.g., taxes and fees, tradable permits) and performance-based standards may produce lower costs (see ch. 9). While no country has used these approaches extensively, a number of other countries' systems do appear more flexible than the United States, which may enable them to achieve more pollution reduction per compliance dollar spent. Another source of environmental efficiency is to reduce pollution through prevention (in-process changes) as opposed to end-of-pipe methods. Countries appear to differ little on the relative extent of in-process changes.

Some analysts have argued that some environmental regulations impose sizable costs on the economy, but deliver quite small benefits.[8] Such analysis is complex and requires a greater understanding of costs and benefits than currently exists. As a result, this report does not examine the issue of whether U.S. environmental regulations are too strong (or too weak). Rather, it discusses the extent to which U.S. regulations affect economic competitiveness. Chapters 8 and 9 examine ways in which pollution control regulations can be modified to minimize their negative effect on industrial competitiveness, while achieving stable or greater levels of environmental protection.

U.S. POLLUTION ABATEMENT AND CONTROL EXPENDITURES

The Bureau of Economic Affairs (BEA) in the Department of Commerce estimates that U.S. pollution abatement and control costs in 1991 were $91.5 billion, or 1.61 percent of GDP.[9] The Environmental Protection Agency (EPA) reports a higher figure of $108 billion in 1990, or 1.95

[8] Some have called for regulations increasingly informed by sounder scientific information, often based on risk assessment techniques to determine relative risks, benefits, and costs. It is beyond the scope of this study to examine the potential for such approaches to lower compliance costs while maintaining current levels of environmental protection.

[9] Gary L. Rutledge and Mary L, Leonard, "Pollution Abatement and Control Expenditures, 1987-91," *Survey of Current Business*, vol. 73, No. 5, May 1993, p. 61. These are net costs, which subtract the savings firms received from recovered energy and materials due to pollution control. In 1991, these amounted to approximately $1.6 billion, Gross pollution abatement and control costs were $93.1 billion.

percent of GDP.[10] Box 7-A discusses the different methods for measuring costs.

Total pollution control and abatement expenditures (constant dollars) declined slightly in the early 1980s, then steadily increased throughout the rest of the 1980s (see figure 7-2). Expenditures increased from $52 billion in 1972 to $108 billion (by EPA calculations) in 1990 (inconstant 1990 dollars) .11 However, as a share of GNP, environmental expenditures have increased less rapidly, from 1.52 percent in 1972 to 1.95 in 1990.[12]

According to BEA, business accounted for slightly over half, or $48 billion, of the $91 billion spent on pollution control and abatement in 1991 (see table 7-l.) Most of the cost to business was for acquisition and operation of pollution control equipment; a smaller share was for fees to publicly owned wastewater treatment works and for costs of pollution control devices on automobiles and trucks purchased by business. Of the business expenditures, approximately $21 billion was incurred by manufacturers: $6.4 billion for electric utilities; $1.6 billion for mining; and the rest by other sectors, including expenditures on waste collection and sewage treatment.

Expenditures by manufacturers are displayed in figure 7-3. The high level of capital expenditures in the mid-1970s reflects initial acquisition of equipment as industry complied with the 1970 Clean Air Act and the 1972 Clean Water Act. The portion of capital expenditures for pollution abatement and control then tapered off for several years. It appears to be increasing again, in part because of the 1987 Clean Water Act amendments and the 1990 Clean Air Act amendments. Operating costs have increased slowly and steadily, as the stock of pollution control equipment has grown. In 1991, capital expenditures to comply with air and water requirements accounted for almost 85 percent of pollution control and abatement capital expenditures; solid waste, including hazardous waste, accounted for the rest. Operating costs were divided almost equally between the media (see figure 7-4).

FORD MOTOR CO.

***Large** fans and ducts transfer exhaust emissions from automobile paint booth operations to the next stage of the emission control system. The $35 million dollar system reduces solvent emissions.*

Pollution Abatement and Control Expenditures by Sector

Pollution control costs for industry can be defined as the direct and intentional outlays by industry for pollution abatement and control. These costs differ significantly by sector. In general, process industries (e.g., chemicals, petroleum) experience higher compliance costs than

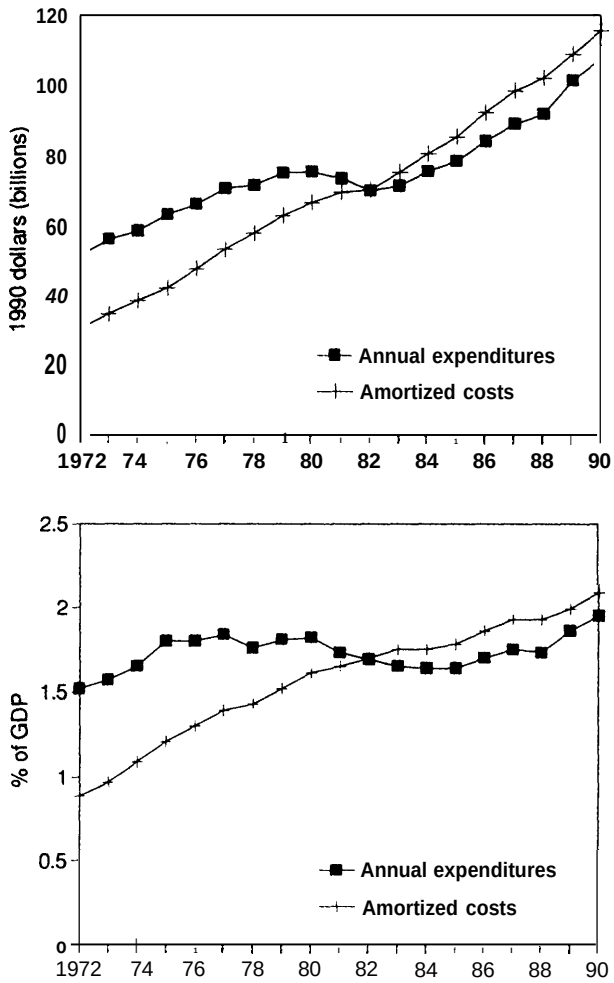
10 However, EPA includes some expenditures that are only tangential to pollution abatement, such as 100 percent Of the $17 billion spent on municipal solid waste collection costs. The EPA figures for 1990 are estimates. Environmental Protection Agency, op. cit., footnote 2.

11 Environmental Protection Agency, Op. Cit., footnote 2.

12 Historic statistics are generally expressed as a share of Gross National Product (GNP) whereas more current statistics are expressed as a share of Gross Domestic Product (GDP), Differences between the two measures are insignificant.

Box 7-A-Government Measures of Pollution Abatement and Control Costs

Figure 7-A1—Differing Measures of Environmental Compliance Costs



SOURCE: Environmental Protection Agency, *Environmental Investments* (Washington, DC: Island Press, 1991).

There are three main sources of data on U.S. environmental compliance costs: the Environmental Protection Agency (EPA) published a report in 1990 on total pollution abatement and control costs; the Census Bureau publishes an annual report on manufacturers abatement costs; and the Department of Commerce's Bureau of Economic Analysis (BEA) annually publishes data on total costs that rely in part on the Census Bureau data.

BEA and EPA estimates differ significantly. One reason is that the EPA study included all costs ($17 billion) for solid waste management collection. BEA includes only 70 percent of these costs. EPA includes all superfund costs ($4.2 billion). BEA includes a smaller but indeterminant share. Because garbage has been collected for at least 100 years, It makes little sense to include all these *costs* when considering the effect of regulation on economic competitiveness. EPA (but not BEA) also included a share of expenditures for water supply ($4 billion), pesticide and fungicide regulations ($2 billion), and nonpoint source water pollution controls ($0.77 billion).[1] Both include the costs from mobile source pollution control (primarily automobile pollution control devices), but BEA's estimate ($14.6 billion) was almost double the EPA estimates of $7.7 billion.

EPA and BEA account for capital expenditures for environmental protection indifferent ways. BEA counts capital expenditures and operating costs in the year they are made. In contrast, the EPA study converted the data into annualized expenditures (the sum of operating costs for the year in question plus amortized capital costs, which include interest and depreciation associated with accumulated capital investment).

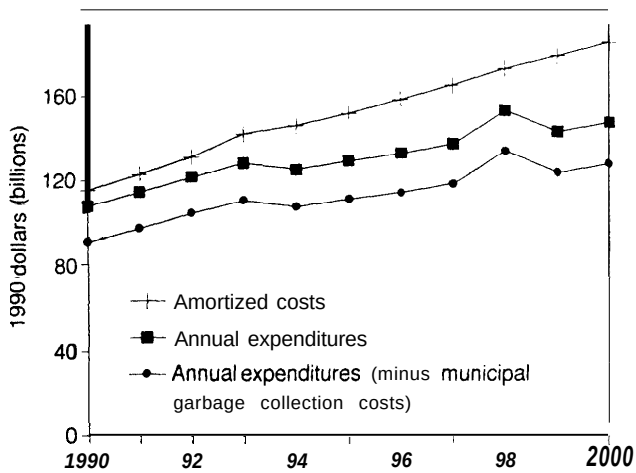
[1] U.S. Environmental Protection Agency, *Environmental Investments: The Cost of A Clean Environment* (Washington, DC: Island Press, 1991).

Box 7-A-Government Measures of Pollution Abatement and Control Costs-Continued

In other words, if a firm spent $20 million in 1975 on capital equipment with a useful life of 20 years, the EPA study would record $1 million for each year from 1975 to 1994, and add in annual interest payments.[2] The EPA study provides both actual and annualized costs, but its annualized numbers have been more widely reported.

While EPA's actual and annualized measures are both valid, the latter measure gives the impression that the environmental regulatory cost burden has risen steadily and significantly (278 percent) since 1972, when, in fact, annual expenditures (operating costs plus capital costs in the year purchased) increased only 77 percent (adjusted for inflation, figure 7-Al).

Figure 7-A2—EPA Environmental Compliance Cost Projections



SOURCE: Environmental Protection Agency, *Environmental Investments* (Washington, DC: Island press, 1991).

Using the annualized method, EPA estimated that the cost of environmental compliance will increase significantly in the 1990s, increasing 61 percent from 1990to$185 billion in 2000, assuming full implementation of all existing and new regulations currently under development or proposed by EPA. However, nonannualized expenditures in 2000 will increaseto$147 billion, and $127 billion if local garbage collection is not included (figure 7-A2).

Since 1973, the Census Bureau has annually reported pollution abatement and control expenditures for manufacturers (SIC 20-39).[3] in 1990, when Census surveyed over 20,000 randomly selected manufacturing establishments, over 90 percent responded to the survey.[4] Appendix 7-1 discusses the validity of this data.

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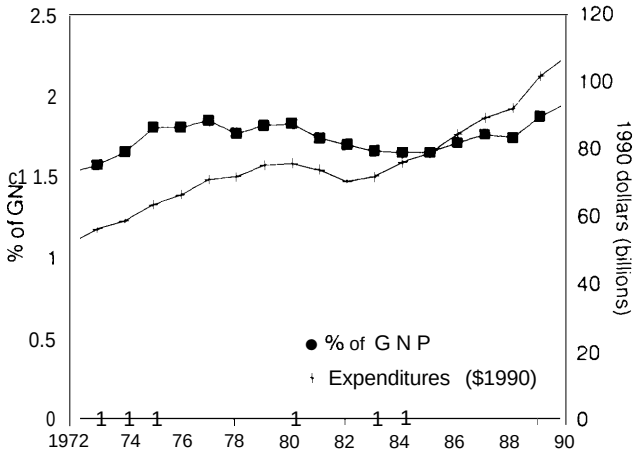
2 This is a particularly important distinction to make in estimating environmental industry revenues, since amortized costs measure depreciation, interest, and operating expenses.

3 U.S. Department of Commerce, Economics and Statistics Administration, Bureau Of the Census, *Pollution Abatement Costs and Expenditures* MA200 (Washington, DC: U.S. Government Printing Office, published annually).

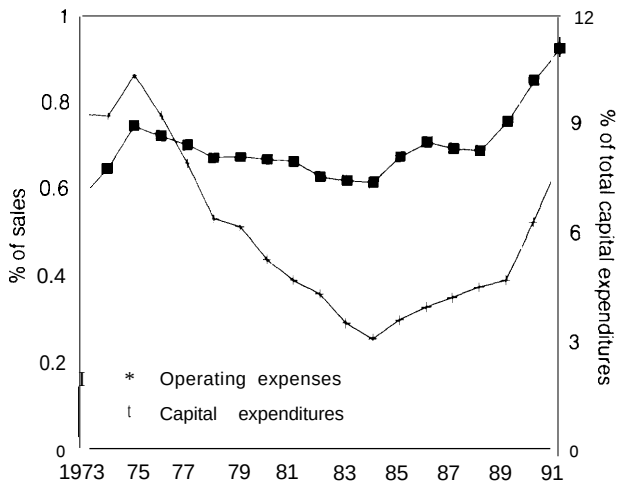
4 There are two mistakes commonly made when interpreting Census data. First, while Census reports total gross operating costs, net costs should be used. To calculate net costs, operating costs recovered (usually through recycling or energy production) are subtracted from gross operating costs. Second, total environmental expenditures are sometimes calculated as the sum of capital expenditures and annual operating costs. However, this overestimates total costs since operating costs already include costs of depreciation of capital equipment. Subtracting depreciation fromthe total operating costs and capital expenditures provides a more accurate measure of total spending,

Figure 7-2—U.S. Environmental Compliance Costs



SOURCE: Environmental Protection Agency, *Environmental Investments* (Washington, DC: Island Press, 1991).

Figure 7-3-Trends in Pollution Abatement Expenditures for U.S. Manufacturers



SOURCE: U.S. Census Bureau, *Pollution Abatement Costs and Expenditures* (Washington, DC: U.S. Government Printing Office, various years).

Table 7-I—Composition of Spending on Pollution Abatement and Control in 1991 ($ millions)

Sector	Amount	Share
Personal consumption	$18,544	20%
Government[b]	24,653	27%
Business	48,259	53°/0
Plant & equipment	42,515	
Motor vehicle emission abatement	5,744	
Net total	$91,456	100%

Estimates of sectoral composition of business plant & equipment operating and capital expenditures

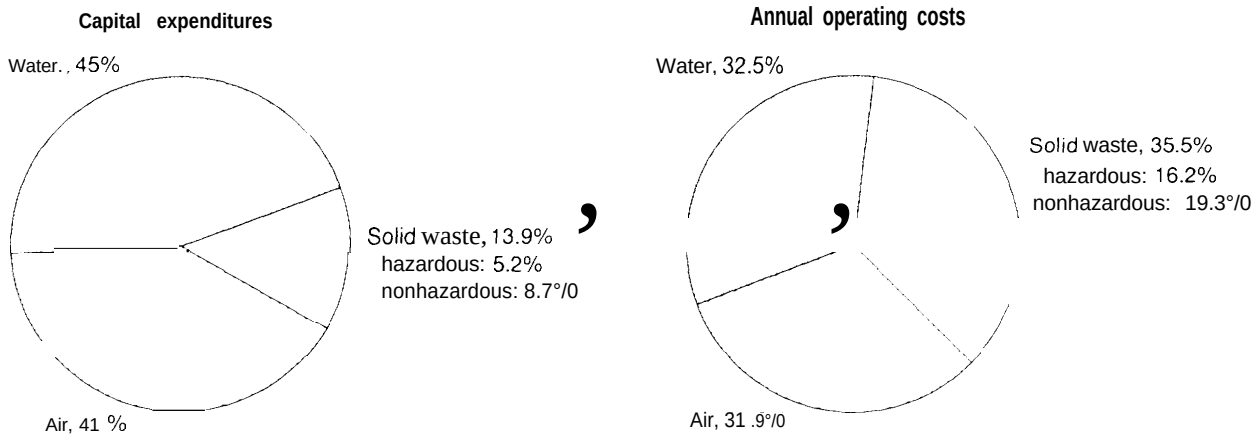
Sector	Amount	Share
Manufacturing	$20,910	49%
Electric utilities	6,385	15%
Mining	1,562	4%
Other business[d]	13,658	32%
Total business	$42,515	100%

a Includes mobile source pollution control, private septic systems and sewer connections linking household plumbing to street sewers, and household payments for sewage treatment.
b Includes government direct expenses, principally for investments and operation of municipal water treatment facilities, as well as costs of regulation and monitoring, and research and development.
c Includes capital expenditures and annual operating Costs, such as payments to government units for sewage services and waste collection and disposal. Excludes the cost of mobile source (automobile and truck) pollution control equipment.
d Other sectors, such as construction, services, retail trade, etc., while perhaps not bearing large pollution control costs related to stationary source capital equipment, do bear costs through payments for sewage services and solid waste collection and disposal.

SOURCE: Derived by OTA from data provided in Gary Rutledge and Mary Leonard, "Pollution Abatement and Control Expenditures, 1987-91 ," *Survey of Current Business,* May 1993, pp. 55-59; U.S. Bureau of the Census, *Pollution Abatement Costs and Expenditures, 1991, MA200 (91)-1* (Washington, DC: U.S. Government Printing Office, 1993), and other unpublished data provided by Gary Rutledge.

the discrete part manufacturers (e.g., electronics, automobiles). In large part, this is because process industries use significant amounts of energy and process large amounts of materials to produce output. This transformation of raw materials into products is often pollution-intensive. Four broad industrial sectors (chemicals, petroleum refining, pulp and paper, and primary metals) that produce slightly over 20 percent of U.S. manufacturing value added account for over 70 percent of all pollution control capital expenditures by manufacturers, approximately 80 percent of all criteria air emissions by manufacturers (particulate, sulfur oxides, nitrogen oxides, volatile organic compounds, and carbon monoxide), nearly 70 percent of Toxic Release Inventory emissions,

Figure 7-4-Manufacturers' Pollution Abatement Costs by Media: 1991



SOURCE: U.S. Census Bureau, *Pollution Abatement Costs and Expenditures, 1991* (Washington, I) : U.S. Government Printing Office, 1993) page 12.

and over 70 percent of manufacturing energy usage[13] (see figure 7-5).

In 1991, 7.9 percent of capital expenditures by manufacturers in the United States went toward pollution control equipment. The share can be higher in particular industries. For example, over one-quarter of new capital expenditures by the petroleum industry were for pollution control, while the chemical industry spent over 13 percent. In contrast, the rubber, machinery, and printing industries spent less than 2 percent of capital expenditures for pollution control. However, significant differences among subsectors are obscured when looking at broad industrial categories. For example, while only 4.6 percent of capital expenditures for the fabricated metals industry as a whole went for pollution control, one subsector—the metal plating and polishing industry—spent over 27 percent.

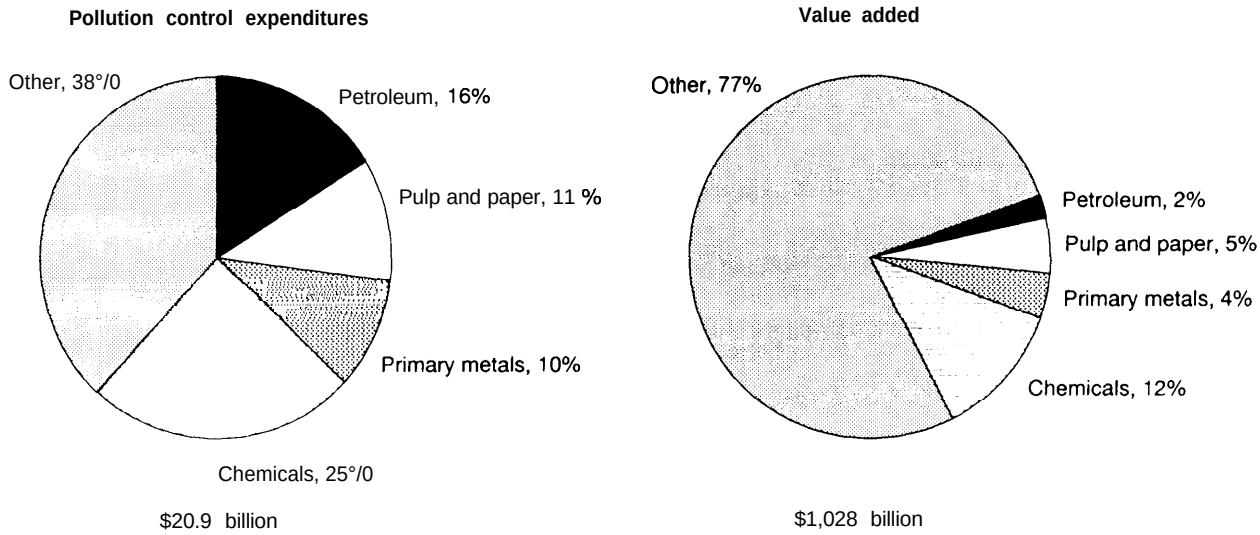
Total compliance costs (capital costs plus operating costs minus depreciation) as a share of sales and value added also differ by industry. The petroleum industry spends the most, about 2.2 percent of sales, while the pulp and paper, chemicals, and primary metals industries all spend over 1.65 percent of sales on pollution abatement and control. Share of value added may be a more accurate measure of environmental regulatory burden, since it measures the level of economic activity performed by the firm, and does not include the cost of materials purchased. Using sales as the denominator understates the true cost of pollution control to a firm, since the pollution control costs embedded in the firms' purchased products are not included in their pollution control costs, but are included in the sales figures.[14]

As a share of value added, the petroleum industry spends over 15 percent on pollution control, the pulp and paper and primary metals spends over 4 percent, and the chemical industry spends over 3 percent. For manufacturing overall,

13 U.S. Census Bureau, *1990 Annual Survey of Manufactures: Value of Product Shipments, M90(AS-2)* (Washington, DC: U.S. Government Printing Office, 1990); U.S. Congress, Office of Technology Assessment, *Industrial Energy Efficiency,* OTA-E-560 (Washington, DC: U.S. Government Printing Office, August 1993); U.S. Environmental Protection Agency, Office of Pollution Prevention and Toxics, *1991 Toxic Release Inventory, Public Data Release* (Washington, DC: Environmental Protection Agency, May 1993).

14 Without the use of more sophisticated models relying on input/output tables, it is not possible 10 assess total pollution control costs to the firm embedded in its purchases. For example, firms that purchase large amounts of energy (e.g., aluminum or industrial gas producers) pay more for electricity due to environmental controls on electrical utilities.

Figure 7-5--Manufacturers' Pollution Control Expenditures and Value Added, 1991



SOURCE: U. S. Census Bureau, *Pollution Abatement Costs and Expenditures,* 1991 (Washington, C) C: U. . Government Printing Office, 1993); U.S. Census Bureau, 1991 *Annual Survey of Manufactures,* Statistics *for Industry Groups and Industries* (Washington, DC: U.S. Government Printing Office, 1992).

these costs are less--0.80 percent of sales and 1.72 percent of value added in 1991[15] (see table 7-2.) As discussed in appendix 7-A, these figures may underreport actual costs, possibly by as much as 20 to 30 percent.

Even among most high-compliance-cost sectors, pollution control costs are only one of many factors affecting competitive advantage. Not all high-compliance-cost industries are heavily involved in international trade. Among those that are, some industries, such as chemicals and wood pulp, are highly competitive internationally, with significant trade surpluses.[16] Others, such as primary metals, have struggled competitively .17 Because environment is seldom the primary factor in determining competitive advantage, it is misleading to look at the performance of sectors as a measure of the effect of pollution abatement costs on competitiveness. It is possible, for example, that lower compliance costs in the chemical industry could make it even more competitive. Moreover, when compared to other corporate expenditures these costs are not trivial. For example, while business spent $43 billion on

15 At least one analysis claims that costs are much higher. A report by the National Commission for Employment Policy (*Measuring Employment Effects in the Regulatory Process,* Washington, DC: January 1993), uses Census data to assert that total abatement expenditures account for 3.48 percent of sales. However, this figure appears to significantly overstate the actual cost effect. The authors overestimated Census costs (double counting capital expenditures and depreciation and failing to subtract recovered costs) and used a methodology resulting in inflated costs,

16 The chemical industry's exports in 1991 were $43 billion and the trade surplus was $18.8 billion. U.S. *Chemical Industry Statistical Yearbook, 1992* (Washington, DC: Chemical Manufacturers Association 1992). However, developing nations, which generally have weaker regulations, increased their share of chemical exports faster than developed nations between 1980 and 1991. Earl Anderson, "Developing Nations' Chemical Exports Surge, " *Chemical and Engineering New,* Aug. 2, 1993, pp. 14-15. The United States has enjoyed a trade surplus in pulp since 1987, importing $1.9 billion worth of pulp in 1992 and exporting $3.1 billion. However, the paper industry ran a $2 billion trade deficit in 1992. U.S. Department of Commerce, *U.S. Industrial Outlook, 2993,* (Washington, *DC:* U.S. Government Printing Office).

17 In 1992, the U.S. ran a $s billion trade deficit in steel mill products (U.S. Department of Commerce, International Trade Administration, *U.S. Industrial Outlook, '92* (Washington, DC: U.S. Government Printing Office, 1992), p, 142.

Table 7-2—Pollution Abatement Expenditures by U.S. Manufacturing Industries, 1991[a] (millions of dollars)

Industry & (SIC Code)*	Pollution Capital Expenditures $	Pollution Capital Expenditures % of Total Capital Exp.	Net Operating costs	Total Pollution Control Expenditures $	Total Pollution Control Expenditures % of Sales	Total Pollution Control Expenditures O/. of Value Added
Petroleum (29)	**$1,463**	**25.7%**	**$1,982**	**$3,444**	**2.25%**	**15.42%**
Primary (33)	**$673**	**11.6%**	**$1,512**	**$2,185**	**1.68%**	**4.79%**
Blast furnace (331)	*$398*	*12.0%*	*$851*	*$1,249*	*2.26%*	*6.49%*
Paper (26)	**$1,233**	**13.8%**	**$1,139**	**$2,372**	**1.87%**	**4.13%**
Pulp Mills (261)	*$169*	*17.2%*	*$130*	*$299*	*5.70%*	*12.39%*
Chemical (28)	**$2,066**	**13.4%**	**$3,114**	**$5,180**	**1.88%**	**3.54%**
Inorg.Chem (281)	*$211*	*15.9%*	*$472*	*$683*	*2.74%*	*4.59%*
Stone (32)	**$154**	**7.2%**	**$345**	**$499**	**0.93%**	**1.77%**
Lumber (24)	**$141**	**11.1%**	**$232**	**$373**	**0.63%**	**1.67%**
Leather (31)	**$15**	**16.2%**	**$41**	**$56**	**0.65%**	**1.37%**
Fabricated (34)	**$177**	**4.6%**	**$757**	**$934**	**0.65%**	**1.34%**
Plating (3471)	*$42*	*27.5%*	*$176*	*$218*	*5.77%*	*8.81%*
Food (20)	**$482**	**5.3%**	**$1,067**	**$1,549**	**0.42%**	**1.11%**
Rubber (30)	**$82**	**2.0%**	**$385**	**$466**	**0.49%**	**0.98%**
Textile (22)	**$57**	**3.3%**	**$190**	**$247**	**0.38%**	**0.93%**
Electric (36)	**$234**	**2.9%**	**$715**	**$949**	**0.49%**	**0.91%**
Transport.	**$301**	**3.0%**	**$909**	**$1,210**	**0.33%**	**0.80%**
Motor Vehicles (371)	*$182*	*2.9%*	*$443*	*$625*	*0.31%*	*0.86%*
Furniture (25)	**$24**	**3.4%**	**$117**	**$141**	**0.38%**	**0.73%**
Machinery (35)	**$128**	**1.9%**	**$517**	**$646**	**0.29%**	**0.57%**
Miscellaneous (39)	**$13**	**1.8%**	**$66**	**$79**	**0.26%**	**0.48%**
Instruments (38)	**$104**	**2.4%**	**$230**	**$335**	**0.27%**	**0.42%**
Printing (27)	**$37**	**0.8%**	**$166**	**$203**	**0.15%**	**0.21%**
Tobacco (21)	**$6**	**1.5%**	**$38**	**$44**	**0.14%**	**0.18%**
Total U.S. manufacturers	**$7,390**	**7.9%**	**$13,522**	**$20,912**	**0.80%**	**1.72%**

a This table lists expenditures and costs reported *by* industry to the U.S. Census Bureau. As discussed in the text, these figures may underreport actual costs, possibly by as much as 20 to 30 percent.

Net operating costs = Total operating costs and payments to governmental units minus casts recovered and equipment depreciation.

Total pollution control expenditures = Total operating costs plus payments to governmental units plus total capital expenditures minus costs recovered and equipment depreciation,

•Pollution abatement and control cost data are only for establishments with 20 employees or more. To ensure comparability, total capital expenditures, value-added, and sales were estimated for establishments of 20 employees or more, using ratios from 1987, the most recent year the Census provides data for, (U.S. Bureau of the Census, 1987 Census *of Manufactures,* MC87-S-1 [Washington, DC: U.S. Government Printing Office, 1991).

SOURCES: U.S. Bureau of the Census, *Pollution Abatement Costs and Expenditures, 1991 MA200 (91)-1* (Washington, DC: U.S. Government Printing Office, 1993); U.S. Bureau of the Census, *1991 Annual Survey of Manufacturers, Statistics for Industry Groups and Industries M91* (AS-1) (Washington, DC: U.S. Government Printing Off Ice, 1993).

Table 7-3-Selected Corporate Costs, 1991 (billions of dollars)

Non-environmental new plant and equipment[a]	$519
Corporate R&D[b]	78
Pollution abatement and control	43
Employee training[c]	43

a *U.S. Bureau of the Census, Statistical Abstract of the U. S., 1992* (Washington, DC: U.S. Government Printing Office, 1992), p. 538. Capital expenditures for environmental control were subtracted from total expenditures on plant and equipment.
b National Science Foundation/Science Resources Studies, *National Patterns of R&D Resources: 1992* (Washington, DC: National Science Foundation, 1993), table b-3.
c This figure includes nonmilitary related training expenditures in government. Jack Gordon, "Training Budgets: Recession Takes A Bite," *Training, October* 1991, p. 37.

plant and equipment for pollution abatement and control in 1991, it spent $43 billion on formal training and $78 billion on R&D[18] (see table 7-3.) To the extent that pollution control expenditures make a claim on the resources of the firm, they could divert funding from these activities.

Future Costs

New and stricter environmental regulations put in place in the 1990s may increase pollution control costs, particularly for some industries. Currently, about one-third of compliance costs (public and private) result from regulations under the Clean Air Act, another third from the Clean Water Act, and the remainder from a variety of laws covering drinkingwater contamination, pesticides and herbicides, chemical production and use, and solid and hazardous waste disposal.[19] Assuming full implementation of all existing and pending regulations and rules, clean air spending (nonannualized) could increase about 85 percent between 1990 and 2000.[20] Compliance costs for water are expected to increase more slowly, by approximately 28 percent. Costs for hazardous waste disposal and cleanup will continue to grow, particularly for Superfund, whose costs are expected to rise from $3.6 billion in 1990 to $9.5 billion in 2000. Federal Government costs, principally for Department of Defense (DOD) and Department of Energy (DOE) cleanup of contaminated sites, are also likely to grow significantly.

EPA projects that with full implementation of present laws, environmental costs will rise 40 percent by 2000, to $147 billion, including local garbage collection ($127 billion excluding garbage collection) .21 As a share of GDP, environmental costs (including garbage collection) would rise from 1.95 percent in 1990 to 2.25 percent in 2000.

Future reductions in pollution may be more expensive if firms must reduce pollution to very low levels. As cheap reductions are exhausted, more expensive methods may be needed. Yet there are reasons why costs may, in fact, be lower than EPA estimates. First, full implementation of all laws—including bringing all cities into attainment with the national ambient air quality standard for ozone and satisfying the nation's municipal wastewater treatment needs to bring about fishable/swimmable water quality-may not occur or may occur more slowly than EPA projects. Assuming 1990 levels of implementation, EPA forecasts costs to increase only to about $133 billion, by 2000, $13.7 billion less than with full implementation.[22] In addition, in estimating costs,

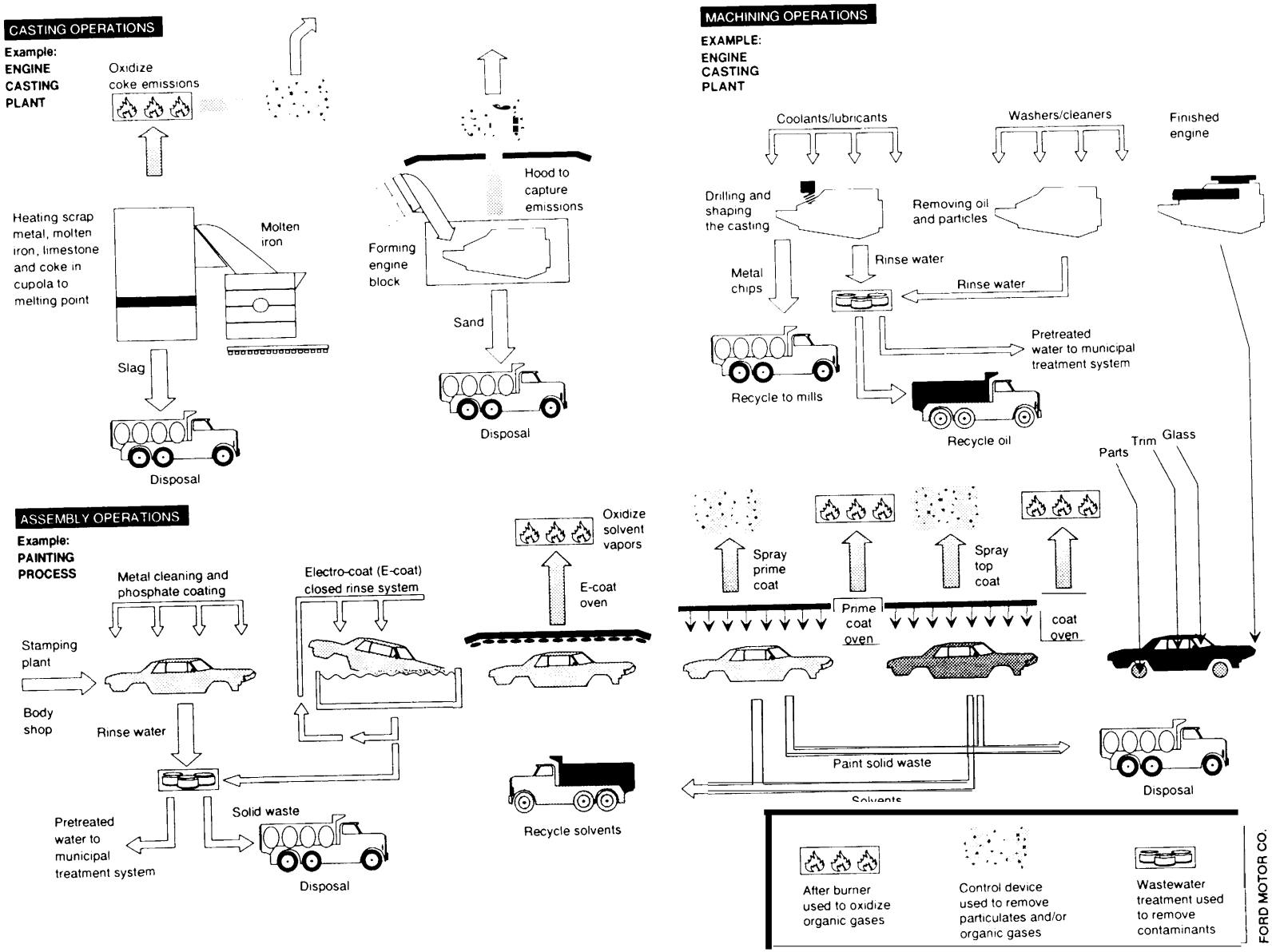
18 U.S. business is widely viewed as placing too little emphasis ontraining and R&D. U.S. Congress, Office of Technology Assessment, *Worker Training: Competing in the New International Economy,* OTA-ITE-547 *(Washington DC:* U.S. Government Printing Office, September 1990).

19 Raymond J. Kopp, Paul R, Portney, and Diane E. DeWitt, "International Comparisons Of Environmental Regulation," *Environmental Policy and the Cost of Capita/,* Monograph Series on Tax and Environmental Polities and U.S. Capital Costs (Washington, DC: American Council for Capital Formation, Center for Policy Research, 1990).

20 Environmental Protection Agency, *Environmental Investments,* Op. cit., footnote 2.

21 Ibid.

22 Ibid.



While the painting process is the main source of emissions from automobile production, other steps, including casting and machining, also produce pollution and waste. Various prevention, control, treatment, and disposal options are employed to control wastes.

EPA assumed that future compliance will be attained with current technologies. Technological innovations could lower compliance costs as they come on line.[23] For example, in the pulp and paper industry, new in process methods to treat waste cost slightly more than conventional systerns, but result in lower operating costs and avoided end-of-pipe costs, with the result that total costs are lower.[24]

Accuracy of the Cost Estimates

The principal source of data on pollution abatement and control costs for manufacturers is from the survey of abatement expenditures by the Bureau of the Census. There are various ways the data could overstate or understate the actual costs.

There are several potential sources of overreporting, although their extent appears to be minor. Anecdotal evidence indicates that respondents may include, as pollution control costs, those costs that were incurred for worker health and safety.[25] In addition, firms may include all the cost of an expenditure when only part of it is attributable to environmental regulation. However, one study suggests that, if anything, firms are likely to underreport expenditures when they do not have full information. Plant managers may classify some investments as environmental in order to get projects approved more easily, particularly when the return on investment (ROI) is low.[26] In addition, firms may lack full knowledge of recovered costs.[27] Finally, while there is no evidence of this, some analysts speculate that some respondents exaggerate costs in order to influence regulation.[28]

The preponderance of evidence suggests that the survey underreports pollution control costs. For example, while Census figures indicate that pollution control costs added 4 cents per pound to the price of copper in 1985,[29] at least four other sources, based on actual examination of copper smelting fins, found that the expenses were much higher, ranging from 7.5 to 15 cents per pound.[30] Some industry association surveys of compliance costs also report slightly higher costs than Census.[31]

Census surveys may underreport for two reasons. First, survey respondents normally do not have complete knowledge of all expenditures,

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23 Robert Leone, "Some Complication in the Measurement of Environment Control Impacts: A Case Study of Water pollution Controls," *Socio-Economic Planning Science,* vol. 12, No. 3, 1978.

24 Interview with Neil McCubbin, N. McCubbin Consultants, Inc. December 1992.

25 Raymond J. Kopp and Paul R. Portney, "Estimating Environmental Compliance Costs for Industry: Engineering and Economic Approaches, " in *Workshop on Effects of Environmental Regulation on Industrial Compliance Costs and Technological Innovation,* National Science Foundation Division of Policy Research and Analysis, (Washington, DC: Sept. 10-11, 1981).

26 Beth Snell and Bob Unsworth, "Evaluation of Uncertainty Associated with Air Pollution Abatement Compliance Cost Estimates—Stationary Sources," (memorandum) Cambridge, MA: Industrial Economics Inc., Oct. 13, 1992.

27 on estimate suggests that this leads to a l-percent overreporting of necosts. (Ibid., P. 5.)

28 Richard Andrews, " Summary,'' *Workshop on Effects of Environmental Regulation on Industrial Compliance Costs and Technological Innovation* (Washington DC: Nationat Science Foundation, September 1981).

29 Data on pollution control costs from the U.S. Bureau of the Census, *Pollution Abatement Costs and Expenditures, 1985*, MA-200(85)- 1 (Washington DC: U.S. Government Printing Office, 1987),

30 See U.S. Congress, Office of Technology Assessment, *Copper: Technology and Competitiveness*, OTA-E-367 (Washington, DC: U.S. Government Printing Office, September 1988)----10 to 15 cents per pound; National Research Council, Competitiveness of the U.S. Minerals and Metals Industry (Washington, DC: National Academy Press, 1990)--9 to 15 cents per pound; "Counting the Cost of Clean Air,' E&MJ, January 1990—7.5 cents per pound; Duane Chapman, "Environmental Standards and International Trade in Automobiles and Copper: The Case for a Social Tariff," Natural Resources Journal, vol. 31, winter, 1991, pp. 449-461-10 to 15 cents per pound. Total U.S. copper production costs averaged 65 cents per pound.

31 For example, see: *A Survey of Pulp and Paper Industry Environmental Protection Expenditures - 1990* (New York, NY: National Council of the Paper Industry for Air and Stream Improvement, Inc., 1991); *Petroleum Industry Environmental Performance, 1992* (Washington DC: American Petroleum Institute, 1993).

including the costs of environmental controls in retrofits and for environmental operating expenditures, since firms tend not to classify these as discrete categories in their accounting systems.[32] Second, the Census survey does not ask respondents to report interest expense; productivity losses; fees, taxes, and frees; administrative and R&D costs; and training costs.[33]

Without establishment-level studies, assuring the validity of these cost data is difficult. It appears, however, that actual costs may be 20 to 30 percent higher than reported costs. Appendix 7-A discusses possible sources of underreporting and, in some cases, the likely associated costs.

Compliance costs do not provide a complete picture of either total industry level expenditures or effects on GDP.[34] A complete picture would account for the costs of dislocations associated with regulation, including costs resulting from closed plants due to regulation or from reduced output (e.g., laid-off workers) due to higher prices.[35] If a regulated firm goes out of business and the products are made all or in part by firms outside the United States, the costs will be greater than if another U.S. firm increased production to fill demand. Also, if regulated firms cut back production because of regulations, this may be compensated for by increases in production by firms supplying environmental goods and services. Macroeconomic costs may exceed industry compliance costs if impacts of increased prices, reduced productivity, and other factors reduce economic activity[36] (see app. A).

A complete picture would also need to account for the significant benefits of environmental regulations, or, put another way, the costs companies, workers, and society would bear if environmental regulations were not in place. A cleaner environment lowers health care expenditures and improves human health, increases natural resource productivity, and provides valuable amenities (e.g., swimmable rivers). Only now is research being undertaken to accurately quantify these benefits.[37]

PRIVATE SECTOR COMPLIANCE COSTS COMPARED WITH OTHER NATIONS

U.S. pollution abatement costs would have no impact on U.S. economic competitiveness if firms in other countries faced equivalent regulatory costs and burdens. To the extent that they do not, U.S. firms could face a competitive disadvantage. Unfortunately, the literature comparing environmental management is sparse and largely limited to Western Europe, Japan, and North America, making accurate comparisons of environmental regulations across all nations extremely difficult. Few studies compare various countries' approaches to regulation, for the information is either not available or not always comparable.

There are several ways to compare regulatory strictness. First, pollution abatement compliance costs can provide a measure of regulatory burden by delineating the costs borne by fins. However, cost data are available from only a handful of nations, and differences in definitions and rneas-

32 Duane Chapman, "Environment@ Standards and International Trade in Automobiles and Copper: The Case for a Social Tariff," Ibid.

33 The Census Bureau does not survey firms with fewer than 20 employees. However, one estimate suggests that small firms account fOr less than 2 percent of the total costs, and about 5 percent of sales. (Beth Snell and Bob Unsworth, op. cit., footnote 26)

34 See U.S. Congress, Congressional Budget Office, "Assessing the Costs of Environmental Legislation" (staff working paper, May 1988).

35 See Maureen L. Cropper and Wallace E. Oates, "Environmental Economics: A Survey, " *Journal of Economic Literature,* vol. 30, June 1992, pp. 675-740.

36 See 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, 1990, pp. 853-873.

37 Debra S. Knopman and Richard A. Smith, "20 Years of the Clean Water Act: Has U.S. Water Quality unproved'?' *Environment,* January/February, 1993. vol. 35, No. 1; Organization for Economic Co-Operation and Development *Environmental Policy Benefits: Monetary Valuation* (Paris: OECD, 1989). The EPA, as mandated by the 1990 Clean Air Act Amendments, Section 812, is conducting a study to quantify the benefits of U.S. air pollution regulations. This study will not be released until lat1994.

urement complicate comparisons. Because countries vary in their shares of highly polluting industries, it is best to compare costs for particular industries.

Second, *emission standards* can indicate differences in regulatory strictness. However, standards are often difficult to compare without exhaustive analysis. First, some standards are measured in hours, others in days; some apply to the overall plant, others to particular sources. Also, different categories of polluters may be regulated to different standards (e.g., new sources v. existing sources). Second, and more importantly, the presence of standards gives little clue to their application in practice—strict laws maybe loosely enforced. Third, air standards for some pollutants (e.g., NO_x, ozone) give no indication of the relative degrees of control placed on different sources, such as large and small stationary sources and mobile sources. Some places with low standards may also have significantly less mobile source emissions, necessitating relatively less control on industry. Finally, many of the comparisons of regulatory strictness emphasize air regulations, particularly of oxides of nitrogen @OX) and sulfur oxides (SO_2). Because this is one major area where U.S. regulations may have lagged behind several other nations in the past, simply focusing on common pollutant air regulations can give a misleading picture of regulatory strictness. It is important to focus on all regulations, including volatile organic compounds (VOCs) and air toxics, water and solid and hazardous wastes.

Third, it is possible to compare *ambient concentrations* of pollutants to ascertain regulatory strictness. However, differences in industrial structure, geography, climate, population concentration, and energy and transportation use may have a greater effect on ambient concentrations than differences in regulatory strictness.

Fourth are comparisons of rules and regulations governing the *regulatory process and form.* This assumes that the process by which regulations are formed and implemented can affect outcomes. For example, the degree of public involvement in regulation-making and in prompting enforcement actions differs markedly by country. The United States has a relatively open process, which can make the process of finalizing regulations lengthy and difficult. However, the openness of the U.S. system does provide an opportunity for many parties to have their voices and viewpoints heard and considered. In addition, permitting systems vary in flexibility.

Pollution Abatement and Control Costs in Selected Countries

Unfortunately, environmental cost data for different nations are limited and of varying quality. A number of OECD nations provide time series data for some years, going back to the 1970s, on total private and public sector environmental expenditures .38 Because these data are reported by individual countries, possibly using different methodologies, they are best seen as providing a general yardstick to compare compliance costs. Data are often not available for industries located in countries with less stringent standards.

A very few countries (including the United States, Germany, Japan, and the Netherlands) provide data for environmental capital expenditures by individual manufacturing sectors (e.g., chemicals, pulp and paper). However, there are differences in definition, which must be adjusted for to make meaningful comparisons. For example, some surveys exclude equipment when it is required by the manufacturing process for technical reasons (e.g., United States, the Netherlands, Denmark, Sweden), while others include it (Germany). Some surveys include the costs of interest

38 Japan provides data on public sector expenditures, but not on total private sector expenditures. It does provide data on pollution control capital expenditures for some industries.

payments on equipment (Canada, Holland), while others exclude it (United States). Some countries (Germany and Japan) include noise abatement expenditures, while the United States does not.

Because investments can fluctuate significantly between years, and because some countries may have imposed stricter regulations sooner, it is more accurate to examine time series of data. Some costs are not the result of strict standards in the home country, but rather demands arising in other nations that the country exports to. For example, much of the recent increase in pollution abatement expenditures by the Canadian and Swedish pulp and paper industries may result from consumer pressure from Europe (particularly Germany) for chlorine-free paper, not solely from higher standards.[39] In spite of these limitations, the industry-level cost data can provide a broad picture about the different pollution control burdens placed upon industry in different countries,

Table 7-4—Relative Investments in Pollution Control by Industry[a] (U.S. percentage of investments defined as 100)[b]

Country	1978	1979	1980	1981
United States	100	100	100	100
Germany	76	67	74	89
The Netherlands	67	72	72	85
Denmark	64	41	66	81
Sweden				52

a The author adjusted the data for each country to be generally comparable. For example, in comparing Dutch and U.S. figures, he did not include Dutch investments in noise control, since U.S. studies did not collect data on these costs for U.S. industry. He did not compare all countries together, but rather compared the Dutch to the other countries individually. In addition, because of differences in definitions, German figures are probably slightly overstated relative to theothernations. As a result, these data should be seen as indicative of the direction and magnitude of differences, but should not be seen as exact measures of differences in spending.

b Investment in pollution control by industry divided by total capital expenditures by industry in the country, normalized to the U.S. value at 100.

SOURCE: Based on data in "international Comparison of Industrial Pollution Control Costs," L. H.E.C. Plooy, Statist&d *Journal of the United Nations, 1985,* pp. 55-68.

OVERVIEW OF DIFFERENCES IN COSTS

There are several different data sources presenting pollution abatement compliance costs for a number of countries, including total private sector compliance costs and costs by particular industry. All point to the conclusion that U.S. private sector pollution control costs are among the highest in the world as a percentage of both GDP and total private sector investments.

A study of five countries, which attempted to control for differences in survey methods discussed above, found that during the period from 1978 to 1981, U.S. industry investments in pollution control were between 10 to 50 percent higher than European countries (see table 7-4). For example, in 1980, investments in environment as a percent of total Dutch industry investments were only 70 percent of the U.S. rate, despite its having some of Europe's strictest regulations. Differences between the United States and most other European countries were probably greater.

According to OECD information, U.S. private sector pollution control costs as a share of GNP were nearly twice that of any European country in the 1970s, although in the 1980s the gap narrowed with a few countries[40] (see table 7-5.) For example, as a portion of GNP, German private sector expenditures were approximately 60 percent of those in the United States in the 1970s, but by 1990 the two were about equal. Spending by French and Dutch companies continued to be less. U.S. private sector pollution control expenditures as a percentage of GNP are higher or as high as any other OECD nation that reported private

39 Interview with Neil McCubbin, N. McCubbin Consultants, Inc., December 1992.

40 *OECD Environment Monographs, No.* 38, *Pollution Control and Abatement Expenditures in OECD Countries* (Paris: OECD, November 1990); *also OECD Environment Monographs, No. 75, Pollution Control and Abatement Expenditures in OECD Countries* (Paris: OECD, June, 1993).

Table 7-5-Private Sector Pollution Control Expenditures as Percentage of GNP[a]

Country	1972	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90
U.S.	0.67	0.74	0.82	0.90	0.90	0.91	0.89	0.94	0.96	0.95	0.89	0.88	0.89	0.89	0.86	0.8	0.8	0.8	0.86
Austria	0.26	0.37	0.39	0.37	0.33	0.44	0.33	0.30	0.39	0.36	0.47	0.50	0.47	0.73	0.74	0.7	0.7		
Finland											0.70	0.62	0.71	0.65	0.60	0.82	0.64		
France										0.32	0.31	0.30	0.29	0.30	0.32	0.3	0.3	0.3	0.33
Germany				0.56	0.53	0.52	0.50	0.49	0.53	0.58	0.63	0.64	0.62	0.74		0.8	0.8	0.79	0.8
Netherlands								0.31	0.34	0.34	0.35	0.26	0.26	0.30	0.33	0.6		0.46	
Norway														0.27					
Sweden			0.22												0.27				
United Kingdom							0.84			0.76				0.62					1.0[b]
Canada																		0.28	
Portugal																		0.1	

[a] Japan does not provide aggregate data on private sector environmental costs.

[b] United Kingdom private sector expenditures include expenditures by privately owned water treatment and supply plants, which in most other nations listed are assigned to the public sector.

SOURCES: *OECD Environment Monographs, No. 38, Pollution Control and Abatement Expenditures in OECD Countries* (Paris: OECD, November 1990). For data after 1986, *OECD Environment Monographs, No. 75*, OECD, 1993.

sector data as a whole .41 While these numbers give **a sense** of the magnitude of differences in **costs, they** should be interpreted cautiously.

INDIVIDUAL COUNTRIES

Japan—The view is frequently held **that** Japanese manufacturers spend significant amounts of money on pollution control; in fact they spend significantly less than U.S. manufacturers. In part, this view is fueled by the fact that the Japanese have placed high levels of emphasis on energy conservation and on recycling of industrial and consumer products, logical steps for a nation that imports almost all of its energy and materials and has little space for landfills. Energy conservation has contributed to a reduction in some air pollutants. Moreover, much of the pollution control spending by industry in Japan is by electric utilities. Between 1972 and 1990, Japanese electric utilities spent 2.8 times more on pollution control equipment as a share of capital expenditures than manufacturers did. In 1990, they spent 2,5 times more, while U.S. electric utilities spent 14 percent less than manufacturers.[42] As a result, much of the money spent on pollution control in Japan is spent by utilities rather than manufacturers. This is also consistent with the Japanese stress on controlling common air pollutants.

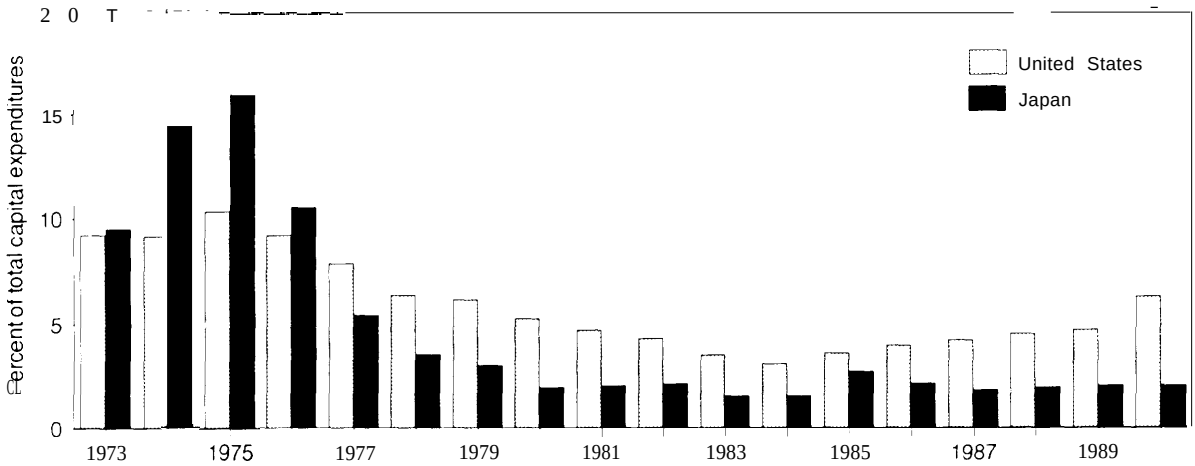
Japanese industry made high levels of investments for pollution control in the early 1970s. However, since 1977, U.S. industry has paid more to control pollution, and that gap is growing (figure 7-6). In 1975, Japanese pollution control investments by manufacturing firms peaked at 16 percent of total investments, while U.S. investments were around 10 percent.[43] However, investments by Japanese firms fell sharply after this initial surge (much of it was to comply with new

41 private sector expenditures excluded mobile source control expenditures, although it appears that the United States pays more per GDP for mobile source control than other countries. Japanese data were limited to a survey of a sampling of industrial firms and are discussed below.

42 Japanese Ministry of International Trade and Industry, *Shuyo-Sangyo no Setsubi-Toshi-Keikaku Heisei 4* (Plants and Equipment Investments of Major Industries, 1992); U.S. Census Bureau, *Pollution Abatement Costs and Expenditures, 1990, MA-200(90)-1* (Washington DC: U.S. Government Printing Office, 1987).

43 This information is derived from a survey by the Japanese Ministry of International Trade and *Industry, Plants and Equipment Investments of Major Industries. In* 1992, the most recent year MITI reported data (for 1990), MITI surveyed the approximately 3,000 Japanese firms with capital stock of over 100 million yen. MITI received 812 usable responses. MITI asked the firms to report capital equipment purchased for environmental protection. Given the possibility that responding firms have higher expenditures than the sample as a whole, it is not likely that the sampling methodology causes underreporting. (Interview with MITI officials, May, 1993.)

Figure 7-6—Pollution Control Capital Expenditures by U.S. and Japanese Manufacturers



SOURCE: U.S. Census Bureau, *Pollution Abatement Costs and Expenditures* (Washington, DC: U.S. Government Printing Office, various years); Japanese Ministry of International Trade and Industry, *Shuyo-Sangyo no Setsubi-Toshi-Keikaku Heisei 4* (Plants and Equipment Investment of Major Industries, various years).

Japanese NO_x and SO_2 regulations) and have averaged around 2 percent of total investments in recent years.[44] In contrast, while U.S. investments never reached this peak, they also did not decline to as low levels and have shown signs of increasing since the late 1980s to over 6.25 percent in 1990 (and 7.9 percent in 1991), while Japanese costs appear stable.[45] Between 1973 and 1990, manufacturers in Japan spent an average of 4.4 percent of investments on pollution abatement, while manufacturers in the United States averaged slightly more, 5.3 percent.[46] Japanese costs are lower than U.S. costs in all media, but particularly in solid and hazardous wastes, where they spend very little[47] (see figure 7-7).

These differences are not caused by different industrial structures, for the trends and differences are consistent across sectors. For example, trends in spending by the chemical industry show a similar pattern (figure 7-8). Similarly, spending for the automobile industry shows consistent differences (see box 7-B). Capital and operating costs associated with the 1990 Clean Air Act Amendments could increase this differential further. Moreover, this differential does not appear to be due to more efficient approaches to pollution

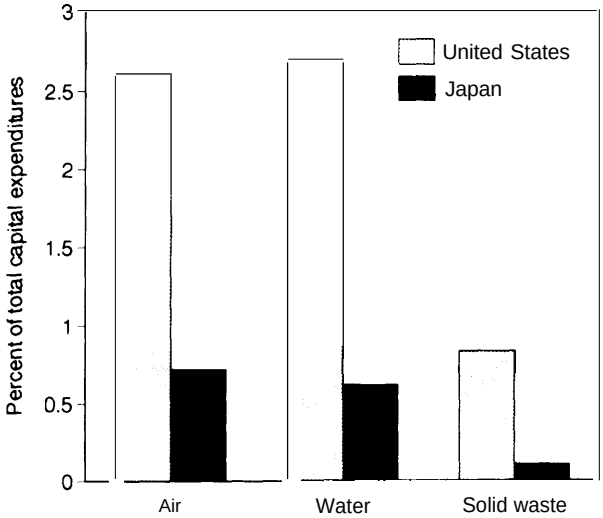
44 Differences in the size of the environmental goods o,services (EGS) markets in the United States and Japan are consistent with these differences in compliance costs, Controlling for differences in size of population the Japanese EGS market is 60 percent of the U.S. EGS market. (Based on OECD data in "The OECD Environment Industry: Situation, Prospects and Government Policies, ' OCDE/GD(92)1 (Paris: OECD, 1992).

45 Japan Ministry of International Trade and Industry, *Plants and Equipment Investments of Major Industries*, various years; and U.S. Bureau of the Census, *Pollution Abatement Costs and Expenditures,* various years, op. cit., footnote 42.

46 Japan, does, however, include noise pollution expenditure, while the United States does not. As a result, Japanese investments in 'o[ise] abatement were subtracted from total costs. It is not known how much U.S. firms spend on noise pollution, although it may well be less. Even so, these Japanese expenditures arc relatively small, accounting for about 10 percent of total pollution control capital expenditure in 1990.

47 Japan does not have Superfund type provisions for the cleanup of contaminated sites. In addition, while the United States regulates over 425 chemicals under RCRA, Japan has no "hazardous wastes" category per se, although roughly 30 hazardous substances are monitored. Moreover, over 75 percent of Japanese municipal solid waste is incinerated through 1,900 incinerators, with many used to generate electricity or heat. Louise Jacobs and Leigh Harris, *Public-Private Partnerships in Environmental Protection, A Study of Japanese and American Frameworks for Solid Wastes and Air Toxics* (Lexington, KY: The Council of State Governments, 1991).

Figure 7-7—Pollution Control Capital Expenditures by Media by U.S. and Japanese Manufacturers, 1990



SOURCE: U.S. Census Bureau, *Pollution Abatement Costs and Expenditures* (Washington, DC: U.S. Government Printing office, various years); Japanese Ministry of International Trade and Industry, *Kogai to Taisaku* (Pollution and Anti-Pollution Measures) vol. 27, No. 15, 1991.

control. Despite progress on industrial energy efficiency, anecdotal evidence suggests that Japanese industry has not emphasized pollution prevention in managing industrial waste.

Germany--In the 1970s, West German manufacturers spent less on capital expenditures for pollution control (as a percent of total capital expenditures) than did American manufacturers. For example, while in 19786.3 percent of U.S. capital expenditures went to pollution control, only 3.6 percent of German manufacturers' capital was spent for this purpose. The gap has narrowed since the mid-1980s, to where spending now appears to be about the same (see figure 7-9). In 1990, as a share of total capital expenditures, pollution control expenditures were lower in West Germany than in the United States in 12 of 17 manufacturing sectors, and were lower for manufacturing as a whole (4.2 percent v. U.S. spending of 6.25 percent, see figure 7-10).[48] However, because German capital expenditure rates as a percent of sales are higher than comparable U.S. rates, pollution control capital investments as a share of sales are slightly higher than in the United States (0.26 percent of sales v. 0.22 percent).

Other European Countries-Germany, Austria, and some of the Scandinavian countries are considered to have the strictest pollution control regulations and enforcement in Europe. But the fact that U.S. and German costs appear equivalent suggests strongly that U.S. costs are higher than for most other nations in Europe. The sector-based data available for the Netherlands and, to a limited extent, for France, support this view. OECD data suggest that industry in countries such as Great Britain and Canada also have lower costs.[49]

Pollution control costs for Dutch industry were much lower than U.S. costs through the mid-1980s. For example, in 1975, when over 10 percent of manufacturing investments in the United States went to pollution control, only 2 percent of Dutch investments did (figure 7-1 1). However, Dutch spending appears to have increased, so that it is now only slightly lower than U.S. spending as a portion of capital expenditures. In 1990, 6.25 percent of manufacturing investments in the United States went to pollution

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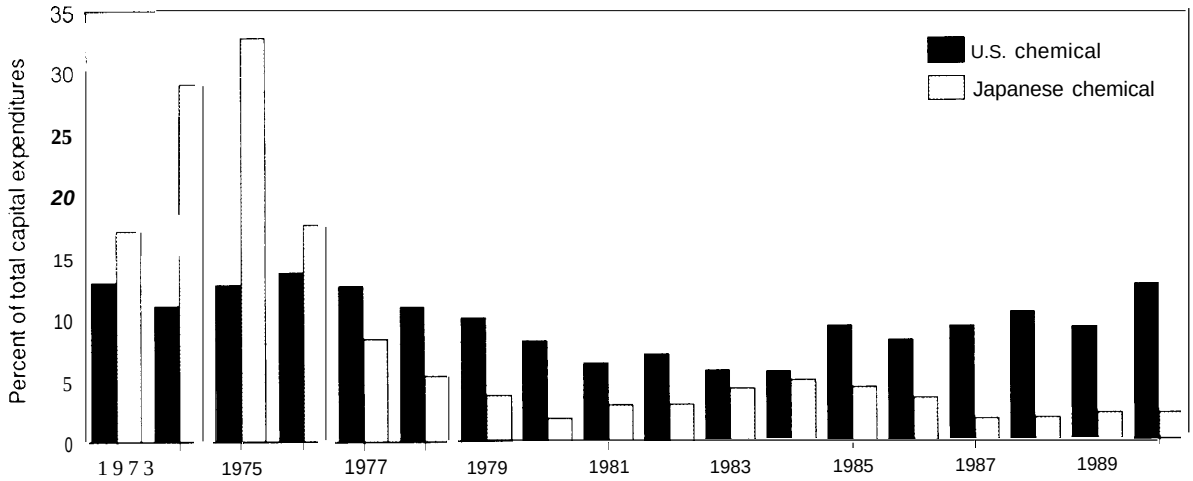
48 German data include a number of costs not included in the Us, data. Expenditures in noise abatement, land purchases, and capital for environmentally friendly products are included. The data reported here subtract these costs (approximately 19 percent of total costs) from the total German data to make it more comparable to U.S.data.

49 Historically, private sector pollution control expenditures in the United Kingdom have been lowerthan in the United States and Germany. However, in 1989, public water authorities in England and Wales became privately owned companies, As a result, in 1990, U.K. private sector expenditures (1 percent) as a share of GNP were actually slightly higher than in Germany (0.8 percent) and the United States (0.86 percent). However, after reallocating the estimated costs of the formerly public water treatment authorities to the public sector, pollution control expenditures by the private sector in the U.K. amount to approximately 0.75peroent of GNP.

Figure 7-8—Trends in Pollution Control Capital Investments by U.S. and Japanese Chemical Firms



SOURCE: U.S. Census Bureau. *Pollution Abatement Costs and Expenditures* (Washington, DC: U.S. Government Printing Office, various years); Japanese Ministry of International Trade and Industry, *Shuyo-Sangyo no Setsubi-Toshi-Keikaku Heisei 4* (Plants and Equipment Investment of Major Industries, various years).

control compared to 5.1 percent in the Netherlands. After adjusting for differences in method, Dutch operating costs (0.57 percent of sales) for pollution control by industry are also lower than U.S. costs (0.72 percent) .[50]

According to a recent survey, French manufacturing industry spent approximately 2.9 percent of new capital expenditures on pollution control in 1991 (compared to 7.9 percent in the United States).[51] These differences were consistent across sectors; for example, the share of pollution control investments in chemicals was 6.5 percent in France and 12.9 percent in the United States, and in transportation, including automotive, 0.9 percent in France and 3 percent in the United States, The article also cites European Commission data, indicating that pollution control costs in Italy are significantly lower than in France.[52]

Newly Industrialized and Developing Country

Costs-Evidence suggests that pollution control costs in developing and newly industrialized (NICs) are significantly lower than in the United States. For example, environmental compliance costs are estimated at 0.24 percent of GDP in Thailand and 0.38 percent in Indonesia and Korea (1987) compared to 1.63 percent in the United States (1990).[53] Moreover, a greater share of these costs may be for public infrastructure (e.g., sewage treatment plants) than is true in the United States. In addition to having lower environmental

50 Other than the United States, the Netherlands is the only country that provides data on operating ss well ss capital costs at the industry level. The Dutch survey includes a number of costs not included in the U.S. data, including the costs of interest on capital equipment, R&D expenditures, expenditures on noise and landscaping, and environmental taxes and fees on fuels used or the extra costs of fuels with low sulfur content. To make the data more comparable, these items were subtracted from total Dutch costs. "Statistics on the Costs of Environmental Control by Industry," paper from the Netherlands Central Bureau of Statistics, Department of Manufacturing and Construction, undated.

51 Robert Quivaux and Philippe Sabot, "Antipollution Investments by Industry,' *Industries* (Paris), July-Aug 1993, in Foreign Broadcast Information Service, *JPRS Report: Environmental Issues, JPRS-TEN-93-022,* Sept. 3, 1993, pp. 15-19.

52 Ibid.

53 Dhira Phantumvanit and Theodore Panayotou, "Industrialization and Environmental Quality: Paying the Price,' paper presented at the 1990 TDRI conference, Industrializing Thailand and Its Impact on the Environment Dec. 8-9, 1990.

Box 7-B—Pollution Control and Automobile Production in Competitive Context

Relative to many materials intensive process industries, such as chemicals, the automobile production process is not highly polluting. As a result, the industry faces lower facility compliance costs than some other industries, although imposition of Clean Air Act and other regulatory requirements will raise them.

While automakers face regulatory requirements in a number of areas, including hazardous waste cleanup and disposal and water pollution, the major source of pollution and compliance costs is related to air emissions from the automobile painting process. Paints have traditionally been applied in a liquid form, with organic solvent-based carriers that upon application, evaporate and are emitted into the air. Automakers have three basic control options: changing the coating formulation, improving transfer efficiency, and adding on controls. Modified coatings, including higher solids paints (increasing the paint content relative to the solvent content), water-based coatings containing few organic solvents, and solvent-free powder coatings can reduce emissions of volatile organic compounds (VOCs). However, technical limits and retrofit costs inhibit wider use of water-borne and powder technologies in the near term. Improving transfer efficiency means that more sprayed paint adheres to the car and is not wasted. In the last 20 years, automakers have Improved transfer efficiency substantially-in part to cut paint costs-and additional improvements are sought. Finally, incinerators are used to burn VOCs in oven and paint booth exhausts, supplemented in several installations by carbon adsorption units to concentrate the solvents.

The United States has regulated VOCs from automobile painting since the late 1970s. As a result, most U.S. plants have, at minimum, electro-deposited waterbased primecoats, low VOC coatings (using high solids paints), high efficiency electrostatic spray applicators, and oven exhaust incineration.[1] Because of these requirements, automobile assembly plants (SIC 3711) in the United States spent an estimated $82 million in 1991 on capital equipment to control VOCs, amounting to 63 percent[2] of their $130 million for pollution control capital expenditures, the latter accounting for 6.4 percent of their total capital expenditures. According to estimates by the American Automobile Manufacturers Association, VOC control costs might triple if stricter lowest achievable emission rate (LAER) standards are required at every facility.

Regulations also impose indirect costs. Permitting requirements can reduce operational flexibility needed to accommodate changes in the production process. Moreover, they can potentially delay introduction of new production, particularly when permits are required prior to construction. Because demand for autos fluctuates and models change, operational flexibility and timely regulatory decisions can bean important competitive factor. Finally, regulatory requirements may affect product quality, particularly the paint finish.

Automobile and truck producers in Japan appear to face less stringent and detailed requirements and therefore lower compliance costs and probably greater operational flexibility and product quality advantages. In 1990, U.S. automobile and truck producers, including parts suppliers (SIC 371) spent over five times more on pollution control equipment than Japanese firms as a percent of total capital

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1 Energy and Environmental Analysis, inc., *'Comparison of U.S. Air Quality Standards and Controls to the Air Pollution Controls in Japan, Germany, Canada, Mexico, and South Korea," draft report prepared for the Office of Policy Analysis and Review, Office of Air and Radiation (Washington, DC: U.S. Environmental Protection Agency, 1992).

2 The majority of this is presumably for paint VOC controls. U.S. Census Bureau, *Pollution Abatement and Control Expenditures,* 7997 (Washington, DC: U.S. Government Printing Office, January 1993).

investments, and three times more as a percent of sales.[3] Moreover, Japanese permitting requirements are generally much simpler, with VOC sources and changes to them not requiring permits or prior government approvals.[4] Finally, it is widely asserted that weaker VOC regulations make it possible for automakers in Japan to achieve very high quality finishes on their premium models (smoother and higher gloss) without facing the environmental control costs U.S. automakers would incur.

If the U.S. motor vehicles industry (SIC 371) spent the same share of investments on controlling pollution from production facilities as the Japanese, they would have spent $247 million less in 1990 in pollution control capital expenditures and $410 million less in operating expenses. Differences in air, water, and waste regulations on the automobile industry (not including costs of regulation on supplier industries, such as steel, glass, rubber) added approximately $50 to the cost of a $15,000 car (sales price of original equipment manufacturer).[5]

While regulatory requirements will likely increase, there are a number of technical changes and regulatory modifications that could minimize the competitive burden. First, new approaches to VOC control may reduce compliance costs relative to end-of-pipe control. The United States Council for Automotive Research (USCAR), an umbrella organization for the big three U.S. automobile manufacturers, has formed along-term low emission paint systems consortium to conduct research and demonstrate VOC reduction alternatives, including electro-coating, powder-based primers, surface coats, and clear-coat paint systems, and waterbased base coats (see ch. 10).

Second, a number of regulatory modifications, including use of facility-wide emissions caps, performance standards, expedited permitting, and emissions trading, could make it easier for the industry to comply with regulatory requirements (see ch. 9). Some specific changes advocated by the auto industry include expanding pre-construction activities which can commence prior to New Source Review permit issuance, determining Best Available Technology/Lowest Achievable Emission Rate requirements at the time the permit application is complete, and prompt development by EPA of Maximum Available Control Technology standards for automobile production paint facilities.

3 Japanese automobile firms maintain higher capital investment rates as a percent of sales than do U.S. automakers. Japan Ministry of International Trade and Industry, *Plants and Equipment Investments of Major Industries, 1992 (Tokyo:* MITI, 1992), pp. 480-493; and U.S. Bureau of the Census, *Pollution Abatement Costs and Expenditures, 1990,* op. cit.

4 Energy and Environmental Analysis, Inc., op. cit.

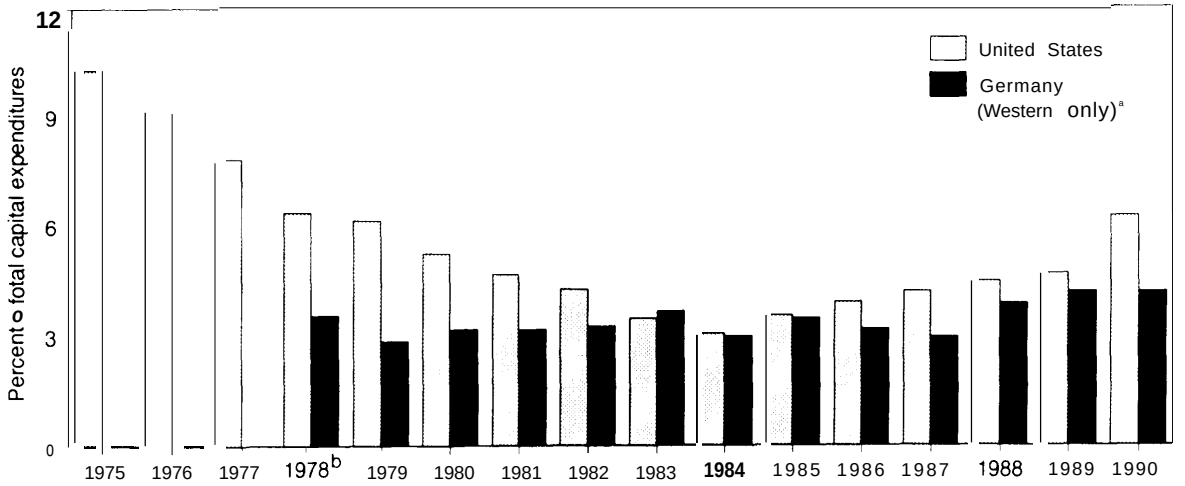
5 This includes pollution control capital and operating expenditures andassumes Japanese industries spend the same ratio of operating costs to pollution control capital rests. OTA calculations based on data from U.S. Census Bureau, *Pollution Abatement and Control Expenditures,* op. cit.; and the Japanese Ministry of International Trade and Industry, *Plants and Equipment /investments of Major Industries, 1992,* op. cit.

compliance costs, these nations also have significantly lower labor costs.

While many less-developed countries have minimal regulations, or poor enforcement, some multinational corporations (MNCs) claim to apply their higher home country standards to their investments or plants in less-developed nations. However, little systematic evidence has been presented to evaluate this claim.[54] Moreover, while U.S. maquiladoras firms in Mexico say that

54 One survey of U.S. multinationals suggests that only around 20 percent had written policies to meet or exceed U.S. regulations overseas when foreign laws are less stringent, while 40 percent of the respondents said this was very important. Margaret Flaherty and Ann Rappaport, *Multinational Corporations and the Environment: A Survey of Global Practices* (Medford, MA: Tufts University, Center for Environmental Management, 1991).

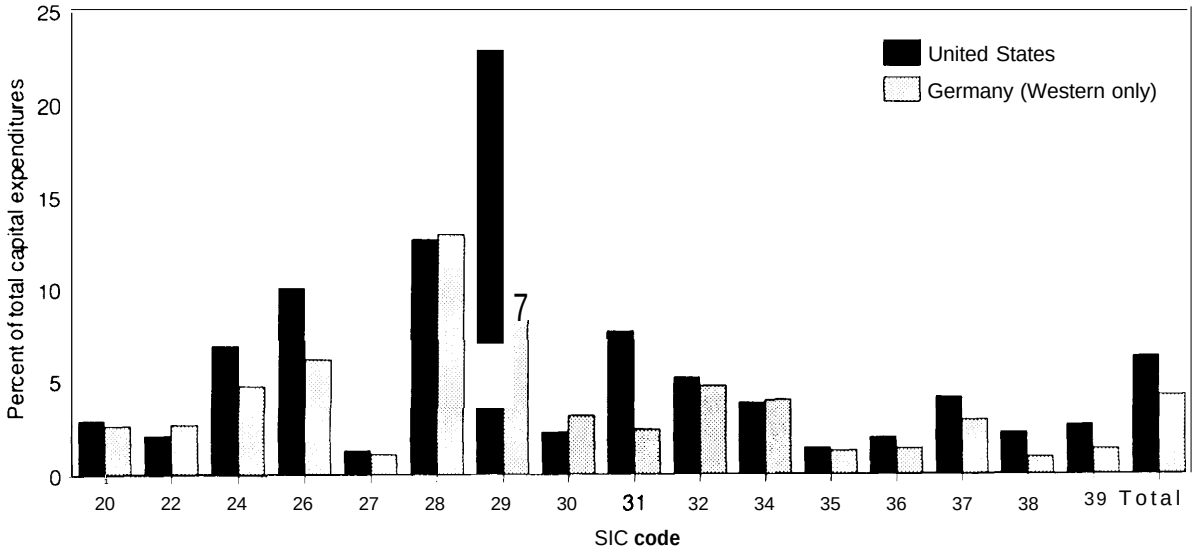
Figure 7-9—Trends in Pollution Control Capital Expenditures by U.S. and German Manufacturers



a German data includes costs for noise abatement, land purchases, and capital for environmentally friendly products that are not included in the U.S. data. To make the data comparable, expenditures on these items (approximately 19 percent of total costs) were subtracted from total German costs.
b German cost data not collected prior to 1978.

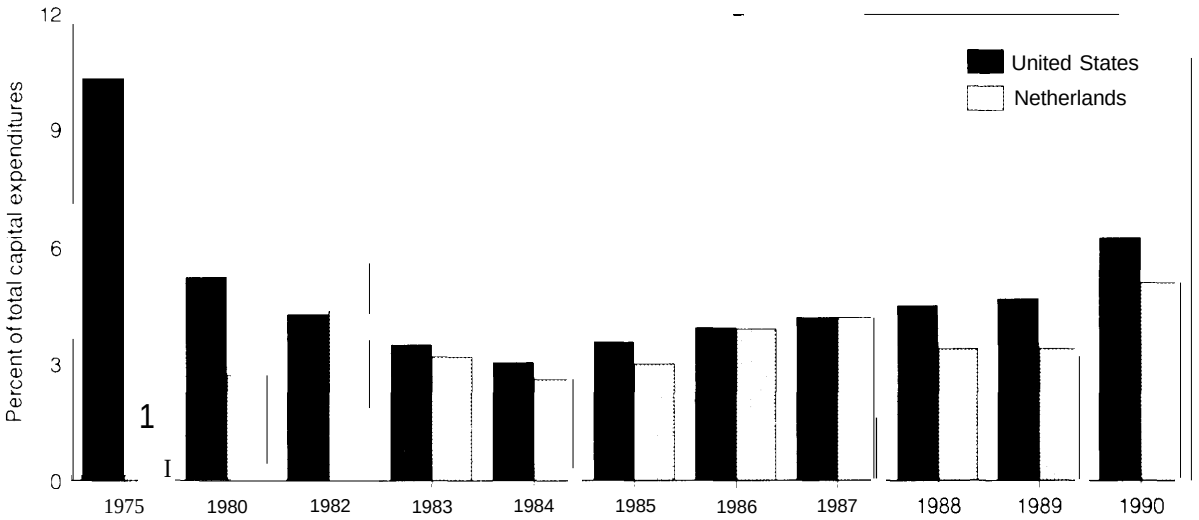
SOURCE: U.S. Census Bureau, *Pollution Abatement* Costs *and Expenditures* **(Washington, DC: U.S. Government Printing Office, various years);** Statistisches Bundesamt, *Investitionen fur Umweltschutz im Produzierenden Gewerbe 1990* **(Wiesbaden: Metzler Peoschel,** 1992).

Figure 7-10—Pollution Control **Capital Expenditures by U.S. and German Manufacturing Industries, 1990**



SOURCE: U.S. Census Bureau, Pollution *Abatement Costs and Expenditures,* 1990 **(Washington, DC: US. Government Printing** Office, 1992); Statistisches Bundesamt, *Investitionen fur Umweltschutz im Produzierenden Gewerbe* 1990 **(Wiesbaden: Metzler Peoschel,** 1992).

Figure 7-1 l—Trends in Pollution Control Capital Expenditures by U.S. and Dutch Manufacturers



SOURCE: U.S. Census Bureau, *Pollution Abatement Costs and Expenditures* (Washington, DC: U.S. Government Printing Office, various years); "Industrial Investments for the Protection of the Environment, 1990," Government of the Netherlands.

they don't illegally pollute, others dispute this claim and argue that sewage and other runoff from the area is often highly infused with industrial wastes.[55] Even if MNCs abide by home country standards, they may receive a cost advantage for products shipped to countries with higher regulations if their local suppliers are unregulated.

Government Support

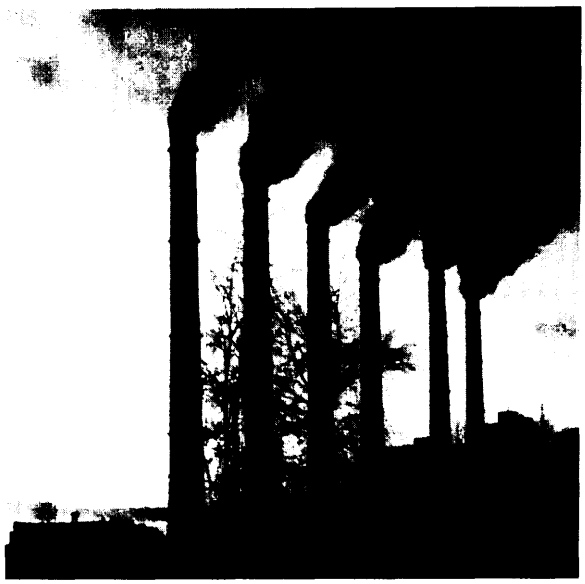
Support for industry to comply with pollution control regulations follows similar patterns for industrial development assistance overall-the United States tends to provide less direct assistance to industry than many of its major industrial competitors, and relies principally on regulatory measures to ensure environmental protection.[56] In contrast, a number of European nations supplement regulation with explicit use of technology and industrial policies to help industry reduce pollution, particularly through support of development and diffusion of innovative environmental technologies.[57]

Several countries provide direct assistance to help firms address pollution control requirements. The Japanese Government contends that private commercial banks are not necessarily willing to finance unprofitable pollution control investments, and that government-sponsored fund-

55 For example, see **Joseph La** Dou, ' **'Deadly Migration: Hazardous Industries' Flight to the Third World, "** *Technology Review,* **vol. 94, No. 5, July 199 i; Sanford Lewis et. al., "Border Trouble: Rivers in Peril. A Report on Water Pollution Due to Industrial Development in Northern Mexico, " National** Toxics **Campaign Fund, May 1991; Diane M. Perry, Roberto Sanchez, William H. Glaze, and** Marisa Mazari, "Binational **Management of Hazardous Waste: The** Maquiladora **Industry at the U.S.-Mexico Border,** *Environmental Management,* **vol. 14, No. 4, 1990, pp. 441** -450; **Sandy** Tolan, **"Hope and Heartbreak, '** *The New York Times Magazine,* **reprinted from Best of Business Quarterly, Winter 1990-9 1; U.S. Congress, General Accounting** Office, **"U.S.-Mexico Trade: Assessment of Mexico's Environmental Controls for New Companies,"** GAO/GGHD-92-1 **13, August, 1992.**

56 U.S. Congress, Office **of Technology Assessment,** *Competing Economies,* **Op. Cit.,** footnote **1.**

57 Alan C. Williams, "A Study of Hazardous Waste Minimization in Europe: Public and Private Strategies to Reduce Production of Hazardous Waste, "*Boston* **College** *Environmental Affairs Law Review,* **V. 14, Winter 1987, pp. 167-255; Kenneth** Geiser, **Kurt Fischer, and Norman** Beecher, "*Foreign Practices in Hazardous Waste Minimization: A Report to the U.S. Environmental Protection Agency* (Medford, **MA: Tufts** University, **Center for Environmental Management, August 1986).**


LARRY MARKEL

Oil Shale Plant in Estonia. Compared to expenditures by industry in the United States for pollution control, firms in most developing countries and Eastern Europe face significantly lower costs.

ing is needed. Between 1975 and 1990, the Japanese Development Bank, the Japan Finance Corporation for Small Business, the Japan Environment Public Corporation, and other institutions provided approximately 35 percent of all funds invested by Japanese industry for pollution control and, in 1992, provided over $2 billion in loans.[58] The loans have interest rates 1 to 2 points lower than commercial loans, interest payments deferred for the first 2 to 3 years, and longer terms.[59] Many Japanese prefectures and larger cities provide direct technical assistance to help firms manage wastes, and most Chambers of Commerce maintain a Pollution Control Office.[60]

European nations are generally less active, but many still provide more financial assistance than the United States. Germany provides interest-subsidized loans for the installation of pollution control equipment.[61] Industry associations manage government grants that pay half the costs of environmental consultants to small and medium-sized enterprises.[62] Germany also provides partial grants for some pollution control investments and R&D. At least 97 distinct programs for environmental assistance to German industry have been identified.[63] Several other European countries, including the Netherlands and Denmark, provide sizable grants for the development of clean technologies (see ch. 10).

Publicly supported pollution control financing programs in the United States are quite small. Prior to 1986, air and water pollution control facilities were eligible for tax exempt Industrial Development Revenue Bonds (IDB's). However, the 1986 Tax Reform Act severely restricted the use of these bonds for pollution control equipment by industry, as these were increasingly considered more of a subsidy to private industry instead of support for public infrastructure. As a result, very few IDBs are issued for industrial pollution control equipment.[64]

The Pollution Control Loan program operated by the U.S. Small Business Administration (SBA) made only four loans totalling $3.7 million in 1991 and 1992. (Some pollution control loans

58 The *Quality of Environment in Japan,* 1992, Environment Agency, Government of Japan, 1992, p. 133. This included approximately $1 billion through the Small Business Corporation for energy and environmental loans.

59 "Business of Japan Environment Public Corporation,' Environment Administration 1992.

60 Geiser, Fischer, and Beecher, op. cit., footnote 57, p. 54.

61 Organization for Economic C@ Operation and Development, *OECD Environmental Performance* Reviews: Germany (Paris: OECD, 1993).

62 Konrad von Moltke, "American Industry and the Environment: Implications for Trade and Competitiveness," contractor report prepared for the Office of Technology Assessment, November 1992.

63 Ibid.

64 U.S. Congress, General Accounting Office, The *Effect of the Volume Cap on Investment in Environmental Infrastructure* (Gaithersburg, MD: U.S. General Accounting Office, Oct. 28, 1993).

may be funded under the regular SBA 7A loan guarantee program, but SBA does not report these loans by purpose).

The Federal Government also provides some support to U.S. industry for development of cleaner technologies. For example, DOE's Office of Industrial Technologies funds industry consortia for the development of more energy-efficient and cleaner technologies. These activities are discussed in chapter 10.

A number of other countries have more general tax incentives for pollution control. Accelerated depreciation is the most common tax incentive for pollution control investment.[65] Many countries offer special rates for the depreciation of pollution control equipment that allow at least 80 percent of the cost to be written off after no more than 3 years.[66] The Japan Ministry of Finance establishes a much shorter life span for pollution control equipment than for other fixed assets. Japanese industry can depreciate pollution control equipment in 7 years, and some ''urgently needed' equipment even faster.[67] In addition, Japan allows a special capital cost allowance of 20 percent of the acquisition cost of pollution control equipment for the first year of use. MITI has proposed reducing fixed asset taxes on CFC-free equipment and has allowed new purchases to be depreciated more quickly.

Although no longer in effect, German firms were until recently allowed to take accelerated depreciation of pollution control investments.[68] In 1989, their net value was estimated at more than DM1 billion, or about 13 percent of total private sector environmental capital investments.[69] (In accordance with European Community policy, the net subsidy effect of accelerated depreciation may not exceed 15 percent of the net cost of the environmental portion of the investment.) Taiwan allows air and water pollution control equipment to be depreciated in 2 years, while Mexico allows a first year deduction of 90 percent. While these subsidies may provide an advantage to firms in other countries, they may also stimulate needed environmental investments.

Some countries target abatement incentives for innovative technologies or pollution prevention. In the Netherlands, for example, companies investing in innovative environmental technologies (as selected by the environment ministry) can deduct the full amount of expenditures from taxable income in the first year, instead of the 10-year depreciation period that usually applies. (A broader tax incentive was in effect until 1984, but proved too expensive.)

In the United States, special provisions for writing off investments in pollution control equipment only apply to plants in operation in 1976 or before. As new plants replace old ones, the write-off has declined in importance. Even for facilities in operation in 1976, it takes 5 years for most manufacturers to fully write off the cost of pollution control equipment certified under section 169 of the U.S. tax code. The recovery period is far longer for manufacturing firms that are subject to alternative minimum tax. Finally, while the law includes equipment that prevents the creation of pollutants, in addition to equipment that reduced and controlled pollutants, the amor-

65 Stephen F. Clarke, "The Tax Treatment of Expenditures on Antipollution Equipment and Facilities in Selected Foreign Countries," in *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. 53-61.

66 Ibid.

67 Bruce Aronson, "Review Essay: Environmental Law in Japan," *Harvard Environmental Law Review,* vol. 7, No. 1, 1983, p. 158.

68 In 1988, 73 percent of all investments in water, 68 percent in air, and 48 percent in waste management claimed an accelerated depreciation allowance. OECD Technology and Environment program, "Background Paper on Policy Tools and Their Applications in Various Member Countries" (Paris: OECD, June 3, 1991).

69 Konrad von Moltke, op. cit., p. 61.

tizable cost of the facility must be reduced by the amount of savings generated.[70]

While Federal incentives for investment in pollution control facilities are limited, 38 States offer incentives in the form of sales and property tax exemptions, tax credits, and accelerated depreciation of equipment.[71] However, because State tax rates are much lower than Federal, the effect of these incentives is generally quite small. Many also contain a bias against pollution prevention.

Environmental Standards and Enforcement

While OTA has not made detailed comparisons of regulatory strictness, some broad generalizations can be made. Taking into account all compliance actions demanded of industry, U.S. air, water and waste regulations appear to be among the strictest, but the differences are not large among the leading OECD nations. While differences exist among media, Germany, Austria, Sweden, and some other Northern European countries also impose strict regulations on their firms (see app. 7-B). The differences in regulation between the United States and the middle tier of countries are somewhat larger. A number of developed nations fall into this group, including Australia, Britain, Canada, and France.

Assessing regulatory stringency in Japan is difficult, in part because while Japanese regulations to control several common air pollutants (No_x, SO_2), have been stricter than U.S. regulations (although they will probably be comparable as the 1990 Clean Air Act Amendments are implemented), in some other areas Japanese regulations are less strict. The Japan Environment Agency, the main regulatory body, is relatively weak in comparison to other Japanese ministries, such as MITI.[72]

Differences between the United States and the lagging OECD nations, Eastern European nations, and NICs is more significant. For example, Greek laws to control pollution are poorly developed and enforcement is lax.[73]

Enforcement of standards in Eastern Europe and the former Soviet Union was very low. Standards and enforcement in the NICs, such as Hong Kong, Korea, and Taiwan, is low, although there are now efforts to strengthen them.[74] (Singapore's environmental regulations are considered on a par with those of several advanced industrial nations.)

Developing countries' standards and enforcement remain low. In 1985 and 1989 the World Health Organization surveyed 116 countries to determine their ability to control key environmental problems, and included such factors as legislation, enforcement, and staffing. They found that while all industrialized countries met most of the requirements needed to control pollution, only 18 percent of the moderately to rapidly industrializing countries and less than 5 percent of the less

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70 While the united States does provide less targeted assistance, this does not measure overall levels Of corporate taxation, which are also different between nations. See: Organization for Economic Co-operation and Development, *Taxation in OECD Countries, 1993* (Paris: OECD, 1993).

71 National Association of State Development Agencies, *Directory of Incentives for Business Investment and Development in the United States* (Washington DC: The Urban Institute Press, 1992).

72 Some scholars suggest that the Japanese Environment Agency does not have significant power and cannot afford to offend industry. (Cited in Alan S, Miller and Curds Moore, "Japan and the Global Environment," *Environmental Law and Policy Forum*,, vol. 1, 1992, p. 38; also Bruce E. Aronson, "Review Essay: Environmental Law in Japan," *Harvard Environmental Law Review*, vol *7, No.* 1, 1983, p, 145).

73 For example, in May of 1992 Greece passed its first law to control urban airpollution, and much of the focus was on automobiles, nOt industry. The country's first general environmental law was not passed until 1986 and was not begun to be implemented until late 1990. ("Greek Parliament Passes Country's First Air Pollution Law As Conditions Worsen," *International Environmental Reporter*, June 3, 1992, p. 353.)

74 Stacy Mosher, "Hong Kong: Going Green," *Far Eastern Economic Review*, Feb. 27, 1992, p. 17,

developed countries, did so.[75] For example, in Thailand, industrial hazardous wastes are often dumped into rivers and landfills, or stored in drums on site with little or no treatment. Most biodegradable waste is discharged untreated into public water bodies.[76] Many of these countries have highly competitive manufacturing sectors in some areas, boosted not only by low environmental standards and enforcement, but also by low labor costs, and lower standards for worker health and safety.

Standards tell only part of the story. Enforcement and compliance make up the rest. While no country can staff full enforcement, the gap between regulation and enforcement is normally smaller in OECD nations. Developing and newly industrialized nations' standards might be high, but enforcement is often virtually nonexistent.[77] For example, Argentina's new environment secretariat has little power to even inspect polluting plants.[78] Hong Kong has in place environmental legislation, but extremely lax enforcement means that industry is required to spend little and pollution levels remain high.[79] South Korea amended its air pollution law in 1991, but monitoring of discharge by industry is very limited, particularly for pollutants other than SO_2 and particulate.[80] Relying solely on emission standards would lead to an overestimation of the strictness of environmental regulation.

Regulatory Styles

While confirming data are difficult to obtain, many analysts conclude that the U.S. regulatory style is more rigid than those of most other nations.[81] The relationship between regulatory styles and regulatory stringency is complex, in part because many countries with more cooperative styles of regulation appear to place less stringent environmental demands on business. However, it is important to consider standards separately from regulatory styles. When goals and laws are set and commitment to enforcement is evident, cooperative frameworks can make implementation easier and more cost-effective, without necessarily weakening performance. As such, regulatory styles can affect competitiveness.

While increased attention is being paid to more cooperative regulatory processes (e.g., negotiated regulations), the U.S. system is still characterized by adversarial relations between industry and regulators (see figure 7-12). Many U.S. firms spend significant time and effort fighting regulations and delaying implementation, while regulatory agencies often enforce standards in ways that make it harder and more expensive for industry to comply. Short rigid deadlines can lead firms to invest in readily available end-of-pipe approaches rather than pollution prevention. If all facilities face equal strictness, inflexible regulatory demands can raise the costs of regulation beyond those that would follow adjusting control to the

75 Countries that did not meet most of the requirements include some of the most populated nations, including Brazil, India, Mexico, and China, which collectively account for approximately 40 percent of the world's population. Countries meeting most standards contain only 24 percent of the world's population. Morns Schaefer, *Combating Environmental Pollution: National Capabilities for Health Protection* (Geneva: World Health Organization, 1991).

76 Phantumvanit and Panayotou, op. cit., footnote 53.

77 "China: Breathing the Air of Success," *The Economist,* vol. 322, No. 7746, Feb. 15, 1992, p. 40.

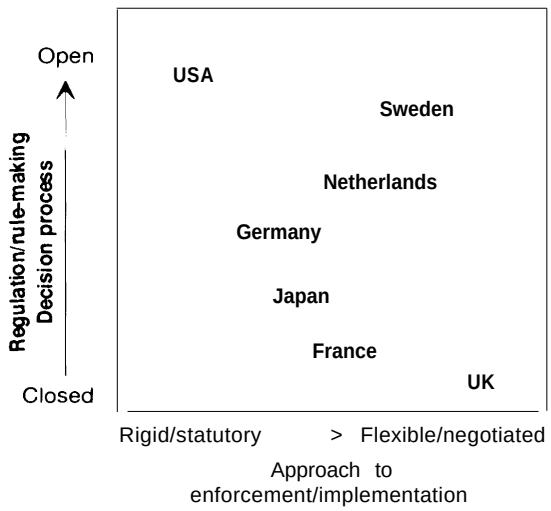
78 "Argentina: Jailing of Executives for Water Pollution Prompts Debate Between Secretariat, Courts," *International Environmental Reporter,* May 20, 1992, p. 308.

79 Emily Lau, "Hong Kong: A License to Pollute," *Far Eastern Economic Review, May* 10, 1990, p. 23,

80 Energy and Environmental Analysis, Inc., *Comparison of U.S. Air Quality Standards and Controls To the Air Pollution Controls in Japan, Germany, Canada, Mexico, and South Korea,* prepared for Office of Policy Analysis and Review, Office of Air and Radiation, U.S. Environmental Protection Agency, February 1992.

81 David Vogel, *National Styles of Regulation: Environmental Regulation in Great Britain & the United States* (Ithaca, NY: Cornell University Press, 1986).

Figure 7-12-Qualitative Mapping Along Key Environmental Political Variables



SOURCE: Derived from Clinton Andrews, "Policies to Encourage Clean Technology," eds., Clinton Andrews, Frans Berkhaut, Robert Socolow, and Valerie Thomas, *Industrial Ecology and Global Change* (Cambridge, England: Cambridge University Press, Forthcoming, 1 994).

actual technological conditions of the facility. In some cases, technology based standards can freeze environmental control technologies and impede industry's willingness to develop or apply more cost-effective control or prevention approaches.[82] Finally, permitting in the United States is often arduous and time-consuming, requiring extensive studies and documentation.

In many other countries there is a more cooperative relationship between regulators and industry, and relative flexibility in enforcement. This can be helpful if firms need additional time to meet a standard, particularly through pollution prevention. However, public and nongovernmental organization (NGO) involvement is more restricted than in the United States and measures to assure compliance may be weaker in some cases.

Some European countries have established multipartite, collaborative efforts with industry, government, academia, and occasionally NGOs, to formulate and implement pollution control regulations. The Netherlands Environmental Policy Plan formulates objectives to be achieved by 2010. The Environment and Economics Ministries consult with individual branches of industry (e.g., chemicals, printing, metal products) to develop objectives, schedules, and strategies for each sector. In addition, representatives from industry, government, NGOs, and academics consult on specific issues (e.g., waste minimization) to develop strategies and assess technology needs and developments.[83] As part of this, the Environment Ministry, in consultation with industry and academics, identified 30 key waste streams and organized groups of producers and users for each material to develop consensus on methods of waste minimization.

In Germany, which is often characterized as having the most command-and-control-like system in Europe, there is significant bargaining over the terms of regulatory actions between enforcement agencies and their clients.[84] The Canadian Government recently established the National Roundtable on Environment and Economy to bring together government, industry, and NGOs to reach a consensus on problem definition and environmental action needed in Canada.[85]

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82 U.S. Environmental Protection Agency, The National Advisory Council for Environmental Policy and Technology (NACEPT), *Improving TechnofogyDIfisionjorEnvironmenra/Projection* Technology Innovation and Environment Committee's 1991 Report and Recommendations (Washington DC: Environmental Protection Agency, 1991).

83 See J. Cramer, B. de Laat, and G. Straten, "The Netherlands' NEEP: Can Environmental Goals Be Met Through NEEP Measures, *Pollution Prevention, (European Edition),* vol 2. August 1992, pp. 25-8.

84 Jochen Hucke, "Implementing Environmental Regulations in the Federal Republic of Germany," *Policy Studies Journal, vol. 11, No.* 1, September 1982, p. 130; see also Arieh A. Ullmann, "The Implementation of Air Pollution Control In German Industry," *Policy Studies Journal,* vol. 11, No. 1, September 1982, p. 141.

85 Jean Pasquero, "Supraorganizational Collaboration: The Canadian Environmental Experiment," *Journal of Applied Behavioral Science* vol. *27, No.* 1, March 1991, pp. 38-64.

Firms in other countries often face less arduous permitting requirements, allowing them higher levels of operational flexibility. Danish environmental inspectors have discretion to make exceptions to the regulations, particularly if the present production equipment's lifetime has not permitted sufficient amortization or if the firm needs extra time to deploy the environmental technology.[86] Japan, prefectural governments have 60 days to decide to issue a new permit, after which the firm can legally operate according to its permit request specifications.[87] In Britain, regulators operate with considerable discretion.[88]

In some cases, such flexibility may come at the cost of less vigorous enforcement, however.

Information Disclosure and Public Access

While some European countries are discussing measures similar to the U.S. Toxic Release Inventory (TRI) system, only the United States requires companies to routinely disclose to the public information about their emissions.[89] In Germany, companies are not required to submit confidential information and there is no equivalent to U.S. freedom of information programs for the public at large.[90] The Japanese Government discloses little environmental information about companies to the public.[91] To the extent that competitors can reverse-engineer proprietary processes on the basis of information provided to regulatory agencies, companies operating in the United States may beat a disadvantage relative to those in countries that collect less information or better maintain its confidential nature.[92]

The degree of public participation in the formation of regulations and rules also differs by country. Many U.S. environmental laws explicitly require public participation in formulation of rules and regulations and other administrative actions (see figure 7-12). Several laws also authorize citizen suits against parties (including government agencies) alleged to be in violation of the law. In contrast, some European countries and Japan limit participation rights.[93] For example, Japanese law seldom if ever gives environmental organizations the right to sue the government. The national government has no freedom of information laws, while only a small number of Japan's prefectures and municipalities have them.[94] Japanese Government practices and laws contribute to the weakness of environmental organizations.[95] The environmental movement has faced opposition from industry and government.[96] Even in the EC, NGOs cannot bring suit in the European Court of Justice against countries that violate EC laws.[97]

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86 OECD, "Back~ound paper on Policy Tools and their Applications in Various Member Companies,' Op. cit., footnote 67.

87 Ibid.

88 Vogel, op. cit., footnote 81.

89 Under the TRI (mandated in Section 313 of the Emergency Planning and Community Right-to-Know Act of 1986), certain manufacturers in the United States must report on an annual basis the amounts of over 300 toxic chemicals that they release to the air, water, or land.

90 SRI International, "Analysis of Impact of U.S. Federal and State Reporting Requirements on Sensitive and Proprietary Company Information," prepared for the U.S. Chemical Manufacturers Association, Washington, DC, July 1992.

91 "Intervie, with Mr. Saburo Kate: The Subsidization of Johkasu," *Water Report* (Tokyo), vol. 1, *No. 3*, 1991, p. 9-10.

92 SRI International, op. cit., footnote 90.

93 v,n Moltke, op. cit., footnote 6*.

94 Jacobs and Harris, op. cit., footnote 47, p. 14.

95 Jim Griffith, "The Environmental Movement in Japan," *Whole Earth Review*, winter 1990, pp. 90-97.

96 Miller and Moore, op. cit., foomote 72.

97 Hillary French, "The EC: Environmental Proving Ground,' *World Watch*, vol. 4, No. 6, November/December 1991, pp. 26-33.

U.S. publicly-held companies must also disclose more in securities reporting, particularly potential future significant liabilities. In contrast, such information is very scanty among European firms,[98] and virtually non-existent among Japanese companies.

Future Directions

Regulations on industrial pollution appear to be getting stricter in many countries. In Europe, while EC-wide regulations will increase the regulatory stringency of the countries with the weakest standards, it is unlikely that regulations will be harmonized at the level of the strictest nations. Moreover, when EC directives have been issued, many countries have either not adopted them or been extremely slow to adopt them,[99] particularly in the area of water quality.[100] Inadequate EC enforcement, at least in the near term, will remain a problem.[101] Countries in other regions are also raising standards, but progress is slow. Many of the newly industrialized countries are giving increased attention to the environment, both in setting and enforcing standards.[102] For example, while standards are low in countries such as Hong Kong, Korea, and Taiwan, and enforcement even lower, there is increasing pressure by government and the public to regulate industry more stringently. However, industry resistance makes this a slow process, and enforcement is spotty. Over the long term, however, the likelihood is that enforcement will improve.

EFFECTS OF REGULATION ON INNOVATION, TRADE, AND INDUSTRIAL LOCATION

Since enactment of the major pollution laws in the early 1970s, many have claimed that regulations controlling industrial pollution and economic growth and development are inversely related. More recently, however, a number of analysts have argued that environmental protection and economic growth are compatible and that vigorous environmental protection is necessary to achieve sustainable long-term economic development (see ch. 3.)

The debate has often been characterized by lack of data, poor analysis, and sweeping generalizations of only limited applicability. It is not the purpose of this report to address definitively the question of the relationship between environmental regulations and economic competitiveness. However, this section reviews some studies on the effects of environmental regulation on innovation, trade, and industrial location. Appendix A reviews the literature examining the relationship between environmental regulations and GDP and industrial productivity.

Effects on Innovation

A number of studies attempt to explain the relationship between environmental regulation

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98 For example, see 'UK Study Says Corporate Environmental Reporting Does Not Disclose Enough Concrete Information,'' *Business and the Environment,* September 1992, p. 8.

99 Under EC law, directives falling under Articles 130 R and S, which cover most environmental matters, must be approved unanimously by the Council of Ministers. This may prove difficult if countries with low standards resist the new measures. "Business Can Expect Tougher Measures as a Result of the Maastricht Summit, Report Says," *International Environmental Reporter,* June 3, 1992.

100 ''The EC and Environmental Policy and Regulations, United States Department of Commerce, International Trade Administration, Oct. 1, 1991.

101 By 1990, the EC had identified 303 cases in which member nations had incorrectly or incompletely implemented EC environmental directives and 60 cases where they had not been implemented at all. Hillary F. French, "The EC: Environmental Proving Ground," op. cit., footnote 97, p. 26-33.

102 Paul Cullen Beately, "The Benefits of a Global Environmental Compliance Strategy,' *Corporate Management,* vol. 158, No. 3, June 1989, pp. 14-19.

and technological innovation.[103] Depending on its form, regulation can help or hinder the development and application of new technologies that will permit more efficient solutions to environmental problems. Sometimes regulations can discourage use of new environmental technology. Most studies have found that the direct impact of environmental regulation on nonenvironmental technological innovation was negative, although weak. But because competitiveness in advanced industrial nations is based increasingly on innovation, such negative effects could be harmful.

Regulation could hinder innovation in several ways. First, by diverting funds from capital investment in new plant and equipment to pollution control, regulation could retard the diffusion rate for new process innovation and could reduce funds available for commercially oriented R&D. Regulatory requirements are often stricter for new facilities (which usually must install the best available technology) than for older investments; some argue that such regulations discourage new investments.[104] However, it is rare for regulation to be the decisive factor in choosing to develop a new facility.

Second, regulation can delay the introduction of new industrial processes. Delays may stem from lack of agency staff for permit processing, from poorly prepared industry applications, and occasionally from citizen review of new or modified permits. For industries that depend on continuous innovation to maintain competitive advantage, permit delays can be a significant problem. Permitting delays can sometimes impede the introduction of environmentally beneficial technology.[105]

Finally, regulation can increase the risks of" innovation. If firms feel that regulations are likely to change so as to make pending innovations obsolete or unusable, they may wait until they receive clearer signals.

However, there can be circumstances where regulation stimulates innovation. Regulations may pressure firms to develop new products or processes, thus adding to the dynamism of the economy (see ch. 5). For example, regulation is credited with encouraging a number of new technologies in automobiles, including some (e.g., computerized engine controls) not directly related to pollution control. In addition, overcoming problems related to regulation may sometimes enhance a fro's problem-solving capacities and contribute to commercial innovation.[106]

The way in which regulations are designed and implemented often affects innovation (see ch. 9). The use of technology-based standards rather than performance standards can dictate particular technological solutions, leading to increased diffusion of an existing technology but retarding the diffusion or development of superior new technologies.[107] The regulatory focus on end-of-pipe

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[103] Roy Rothwell, "Industrial Innovation and Government Environmental Regulation: Some Lessons From the Past, *Technovation*, vol. 12, No. 7, October 1992, pp. 447-458; A. Irwin and P. Vergragt, "Rethinking the Relationship between Environmental Regulation and Industrial Innovation The Social Negotiation of Technical Change," *Technology Analysis and Strategic Management*, vol. 1, No. 1, 1989, pp. 57-70; Organization of Economic Cooperation and Development, *Environmental Policy and Technical Change* (Paris: OECD, 1985); Nicholas A. Ashford and George Heaton, "Regulation and Technological Innovation in the Chemical Industry," Law *and Contemporary Problems*, vol 46, *No*, 3, *1983*, pp. *109-157*.

[104] Robert Crandall, "Pollution Controls and Productivity Growth in Basic Industries, " *Productivity Measurements in Regulated Industries*, ed. Thomas G. Cowing and Rodney E. Stevenson (New York, NY: Academic Press, 1981).

[105] For example, according to one petroleum industry source, in the course of rebuilding part of a petroleum refinery in Texas, the company sought to also rebuild older inefficient furnaces (making them more energy efficient and less polluting), However, the State indicated it would not be able to issue a permit for the furnace rebuild for at least 9 months to a year. Because the other construction work was to be completed before this, the company choose to not improve the furnaces, since this would have involved shutting down production at a later date.

[106] Roy Rothwell, op. cit., footnote 103.

[107] Wesley A. Magat, "The Effects of Environmental Regulation on Innovation," Law *and Contemporary Problems*, vol. 43, winter-spring, 1979, pp. 4-25.

treatment diverts attention away from fundamental process changes. In addition, a rigid regulatory system can make firms unwilling to risk seeking new ways to solve environmental problems, for fear that if the solutions do not fully meet environmental regulations, they will waste time and money, and be penalized for noncompliance. Tight compliance deadlines may also lead firms to choose existing technological solutions rather than develop new, potentially more effective ones.[108] Finally, the current regulatory system gives firms little benefit if they outperform regulatory standards; as a result, they have little incentive to innovate.

Impacts on Trade and Industrial Location

The impact of environmental regulation on trade and overseas investment was discussed in detail in a prior report in this assessment, *Trade and Environment: Conflicts and Opportunities*, and therefore will be only summarized here.[109] Environmental regulation could affect trade negatively if, by raising the costs of U.S. goods relative to producers in nations with lower environmental control costs, U.S. exports fell and imports rose. Some studies find it impossible to isolate the effect of environmental regulation on trade because other variables such as the cost of capital and labor and exchange rate fluctuations overshadow the effects of increased environmental regulation costs.[110] A recent OECD workshop concluded that environmental regulations "have had minimal effects on overall trade balance between OECD and non-OECD countries."[111]

However, other studies claim larger impacts.[112] One study concluded that a l-percent increase in cost due to environmental regulation would have resulted in a net reduction of the U.S. balance of trade of $6.5 billion in 1982.[113] The study concludes that this is a small effect. However, it is worth noting that, if a similar impact had occurred in 1991, the $101 billion U.S. merchandise trade deficit that year would have increased by $8.6 billion. Yet another study found that if a hypothetical pollution tax were imposed on imported Mexican products equal to the difference in environmental control costs borne by counterpart U.S. industries, Mexican exports to the United States would decline 1.2 to 2.6 percent.[114] This would reduce U.S. imports from Mexico by $600 million a year. Moreover, most

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108 Nicholas A. Ashford, "A Unified Technology-Based Strategy for Incorporating Concerns About Risks, Costs, and Equity in Setting National Environmental Priorities," paper presented at the Conference on Setting National Environmental priorities, Resources for the Future, Nov. 16-17, 1992.

109 See also, Paul Portney, Adam Jaffe, Steven Peterson and Robert Stavins, *Environmental Regulations and the Competitiveness Of U.S. Industry* (Cambridge, MA: Economics Resource Group, 1993).

110 U.S. Department of Commerce, "U.S. Pollution Control Costs and International Trade Effects-1979 Status Report" (mimeo), September 1979, p. 3; also J. Tobey, "The Effects of Domestic Environmental Policies on Patterns of World Trade: An Empirical Test," *Kyklos*, vol. *43, No. 2,* 1990, pp. 191-209.

111 Organization for Economic C& Operation and Development, *"EnvironmentalP olicies and Industrial Competitiveness, "*(Paris: OECD, *1993).*

112 Organization for Economic Co-operation and Development *Macroconomics Evaluation of Environmental* Programmed, 1978, p. 11, OECD, *Macro-Economic Impact of Environmental Expenditures* (Paris: OECD, 1985); Carl A. Pasurka, "Environmental Control Costs and U.S. Effective Rates of Protection," *Public Finance Quarterly, vol. 13, No. 2,* April 1985, pp. 161-182; Joseph P. Kalt, "The Impact of Domestic Environmental Regulatory Policies on U.S. International Competitiveness," A. Michael Spence and Heather A. Hazard (eds.), *International Competitiveness* (Cambridge, MA: Ballinger Publishing Co., 1988); Carl Pasurka and Deborah Vaughn Nestor, "Trade Effects of the 1990 Clean Air Act Amendments," report prepared by the Economic Analysis and Research Branch, Office of Policy, Planning and Evaluation, U.S. EPA, Mar. 24, 1992.

113 H. David Robison, "Industrial Pollution Abatement: the Impact on Balance of Trade," *Canadian Journal of Economics*, vol. 21, No. 1, February 1988,

114 Patrick Low, "Trade Measures and Environmental Quality: Implications for Mexico's Exports," paper presented at the Symposium on International Trade and the Environment, sponsored by the World Bank, Washington, DC, Nov. 21-22, 1991.

studies rely on data that, as discussed previously, appear to underreport environmental compliance costs. Higher costs would result in greater impacts.

Some studies suggest that sectoral effects are more significant than economy-wide effects.[115] For industries with high compliance costs, such as pulp and paper, copper refining, and steel, the effects on trade can be larger.[116] For example, OTA concluded that the cost to the U.S. copper industry, particularly copper smelting, of environmental regulation "has been large, with substantial negative impacts on competitiveness and capacity. "[117] Robinson found that between 1973 and 1982 the United States increased its net imports of goods more from industries with higher environmental control costs than from those in which such costs were lower.[118] Because the products of many highly polluting industries tend to be standardized intermediate goods purchased by other industries (e.g., chemicals, petroleum, minerals) with high price elasticity of demand, small changes in price may cause larger changes in sales.119

Some argue that uneven regulation may induce U.S. firms to migrate to countries with lower levels of regulation-the so-called pollution haven effect. There are reasons to suggest that the migratory effect of environmental regulation is likely to be less than the trade effect. Most economy-wide studies suggest a low impact on investment from differing environmental regulation; [120] one study found no significant effects.[121] A study of U.S. maquiladora plants (plants locating in Mexico near the U.S. border through a special Border Industrialization Program) found no relationship between the level of low Mexican regulations and U.S. investment.[122] However, in part, these findings may result from limitations in research methodologies making it difficult to isolate effects of environmental regulations from the effects of a large number of other variables (e.g., labor costs, market access).

On the other hand, anecdotal evidence, case studies, and surveys of businesses suggest that lower environmental regulations do play a role. For example, one study found that 26 percent of maquiladora operators in Mexicali cited Mexico lax environmental enforcement as a major or important reason for their relocation there 123 (see box 7-C).

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115 Organization for Economic Co-Operation and Development, *Summary Report of the Workshop on Environmental Policies and Industrial Competitiveness, 28-29 January 1993* **(Paris:** OECD, 1993).

116 U.S. Department of **Commerce,** 1979, op.cit., **footnot**, 109, p. 12; Public Research Institute, *The Effects of Effluent Discharge Limitations on Foreign Trade in Selected Industries,* **Report to the U.S. National Commission on Water Quality (Arlington, VA: February 1976).**

117 U.S. Congress, Office of Technology **Assessment,** *Copper: Technology and Competitiveness,* OTA-E-367 (Washington, **DC: U.S. Government Printing Office, September 1988).**

118 **H. David Robinson, "Industrial Pollution Abatement: the Impact on Balance of Trade, " op. cit., footnote 113.**

119 General Agreement **on Tariffs and Trade** (GATT) **Secretariat, "Trade and the Environment, " Feb.** 12, 1992, p. 20.

120 **For** example, **see** Ingo Walter, **' 'Environmentally Induced Industrial Relocation to Developing Countries, " Seymour J. Rubin and Thomas R. Graham** (eds.), *Environment and Trade* (London: **Frances** Pinter **Ltd., 1982); Hege Merete Knutsen,** ''International **Location of Polluting Industries: Review of the Literature, " Department of Human Geography, University of Oslo, Norway, unpublished** manuscript, **1991.**

121 **H** Jeffrey Leonard, *Pollution and the Struggle for the World Product* (New York, NY: Cambridge **University** Press, 1988).

122 **Gene M. Grossman** and Alan B. Krueger, ' **'Environmental Impacts of a North American Free Trade** Agreement,'' **paper presented at the conference on the** U.S **,-Mexico Free Trade Agreement sponsored by** the **Mexican** Secretary **of Commerce and Industrial Development, Oct. 8, 1991.**

123 Thirteen percent of the firms **said** that weaker environmental legislation was a major factor in selecting Mexico, while **another 13 percent said it** was **an important factor. (Roberto Sanchez, "Health and Environmental Risks of the** Maquiladora **in** Mexicali, " *Natural Resources Journal*, **vol. 30, winter 1990.) One economic development** official **for** the **Mexican state of Sonora suggests, "The red tape and expense of** American environmental **law is a powerful incentive for some companies to** locate in **Mexico. I've had a couple of companies come down** solely **for that reason." (Quoted in Sandy ToIan, "Hope and** Heartbreak,'' **op. cit., footnote 55.)**

Box 7-C-Regulations and the Furniture Industry in Los Angeles

Environmental regulations in the Los Angeles area are among the strictest in the nation, particularly with regard to air pollution emissions. As a result, regulations have been singled out as a contributor to the relocation of industry out of Southern California. Disentangling the importance of environmental regulations in this industrial migration is difficult, as a host of other factors seem to be operating, including high direct and indirect labor costs, high taxes, land costs, and declining quality of life-including pollution.[1]

The wood furniture industry has been the focus of significant attention because of strict regulations on air emissions. California ranks second in the nation in the production of household furniture; about half of its furniture firms are within the South Coast Air Basin.[2] Claims have been made that furniture manufacturing is being displaced from the Los Angeles economy to Mexico for environmental reasons. The California industry is dominated by a large number of small firms.[3] These firms pay relatively low wages,[4] employ relatively low-skilled workers, have low levels of technology adoption, and have low profit margins. Avery large percentage of the furniture industry workforce is Hispanic. The industry has sought to retain competitive advantage through low costs, while in turn depending on low wage rates. The segments of the industry producingcoated wood furniture is particularly affected by environmental regulations. The environmental impacts of furniture manufacturing are due to t he presence of solvents in wood finishing products. Within this segment, the ability to control solvent emissions varies widely according to the nature of the product being finished. Much of the increase in regulatory pressure on the wood furniture industry came about as a result of local regulations in 1987, which were directed at solvent and coating use for wood furniture producers.

Reported pollution control costs are relatively low for California furniture firms. In 1990, they reported $9.7 million in pollution control expenditures.[5] Even assuming that these costs fall solely on a selected group of SIC codes that use wood finishes, they amounted to only about 0.6 percent of sales and about 1.2 percent of value added. However, air regulations in the furniture industry can reduce productivity and lower product quality. For example, new coatings that comply with South Coast air quality rules often take longer to apply and dry, there are more rejects, and finish quality is poorer.[6] These costs are not reflected in the reported expenditure figures. Increased costs of coatings maybe excluded. (Some savings in coatings are obtained from switching to high-volume, low-pressure spray guns.)

Other factors affect the decisions of these firms to move out of Los Angeles, including salary costs (especially worker's compensation), the rising cost (or value) of land in relation to the value added of the production facilities, and the desire to retain existing advantageous permit conditions when facilities

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1 Barry R. Sedlik and Robert H. Herzstein, *Business Climate In Southern California* (Rosemead, CA: Southern California Edison, November, 1991).

2 Luci Hise, "The Role of Environmental Regulations in Industrial Location: Furniture Manufacturing in Southern California" Masters thesis, Department of Urban Planning, UCLA, 1992, p. 92.

3 Over 70 percent of the establishments in 1989 had less than 50 employees, and 54 percent had less than 20 employees. ibid.

4 Wages range from an average of $5.11 an hour for assemblers with few skills, to $10.97 for maintenance mechanics. Furniture industry wages were 65 percent of regional manufacturing average in 1987, down from 87 percent in 1977. ibid., p. 43.

5 However, because Rule1136 did not get adopted until August 1988, It is possible that compliance costs will increase. These costs are for establishments with greater than 20 employees. Share of sales figures were normalized to reflect this.

6 Luci Hise, op. cit.

must move or expand rather than having to meet new source standards in the region.[7]

In contrast, Mexico had no established standards regulating emissions **from paint coatings and solvents in wood furniture manufacturing.* In 1991, Mexico employed approximately 255 pollution inspectors, roughly the same number of inspectors for the South Coast Air Quality Management District, which** *covers* **four counties in the Los Angeles area.[9]**

While the difference between environmental regulation in Los Angeles and Mexico is stark, differences in wages are also large. Mexican furniture industry wage levels are less than 10 percent of Los Angeles wages .[10] Because of the high cost of living, Los Angeles labor costs are also one-third more than in parts of Texas, Colorado, and Oklahoma.[11] Moreover, workers' compensation is nonexistent in Mexico and quite high in California. From 1980 to 1989, workers compensation rates more than doubled for wood furniture manufacturers, from $9.06 to $19.40 per $100 dollars of labor costs.[12] Other worker-related costs are also higher, including health care and retirement benefits, and expenses related to worker safety and health. Southern California utility rates areas much as 50 percent higher than those in other States. Land prices are among the highest in the Nation. The 1990 average price for a single family home in the State was $210,000, more than double the national average.[13]

The U.S. General Accounting Office found that between 11 and 28 wood furniture manufacturers in the Los Angeles area relocated to Mexico between 1988 and 1990, taking with them 960 to 2,547 jobs.[14] About 80 percent of the firms cited stringent air pollution standards as well as lower labor costs as major factors in t heir location decision. In Mexico, these firms faced no air pollution standards fort he application of paint coatings and solvents.[15] But the majority of firms that relocate from Southern California go to other U.S. States, rather than to Mexico.

Clearly, the ability of manufacturing industries to stay in an area with increasing population, rising property values, and associated environmental pressures that drive more stringent environmental standards is heavily dependent on the degree of value added of the activity in question. Low value-added industries that face environmental pressures will have a harder time staying in the area. Differences in labor compensation (wage rates, benefits, workmens' compensation insurance) between furniture workers in Mexico and Los Angeles appear to be driving the relatively small amount of relocation that is occurring. However, strict environmental regulations governing the furniture industry in Los Angeles and their absence in Mexico appear to be exacerbating this situation.[16]

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7 Konrad von Moltke, "American Industry and the Environment: Implications forTrade and Competitiveness," contractor report prepared for the Office of Technology Assessment, November 1992, p, 51.

8 Luci Hise, op. cit.

9 "Can Mexico Clean Up Its Act?" Los Angeles *Times*, November 17, 1991, p. A1.

10 GAO reports that the average wage in wood furniture in Los Angeles was $8.92 an hour, while it was $0.77 for wood furniture workers in the maquiladora program (p. 4).

11 Ibid. In 1991, average hourly earnings of workers in Los Angeles were $11.17 while in San Antonio, TX they were $8.19, In the nonmetro areas of these States, the wage rates are lower. Bureau of Labor Statistics, *Employment and Earnings* (Washington, DC: May 1991).

12 Ann M. Lesperance, "Air Quality Regulations and Their Impact on Industrial Growth in California, Based on Census Data: A Case Study of the South Coast Air Quality Management District Rule 1136 and the Wood Products Coating Industry," Masters thesis, Department of Environmental Health Sciences, University of California, 1991.

13 Richard L. Stern and John H. Taylor, "IS the Golden State Losing It?" *Forbes*, October 29, 1990, p. 87.

14 U.S. Congress, U.S. General Accounting Office, "U.S.-Mexico Trade: Some U.S. Wood Furniture Firms Relocated From Los Angeles Area to Mexico," April 1991.

15 Ibid.

16 Luci Hise, op. cit; Anne Lesperance, Op. cit.

Case studies may find greater impacts because pollution control requirements affect some industries more than others. Industries such as mineral processing, toxic products, and intermediate organic chemicals, which face relatively high compliance cost, are more likely than others to relocate for environmental reasons.[124] For example, one 1988 study found that U.S. operations that moved to Mexico were either relatively labor-intensive, low-polluting light manufacturing operations that moved principally to take advantage of low wages, or producers of hazardous waste such as asbestos.[125] As a result, for the subset of industry that is labor-cost sensitive, is relatively footloose, or is making new investment decisions, and has high environmental compliance costs, weak environmental regulations can add to the cost advantage gained by low labor costs.

However, some analysts maintain that environmental regulations could positively affect trade. One argument is that, if the United States is a net exporter of environmental goods and services (including environmentally preferable technology), then the country receives net economic benefits that should be counted against costs of regulation (see ch. 5). Some also argue that, even if U.S. firms are subject to more stringent regulations now, other countries' regulations will catch up. U.S. firms could then beat an advantage having had more experience in producing goods able to meet strict standards. Most importantly, firms in other countries may have to invest sizable amounts to come up to speed and, because they have less experience in dealing with pollution, may do so at relatively higher costs. These nations and their resident firms may then be at a competitive disadvantage.[126] In the meantime, U.S. firms still face higher costs.

INDUSTRIAL LOCATION WITHIN THE UNITED STATES

A number of studies have examined how environmental regulations affect investment and growth among U.S. States. Their finding is that differences in environmental regulation are not a major factor governing industry location within the United States. However, it may affect the location of highly polluting industries and influence the location of industry between adjacent States. For example, one study found no statistically significant effect of State environmental regulations on the location of most branch plts.lzT However, the results regarding the effect on highly polluting industries was less conclusive. A study of the location of motor vehicle branch plants found that while environmental regulations had little effect on location, there was some evidence that firms were deterred at the margin from locating in regions where ground level ozone problems were particularly severe.[128] According to a survey and interviews with managers responsible for 162 new branch plants of large U.S. corporations, traditional location factors, such as labor cost and availability, access to markets and materials, and transportation were the key determinants of location choices between regions.[129] As expected, environmental regulations were more important for more polluting plants than less polluting ones, but even for these plants, other factors carried greater

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124 Ibid.

125 Leonard, **op. cit., footnote** 121.

126 Moreover, in doing so they may rely heavily on technology and products developed in nations with **more advanced environmental regulations.**

127 Tim Bartik, "The Effects of Environmental Regulation **on Business** Location **in** the United **States,** *Growth and Change*, summer 1988.

128 Virginia D. McConnell **and Robert M. Schwab,** "The Impact of Environmental Regulation on Industry Location Decisions: The Motor **Vehicle Industry,** *Land Economics, vol. 66, No.* **1, February 1990,** pp. 67-81.

129 Howard Stafford, "Environmental Protection and Industrial Location," *Annals of the Association of American Geographers,* vol. *75, No. 2,* 1985, pp. *227-240.*

weight. One of the major concerns with environmental regulations was the uncertainty about when necessary permits would be obtained.

A study using an econometric model found that States with more stringent environmental standards experienced stronger economic growth in the 1980s than States with weaker regulations.[130] One reason for this counter-intuitive finding may be that many States with high concentrations of industry not only have more pollution (and thus a need for stronger regulations), but also have nonregulatory locational advantages (e.g., large markets, a large number of input suppliers, good transportation and other infrastructure, and a profusion of vital services). Compliance costs are likely to be higher in these areas than in less-developed and slower growing places.

CONCLUSION

The U.S. regulatory system for dealing with industrial pollution and wastes was set up at a time when the Nation had relatively few worries about international economic competition and the national economy was more insulated from foreign competitors. In a more closed economy, high regulator-y costs could be passed on to consumers. However, in a more global economy with highly competitive foreign fins, many prices are determined by world markets, and firms are less able to pass on the costs of regulation.

Given the assumption that U.S. regulatory standards will continue to be as strict as they now are, or get even stricter in the next decade, there are several possible options for reducing the competitive disadvantage of differential compliance costs and requirements. For example, the United States can work with other nations to encourage them to raise their standards. It also could work to develop new technologies that would make it cheaper for firms to comply with U.S. requirements. In addition, the United States can modify its environmental regulatory system to make it easier for U.S. industry to comply with regulations, while still meeting environmental goals. The latter issues are the topic of chapters 8 and 9.

130 Stephen M. Meyer, "Environmentalism and Economic Prosperity: Testing the Environmental Impact Hypothesis," unpublished paper, MIT Project on Environmental Politics and Policy, Cambridge, MA, Oct. 5, 1992.

APPENDIX 7-A. POSSIBLE SOURCES OF UNDERREPORTING OF POLLUTION ABATEMENT COSTS

The U.S. Bureau of the Census' Pollution Abatement and Control Expenditure (PACE) surveys are the principal source of information on U.S. manufacturing pollution abatement and control compliance costs. However, a number of researchers have suggested that these surveys may underreport the true cost of compliance. It is difficult to accurately quantify the extent of underreporting. Adding the costs of those factors discussed below that are quantifiable increases costs by approximately 50 percent. However, 60 percent of this increase is related to interest costs, which should or should not be used depending on the definition of costs. The value of other factors cannot at this time be quantified. As a result, a reasonable but very rough estimate suggests that these costs may be underestimated by as much as 25 percent. There area number of areas that may be underreported, some of which may be addressed by more comprehensive survey methods.

Underreporting from Omitted Cost Items

PRODUCTIVITY LOSSES

If a firm has to stop production because of environmental problems, costs are incurred. If it has to substitute new materials or processes that are less productive than original ones, productivity could decline. More significantly, if environmental equipment is less productive than other equipment, these costs will not be included. However, most pollution control equipment is added to the end of the production process and is not likely to significantly affect production process rates. Moreover, as discussed in chapter 8, at least some inprocess changes boost productivity as they improve energy and materials efficiency.

PRODUCT QUALITY IMPACT

In some cases, environmental regulations lead firms to make changes in materials or processes that negatively effect product quality. For example, because of stringent U.S. volatile organic compounds (VOCs) regulations, U.S. automakers use ''high-solid' paints that sometimes produce lower gloss finishes. In contrast, Japanese automakers can use 'low-solid" paints that allow for a premium "high gloss' finish, particularly on some of the higher priced models.[1]

POLLUTION CONTROL COSTS EMBEDDED IN OTHER PURCHASES

For many industries, the costs of materials and supplies is higher because of environmental regulations. For example, firms in industries that use large amounts of electricity (e.g., industrial gas producers) pay higher prices for electricity because of the regulations on electric utilities. The PACE survey would identify the utilities' higher costs due to environmental regulations, but not added costs for utility customers from higher electric rates.

INTEREST EXPENSE

The PACE survey does not include interest expense for equipment. Using a real interest rate of 7 percent and a 20-year life for investments,[2] interest expense increases the costs of capital investments by 88 percent. This would add another $6.5 billion to manufacturing compliance costs to the $7.4 billion invested in 1991, raising total compliance costs ($21 billion) 31 percent.

FEES AND TAXES

Census figures do not include fees and taxes, which, while currently small, are likely to be a growing share of environmental costs, particularly as new fees related to the 1990 Clean Air Act

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[1] **American Automobile Manufacturers Association** *The Effect of Air Pollution Control Laws on the International Competitiveness of the U.S. Automobile Manufacturers* **(Washington DC: AAMA, Jan. 5, 1993).**

[2] **U.S. Environmental Protection Agency (EPA) uses a 7-percent interest rate to estimate environmental compliance costs, and assumes a useful life of most pollution control equipment at 20 years. (EPA,** *Environmental Investments: The Cost of a Clean Environment,* **Washington, DC: Island Press, 1991).)**

Amendments take effect. For example, Boeing's fees and taxes for environmental permits in the United States increased from $23,000 in 1985 to $2 million in 1991, while its overall costs for environmental compliance exceed $100 million annually.[3] In addition, taxes on industry to support the Superfund Trust Fund are not reported in the Census data. In 1990, the domestic petroleum industry paid $295 million, the chemical industry paid $273 million, and manufacturers paid approximately $252 million, for a total of $820 million. Leaking underground storage tank trust fund taxes were approximately $30 million in 1990. Together, these two taxes add an additional 4.1 percent to total annual pollution control expenditures.[4]

COSTS OF REGULATORY DELAYS

Environmental regulation can delay new investments, as firms wait to obtain permits. Calculating the impact of these delays on costs is very difficult. However, as competitive pressures on U.S. manufacturing have intensified, the potential impact of regulatory delays becomes more serious. Shorter product life cycles, more rapid product introduction, more customized and niche products, and increased use of flexible manufacturing systems require firms to be able to make more frequent and rapid changes in production. To the extent that the current regulatory system is based on an earlier model of manufacturing, characterized by long runs of standardized products with few changes in operating conditions, it can potentially hinder the ability of manufacturers to make changes needed to respond to changing market demands. As a result, regulatory delays, and slow and inflexible permitting processes can sometimes impede a fro's efforts to remain competitive.

LOSS OF PROPRIETARY INFORMATION

In some industries, particularly process industries, information reported to regulatory agencies that becomes available to the public maybe used by competitors to make inferences about the firm's manufacturing process. For example, since basic synthesis methods have been published for most commodity chemicals, a chemical company's competitive edge is often based on know-how or production techniques that provide small but significant advantages for efficiency, yield, and cost.[5] A recent study by the Chemical Manufacturers Association suggests that the reports required by some State environmental laws, if made available to competitors, combined with readily available information at the Federal level, would give them significant opportunities to ''reverse-engineer' proprietary products and processes.[6] One firm indicated to OTA that they had little faith in environmental agencies' ability to maintain confidentiality of sensitive company documents, and that the company itself used this source of information to gain information about their competitors. In part the problem stems from the fact that there appears to be no uniform definition between agencies and programs of what constitutes proprietary information. Moreover, many State environmental agency staff may lack training or experience in this critical area,

RESEARCH AND DEVELOPMENT COSTS

R&D costs are also not included, but are likely to be small. The National Science Foundation estimates that in 1990, total R&D by the private

[3] In 1990, Boeing paid approximately $2 million for water discharge and air emission fees and permit charges, $2 million for land disposal fees (tipping fees), and $6,5 million to publicly operated sewage treatment plants (POTWs). (Information provided by the Boeing Co.)

[4] U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, "Who Pays for Superfund,'' November, 1990. Also unpublished data from this office.

[5] *Impact of the Chemical Weapons* Convention on *the U.S. Chemical Industry-Background Paper*, OTA-BP-ISC-106 (U.S. Congress, Office of Technology Assessment, Washington, DC: U.S. Government Printing Office, August 1993).

[6] SRI International, *Analysis of Impact of US. Federal and State Reporting Requirements on Sensitive and Proprietary Company Information* (Menlo Park, CA: SRI International, Project 3307, July 1992).

sector for pollution abatement was approximately 2.4 percent of private sector pollution control costs.[7] However, much of this R&D was for automobile mobile source controls, new products (e.g., reformulated gasoline), and the environmental goods and services industry. R&D by firms toward compliance with process regulations appears to be less. For example in the petroleum and pulp and paper industries they represented only 2.2 and 1.0 percent respectively of annual pollution control compliance costs.[8]

PENALTIES AND FINES

In Fiscal Year 1991, EPA assessed a total of $87 million in fines and penalties, not all of it to manufacturing firms.[9] While exact data are not available on State fines and penalties, estimates suggest that they total less than $280 million a year.[10] Assuming that some local air pollution control authorities also levy frees, it appears that no more than $400 million is levied in fines. Including all these penalties would increase pollution control costs by approximately 1.9 percent.

OTHER COSTS

The survey also excludes several other costs, including: land needed for pollution control equipment; noise abatement expenditures; and expenditures for complying with regulations to protect worker health and safety, which can be substantial in particular industries. In addition, the potential negative effect of the Comprehensive Environmental Response, Compensation, and Liability ("Superfund") on business access and cost of credit is unknown.[11]

Underreporting From Lack of Full Knowledge of Costs

ENVIRONMENTAL COSTS EMBEDDED IN NEW CAPITAL EQUIPMENT

Companies sometimes do not report the environmental costs embedded in new generations of production equipment. For example, in reviewing reported project expenditures for a segment of the U.S. pulp and paper industry, OTA found that the share of new equipment costs that were environmental were not reported as such. If these expenditures are included, environmental capital costs as a share of total capital costs increase from approximately 12 percent to between 15 and 16 percent.[12] Assuming similar shares for all capital investments, total pollution control costs would increase 10 percent.

ADMINISTRATIVE COSTS

PACE does not directly ask for costs related to environmental regulatory compliance, environmental auditing, recordkeeping, training, and legal services to comply with regulations, particularly at the corporate level, as opposed to the plant or facility. However, while these costs are not insubstantial, relative to overall operating and capital costs they are small. For example, in the pulp and paper industry, corporate environmental administrative costs were only 3.5 percent of

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[7] Unpublished data, National Science Foundation,

[8] American Petroleum Institute, *Petroleum Industry Environmental Performance, 1992* (Washington, DC: API, 1992); National Council of the Paper Industry for Air and Stream Improvement Inc., *A Survey of Pulp and Paper Industry Environmental Protection Expenditures - 1991 (New York, NY:* NCASI, 1992).

[9] Interview with Rick Duffy, Environmental Protection Agency, December 1992.

[10] EPA does publish data on fines levied by states under RCRA. In FY91 these totaled $148.6 million. RCRA fines appear to Constitute at least half of all fines, with fines for air and water accounting for the other half.

[11] There is some evidence that banks are less likely to make loans to businesses with ground contamination on site. U.S. Environmental Protection Agency, Office of Policy, Planning and Evaluation "A Preliminary Report on the Indirect Effects of the Superfund Program" (Washington, DC: U.S. EPA, May 20, 1992.

[12] Neil McCubbin, "Environment and Competitiveness in the Pulp and Paper Industry," contractor report prepared for the Office of Technology Assessment, January 1993.

operating costs.[13] However, administrative and legal fees in the Resource Conservation Recovery Act (RCRA) and Superfund proceedings can be larger.[14] These costs can be larger as a percent of sales in small and medium-sized firms.

MANAGEMENT AND ENGINEERING STAFF TIME

Companies may not know or accurately report the managerial and technical time devoted to environmental issues. These issues, particularly related to hazardous waste, occupy a significant portion of time for some top executives—time that might otherwise be spent on matters more central to the corporation's function.[15] In addition, in many firms, a number of department heads, technicians, and engineers devote some share of their time to environmental compliance, which may not be reported.

ENVIRONMENTAL TRAINING

Training for environmental compliance, which can sometimes be a significant share of corporate training expenses, is often not known or reported.

OTHER COSTS

Other items, such as asbestos removal, transformer replacement to eliminate PCBs, and underground storage tank replacement, may also not be reported as environmental expenditures.[16] In addition, some operating costs, such as energy use by abatement equipment, may not be separately recorded.

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13 NCASI, *A Survey Of Pulp and Paper Industry Environmental Protection Expenditures -1990, Op.* cit., footnote 8.

14 For example, Portney estimates that costs of litigation and other noncleanup related expenses could exceed 20 percent of total Superfund cleanup costs. Paul Portney, ' 'The Economics of Hazardous Waste Regulation" U.S. *Waste Management Policies: Impacts on Economic Growth and Investment Strategies,* Monograph Series on Tax and Environmental Policies and U.S. Capital Costs (Washington, DC: American Council for Capital Formation, Center for Policy Research, 1992).

15 John H. Sheridan, "Environmental Issues Sap Executive Time, " *Industry Week,* Mar. 16, 1992.

16 One report to EPA suggests a small degree of underreporting of capital investments due to inadequate information and a likely effect of underreporting of operation and maintenance costs. However, the size of this underreporting is not known. Firms also appear to underreport estimates of recovered costs, which would offset to some degree the underreporting of operation and maintenance costs. Beth Snell and Bob Unsworth, "Evaluation of Uncertainty Associated With Air Pollution Abatement Compliance Cost Estimates-Stationary Sources" (memorandum) (Cambridge, MA: Industrial Economics Inc., Oct. 13, 1992).

APPENDIX 7-B. NATIONAL DIFFERENCES IN POLLUTION CONTROL STANDARDS AFFECTING MANUFACTURING INDUSTRIES

It is very difficult to develop accurate cross-national comparisons of environmental regulations and approaches. With only a few exceptions (e.g., some air pollution standards), relatively little information is available.

Air Pollution

The most widely available data on *ambient* standards concern air quality, particularly for sulfur dioxide (SO_2), total suspended particulate matter (TSP), and nitrogen oxides (NO_x).[1] International comparisons of ambient air standards suggest that U.S. standards are very high, although nonattainment remains a major problem. Countries such as Germany and Japan may have higher standards for some pollutants. German standards were especially high, largely in response to concerns with acid rain. In Japan, local standards are often stricter than national rules,[2] although it is unclear the degree to which industry complies with more stringent local standards.[3] Comparisons of *emission* standards show similar patterns. Again, U.S. standards are among the strongest, although Japanese and German regulations of SO_2 and NO_x are stricter. However, countries regulations vary by categories of sources and fuels. For example, in the United States, older sources in most cases have not been required to meet the same performance standards as new facilities, although recent changes will require more retrofitting by utilities. Germany and Japan have required more retrofits. However, while the U.S. Clean Air Act regulates 189 toxic pollutants and 6 criteria pollutants, Japan's Air Pollution Control Law designates only 10 regulated pollutants.[4]

U.S. standards for some emissions, such as total suspended particulate (TSP) and volatile organic compounds (VOCs,) appear to be the highest in the world. When fully implemented, the 1990 Clean Air Act amendments on air toxins will probably be the most demanding. Notably, Japanese regulations of VOCs and hazardous air pollutants are much weaker than those in the United States, and the guidelines are not generally followed.[5] For example, in the organic chemical industry, the Japanese regulate only a few selected organics as toxics. VOC emissions from Japanese automobile painting are subject to minimal regulations, allowing the use of "low-solid' paints that enable a higher gloss finish than from paints with higher solids.[6] In contrast, in response to U.S. VOC regulations, automakers here use higher-solid paints, making it more difficult to achieve high gloss finishes. German controls on automobile painting more closely approximate those of the United States, while

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[1] Raymond J. Kopp, Paul R. Portney, and Diane E. DeWitt, *International Comparisons of Environmental Regulation* (Washington DC: Resources for the Future, September 1990); *Clean Air Around the World: The Law and Practice of Air Pollution Control in 14 Countries in 5* Continents (Brighton, England: International Union of Air Pollution Prevention Associations, 1988); also, Gregory C. Pratt, "Air Toxics Regulation in Four European Countries and the United States," *International Environmental Affairs*, vol. 4, No. 2, spring 1992, pp. 79-100.

[2] Energy and Environmental Analysis, Inc., *Comparison of U.S. Air Quality Standards and Controls to the Air Pollution Controls in Japan, Germany, Canada, Mexico, and South* Korea, prepared for Office of Policy Analysis and Review, Office of Air and Radiation, U.S. Environmental Protection Agency, February 1992 (draft).

[3] Louise Jacobs and Leigh Harris, *Public-Private Partnerships in Environmental Protection: A Study of Japanese and American Frameworks for* So/id *Wastes* and Air *Toxics* (Lexington, KY: The Council of State Governments, 1991).

[4] Energy and Environmental Analysis, op. cit., footnote 2.

[5] Energy and Environmental Analysis, Inc., op. cit., footnote 2, p. 1-11. See also "Interview With Dr. Yasumoto Magara: Amendment of Drinking Water Quality Standards," *Water Report (Tokyo)*, vol. 1, No. *4, 1991.*

[6] *in* part, this maybe because as a strategy to control ground level ozone, the Japanese control NOx more heavily than VOCs. Energy and Environmental Analysis, Inc., ibid,

Canadian controls are weaker.[7] Most developing nations, including Korea and Mexico, have no set standards for VOCs, including automobile painting operations. In Mexico, furniture firms face no air pollution standards for the application of paint coatings and solvents.[8]

Water Pollution

In part because standards are often set by subnational governments, it is more difficult to obtain data and compare water regulations between nations. In spite of this, there is some evidence that many other nations regulate water pollution less stringently than the United States. For example, Japanese regulations to protect ground water were established only in 1990.[9] While the Japanese Government has moved to reduce air pollution, it has taken much less action to reduce water pollution and contamination of drinking water.[10] Japan lags behind other industrialized countries in setting chemical standards in drinking water, and currently regulates only 26 contaminants for water quality .[11] Water controls in other countries are also weaker.[12] For example, Canada is only now requiring that all pulp and paper mills install secondary treatment, while virtually all U.S. mills installed secondary water treatment after the mid-1970s.[13]

Hazardous Waste

U.S. laws regulating hazardous wastes are very strong compared to most countries. While many European countries have laws similar to the Resource Conservation and Recovery Act (RCRA), none is as restrictive and comprehensive.[14] For example, while the United States lists approximately 500 wastes as hazardous, the United Kingdom designate 31, the French control approximately 100, and the Germans restrict 348.[15] One estimate suggests that only 20 percent of Italian toxic waste is disposed of properly, with the rest either stockpiled, dumped illegally, or exported.[16] Of the six distinct classifications of waste established by OECD member countries, only the United States regulates waste in all six.[17] However, EC waste laws appear to be getting

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[7] **Ibid.**

[8] **U.S. Congress, U.S. General Accounting Office, "U.S.-Mexico Trade: Some U.S. Wood Furniture Firms Relocated From Los Angeles Area to Mexico' (Washington, DC: U.S. Government Printing Office, April** 1991); also **Ibid.**

[9] Louise **Jacobs and Leigh Harris,** *Public Private Partnerships in Environmental Protection: A Study of Japanese and Amen"can Frameworks for Solid Wastes and Air Toxics*, op. cit.

[10] Curtis Moore and Alan **Miller, "Japan and the Global Environment,'** *Environmental Law and Policy Forum, vol.* **1,** 1992, p. 38; Bruce **E. Aronson, "Review Essay: Environmental Law in** Japan,'' *The Harvard Environmental Law Review,* **vol.** *7, No.* **1,** 1983, **pp. 135-171; and** Shigeki Masunaga, **"Water Pollution Control in** Japan,'' *Water Report* **(Tokyo), vol.***2, No. 3, 1992.* **Japan did take early action to reduce mercury and some other toxic heavy metal levels in water, due tmercury poisoning around several industrial facilities.**

[11] ''Interview with **Dr.** Yasumoto Magara: **Amendment of** Drinking **Water Quality Standards,'** *Water Report* **(Tokyo), vol. 1, No.***4, 1991. In* **contrast, the** United **States regulates 83 contaminants.**

[12] One survey of U.S.-owned chemical **facilities** in **Europe found significantly larger discharges of some toxic chemicals** to **water** than **in the United States, According to the study, discharges of three chemicals —benzene,** MEK, **and** xylene-from **individual chemical plants in Europe exceed the total discharge to water for the same chemicals from all 26,000 facilities that report to the U.S. Toxic Release Inventory. David** Sarokin, **' 'Toxic Releases from Multinational Corporations: Does the Public Have a Right to Know?' (Washington, DC: The Public Data Project and Friends of the Earth, July 1992).**

[13] **Discussion** with official **from** the **National Council on Air and Stream Improvement, New** York, **NY, December** 1992.

[14] **K**$_{app}$, Portney, **and** DeWitt, *International Comparisons of Environmental Regulation*, op. cit., footnote **'.**

[15] Kopp, Portney, and DeWitt, **Ibid.,** p. **28.**

[16] **John** Glover, **"Italian Industry Aims to Get Greener, But on its Own Terms,"** *Chemical Week,* **Feb. 6, 1991.**

[17] Source: OECD, *Transfrontier Movements of Hazardous Waste* (Paris: 1985); and Resources **for** The Future, *International Comparisons of Environmental Regulations.* **(Cited in Steel** *industry Annual Report,* **U.S. International Trade Commission, September 1991, p. 3-30.)**

stricter.[18] Japanese ambient standards for dioxin ingestion is 5,000 picograms per day for adults, as compared to the U.S. standard of 50 per day.[19] Few other nations have the regulatory provisions (including mandatory planning in some States and information disclosure) the United States has to encourage waste minimization.

The difference between U.S. hazardous waste laws and those in developing countries is even greater. Few developing nations have significant laws regulating hazardous wastes, For example, maquiladora plants in Mexico generate unknown but evidently large amounts of hazardous wastes, and compliance with Mexican waste laws appears to be low.[20]

U.S. law governing abandoned waste sites is by far the strongest in the world. No other nation has a Superfund law that imposes strict, joint and several, and retroactive liability on industry. While the EC is considering legislation to regulate contaminated sites, it is likely to only address future and not past liability. Industries in Japan are not subject to similar laws.

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The discussion above is a selective discussion of national-level environmental standards affecting manufacturing; subnational standards (which in some cases exceed national requirements) are not considered. A number of areas are not covered. It does not, for example, include differences in requirements pertaining to global environmental issues (such as phase out of substances that deplete the stratospheric ozone layer). Nor does it include post consumer responsibility for product disposal. For example, Germany is starting to make manufacturers responsible for the ultimate disposal of the products they sell. Initially focused on packaging, the requirements may eventually apply to a wide variety of products, including automobiles, computers, and other equipment. Different countries' environmental requirements affecting land use, resource management, wildlife, endangered species, could have differential effects on manufacturers, but are not covered here.

As legislative and administrative bodies periodically revise and amend prior laws and regulations, relative rankings among countries change. Some U.S. environmental laws, including the Clean Water Act and the RCRA, are up for reauthorization. The Japanese Diet is considering changes in Japan's basic environmental law. Administering agencies also vary in the commitment made to implement standards and requirements in a timely fashion, and in the resources available for enforcement.

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18 "Europe Making Progress with Environmental Regs" *Pollution Engineering,* Sept. 1, 1992.

19 Moreover, the 2,000 incinerators in Japan, the main source of waste treatment &e@ are not monitored for dioxin output. Landfills are scarce in Japan and, as a result, the Japanese are constructing landfills in ocean bays and inlets, using the newly created land as industrial sites. Louise Jacobs and Leigh Harris, *Public Private Partnerships in Environmental Protection: A Study of Japanese and American Frameworks for Solid Wastes and Air Toxics* (Lexington, KY: The Council of State Governments, 1991).

20 By law, these firms are supposed t. ship hazardous wastes back to the U. S., but this provision is notwell enforced. U.S. Congress, Office of Technology Assessment, *U.S. Mexico Trade: Pulling Together or Pulling Apart?,* ITE-545 (Washington, DC: U.S. Government Printing Office, October 1992); See also U.S. Congress, Government Accounting Office, *U.S.-Mexico Trade: Assessment of Mexico's Environmental Controls for New Companies,* GAO/GGD-92-113 (Washington DC: August, 1992).