A Profile of Tax Subsidies and Investment Behavior in Six Major Polluting Industries

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This report was prepared as part of a larger effort to examine the impact of various federal subsidies on the polluting behavior of six major U.S. industries. It was directed by Claire Breidenich of EPA's Office of Policy, Planning and Evaluation, with technical advice from Carl Pasurka. At Abt Associates, the project team included Greg Michaels (project manager), Lisa Akeson, Mark Wenner, and Jonathan Michaeli.

1. INTRODUCTION

1.1 Policy Relevance

The U.S. Federal Government has historically provided subsidies to industries through a variety of channels including direct approaches, such as grants, export credits, loan guarantees, below-market land leases, and indirect approaches, such as publicly funded research and development of new technologies, investment tax credits, and accelerated depreciation allowances. The rationale for the industrial subsidies stems from a desire to spur investment, to improve labor productivity, to generate more employment, and to enhance international competitiveness. Tax policy changes, especially tax credits, lower corporate rates, generous depreciation allowances, and capital gain exclusions, have proven effective in stimulating investment growth in the past (Hall and Jorgenson, 1967). Furthermore, in the last few decades as environmental regulations have tightened, some industries may have used these subsidies to help shift to more environmentally benign production processes. Investment tax credits, for example, could help defray the cost of pollution abatement compliance by subsidizing the purchase equipment that either reduced pollution at the end of the production line or conserved on inputs during the production process itself so as to diminish total waste and pollution creation.

How cost effective these incentives have been is open to debate (Coen, 1969; Eisner, 1969; and Clark, 1979). These subsidy programs imply either budgetary outlays or lost tax revenue. In a time of budget austerity policy makers maybe faced with a dilemma. By reducing industrial subsidies they can help reduce the public budget deficit but it could have possibly adverse effects on environmental protection efforts. Reduced subsidies could discourage investments and associated production processes in highly polluting industries that hitherto were profitable and attractive and as a result foster environmental protection goals. Alternatively, elimination of some subsidies could remove incentives for manufacturers to invest in pollution control technology and decrease levels of environmental protection. If the latter case holds, two public policy objectives may be at odds.

1.2 Purpose

This report seeks to review investment trends in pollution control technology to determine existing patterns and to highlight the likely investment incentives that six, highly polluting industries (metals mining; petroleum; primary metals, pulp and paper; chemicals and allied products; and electric utilities) may face if accelerated depreciation allowances, the largest subsidy currently available, were liberalized and reduced. Magnitudes of investment responses are not provided, only directions. Further modeling exercises will have to be undertaken to derive estimates of gross investments by sector and industry and public budget impacts.

1.3 Organization

The report is organized in the following manner. The second section identifies the major types of industrial subsidies that currently exist. Few direct subsidies exist but depreciation allowances were found to be quite significant. Data are presented for each of the six highly polluting industries in order to determine which sector benefits the most for these allowances. The third section uses the U.S. Department of Commerce's data to disaggregate capital expenditures on pollution abatement into two categories: end-of-line abatement investments and product process changes. In addition, industry-specific outlooks are presented with the purpose of identifying likely future investment trends and growth opportunities. The last section explains selected fundamental concepts in tax policy analysis, introduces the cost of capital formula and pinpoints likely investment incentives that may arise with a change in capital recovery allowances, the principal tax incentive. The conclusions are suggestive of what may occur with such a change.

2. REVIEW OF SUBSIDIES

The purpose of the initial stage of this analysis was to identify the various types of subsidies available to six highly polluting industries identified by EPA -- chemicals and allied products, electric utilities, mining, petroleum products (including crude and natural gas production), primary metals, and pulp and paper. For the most part, federal subsidies fall within two broad categories: direct subsidies and tax expenditures. Direct subsidies can be thought of as some form of direct transfer of funds from the federal government to entities, such as corporations. Tax expenditures do not involve a transfer of funds, but rather refer to statutory reductions in taxes that would otherwise be owed by entities to the federal government; the effect of such tax reduction is to "fund" government objectives, such as providing investment incentives. The first step of the analysis was to quantify both the direct subsidies and the tax expenditures associated with each industry. These subsidies were then reviewed in terms of their relative size and thus the approximate savings due to the removal of that subsidy. In addition, the individual subsidies were loosely categorized in terms of their likelihood of affecting the environment (either positively or negatively). The results of this categorization of subsidies are presented in Exhibits 2-1 to 2-5.

Literature from several different sources was consulted for this analysis, including tax expenditure estimates from the Congressional Joint Committee on Taxation. In addition, information was obtained from a variety of politically-oriented special interest reports. The latter sources were used to better characterize the potential effects of removing subsidies. The intent of presenting these data is to provide indications of the magnitude of different types of subsidies, not to present exact figures.

2.1 DIRECT SUBSIDIES

Spending subsidies, the most common form of a direct subsidy, are issued as outright grants to industrial sectors. The first two columns of Exhibit 2-1 enumerate the different types of spending subsidies provided to various industrial sectors, as estimated by the Progressive Policy Insitute (Shapiro, 1995). The third column presents five-year estimates of the savings associated with elimination or significant decrease in these subsidies, which gives an indication of the potential fiscal impact of a change in each subsidy. The last two columns represent a qualitative appraisal of the potential of a cut in a particular subsidy to change the environmental impact of the industry or sector, and the degree of the potential change. To assess the degree of change, both the strength of the specific subsidy's linkage to environmental quality, and the magnitude of the subsidy were considered. Tabulations of individual sub-sector subsidies to agriculture and transportation are excluded because they were not within the scope of this analysis. However, several sub-sectors of the energy industry are included, given their applicability to either electric utilities or petroleum products. The estimated savings to the federal government resulting from removal of these subsidies should be interpreted as indicators only, because of the special-interest nature of their source.

Exhibit 2-1: Spending Subsidies by Industrial Sector

Industrial Sector	Type of Spending Subsidy	5-year Savings w/o Subsidy (billions)	Potential to change environmental impact	Degree of change
Agriculture		$31.30		
Energy		$15.30		
	a) Energy Department Nuclear Production	$3.00	Yes	Significant
	b) Naval Petroleum and Oil Shale Reserve	$1.00	Yes	Low
	c) Strategic Petroleum Reserve	$0.00	Yes	Low
	d) Tennessee Valley Authority (TVA)	$1.00	Yes	Moderate
	e) Nuclear Waste Disposal Program	$0.60	Yes	Moderate
	f) Nuclear waste disposal fees	$0.30	Yes	Moderate
	g) Rural Utilities Service	$0.60	Yes	Moderate
	h) Other Energy subsidies	$8.80		
Mining and Timber		$3.80		
	a) Mine Safety and Health Administration	$1.00	No	
	b) Minerals Management Service	$0.90	Yes	Low
	c) Bureau of Mines	$0.90	Yes	Low
	d) 1872 Mining Act	$0.30	Yes	Moderate
	e) Timber sales from national forests	$0.70	Yes	Moderate
Transportation		$30.60		
Aerospace and High-Tech Industry		$16.70		
	a) NASA space station	$10.40	No	
	b) NASA Advanced Subsonic and Supersonic Research	$1.80	No	
	c) Military export sales	$2.50	No	
	d) Sematech and Technology Reinvestment Project	$1.50	No	
	e) Advanced Technology Program	$0.50	No	

Industrial Sector	Type of Spending Subsidy	5-year Savings w/o Subsidy (billions)	Potential to change environmental impact	Degree of change
Finance		$2.20		
	a) FDIC examinations of state-chartered banks	$1.50	No	
	b) Securities and Exchange Commission	$0.40	No	
	c) Commodities Futures Trading Commission	$0.30	No	
Miscellaneous		$31.30		
	a) Federal Communications Commission (FCC)	$11.60	No	
	b) Special hospital subsidies	$5.90	No	
	c) Wastewater Treatment Grants	$2.60	Yes	Significant (
	d) University overhead payments	$1.60	No	
	e) Small Business Administration (SBA)	$1.60	No	
	f) Food and Drug Administration	$1.40	No	
	g) Export-Import Bank	$1.40	Yes	Low
	h) Superfund	$1.00	Yes	Moderate
	i) Public housing	$0.90	No	
	j) Travel and Tourism Administration and International Trade Administration	$0.80	No	
	k) Davis-Bacon Act	$0.80	No	
	l) Market Promotion Program	$0.50	No	
	m) Native American Business Grants	$0.40	No	
	n) Overseas Private Investment Corporation (OPIC)	$0.30	Yes	Low
	o) Bureau of Alcohol, Tobacco and Firearms	$0.30	No	
	p) National Parks concessions	$0.20	No	
All Sectors Combined		$131.20		

Sources: (Shapiro, 1995) and assessments by Abt Associates Inc.

It does not appear that the cutback in the spending subsidies proposed by the Progressive Policy Institute would significantly alter the production and/or output of the six targeted industries for two reasons. First, the majority of the subsidies listed in Exhibit 2-1 do not directly affect the manufacturing industries or the nonmanufacturing industries included in this analysis. Second, the magnitude of savings associated with the identified rollbacks appears to be relatively small.

2.2 TAX EXPENDITURES

2.2.1 Overview of All Tax Subsidies

The term "tax expenditure" is used to describe a government spending program that is implemented through the Internal Revenue Code. It is an entitlement paid out to any business meeting specified eligibility rules regardless of cost. Tax expenditures are distributed more widely across industries than are spending subsidies, and therefore are more likely to affect the six industries included in this analysis. In addition, due to their magnitude, tax expenditures should have a greater influence on industrial production processes. Exhibit 2-2 presents estimates of governmental savings from a rollback in tax subsidies to several industries and their sub-sectors (Shapiro, 1995). Tax expenditures affecting agribusiness were omitted from this table, as in Exhibit 2-1, except for the five-year total proposed cutback. Sub-sectors of energy were also excluded, because none of the tax subsidies to these areas are related to either electricity or petroleum. Again, an initial assessment of the environmental impact of the Progressive Policy Institute's proposals is included in the final two columns of the exhibit. Based upon this assessment, it is unclear whether significant environmental improvements could be obtained by reducing these tax subsidies.

Exhibit 2-3 presents federal estimates of tax expenditures. These estimates were derived from data developed by the Joint Committee on Taxation (1993). Although its findings are not organized to evaluate the specific industries targeted in the current analysis, the Joint Committee report is especially useful because of its comprehensiveness. The report is a complete inventory of federal tax expenditure estimates to every sub-sector of each function category for fiscal years 1995-1999. It also gives clues to whether expenditures in a given sub-sector are projected to increase or decrease over the next several years. When the Committee's figures included an upper bound (i.e. <$0.05 billion) to arrive at sub-sector estimates, a value of $50 million was assumed. The summation of these estimates results in the upper-bound function totals indicated in bold-face in all five fiscal year columns. Again, an appraisal of each expenditure's environmental impact is provided under the "Degree of Change" heading. The notation "Ambiguous" means that an activity may be protective of, rather than harmful to, the environment. For business and commerce, which would include manufacturing industries, the depreciation of buildings and of equipment were two sizeable federal subsidies with unknown potential to affect the environment.

Exhibit 2-2: Tax Subsidies by Industrial Sector

Industrial Sector	Type of Tax Subsidy	5-year Savings w/o Subsidy (billions)	Potential to change environmental impact	Degree of change
Energy		$21.10		
Construction		$17.40		
	a) Tax depreciation on rental housing	$7.30	No	
	b) Private-purpose revenue bonds	$5.30	No	
	c) Low-income housing credit	$4.50	No	
	d) Tax credit for rehabilitating older buildings	$0.30	No	
Finance		$5.00		
	a) Exemption of credit union income	$3.40	No	
	b) Special deduction for certain health insurers	$0.90	No	
	c) Taxable income adjustment for small life insurance firms	$0.50	No	
	d) Exemption of certain income for small property and casualty insurance companies	$0.20	No	
Agribusiness		$2.90		
Timber		$1.00		
	a) Timber-industry exception from uniform capitalization rules	$0.90	Yes	Moderate
	b) Special tax credit for timber companies' reforestation costs	$0.10	Yes	Moderate
Miscellaneous		$54.40		
	a) U.S. territorial possessions tax credit	$19.70	No	
	b) Expensing of advertising costs	$18.30	No	
	c) Foreign sales corporations	$7.50	No	
	d) Tax deferral on income of controlled foreign corporations	$5.70	Yes	Low
	e) Business entertainment	$2.00	No	
	f) Tax benefit for selling a broadcasting facility to a minority-owned business	$0.50	No	
	g) Capital construction by shipping companies	$0.40	No	
	h) Expensing of magazine circulation expenses	$0.20	No	
	i) Magazine, paperback book, and record returns	$0.10	No	
All Sectors Combined		$101.80		

Sources: (Shapiro, 1995) and assessments by Abt Associates Inc.

Exhibit 2-3: Tax Expenditure Estimates By Budget Function, Fiscal Years 1995-1999

(Billions of Dollars)

Function	1995	1996	1997	1998	1999	Potential to change environmental impact	Degree of change
International affairs	**$6.20**	**$6.40**	**$6.50**	**$6.60**	**$6.80**		
a) Exclusion of income of foreign sales corporations (FSCs)	$1.40	$1.50	$1.50	$1.50	$1.60	No	
b) Deferral of income of controlled foreign corporations	$1.10	$1.10	$1.10	$1.20	$1.20	Yes	Low
c) Inventory property sales source rule exception	$3.50	$3.60	$3.70	$3.70	$3.80	No	
d) Interest allocation rules exception for certain nonfinancial institutions	$0.20	$0.20	$0.20	$0.20	$0.20	No	
General science, space, and technology	**$1.00**	**$0.50**	**$0.20**	**$0.10**	**$0.10**		
a) Expensing of research and development expenditures	$1.00	$0.50	$0.20	$0.10	$0.10	Yes	Ambiguous
Energy	**<$2.15**	**<$2.45**	**<$2.55**	**<$2.70**	**<$2.70**		
Natural resources and environment	**<$1.05**	**<$1.05**	**<$1.15**	**<$1.15**	**<$1.15**		
a) Expensing of exploration and development costs, nonfuel minerals	<$0.05	<$0.05	<$0.05	<$0.05	<$0.05	Yes	Significant
b) Excess of percentage over cost depletion, nonfuel minerals	$0.20	$0.20	$0.20	$0.20	$0.20	Yes	Moderate
c) Investment credit and 7-year amortization for reforestation expenditures	<$0.05	<$0.05	<$0.05	<$0.05	<$0.05	Yes	Significant
d) Expensing of multiperiod timber-growing costs	$0.40	$0.40	$0.50	$0.50	$0.50	Yes	Moderate
d) Exclusion of interest on State and local government sewage, water, and hazardous waste facilities bonds	$0.20	$0.20	$0.20	$0.20	$0.20	Yes	Moderate
e) Investment tax credit for rehabilitation of historic structures	$0.10	$0.10	$0.10	$0.10	$0.10	No	
f) Special rules for mining reclamation services	<$0.05	<$0.05	<$0.05	<$0.05	<$0.05	Yes	Low
Agriculture	**<$0.30**	**<$0.30**	**<$0.30**	**<$0.30**	**<$0.30**		
Commerce and housing	**<$38.40**	**<$38.80**	**<$38.05**	**<$37.90**	**<$38.00**		
Financial institutions	*$0.80*	*$0.80*	*$0.80*	*$0.90*	*$0.90*		
a) Bad-debt reserves of financial institutions	$0.10	$0.10	$0.10	$0.10	$0.10	No	
b) Exemption of credit union income	$0.70	$0.70	$0.70	$0.80	$0.80	No	

Function	1995	1996	1997	1998	1999	Potential to change environmental impact	Degree of change
Insurance companies	*<$5.05*	*<$5.55*	*<$5.75*	*<$6.25*	*<$6.75*		
a) Exclusion of investment income on life insurance and annuity contracts	$0.80	$0.90	$1.00	$1.10	$1.20	No	
b) Exclusion of investment income from structured settlement accounts	<$0.05	<$0.05	<$0.05	<$0.05	<$0.05	No	
c) Small life insurance company taxable income adjustment	$0.10	$0.10	$0.10	$0.10	$0.10	No	
d) Special treatment of life insurance company reserves	$2.10	$2.30	$2.50	$2.70	$2.90	No	
e) Deduction of unpaid property loss reserves for property and casualty insurance companies	$1.60	$1.80	$1.90	$2.10	$2.30	No	
f) Special alternative tax on small property and casualty insurance companies	<$0.05	<$0.05	<$0.05	<$0.05	<$0.05	No	
g) Tax exemption for certain insurance companies	<$0.05	<$0.05	<$0.05	<$0.05	<$0.05	No	
h) Special deduction for Blue Cross and Blue Shield companies	$0.30	$0.30	$0.10	$0.10	$0.10	No	
Housing	*$2.50*	*$2.60*	*$2.60*	*$2.60*	*$2.60*		
a) Exclusion of interest on State and local government bonds for owner-occupied housing	$0.50	$0.50	$0.50	$0.40	$0.40	No	
b) Exclusion of interest on State and local government bonds for rental housing	$0.20	$0.20	$0.20	$0.20	$0.20	No	
c) Depreciation of rental housing in excess of alternative depreciation system	$1.00	$1.00	$0.90	$0.80	$0.70	No	
d) Low-income housing tax credit	$0.80	$0.90	$1.00	$1.20	$1.30	No	
Other business and commerce	*<$30.05*	*<$29.85*	*<$28.90*	*<$28.15*	*<$27.75*		
a) Depreciation of buildings other than rental housing in excess of alternative depreciation system	$3.50	$3.20	$2.70	$2.10	$1.50	Yes	Low
b) Depreciation of equipment in excess of alternative depreciation system	$19.90	$19.90	$19.60	$19.10	$19.20	Yes	Significant
c) Expending of up to $17,500 of depreciable business property	$0.90	$0.70	$0.50	$0.30	$0.10	No	
d) Amortization of business startup costs	<$0.05	<$0.05	<$0.05	<$0.05	<$0.05	Yes	Low
e) Reduced rates for first $10,000,000 of corporate taxable income	$3.90	$4.10	$4.30	$4.50	$4.70	Yes	Moderate
f) Permanent exemption from imputed interest rules	<$0.05	<$0.05	<$0.05	<$0.05	<$0.05	Yes	Low
g) Expensing of magazine circulation expenditures	<$0.05	<$0.05	<$0.05	<$0.05	<$0.05	No	
h) Special rules for magazine, paperback book, and record returns	<$0.05	<$0.05	<$0.05	<$0.05	<$0.05	No	
i) Deferral of gain on non-dealer installment sales	$0.40	$0.40	$0.40	$0.50	$0.50	No	
Other business and commerce, continued							
j) Completed contract rules	$0.20	$0.20	$0.20	$0.20	$0.20	No	
k) Cash accounting, other than agriculture	<$0.05	<$0.05	<$0.05	<$0.05	<$0.05	No	
l) Exclusion of interest on State and local government small-issue industrial development bonds	$0.10	$0.10	$0.10	$0.10	$0.10	Yes	Low
m) Deferral of gain on like-kind exchanges	$0.40	$0.50	$0.50	$0.50	$0.60	No	

Function	1995	1996	1997	1998	1999	Potential to change environmental impact	Degree of change
n) Exception from net operating loss limitations for corporations in bankruptcy proceedings	$0.40	$0.40	$0.50	$0.50	$0.50	Yes	Low
o) Deferral of gains from sale of broadcasting facilities to minority-owned businesses	$0.10	$0.10	$0.10	$0.10	$0.10	No	
Transportation	**<$0.15**	**<$0.15**	**<$0.15**	**<$0.15**	**<$0.15**		
Community and regional development	**<$0.45**	**<$0.45**	**<$0.45**	**<$0.65**	**<$0.65**		
a) Investment credit for rehabilitation of structures, other than historic structures	<$0.05	<$0.05	<$0.05	<$0.05	<$0.05	No	
b) Exclusion of interest on State and local government bonds for private airports, docks, and mass-commuting facilities	$0.20	$0.20	$0.20	$0.30	$0.30	Yes	Moderate
c) Regional economic development tax incentives: empowerment zones, enterprise communities, and Indian investment incentives	$0.20	$0.20	$0.20	$0.30	$0.30	Yes	Moderate
Education, training, employment, and social services	**<$2.70**	**<$2.40**	**<$2.40**	**<$2.50**	**<$2.50**		
Education and training	*$1.10*	*$0.80*	*<$0.75*	*<$0.75*	*<$0.75*		
a) Exclusion of interest on State and local government student loan bonds	$0.10	$0.10	<$0.05	<$0.05	<$0.05	No	
b) Exclusion of interest on State and local government bonds for private nonprofit educational facilities	$0.20	$0.20	$0.20	$0.20	$0.20	No	
c) Deductibility of charitable contributions for educational institutions	$0.50	$0.50	$0.50	$0.50	$0.50	No	
d) Exclusion for employer-provided educational assistance benefits	$0.30	ND	ND	ND	ND	No	
Employment	*$1.10*	*$1.10*	*<$1.15*	*<$1.25*	*<$1.25*		
b) Special tax provisions for employee stock ownership plans (ESOPs)	$0.90	$1.00	$1.10	$1.20	$1.20	No	
h) Targeted jobs tax credit	$0.20	$0.10	<$0.05	<$0.05	<$0.05	No	
Social services	*<$0.50*	*<$0.50*	*<$0.50*	*<$0.50*	*<$0.50*		
a) Deductibility of charitable contributions, other than for education and health	$0.40	$0.40	$0.40	$0.40	$0.40	No	
e) Expensing of costs for removing architectural barriers	<$0.05	<$0.05	<$0.05	<$0.05	<$0.05	Yes	Low
f) Credit for disabled access expenditures	<$0.05	<$0.05	<$0.05	<$0.05	<$0.05	No	
Health	**$0.70**	**$0.70**	**$0.80**	**$0.90**	**$0.90**		
d) Exclusion of interest on State and local government bonds for private nonprofit hospital facilities	$0.40	$0.40	$0.50	$0.50	$0.50	No	
e) Deductibility of charitable contributions to health organizations	$0.30	$0.30	$0.30	$0.40	$0.40	No	
Veterans' benefits and services	**<$0.05**	**<$0.05**	**<$0.05**	**<$0.05**	**<$0.05**		
d) Exclusion of interest on State and local government bonds for veterans' housing	<$0.05	<$0.05	<$0.05	<$0.05	<$0.05	No	
General purpose fiscal assistance	**$6.90**	**$7.10**	**$7.50**	**$7.80**	**$8.00**		

Function	1995	1996	1997	1998	1999	Potential to change environmental impact	Degree of change
a) Exclusion of interest on public purpose State and local government debt	$3.20	$3.30	$3.50	$3.70	$3.80	No	
c) Tax credit for section 936 income	$3.70	$3.80	$4.00	$4.10	$4.20	No	

Sources: Joint Committee on Taxation, 1994 and assessments by Abt Associates Inc.

ND: No data

Footnotes to table:

(1) Estimate includes amounts of employer-provided health insurance purchased through cafeteria plans and employer-provided child care purchased dependent care flexible spending accounts. These amounts are also included in other line items in this table.

(2) Estimate includes employer-provided child care purchased through dependent care flexible spending accounts.

(3) Estimate includes employer-provided health insurance purchased through cafeteria plans.

(4) The figures in the table show the effect of the EITC on receipts. The increase in outlays is: $18.6 billion in 1995, $20.6 billion in 1996, $21.6 billion in 1997, $22.2 billion in 1998, and $22.9 billion in 1999.

Exhibit 2-4: Tax Expenditures to Corporations, 1995-1999

Summary Cost Table (fiscal years, $-billions)			
Business & Investment	**1995**	**1995-1999**	**(Average 1995-1999)/1995**
Capital gains (except homes)	$0.40	$2.50	125.00%
Accelerated depreciation	$23.30	$114.50	98.28%
Tax free bonds, public & private	$6.60	$34.00	103.03%
Insurance cos. and products	$4.70	$27.60	117.45%
Multinational	$8.90	$46.60	104.72%
Business meals & entertainment	$3.30	$18.00	109.09%
Oil, gas, energy	$2.60	$14.70	113.08%
Low-income housing credit	$0.60	$4.10	136.67%
R&D tax breaks	$2.80	$10.00	71.43%
Timber, agriculture, minerals	$0.70	$4.00	114.29%
Special ESOP rules	$1.40	$6.60	94.29%
Financial institutions (non-insur.)	$0.90	$4.90	108.89%
Installment sales	$0.30	$1.70	113.33%
Empowerment zones	$0.10	$1.00	200.00%
Other business & investment	$8.50	$45.30	106.59%
Total business and investment	$65.00	$335.40	103.20%

Sources: McIntyre, 1995 and calculations by Abt Associates Inc.

Exhibit 2-4 presents tax expenditures to corporations separated into various categories (McIntyre, 1995). The second column provides total costs for each category for fiscal year 1995. The third column presents estimated five-year total tax expenditures for these categories. The fourth column provides an indication of the direction of change in subsidies by comparing the 1995 levels with the predicted average over the 1995-1999 period. If the 1995 level is less than the average, the subsidy is expected to increase over the period. If it is greater than the average, the subsidy is expected to decrease over the period. Accelerated depreciation again appeared to be the most significant subsidy because of its high budgetary cost as a proportion of total tax expenditures.

As a result of these analyses, we elected to concentrate next on characterizing the extent to which the six industries included in this analysis are affected by accelerated depreciation tax subsidies.

2.2.2 Accelerated Depreciation

Accelerated depreciation allows a firm to write off the costs of its machinery and buildings (capital) at a rate faster than they actually depreciate. Exhibit 2-5 provides a list of the expected costs of seven types of accelerated depreciation over the next five fiscal years (McIntyre, 1995). Once again, included is an evaluation of whether or not a particular subsidy could have an environmental impact. Although the derivation of some components of the accelerated depreciation estimates do not exactly match the estimates of the Joint Committee on Taxation, this set is presented because it represents an attempt to summarize one subsidy of key importance to the objectives of this analysis.

Since accelerated depreciation is a large component of tax expenditures, it follows that is also a principal component of the total tax expenditure subsidies received by the six industries being analyzed. Exhibit 2-6 provides a general capital investment profile for each industry, in terms of capital stocks.

Gross stock is the present value of the stock of "unused"fixed capital. *Net stock* is the value of the gross stock less cumulative depreciation. *Depreciation* is the value of capital lost through physical deterioration, obsolescence, accidents, and aging. The amount of depreciation is determined according to a number of different accounting methods, and reflects the current tax policies related to accelerating depreciation schedules.

The value of gross and net stocks together show how the investment profile within each industry changes over time. For example, the overall level of investment in the electric utilities industry, measured by the change in gross stocks, increased from 1988 to 1989. In other words, the gross stock in 1989 exceeded that in 1988. However, the net stock actually decreased between those years. This implies that the depreciation of past investment exceeded the value of new investment. The difference between net stocks and annual depreciation for a specific

industry in given year indicates the level of remaining future depreciation. Also included in Exhibit 2-6 are the value of *discards*--the value of gross investment that is retired--and the average ages of the gross and net stock. Exhibit 2-7 presents all values from Exhibit 2-6 in terms of U.S. industrial totals.

Exhibit 2-8 approximates the level of 1995 accelerated depreciation tax expenditures in the six industries based on their proportions of 1988-89 annual depreciation for all industries (calculated in Exhibit 2-7). The values were back-calculated by multiplying each industry's percent of total U.S. industrial depreciation by the national total estimates of 1995 accelerated depreciation tax expenditures. As this table demonstrates, approximately 23 percent of U.S. capital depreciation occurs in these six industries alone, and therefore we would expect them to benefit from a similar percentage of total accelerated depreciation subsidies. The values reported also indicate that mining and electric utilities should receive the most subsidization by way of accelerated depreciation.

After determining that the six industries being evaluated receive a large proportion of the accelerated depreciation subsidies provided under the Tax Code, the focus of this analysis shifted to a review of the capital investments made by these industries that might be affected by a change in accelerated depreciation. This capital expenditure analysis is presented in Section 3.

Exhibit 2-5: Estimates of Accelerated Depreciation Tax Expenditures, Fiscal Years 1995-1999

(Billions of dollars)

Type	1995	1996	1997	1998	1999	1995-1999	Potential to change environmental impact	Degree of change
Accelerated depreciation of machinery and equipment	$18.00	$18.50	$18.70	$19.00	$20.00	**$94.10**	Yes	Significant
Accelerated depreciation of buildings other than rental housing	$3.40	$3.10	$2.60	$2.00	$1.40	**$12.50**	Yes	Low
Accelerated depreciation on rental housing	$0.90	$0.90	$0.90	$0.90	$0.90	**$4.60**	No	
Expensing of certain small investments	$0.90	$0.70	$0.50	$0.30	$0.20	**$2.60**	No	
Amortization of start-up costs	$0.10	$0.10	$0.10	$0.10	$0.10	**$0.30**	Yes	Low
Tax incentives for preservation of historic structures	$0.10	$0.10	$0.10	$0.10	$0.10	**$0.30**	No	
Expensing of costs of removing architectural barriers	$0.00	$0.00	$0.00	$0.00	$0.00	**$0.10**	Yes	Low
Total Accelerated Depreciation	**$23.30**	**$23.30**	**$22.90**	**$22.40**	**$22.60**	**$114.50**		

Sources: McIntyre, 1995 and assessments by Abt Associates Inc.

Exhibit 2-6: Capital Stocks and Annual Depreciation, by Industry, 1988-1989
(Equipment and Structures)

Industry	Year	Millions of 1987 dollars				Average Age (Years)	
		End of year		Annual Totals			
		Gross stock	Net stock	Depreciation	Discards	Gross	Net
Total Chemicals (average 1988/9)		226,548	124,536	11,507	9,665	10.46	7.52
Chemicals and allied products	1988	222,620	121,526	11,358	9,590	10.50	7.61
	1989	230,476	127,546	11,656	9,740	10.42	7.42
Total Electric utilities (average 1988/9)		766,425	450,602	25,970	13,924	15.48	11.09
Electric services	1988	760,991	451,144	25,631	13,694	15.33	10.93
	1989	771,859	450,059	26,309	14,154	15.63	11.25
Total Mining (average 1988/9)		468,703	225,955	34,202	31,817	8.61	6.38
Mining	1988	475,376	232,947	34,739	30,817	8.44	6.22
	1989	462,029	218,962	33,665	32,817	8.78	6.53
Total Petroleum products (average 1988/9)		148,523	77,588	5,701	4,166	16.50	12.29
Petroleum and coal products	1988	112,057	59,353	4,740	3,317	13.09	9.48
	1989	112,204	58,359	4,731	3,471	13.37	9.73
Pipelines, except natural gas	1988	36,610	19,044	974	781	19.53	14.70
	1989	36,174	18,420	957	763	20.01	15.26

Industry	Year	Millions of 1987 dollars				Average Age (Years)	
		End of year		Annual Totals			
Total Primary metals (average 1988/9)		213,511	100,315	9,062	8,106	13.03	9.45
Primary metals	1988	181,878	85,210	7,087	6,571	15.38	11.31
	1989	181,091	84,061	7,034	6,565	15.58	11.32
Metal mining	1988	32,032	15,876	2,000	1,466	10.44	7.52
	1989	32,020	15,483	2,002	1,610	10.71	7.66
Total Pulp and paper (average 1988/9)		153,962	84,244	8,136	6,632	10.32	7.32
Lumber and wood products	1988	37,642	19,172	2,215	2,535	10.53	7.67
	1989	37,233	19,094	2,151	2,425	10.71	7.73
Paper and allied products	1988	113,493	62,961	5,821	4,128	10.10	7.07
	1989	119,555	67,261	6,084	4,176	9.92	6.81
Total of 6 industries	1988	1,972,699	1,067,233	94,565	72,899	N/A	N/A
	1989	1,982,641	1,059,245	94,589	75,721	N/A	N/A
Average of 6 industries	1988	328,783.17	177,872.17	15,760.83	12,149.83	12.30	8.94
	1989	330,440.17	176,540.83	15,764.83	12,620.17	12.50	9.08
Total U.S. industry	1988	8,045,345	4,561,885	408,141	282,900	11.66	8.23
	1989	8,272,220	4,672,865	425,261	299,580	11.70	8.25

Source: Bureau of Economic Analysis, 1993.

Exhibit 2-7: Capital Stocks and Annual Depreciation, as a % of Total U.S. Industry, 1988-1989

(Equipment and Structures)

Industry	Year	Millions of 1987 dollars End of year		Annual Totals		Years End of Year	
		Gross stock	Net stock	Depreciation	Discards	Average age Gross	Net
Total Chemicals (average 1988/9)		**2.78%**	**2.70%**	**2.76%**	**3.32%**	**89.56%**	**91.20%**
Chemicals and allied products	1988	2.77%	2.66%	2.78%	3.39%	90.05%	92.47%
	1989	2.79%	2.73%	2.74%	3.25%	89.06%	89.94%
Total Electric utilities (average 1988/9)		**9.39%**	**9.76%**	**6.23%**	**4.78%**	**132.53%**	**134.59%**
Electric services	1988	9.46%	9.89%	6.28%	4.84%	131.48%	132.81%
	1989	9.33%	9.63%	6.19%	4.72%	133.59%	136.36%
Total Mining (average 1988/9)		**5.75%**	**4.90%**	**8.21%**	**10.92%**	**73.71%**	**77.36%**
Mining	1988	5.91%	5.11%	8.51%	10.89%	72.38%	75.58%
	1989	5.59%	4.69%	7.92%	10.95%	75.04%	79.15%
Total Petroleum products (average 1988/9)		**1.82%**	**1.68%**	**1.37%**	**1.43%**	**141.26%**	**149.18%**
Petroleum and coal products	1988	1.39%	1.30%	1.16%	1.17%	112.26%	115.19%
	1989	1.36%	1.25%	1.11%	1.16%	114.27%	117.94%
Pipelines, except natural gas	1988	0.46%	0.42%	0.24%	0.28%	167.50%	178.61%
	1989	0.44%	0.39%	0.23%	0.25%	171.03%	184.97%
Total Primary metals (average 1988/9)		**2.62%**	**2.17%**	**2.18%**	**2.78%**	**111.54%**	**114.71%**
Primary metals	1988	2.26%	1.87%	1.74%	2.32%	131.90%	137.42%
	1989	2.19%	1.80%	1.65%	2.19%	133.16%	137.21%
Metal mining	1988	0.40%	0.35%	0.49%	0.52%	89.54%	91.37%
	1989	0.39%	0.33%	0.47%	0.54%	91.54%	92.85%
Total Pulp and paper (average 1988/9)		**1.89%**	**1.82%**	**1.95%**	**2.28%**	**88.31%**	**88.84%**
Lumber and wood products	1988	0.47%	0.42%	0.54%	0.90%	90.31%	93.20%
	1989	0.45%	0.41%	0.51%	0.81%	91.54%	93.70%
Paper and allied products	1988	1.41%	1.38%	1.43%	1.46%	86.62%	85.91%
	1989	1.45%	1.44%	1.43%	1.39%	84.79%	82.55%
Average of 6 industries	**1988**	**4.09%**	**3.90%**	**3.86%**	**4.29%**	**105.50%**	**108.62%**
	1989	**3.99%**	**3.78%**	**3.71%**	**4.21%**	**106.81%**	**110.01%**

Source: Calculated from Exhibit 2-6.

Exhibit 2-8: Depreciation and Estimated Accelerated Depreciation Tax Expenditures, by Targeted Industry
(Equipment and Structures)

	Year	1988-1989 Average Annual Depreciation (millions of dollars)	Percent of Total U.S. Industrial Depreciation[1]	Estimated 1995 Accelerated Depreciation Tax Expenditures (millions of dollars)[2]
Total U.S. Industry (average 1988/9)		**416,701**	**100.00%**	**23,300.00**[3]
Total Chemicals (average 1988/9)		**11,507**	**2.76%**	**643.52**
Chemicals and allied products	1988	11,358	2.78%	648.41
	1989	11,656	2.74%	638.63
Total Electric utilities (average 1988/9)		**25,970**	**6.23%**	**1,452.35**
Electric services	1988	25,631	6.28%	1,463.23
	1989	26,309	6.19%	1,441.47
Total Mining (average 1988/9)		**34,202**	**8.21%**	**1,913.84**
Mining	1988	34,739	8.51%	1,983.18
	1989	33,665	7.92%	1,844.50
Total Petroleum products (average 1988/9)		**5,701**	**1.37%**	**318.92**
Petroleum and coal products	1988	4,740	1.16%	270.60
	1989	4,731	1.11%	259.21
Pipelines, except natural gas	1988	974	0.24%	55.60
	1989	957	0.23%	52.43
Total Primary metals (average 1988/9)		**9,062**	**2.18%**	**506.92**
Primary metals	1988	7,087	1.74%	404.58
	1989	7,034	1.65%	385.39
Metal mining	1988	2,000	0.49%	114.18
	1989	2,002	0.47%	109.69
Total Pulp and paper (average 1988/9)		**8,136**	**1.95%**	**454.98**
Lumber and wood products	1988	2,215	0.54%	126.45
	1989	2,151	0.51%	117.85
Paper and allied products	1988	5,821	1.43%	332.31
	1989	6,084	1.43%	333.34
Total of 6 industries	**1988**	**94,565**	**23.17%**	**5,399**
	1989	**94,589**	**22.24%**	**5,183**
Average of 6 industries	**1988**	**15,760.83**	**3.86%**	**899.76**
	1989	**15,764.83**	**3.71%**	**863.75**

Sources: Exhibits 2-6 and 2-7 unless otherwise noted.

1 Assumed to represent accelerated depreciation tax expenditures.

2 Calculated as the industry percent of depreciation applied to national accelerated depreciation tax expenditures.

3 Source: McIntyre, Robert S. April 1995. Tax Expenditures: The Hidden Entitlements. Citizens for Tax Justice.

3. DISAGGREGATED CAPITAL EXPENDITURES FOR SELECTED INDUSTRIES

The objective of this component of the analysis was to identify, to the extent possible, the composition of capital investment being made by industries. Any change to depreciation allowances would have an impact on all types of capital investment, and as a result, may have an impact on production activities and associated use of resources or emission of pollutants. Because most firms in all industries expend a portion of their capital investments for pollution abatement activities as well as for process enhancements that may either reduce emissions or reduce resource use, it is important to identify the extent to which these types of investments might also be affected by changes in depreciation allowances. Four types of sources were used to characterize the capital expenditures of the industries selected as the focus for this analysis. Quantitative data came from two sources: U.S. Department of Commerce survey data, and industry trade surveys. Qualitative descriptions of the investment trends in specific industries were obtained from U.S. Department of Commerce Industrial Outlook reports and from trade publications.

3.1 OVERVIEW OF TRENDS

3.1.1 Quantitative Data Sources and Definitions

The primary sources of data on capital expenditures used in this report are annual editions of the U.S. Department of Commerce Current Industrial Reports: Pollution Abatement Costs and Expenditures (PACE), from 1984-1994 (excepting 1987). These data are obtained through a survey of manufacturing establishments; the survey is administered to a sample panel of approximately 17,000 establishments that are a subsample of selected years of the Annual Survey of Manufactures (ASM). The ASM is a sample selected from the Census of Manufactures, supplemented by new establishments identified by the Social Security Administration. PACE surveys for 1989-1994 are based on the 1989 ASM, which is based on the 1987 Census; and 1984-1988 surveys were based on the 1984 ASM (1982 Census). The probability of a firm's selection for the PACE survey is based on the value of shipments reported in the ASM. Data for nonmanufacturing industries (mining, petroleum, and electric utilities) were obtained through a different survey: the Bureau of Census Plant and Equipment Survey: Supplement for Pollution Abatement. This survey has been conducted annually since 1988; previously it was conducted by the Bureau of Economic Analysis.

The PACE reports provide ASM data on annual new capital expenditures, as well as PACE survey data on pollution abatement capital expenditures. These data are reported by major industrial group (2-digit SIC). Pollution abatement expenditure data are further broken down by medium (air, water, or solid waste) and by abatement technique (end-of-line or changes in product process). In addition, since 1992, the PACE includes data on "non-media and other" capital expenditures, which include underground storage tanks and site cleanup; noise abatement; radiation abatement; and multimedia expenditures. Some definitions and terminology were

changed beginning with the 1992 survey form, which may affect year-to-year comparisons. Specifically, the term "pollution" was redefined as "unwanted emissions or wastes" that are "harmful to the environment," and pollution abatement expenditures were defined more narrowly to refer to only those whose primary purpose is environmental protection. These changes were also included in the Plant and Equipment Survey for nonmanufacturing industries.

The Annual Survey of Manufactures itself (reported in periodic issues of Annual Survey of Manufactures: Statistics for Industry Groups and Industries) was the basis for two types of data included in this report: data on the division of new capital expenditures between machinery and equipment and buildings and structures, and new capital expenditures for 1987, when the PACE survey was not conducted and so no PACE report was produced.

There are limitations in interpreting the PACE data. Specifically, the division of capital expenditures between end-of-line and product process enhancements is potentially weak. Respondents were asked to identify the portion of expenditures that is the pollution abatement share of enhancement projects intended for environmental protection. In other words, they were asked to make an estimate of the *incremental* costs of the structures and equipment due to the inclusion of pollution abatement features. The PACE reports state that interviews with survey respondents indicate that these incremental estimates are difficult to make in many instances. In addition, prior to 1992, the abatement technique data did not include solid waste expenditures, only expenditures for air and water pollution abatement.

In this analysis, the total PACE expenditures for specific media plus the total expenditures including nonmedia (termed "Total PACENM" in the tables) have been included. Because nonmedia expenditures were not reported prior to 1992, we estimated nonmedia expenditures for prior years based on the ratio between the sum of nonmedia to total media, averaged over 1992 and 1993. We then applied this percentage to the total media expenditures in prior years to estimate unreported nonmedia expenditures, on the assumption that the types of expenditures included in that classification were ongoing prior to 1992. For example, for 1992-1993 nonmedia expenditures were approximately 2.4 percent of total media expenditures in the Paper and Allied Products industry, which was then applied to total media expenditures in all other years to calculate the level of non-media expenditures in those years.

3.1.2 Trends in Capital Expenditures: Overview

For most industries, capital investments are predominantly for machinery and equipment, rather than for buildings and structures (Exhibit 3-1). Buildings and structures ranged from a low of 8.0 percent of new capital expenditures in 1991 for the paper and allied products industry to a high of 37.6 percent for the petroleum and coal products industry in 1984. The chemicals and allied products industry has the highest average level of expenditure for buildings and structures, but in the context of the highest overall capital expenditures for the industries under review. Unlike building and structure investments, expenditures on machinery and equipment are directly

Exhibit 3-1: Summary of Capital Expenditures for Plant and Equipment by Targeted Industry: 1984-1994

millions of dollars (except percentages) Totals may not agree with detail due to independent rounding

SIC Code	Major Group	Year	New Capital Expenditures Total	Buildings and other structures	Machinery and equipment	Used Capital expenditures Total	Buildings and other structures	Machinery and equipment
26	Paper and allied products	1994	7,311.7	701.5	6610.2	347.8	34.8	313.0
				9.59%	90.41%		10.01%	89.99%
		1993	7,370.3	878.9	6,491.3	303.0	49.0	254.0
				11.92%	88.07%		16.17%	83.83%
		1992	7,950.4	781.3	7,169.2	599.2	74.3	524.9
				9.83%	90.17%		12.40%	87.60%
		1991	9,008.7	723.5	8,285.3	268.8	54.2	214.5
				8.03%	91.97%		20.16%	79.80%
		1990	10,809.2	1,055.0	9,754.2	288.7	44.5	244.2
				9.76%	90.24%		15.41%	84.59%
		1989	10,067.1	1,116.3	8,950.8	283.2	55.2	228.0
				11.09%	88.91%		19.49%	80.51%
		1988	7,210.6	762.3	6,448.3	340.9	64.6	276.3
				10.57%	89.43%		18.95%	81.05%
		1987	5,752.5	740.5	5,012.0	427.4	59.5	367.9
				12.87%	87.13%		13.92%	86.08%
		1986	6,084.4	754.9	5,329.5	375.3	43.2	332.1
				12.41%	87.59%		11.51%	88.49%
		1985	6,272.7	565.9	5,706.8	248.5	57.9	190.6
				9.02%	90.98%		23.30%	76.70%
		1984	5,301.6	485.8	4,815.8	200.5	43.3	157.2
				9.16%	90.84%		21.60%	78.40%
28	Chemicals and allied products	1994	15,455.0	2,551.5	12,903.5	388.5	124.2	264.3
				16.51%	83.49%		31.97%	68.03%
		1993	15,690.0	2,749.3	12,940.8	505.2	244.0	261.2
				17.52%	82.48%		48.30%	51.70%
		1992	16,384.1	2,609.7	13,774.5	695.2	160.7	534.3
				15.93%	84.07%		23.12%	76.86%
		1991	16,008.7	2,615.3	13,393.3	178.9	49.0	129.9
				16.34%	83.66%		27.39%	72.61%
		1990	15,202.1	2,510.6	12,691.5	259.8	72.2	187.6
				16.51%	83.49%		27.79%	72.21%
		1989	13,480.0	2,143.2	11,336.8	191.0	63.1	127.9
				15.90%	84.10%		33.04%	66.96%
		1988	10,858.0	1,693.2	9,164.8	269.0	108.9	160.1
				15.59%	84.41%		40.48%	59.52%
		1987	8,710.6	1,527.3	7,183.3	447.2	155.5	291.6
				17.53%	82.47%		34.77%	65.21%
		1986	7,907.4	1,288.1	6,619.3	206.2	71.6	134.6
				16.29%	83.71%		34.72%	65.28%
		1985	8,180.5	1,407.7	6,772.8	1,026.9	170.3	856.6
				17.21%	82.79%		16.58%	83.42%
		1984	7,643.3	1,271.9	6,371.4	208.7	55.5	153.2
				16.64%	83.36%		26.59%	73.41%

Exhibit 3-1: Summary of Capital Expenditures for Plant and Equipment by Targeted Industry: 1984-1994

millions of dollars (except percentages). Totals may not agree with detail due to independent rounding

SIC Code	Major Group	Year	New Capital Expenditures Total	Buildings and other structures	Machinery and equipment	Used Capital expenditures Total	Buildings and other structures	Machinery and equipment
29	Petroleum and coal products	1994	5,624.0	838.5	4,785.5	262.5	36.1	226.3
				14.91%	85.09%		13.75%	86.21%
		1993	6,302.4	800.3	5,502.1	145.5	34.0	111.5
				12.70%	87.30%		23.37%	76.63%
		1992	6,539.0	571.5	5,967.6	158.4	41.2	117.2
				8.74%	91.26%		26.01%	73.99%
		1991	5,895.9	807.8	5,088.1	291.0	21.0	270.0
				13.70%	86.30%		7.22%	92.78%
		1990	4,158.1	597.0	3,561.1	189.8	17.1	172.7
				14.36%	85.64%		9.01%	90.99%
		1989	3,331.2	642.1	2,689.0	57.6	8.5	49.1
				19.28%	80.72%		14.76%	85.24%
		1988	2,614.1	586.2	2027.9	64.5	23.1	41.4
				22.42%	77.58%		35.81%	64.19%
		1987	2,340.6	557.9	1782.6	106.5	52.4	54.1
				23.84%	76.16%		49.20%	50.80%
		1986	2,577.5	420.3	2,157.2	90.3	36.0	54.3
				16.31%	83.69%		39.87%	60.13%
		1985	3,438.0	1,215.2	2,222.8	83.8	9.4	74.4
				35.35%	64.65%		11.22%	88.78%
		1984	3,774.6	1,417.9	2,356.7	112.4	25.7	86.7
				37.56%	62.44%		22.86%	77.14%
33	Primary metals	1994	6,529.5	669.9	5,859.6	497.3	121.1	376.3
				10.26%	89.74%		24.35%	75.67%
		1993	4,744.4	535.8	4,208.6	285.2	47.2	238.0
				11.29%	88.71%		16.55%	83.45%
		1992	5,344.9	647.9	4,697.0	311.6	45.5	266.0
				12.12%	87.88%		14.60%	85.37%
		1991	5,878.7	472.6	5406.1	196.1	36.5	159.5
				8.04%	91.96%		18.61%	81.34%
		1990	5,788.6	721.4	5,067.2	247.5	40.0	207.5
				12.46%	87.54%		16.16%	83.84%
		1989	5,656.9	611.5	5045.4	284.0	38.9	245.2
				10.81%	89.19%		13.70%	86.34%
		1988	4,669.9	479.5	4190.4	211.2	39.8	171.4
				10.27%	89.73%		18.84%	81.16%
		1987	3,850.9	429.2	3421.6	342.0	56.8	285.2
				11.15%	88.85%		16.61%	83.39%
		1986	3,160.4	367.0	2,793.4	174.4	38.8	135.6
				11.61%	88.39%		22.25%	77.75%
		1985	4,680.0	606.3	4,073.7	617.8	169.6	448.2
				12.96%	87.04%		27.45%	72.55%
		1984	4,184.5	484.7	3,699.8	334.1	66.9	267.2
				11.58%	88.42%		20.02%	79.98%

Bureau of the Census. 1984-1994. Annual Survey of Manufacturers: Statistics for Industry Groups and Industries. MA84-94(AS)-1.

tied to pollution production and resource use, and so should be the basis for comparisons between industries and over time.

The next step in this analysis was to attempt to better characterize the nature of the capital investments being made, in terms of their potential impact on the environment. The Pollution Abatement Costs and Expenditures surveys provided the basis for Exhibits 3-2 through 3-6. These exhibits present first the total expenditures and amount of pollution abatement expenditures in each of the industries under review, and then a series of calculations designed to help interpret the implications of these expenditures. Exhibit 3-2 presents a summary of the value of new capital expenditures for each manufacturing industry from 1984-1994, and then characterizes the pollution abatement component of these expenditures. The exhibit also provides the average level of expenditures for the six industries reviewed, and the total for U.S. manufacturing industries. To characterize pollution abatement expenditures, the exhibit presents the total expenditures on abatement for all identified media, and then the proportion of these that is for "End of Line" abatements or for "Product Process" changes. The exhibit then provides actual or estimated total expenditures associated with no specific environmental medium (label "nonmedia"), the proportion of these not non-specific to media-specific expenditures used to estimate non-specific expenditures in years with no data, and the resulting total of all pollution abatement expenditures. The final two columns compare the two measures of pollution abatement expenditure (without and with non-specific expenditures) to total capital expenditures. Exhibit 3-3 presents the percentage change in all these data from year to year.

Exhibit 3-4 provides a comparison of the six industries being reviewed to total U.S. manufacturing industries, by presenting all data in terms of a proportion of total manufacturing. This presentation makes it clear that the selected industries are both very capital intensive (30 percent or more of total U.S. manufacturing new capital expenditures) and very pollution intensive (70 to 80 percent of U.S. manufacturing pollution abatement expenditures). The six industries average roughly twice the overall proportion of pollution abatement to total new capital expenditures.

Exhibits 3-5 and 3-6 present the value of new capital expenditures and pollution abatement expenditures for nonmanufacturing industries being reviewed and their annual change. There are no data to provide a comparison to total U.S. nonmanufacturing expenditures.

The total share of new capital expenditures that pertains to most of the targeted manufacturing industries increased by 14 percent between 1984 and 1994. Primary metals' percentage did not change significantly, however. Over those same years, these industries' total share of pollution abatement expenditures increased by 37 percent. (This increase was positively skewed by petroleum and coal products, which greatly pushed up the average. The other industries' share of PACE remained fairly constant or decreased.) The petroleum and coal products industry is the most PACE-intensive non-manufacturing industry, closely followed by electric utilities (Exhibit 3-5). The largest percentage increase over the period occurred in the mining industry, however (Exhibit 3-6).

Exhibit 3-2: Summary of New Machinery and Equipment Capital Expenditures and Pollution Abatement Component by Targeted Manufacturing Industry: 1984-1994

millions of dollars (except percentages). Totals may not agree with detail due to independent rounding

SIC Code	Major Group	Year	New capital expenditures[1]	Total Media	Abatement Technique: End of Line (% of Total Media)	Abatement Technique: Product Process (% of Total Media)	Nonmedia and other	Nonmedia and other/ Total Media[2]	Total PACENM[3]	Total Media/ New cap. expend.	Total PACENM[3]/ New cap. expend.
26	Paper and allied products	1994	6,610.2	635.9	55.17%	44.83%	12.2	0.023	648.1	0.096	0.098
		1993	6,491.3	715.6	48.64%	51.36%	22.1	0.023	737.7	0.110	0.114
		1992	7,169.2	1,004.6	56.30%	43.70%	18.0	0.023	1,022.6	0.140	0.143
		1991[5]	8,285.3	1,232.6	53.56%	46.44%	**27.9**	**0.023**	**1,260.5**	0.149	**0.152**
		1990[5]	9,754.2	1,075.2	56.78%	43.21%	**24.4**	**0.023**	**1,099.6**	0.110	**0.113**
		1989[5]	8,950.8	808.2	65.26%	34.73%	**18.3**	**0.023**	**826.5**	0.090	**0.092**
		1988[5]	6,448.3	417.7	65.97%	34.03%	**9.5**	**0.023**	**427.2**	0.065	**0.066**
		1987	5,012.0	NA	NA	NA				NA	
		1986[5]	5,329.5	271.3	80.04%	19.91%	**6.1**	**0.023**	**277.4**	0.051	**0.052**
		1985[5]	5,706.8	332.4	75.38%	24.65%	**7.5**	**0.023**	**339.9**	0.058	**0.060**
		1984[5]	4,815.8	262.3	76.65%	23.35%	**5.9**	**0.023**	**268.2**	0.054	**0.056**
28	Chemicals and allied products	1994	12,903.5	1,931.0	63.25%	36.74%	103.3	0.071	2,034.3	0.150	0.158
		1993	12,940.8	1,957.9	70.32%	29.68%	130.9	0.071	2,088.8	0.151	0.161
		1992	13,774.5	2,120.9	76.26%	23.74%	194.9	0.071	2,315.8	0.154	0.168
		1991[5]	13,393.3	2,066.1	74.22%	25.77%	**146.2**	**0.071**	**2,212.3**	0.154	**0.165**
		1990[5]	12,691.5	1,852.1	80.78%	19.22%	**131.0**	**0.071**	**1,983.1**	0.146	**0.156**
		1989[5]	11,336.8	1,194.8	73.35%	26.65%	**84.5**	**0.071**	**1,279.3**	0.105	**0.113**
		1988[5]	9,164.8	1,095.0	84.94%	15.05%	**77.5**	**0.071**	**1,172.5**	0.119	**0.128**
		1987	7,183.3	NA	NA	NA				NA	
		1986[5]	6,619.3	624.4	77.97%	22.03%	**44.2**	**0.071**	**668.6**	0.094	**0.101**
		1985[5]	6,772.8	738.1	82.11%	17.92%	**52.2**	**0.071**	**790.3**	0.109	**0.117**
		1984[5]	6,371.4	418.1	81.62%	18.38%	**29.6**	**0.071**	**447.7**	0.066	**0.070**
29	Petroleum and coal products[4]	1994	4,785.5	2,572.0	48.20%	51.80%	14.8	0.007	2,586.9	0.537	0.541
		1993	5,502.1	2,648.5	39.57%	60.43%	23.5	0.007	2,672.0	0.481	0.486
		1992	5,967.6	2,685.0	51.33%	48.66%	17.8	0.007	2,702.8	0.450	0.453
		1991[5]	5,088.1	1,462.5	61.07%	38.93%	**10.4**	**0.007**	**1,472.9**	0.287	**0.289**
		1990[5]	3,561.1	916.8	66.57%	33.43%	**6.5**	**0.007**	**923.3**	0.257	**0.259**
		1989[5]	2,689.0	417.6	70.26%	29.74%	**3.0**	**0.007**	**420.6**	0.155	**0.156**
		1988[5]	2,027.9	482.8	62.86%	37.17%	**3.4**	**0.007**	**486.2**	0.238	**0.240**
		1987	1,782.6	NA	NA	NA				NA	
		1986[5]	2,157.2	424.3	48.80%	51.23%	**3.0**	**0.007**	**427.3**	0.197	**0.198**
		1985[5]	2,222.8	290.4	65.19%	34.81%	**2.1**	**0.007**	**292.5**	0.131	**0.132**
		1984[5]	2,356.7	311.7	82.94%	17.06%	**2.2**	**0.007**	**313.9**	0.132	**0.133**

Exhibit 3-2: Summary of New Machinery and Equipment Capital Expenditures and Pollution Abatement Component by Targeted Manufacturing Industry: 1984-1994

millions of dollars (except percentages). Totals may not agree with detail due to independent rounding.

SIC Code	Major Group	Year	New capital expenditures[1]	Total Media	Abatement Technique: End of Line (% of Total Media)	Abatement Technique: Product Process (% of Total Media)	Nonmedia and other	Nonmedia and other/ Total Media[2]	Total PACENM[3]	Total Media/ New cap. expend.	Total PACENM[3]/ New cap. expend.
33	Primary metal industries	1994	5,859.6	428.0	77.41%	22.59%	18.0	0.066	446.0	0.073	0.076
		1993	4,208.6	442.2	78.49%	21.51%	39.0	0.066	481.2	0.105	0.114
		1992	4,697.0	525.7	74.42%	25.57%	34.9	0.066	560.6	0.112	0.119
		1991[5]	5,406.1	673.4	84.11%	15.89%	**44.1**	**0.066**	**717.5**	0.125	**0.133**
		1990[5]	5,067.2	499.1	88.33%	11.67%	**32.7**	**0.066**	**531.8**	0.098	**0.105**
		1989[5]	5,045.4	407.0	88.06%	11.94%	**26.7**	**0.066**	**433.7**	0.081	**0.086**
		1988[5]	4,190.4	309.8	70.74%	29.26%	**20.3**	**0.066**	**330.1**	0.074	**0.079**
		1987	3,421.6	NA	NA	NA				NA	
		1986[5]	2,793.4	225.9	84.55%	15.50%	**14.8**	**0.066**	**240.7**	0.081	**0.086**
		1985[5]	4,073.7	252.9	91.55%	8.45%	**16.6**	**0.066**	**269.5**	0.062	**0.066**
		1984[5]	3,699.8	274.0	86.70%	13.22%	**18.0**	**0.066**	**292.0**	0.074	**0.079**
	Total	1994	30,158.8	5,566.9			148.3		5,715.3		
		1993	29,142.8	5,764.2			215.5		5,979.7		
		1992	31,608.3	6,336.2			265.6		6,601.8		
		1991	32,172.8	5,434.6			**228.6**		**5,663.2**		
		1990	31,074.0	4,343.2			**194.6**		**4,537.8**		
		1989	28,022.0	2,827.6			**132.5**		**2,960.1**		
		1988	21,831.4	2,305.3			**110.7**		**2,416.0**		
		1987	17,399.5	NA							
		1986	16,899.4	1,545.9			**68.1**		**1,614.0**		
		1985	18,776.1	1,613.8			**78.4**		**1,692.2**		
		1984	17,243.7	1,266.1			**55.7**		**1,321.8**		
	Average	1994	7,539.7	1,391.7	61.01%	38.99%	37.1		1,428.8	0.214	0.218
		1993	7,285.7	1,441.1	59.26%	40.75%	53.9		1,494.9	0.212	0.219
		1992	7,902.1	1,584.1	64.58%	35.42%	66.4		1,650.5	0.214	0.221
		1991[5]	8,043.2	1,358.7	68.24%	31.76%	**57.2**		**1,415.8**	0.179	**0.185**
		1990[5]	7,768.5	1,085.8	73.11%	26.88%	**48.7**		**1,134.5**	0.153	**0.158**
		1989[5]	7,005.5	706.9	74.23%	25.77%	**33.1**		**740.0**	0.108	**0.112**
		1988[5]	5,457.9	576.3	71.13%	28.88%	**27.7**		**604.0**	0.124	**0.128**
		1987	4,349.9	NA	NA	NA				NA	
		1986[5]	4,224.9	386.5	72.84%	27.17%	**17.0**		**403.5**	0.106	**0.109**
		1985[5]	4,694.0	403.5	78.55%	21.46%	**19.6**		**423.0**	0.090	**0.093**
		1984[5]	4,310.9	316.5	81.98%	18.00%	**13.9**		**330.4**	0.082	**0.085**
	All industries	1994	94,773.6	7,578.0	58.70%	41.31%	302.6	0.054	7,880.5	0.080	0.083
		1993	87,080.8	7,177.9	54.75%	45.25%	390.3	0.054	7,568.2	0.082	0.087
		1992	86,981.8	7,866.9	63.83%	36.17%	526.1	0.054	8,393.0	0.090	0.096
		1991[5]	84,037.8	7,390.1	71.36%	28.64%	**397.0**	**0.054**	7,787.1	0.088	**0.093**
		1990[5]	85,668.1	6,030.8	74.37%	25.62%	**324.0**	**0.054**	6,354.8	0.070	**0.074**
		1989[5]	80,524.2	4,309.0	76.53%	23.46%	**231.5**	**0.054**	4,540.5	0.054	**0.056**
		1988[5]	66,662.3	3,423.3	77.64%	22.36%	**183.9**	**0.054**	3,607.2	0.051	**0.054**
		1987	65,733.7	NA	NA	NA				NA	
		1986[5]	62,871.6	2,846.9	71.01%	28.98%	**153.0**	**0.054**	2,999.9	0.045	**0.048**
		1985[5]	67,917.2	2,809.7	77.98%	22.02%	**151.0**	**0.054**	2,960.7	0.041	**0.044**
		1984[5]	61,619.0	2,171.8	81.48%	18.52%	116.7	0.054	2,288.5	0.035	**0.037**

Source (unless otherwise noted): Bureau of the Census. 1984-1994. Current Industrial Reports: Pollution Abatement Costs and Expenditures. MA-200(84-94)-1.

Note: Boldfaced typset indicates a constructed value based on available data.

NA: Not Available. PACE survey not conducted in 1987.

1 Bureau of the Census. 1984-1994. Annual Survey of Manufacturers: Statistics for Industry Groups and Industries. MA84-94(AS)-1.

2 Represents an average of 1992, 1993, and 1994 data and applied to 1987-1991 through back-calculation to obtain "Nonmedia and other" values.

3 PACENM denotes pollution abatement capital expenditures (Total Media + Nonmedia and other).

4 Includes SIC codes 2951 and 2952 which are clearly coal product industries.

5 Data on abatement technique for solid waste were not available for 1984-1986 and 1988-1991. Therefore, these values are percentages of air and water, rather than of total media.

Exhibit 3-3: Summary of Annual Percentage Change in New Machinery and Equipment Capital Expenditures and Pollution Abatement Component by Targeted Manufacturing Industry: 1984-1994

millions of dollars (except percentages). Totals may not agree with detail due to independent rounding.

SIC Code	Major Group	Year	New capital expenditures[1]	Total Media	Abatement Technique: End of Line (% of Total Media)	Abatement Technique: Product Process (% of Total Media)	Nonmedia and other	Total PACENM[2]	Total Media/ New cap. expend.	Total PACENM[2]/ New cap. expend.
26	Paper and allied products	1993-94	1.83%	-11.14%	13.41%	-12.70%	-44.80%	-12.15%	-12.74%	-13.73%
		1992-93	-9.46%	-28.77%	-13.60%	17.52%	22.78%	-27.86%	-21.33%	-20.33%
		1991-92[4]	-13.47%	-18.50%	5.13%	-5.91%	-35.56%	-18.88%	-5.81%	-6.25%
		1990-91[4]	-15.06%	14.64%	-5.67%	7.48%	14.64%	14.64%	34.96%	34.96%
		1989-90[4]	8.98%	33.04%	-13.00%	24.43%	33.04%	33.04%	22.08%	22.08%
		1988-89[4]	38.81%	93.49%	-1.08%	2.05%	93.49%	93.49%	39.39%	39.39%
		1987-88	28.66%	NA	NA	NA			NA	
		1986-87	-5.96%	NA	NA	NA			NA	
		1985-86[4]	-6.61%	-18.38%	6.19%	-19.23%	-18.38%	-18.38%	-12.60%	-12.60%
		1984-85[4]	18.50%	26.73%	-1.65%	5.57%	26.73%	26.73%	6.94%	6.94%
28	Chemicals and allied products	1993-94	-0.29%	-1.37%	-10.04%	23.78%	-21.08%	-2.61%	-1.09%	-2.33%
		1992-93	-6.05%	-7.69%	-7.80%	25.07%	-32.84%	-9.80%	-1.74%	-3.99%
		1991-92[4]	2.85%	2.65%	2.76%	-7.89%	33.33%	4.68%	-0.19%	1.78%
		1990-91[4]	5.53%	11.55%	-8.12%	34.09%	11.55%	11.55%	5.71%	5.71%
		1989-90[4]	11.95%	55.01%	10.14%	-27.89%	55.01%	55.01%	38.47%	38.47%
		1988-89[4]	23.70%	9.11%	-13.65%	77.12%	9.11%	9.11%	-11.79%	-11.79%
		1987-88	27.58%	NA	NA	NA			NA	
		1986-87	8.52%	NA	NA	NA			NA	
		1985-86[4]	-2.27%	-15.40%	-5.04%	22.96%	-15.40%	-15.40%	-13.44%	-13.44%
		1984-85[4]	6.30%	76.54%	0.59%	-2.52%	76.54%	76.54%	66.07%	66.07%
29	Petroleum and coal products[3]	1993-94	-13.02%	-2.89%	21.80%	-14.28%	-37.02%	-3.18%	11.65%	11.31%
		1992-93	-7.80%	-1.36%	-22.91%	24.19%	32.02%	-1.14%	6.99%	7.22%
		1991-92[4]	17.29%	83.59%	-15.95%	25.01%	71.77%	83.51%	56.53%	56.46%
		1990-91[4]	42.88%	59.52%	-8.26%	16.44%	59.52%	59.52%	11.65%	11.65%
		1989-90[4]	32.43%	119.54%	-5.25%	12.40%	119.54%	119.54%	65.78%	65.78%
		1988-89[4]	32.60%	-13.50%	11.78%	-19.98%	-13.50%	-13.50%	-34.77%	-34.77%
		1987-88	13.76%	NA	NA	NA			NA	
		1986-87	-17.37%	NA	NA	NA			NA	
		1985-86[4]	-2.95%	46.11%	-25.14%	47.15%	46.11%	46.11%	50.55%	50.55%
		1984-85[4]	-5.68%	-6.83%	-21.41%	104.06%	-6.83%	-6.83%	-1.22%	-1.22%

Exhibit 3-3: Summary of Annual Percentage Change in New Machinery and Equipment Capital Expenditures and Pollution Abatement Component by Targeted Manufacturing Industry: 1984-1994

millions of dollars (except percentages). Totals may not agree with detail due to independent rounding.

SIC Code	Major Group	Year	New capital expenditures[1]	Total Media	Abatement Technique: End of Line (% of Total Media)	Abatement Technique: Product Process (% of Total Media)	Nonmedia and other	Total PACENM[2]	Total Media/ New cap. expend.	Total PACENM[2]/ New cap. expend.
33	Primary metal industries	1993-94	39.23%	-3.21%	-1.39%	5.06%	-53.85%	-7.32%	-30.48%	-33.43%
		1992-93	-10.40%	-15.88%	5.48%	-15.88%	11.75%	-14.16%	-6.12%	-4.20%
		1991-92[4]	-13.12%	-21.93%	-11.52%	60.86%	-20.93%	-21.87%	-10.15%	-10.08%
		1990-91[4]	6.69%	34.92%	-4.78%	36.13%	34.92%	34.92%	26.46%	26.46%
		1989-90[4]	0.43%	22.63%	0.31%	-2.25%	22.63%	22.63%	22.10%	22.10%
		1988-89[4]	20.40%	31.38%	24.49%	-59.19%	31.38%	31.38%	9.11%	9.11%
		1987-88	22.47%	NA	NA	NA			NA	
		1986-87	22.49%	NA	NA	NA			NA	
		1985-86[4]	-31.43%	-10.68%	-7.64%	83.44%	-10.68%	-10.68%	30.26%	30.26%
		1984-85[4]	10.11%	-7.70%	5.59%	-36.08%	-7.70%	-7.70%	-16.17%	-16.17%
	Total	1993-94	3.49%	-3.42%			-31.18%	-4.42%		
		1992-93	-7.80%	-9.03%			-18.86%	-9.42%		
		1991-92	-1.75%	16.59%			16.18%	16.57%		
		1990-91	3.54%	25.13%			17.47%	24.80%		
		1989-90	10.89%	53.60%			46.90%	53.30%		
		1988-89	28.36%	22.66%			19.72%	22.52%		
		1987-88	25.47%	NA						
		1986-87	2.96%	NA						
		1985-86	-10.00%	-4.21%			-13.08%	-4.62%		
		1984-85	8.89%	27.46%			40.75%	28.02%		
	Average	1993-94	3.49%	-3.42%	2.95%	-4.30%	-31.18%	-4.42%	0.99%	-0.30%
		1992-93	-7.80%	-9.03%	-8.24%	15.05%	-18.86%	-9.42%	-0.93%	-0.91%
		1991-92[4]	-1.75%	16.59%	-5.37%	11.52%	16.18%	16.57%	19.71%	19.41%
		1990-91[4]	3.54%	25.13%	-6.67%	18.13%	17.47%	24.80%	16.81%	16.79%
		1989-90[4]	10.89%	53.60%	-1.50%	4.34%	46.90%	53.30%	41.81%	41.49%
		1988-89[4]	28.36%	22.66%	4.36%	-10.77%	19.72%	22.52%	-13.02%	-12.71%
		1987-88	25.47%	NA	NA	NA			NA	
		1986-87	2.96%	NA	NA	NA			NA	
		1985-86[4]	-10.00%	-4.21%	-7.27%	26.61%	-13.08%	-4.62%	17.46%	16.94%
		1984-85[4]	8.89%	27.46%	-4.17%	19.19%	40.75%	28.02%	10.28%	10.62%
	All industries	1993-94	8.83%	5.57%	7.21%	-8.72%	-22.47%	4.13%	-3.00%	-4.33%
		1992-93	0.11%	-8.76%	-14.23%	25.11%	-25.81%	-9.83%	-8.86%	-9.93%
		1991-92[4]	3.50%	6.45%	-10.55%	26.31%	32.50%	7.78%	2.85%	4.13%
		1990-91[4]	-1.90%	22.54%	-4.05%	11.75%	22.54%	22.54%	24.92%	24.92%
		1989-90[4]	6.39%	39.96%	-2.82%	9.21%	39.96%	39.96%	31.55%	31.55%
		1988-89[4]	20.79%	25.87%	-1.43%	4.96%	25.87%	25.87%	4.20%	4.20%
		1987-88	1.41%	NA	NA	NA			NA	
		1986-87	4.55%	NA	NA	NA			NA	
		1985-86[4]	-7.43%	1.32%	-8.93%	31.59%	1.32%	1.32%	9.46%	9.46%
		1984-85[4]	10.22%	29.37%	-4.30%	18.95%	29.37%	29.37%	17.37%	17.37%

Source (unless otherwise noted): Bureau of the Census. 1984-1994. Current Industrial Reports: Pollution Abatement Costs and Expenditures. MA-200(84-94)-1.

Note: Boldfaced typset indicates a constructed value based on available data.

NA: Not Available. PACE survey not conducted in 1987.

1 Bureau of the Census. 1984-1994. Annual Survey of Manufacturers: Statistics for Industry Groups and Industries. MA84-94(AS)-1.

2 PACENM denotes pollution abatement capital expenditures (Total Media + Nonmedia and other).

3 Includes SIC codes 2951 and 2952 which are clearly coal product industries.

4 Data on abatement technique for solid waste were not available for 1984-1986 and 1988-1991.
Therefore, these values are percentages of air and water, rather than of total media.

Exhibit 3-4: Summary of New Machinery and Equipment Capital Expenditures and Pollution Abatement Component by Targeted Manufacturing Industry as a Percentage of All Manufacturing Industries: 1984-1994

millions of dollars (except percentages). Totals may not agree with detail due to independent rounding.

SIC Code	Major Group	Year	New capital expenditures[1]	Total Media	Abatement Technique: End of Line (% of Total Media)	Abatement Technique: Product Process (% of Total Media)	Nonmedia and other	Total PACENM[2]	Total Media/ New cap. expend.	Total PACENM[2]/ New cap. expend.
26	Paper and allied products	1994	6.97%	8.39%	93.99%	108.54%	4.03%	8.22%	120.31%	117.91%
		1993	7.45%	9.97%	88.85%	113.49%	5.66%	9.75%	133.74%	130.76%
		1992	8.24%	12.77%	88.20%	120.82%	3.42%	12.18%	154.93%	147.82%
		1991[4]	9.86%	16.68%	75.05%	162.19%	7.04%	16.19%	169.18%	164.19%
		1990[4]	11.39%	17.83%	76.34%	168.63%	7.52%	17.30%	156.58%	151.97%
		1989[4]	11.12%	18.76%	85.27%	148.00%	7.91%	18.20%	168.74%	163.76%
		1988[4]	9.67%	12.20%	84.97%	152.22%	5.15%	11.84%	126.14%	122.42%
		1987	7.62%	NA	NA	NA			NA	
		1986[4]	8.48%	9.53%	112.71%	68.71%	4.02%	9.25%	112.42%	109.11%
		1985[4]	8.40%	11.83%	96.67%	111.94%	4.99%	11.48%	140.80%	136.64%
		1984[4]	7.82%	12.08%	94.07%	126.13%	5.09%	11.72%	154.53%	149.98%
28	Chemicals and allied products	1994	13.62%	25.48%	107.76%	88.95%	34.14%	25.81%	187.16%	189.60%
		1993	14.86%	27.28%	128.44%	65.60%	33.54%	27.60%	183.55%	185.72%
		1992	15.84%	26.96%	119.48%	65.62%	37.05%	27.59%	170.24%	174.24%
		1991[4]	15.94%	27.96%	104.00%	89.99%	36.82%	28.41%	175.42%	178.26%
		1990[4]	14.81%	30.71%	108.62%	75.00%	40.44%	31.21%	207.30%	210.65%
		1989[4]	14.08%	27.73%	95.84%	113.59%	36.51%	28.18%	196.95%	200.13%
		1988[4]	13.75%	31.99%	109.40%	67.31%	42.12%	32.50%	232.66%	236.42%
		1987	10.93%	NA	NA	NA			NA	
		1986[4]	10.53%	21.93%	109.80%	76.01%	28.88%	22.29%	114.44%	211.69%
		1985[4]	9.97%	26.27%	105.30%	81.35%	34.59%	26.69%	132.21%	267.69%
		1984[4]	10.34%	19.25%	100.17%	99.26%	25.35%	19.56%	186.18%	189.19%
29	Petroleum and coal products[3]	1994	5.05%	33.94%	82.11%	125.42%	4.89%	32.83%	672.17%	650.11%
		1993	6.32%	36.90%	72.28%	133.55%	6.02%	35.31%	583.98%	558.78%
		1992	6.86%	34.13%	80.41%	134.54%	3.38%	32.20%	497.47%	469.38%
		1991[4]	6.05%	19.79%	85.58%	135.94%	2.61%	18.91%	326.86%	312.39%
		1990[4]	4.16%	15.20%	89.51%	130.46%	2.00%	14.53%	365.71%	349.52%
		1989[4]	3.34%	9.69%	91.80%	126.76%	1.28%	9.26%	290.21%	277.37%
		1988[4]	3.04%	14.10%	80.95%	166.26%	1.86%	13.48%	463.61%	443.09%
		1987	2.71%	NA	NA	NA			NA	
		1986[4]	3.43%	14.90%	68.72%	176.76%	1.97%	14.24%	434.38%	415.15%
		1985[4]	3.27%	10.34%	83.60%	158.07%	1.36%	9.88%	315.80%	301.82%
		1984[4]	3.82%	14.35%	101.79%	92.14%	1.89%	13.72%	375.26%	358.65%

Exhibit 3-4: Summary of New Machinery and Equipment Capital Expenditures and Pollution Abatement Component by Targeted Manufacturing Industry as a Percentage of All Manufacturing Industries: 1984-1994

millions of dollars (except percentages). Totals may not agree with detail due to independent rounding.

SIC Code	Major Group	Year	New capital expenditures[1]	Total Media	Abatement Technique: End of Line (% of Total Media)	Abatement Technique: Product Process (% of Total Media)	Nonmedia and other	Total PACENM[2]	Total Media/ New cap. expend.	Total PACENM[2]/ New cap. expend.
33	Primary metal industries	1994	6.18%	5.65%	131.88%	54.70%	5.95%	5.66%	91.35%	91.54%
		1993	4.83%	6.16%	143.38%	47.53%	9.99%	6.36%	127.47%	131.56%
		1992	5.40%	6.68%	116.58%	70.68%	6.63%	6.68%	123.75%	123.69%
		1991[4]	6.43%	9.11%	117.86%	55.50%	11.12%	9.21%	141.65%	143.24%
		1990[4]	5.91%	8.28%	118.76%	45.56%	10.10%	8.37%	139.91%	141.48%
		1989[4]	6.27%	9.45%	115.06%	50.90%	11.52%	9.55%	150.75%	152.44%
		1988[4]	6.29%	9.05%	91.10%	130.90%	11.04%	9.15%	143.97%	145.58%
		1987	5.21%	NA	NA	NA			NA	
		1986[4]	4.44%	7.93%	119.07%	53.49%	9.68%	8.02%	178.59%	180.60%
		1985[4]	6.00%	9.00%	117.41%	38.37%	10.98%	9.10%	150.07%	151.75%
		1984[4]	6.00%	12.62%	106.41%	71.40%	15.39%	12.76%	210.12%	212.48%
	Total	1994	31.82%	73.46%			49.01%	72.52%		
		1993	33.47%	80.30%			55.21%	79.01%		
		1992	36.34%	80.54%			50.48%	78.66%		
		1991	38.28%	73.54%			57.58%	72.73%		
		1990	36.27%	72.02%			60.06%	71.41%		
		1989	34.80%	65.62%			57.23%	65.19%		
		1988	32.75%	67.34%			60.17%	66.98%		
		1987	26.47%	NA						
		1986	26.88%	54.30%			44.55%	53.80%		
		1985	27.65%	57.44%			51.93%	57.16%		
		1984	27.98%	58.30%			47.73%	57.76%		
	Average	1994	7.96%	18.37%	103.93%	94.40%	12.25%	18.13%	267.75%	262.29%
		1993	8.37%	20.08%	108.24%	90.04%	13.80%	19.75%	257.18%	251.70%
		1992	9.08%	20.14%	101.17%	97.92%	12.62%	19.66%	236.60%	228.78%
		1991[4]	9.57%	18.38%	95.62%	110.90%	14.39%	18.18%	203.28%	199.52%
		1990[4]	9.07%	18.00%	98.31%	104.91%	15.02%	17.85%	217.38%	213.40%
		1989[4]	8.70%	16.41%	96.99%	109.81%	14.31%	16.30%	201.66%	198.42%
		1988[4]	8.19%	16.84%	91.60%	129.17%	15.04%	16.74%	241.60%	236.88%
		1987	6.62%	NA	NA	NA			NA	
		1986[4]	6.72%	13.58%	102.57%	93.74%	11.14%	13.45%	233.43%	229.13%
		1985[4]	6.91%	14.36%	100.74%	97.43%	12.98%	14.29%	217.52%	214.48%
		1984[4]	7.00%	14.57%	100.61%	97.23%	11.93%	14.44%	231.52%	227.57%

Source (unless otherwise noted): Bureau of the Census. 1984-1994. Current Industrial Reports: Pollution Abatement Costs and Expenditures. MA-200(84-94)-1.

Note: Boldfaced typset indicates a constructed value based on available data.

NA: Not Available. PACE survey not conducted in 1987.

1 Bureau of the Census. 1984-1994. Annual Survey of Manufacturers: Statistics for Industry Groups and Industries. MA84-94(AS)-1.

2 PACENM denotes pollution abatement capital expenditures (Total Media + Nonmedia and other).

3 Includes SIC codes 2951 and 2952 which are clearly coal product industries.

4 Data on abatement technique for solid waste were not available for 1984-1986 and 1988-1991. Therefore, these values are percentages of air and water, rather than of total media.

Exhibit 3-5: Summary of New Plant and Equipment and Pollution Abatement Component by Targeted Non-manufacturing Industry: 1987-1994

millions of dollars (except percentages). Totals may not agree with detail due to independent rounding.

SIC Code	Major group	Year	New plant and equipment	Total Media	Abatement Technique: End of Line (% of Total Media)	Abatement Technique: Product Process (% of Total Media)	Nonmedia and other	Nonmedia and other/ Total Media[1]	Total PACENM[2]	Total Media/ New plant and equip.	Total PACENM[2]/ New plant and equip.
10,12,13,14	Mining	1994	11,242.3	434.2	75.36%	24.64%	116.5	0.280	550.7	0.039	0.049
		1993	10,075.2	388.8	74.74%	25.26%	114.8	0.280	503.6	0.039	0.050
		1992	8,883.7	317.6	76.70%	23.30%	87.5	0.280	405.1	0.036	0.046
		1991[5]	10,022.5	273.6	88.44%	11.56%	**76.5**	**0.280**	**350.1**	0.027	**0.035**
		1990[5]	9,880.3	251.7	95.67%	4.28%	**70.4**	**0.280**	**322.1**	0.025	**0.033**
		1989[5]	9,207.9	199.9	90.84%	9.10%	**55.9**	**0.280**	**255.8**	0.022	**0.028**
		1988[5]	9,285.4	144.4	94.23%	5.77%	**40.4**	**0.280**	**184.8**	0.016	**0.020**
		1987[5]	8,285.5	132.9	91.85%	8.15%	**37.2**	**0.280**	**170.1**	0.016	**0.021**
29	Petroleum and coal products[3]	1994	28,046.4	4,189.8	57.11%	42.89%	472.6	0.121	4,662.4	0.149	0.166
		1993	28,671.6	3,963.5	58.38%	41.62%	481.9	0.121	4,445.4	0.138	0.155
		1992	29,585.8	3,873.5	59.23%	40.77%	493.8	0.121	4,367.3	0.131	0.148
		1991[5]	35,590.6	3,559.6	80.06%	19.93%	**429.4**	**0.121**	**3,989.0**	0.100	**0.112**
		1990[5]	34,787.3	3,221.3	83.92%	16.08%	**388.6**	**0.121**	**3,609.9**	0.093	**0.104**
		1989[5]	30,081.0	2,275.9	95.52%	4.48%	**274.5**	**0.121**	**2,550.4**	0.076	**0.085**
		1988[5]	26,031.6	1,904.8	99.35%	0.65%	**229.8**	**0.121**	**2,134.6**	0.073	**0.082**
		1987[5]	22,058.1	2,664.9	98.94%	1.06%	**321.4**	**0.121**	**2,986.3**	0.121	**0.135**
491,493	Electric Utilities[4]	1994	46,151.1	4,179.2	82.70%	17.30%	170.2	0.045	4,349.4	0.091	0.094
		1993	45,897.8	4,032.3	81.61%	18.39%	167.7	0.045	4,200.0	0.088	0.092
		1992	42,657.6	2,886.7	77.95%	22.05%	151.2	0.045	3,037.9	0.068	0.071
		1991[5]	38,616.7	1,943.2	84.17%	15.83%	**87.2**	**0.047**	**2,030.4**	0.050	**0.053**
		1990[5]	39,267.5	2,111.1	81.70%	18.30%	**94.8**	**0.047**	**2,205.9**	0.054	**0.056**
		1989[5]	40,319.1	1,819.1	81.93%	18.07%	**81.7**	**0.047**	**1,900.8**	0.045	**0.047**
		1988[5]	36,685.0	2,091.3	85.23%	14.77%	**93.9**	**0.047**	**2,185.2**	0.057	**0.060**
		1987[5]	35,123.4	2,302.1	80.04%	19.96%	**103.4**	**0.047**	**2,405.5**	0.066	**0.068**
	Total	1994	**85,439.8**	**8,803.2**			759.3		9,562.5		
		1993	**84,644.6**	**8,384.6**			764.4		9,149.0		
		1992	**81,127.1**	**7,077.8**			732.5		7,810.3		
		1991	**84,229.8**	**5,776.4**			**593.1**		**6,369.5**		
		1990	**83,935.1**	**5,584.1**			**553.7**		**6,137.8**		
		1989	**79,608.0**	**4,294.9**			**412.1**		**4,707.0**		
		1988	**72,002.0**	**4,140.5**			**364.0**		**4,504.5**		
		1987	**65,467.0**	**5,099.9**			**462.0**		**5,561.9**		
	Average	1994	**28,479.9**	**2,934.4**	71.72%	28.28%	253.1		3,187.5	0.093	0.103
		1993	**28,214.9**	**2,794.9**	71.58%	28.42%	254.8		3,049.7	0.088	0.099
		1992	**27,042.4**	**2,359.3**	71.29%	28.71%	244.2		2,603.4	0.078	0.088
		1991[5]	**28,076.6**	**1,925.5**	84.23%	15.77%	**197.7**		**2,123.2**	0.059	**0.067**
		1990[5]	**27,978.4**	**1,861.4**	87.10%	12.89%	**184.6**		**2,045.9**	0.057	**0.064**
		1989[5]	**26,536.0**	**1,431.6**	89.43%	10.55%	**137.4**		**1,569.0**	0.047	**0.053**
		1988[5]	**24,000.7**	**1,380.2**	92.94%	7.06%	**121.3**		**1,501.5**	0.049	**0.054**
		1987[5]	**21,822.3**	**1,700.0**	90.28%	9.72%	**154.0**		**1,854.0**	0.067	**0.075**

Source (unless otherwise noted): Bureau of the Census. 1984-1994. Current Industrial Reports: Pollution Abatement Costs and Expenditures. MA-200(84-94)-1.

Note: Boldfaced typset indicates a constructed value based on available data.

1 Represents an average of 1992, 1993, and 1994 data and applied to 1987-1991 through back-calculation to obtain "Nonmedia and other" values.
2 PACENM denotes pollution abatement capital expenditures (Total Media + Nonmedia and other).
3 Includes SIC codes 2951 and 2952 which are clearly coal product industries.
4 Does not include Rural Electric Administration utilities.
5 Data on abatement technique for solid waste were not available for 1987-1991. Therefore, these values are percentages of air and water, rather than of total media.

Exhibit 3-6: Summary of Annual Percentage Change in New Plant and Equipment and Pollution Abatement Component by Targeted Non-manufacturing Industry: 1987-1994

millions of dollars (except percentages). Totals may not agree with detail due to independent rounding.

SIC Code	Major group	Year	New plant and equipment	Total Media	Abatement Technique: End of Line (% of Total Media)	Abatement Technique: Product Process (% of Total Media)	Nonmedia and other	Total PACENM[1]	Total Media/ New plant and equip.	Total PACENM[1]/ New plant and equip.
10,12,13,14	Mining	1993-94	11.58%	11.68%	0.82%	-2.43%	1.48%	9.35%	0.08%	-2.00%
		1992-93	13.41%	22.42%	-2.55%	8.40%	31.20%	24.31%	7.94%	9.61%
		1991-92[4]	-11.36%	16.08%	-13.28%	101.62%	**14.34%**	**15.70%**	30.96%	**30.53%**
		1990-91[4]	1.44%	8.70%	-7.55%	169.77%	**8.70%**	**8.70%**	7.16%	**7.16%**
		1989-90[4]	7.30%	25.91%	5.32%	-52.91%	**25.91%**	**25.91%**	17.34%	**17.34%**
		1988-89[4]	-0.83%	38.43%	-3.60%	57.76%	**38.43%**	**38.43%**	39.60%	**39.60%**
		1987-88[4]	12.07%	8.65%	2.60%	-29.25%	**8.65%**	**8.65%**	-3.05%	**-3.05%**
29	Petroleum and coal products[2]	1993-94	-2.18%	5.71%	-2.17%	3.04%	-1.93%	4.88%	8.07%	7.22%
		1992-93	-3.09%	2.32%	-1.44%	2.09%	-2.41%	1.79%	5.59%	5.03%
		1991-92[4]	-16.87%	8.82%	-26.02%	104.55%	**15.01%**	**9.48%**	30.90%	**31.71%**
		1990-91[4]	2.31%	10.50%	-4.59%	23.96%	**10.50%**	**10.50%**	8.01%	**8.01%**
		1989-90[4]	15.65%	41.54%	-12.15%	259.26%	**41.54%**	**41.54%**	22.39%	**22.39%**
		1988-89[4]	15.56%	19.48%	-3.86%	593.35%	**19.48%**	**19.48%**	3.40%	**3.40%**
		1987-88[4]	18.01%	-28.52%	0.42%	-39.03%	**-28.52%**	**-28.52%**	-39.43%	**-39.43%**
491,493	Electric Utilities[3]	1993-94	0.55%	3.64%	1.34%	-5.95%	1.49%	3.56%	3.07%	2.99%
		1992-93	7.60%	39.69%	4.70%	-16.60%	10.91%	38.25%	29.82%	28.49%
		1991-92[4]	10.46%	48.55%	-7.40%	39.33%	**73.31%**	**49.62%**	34.48%	**35.44%**
		1990-91[4]	-1.66%	-7.95%	3.02%	-13.50%	**-7.95%**	**-7.95%**	-6.40%	**-6.40%**
		1989-90[4]	-2.61%	16.05%	-0.28%	1.29%	**16.05%**	**16.05%**	19.16%	**19.16%**
		1988-89[4]	9.91%	-13.02%	-3.86%	22.29%	**-13.02%**	**-13.02%**	-20.86%	**-20.86%**
		1987-88[4]	4.45%	-9.16%	6.48%	-25.98%	**-9.16%**	**-9.16%**	-13.02%	**-13.02%**
	Total	1993-94	0.94%	4.99%			-0.67%	4.52%		
		1992-93	4.34%	18.46%			4.35%	17.14%		
		1991-92	-3.68%	22.53%			**23.50%**	**22.62%**		
		1990-91	0.35%	3.44%			**7.11%**	**3.77%**		
		1989-90	5.44%	30.02%			**34.37%**	**30.40%**		
		1988-89	10.56%	3.73%			**13.20%**	**4.49%**		
		1987-88	9.98%	-18.81%			**-21.20%**	**-19.01%**		
	Average	1993-94	0.94%	4.99%	0.21%	-0.52%	-0.67%	4.52%	5.25%	4.36%
		1992-93	4.34%	18.46%	0.40%	-0.99%	4.35%	17.14%	12.94%	12.14%
		1991-92[4]	-3.68%	22.53%	-15.36%	82.02%	**23.50%**	**22.62%**	31.93%	**32.49%**
		1990-91[4]	0.35%	3.44%	-3.29%	22.38%	**7.11%**	**3.77%**	3.37%	**3.66%**
		1989-90[4]	5.44%	30.02%	-2.61%	22.20%	**34.37%**	**30.40%**	20.60%	**20.56%**
		1988-89[4]	10.56%	3.73%	-3.77%	49.35%	**13.20%**	**4.49%**	-2.23%	**-1.09%**
		1987-88[4]	9.98%	-18.81%	2.95%	-27.37%	**-21.20%**	**-19.01%**	-28.00%	**-28.04%**

Source (unless otherwise noted): Bureau of the Census. 1984-1994. Current Industrial Reports: Pollution Abatement Costs and Expenditures. MA-200(84-94)-1.

Note: Boldfaced typset indicates a constructed value based on available data.

1 PACENM denotes pollution abatement capital expenditures (Total Media + Nonmedia and other).

2 Includes SIC codes 2951 and 2952 which are clearly coal product industries.

3 Does not include Rural Electric Administration utilities.

4 Data on abatement technique for solid waste were not available for 1987-1991. Therefore, these values are percentages of air and water, rather than of total media.

The ratio of pollution abatement expenditures to total new capital expenditures has increased steadily for the targeted manufacturing industries as well as for all industries since 1984 (Exhibits 3-2 and 3-3). This would indicate that industries as a whole are directing a larger share of their investment to pollution abatement. Since 1985, the targeted manufacturing industries have devoted a greater percentage of their capital to pollution abatement expenditures than the industry average. However, they have also become proportionately more capital intensive since then (Exhibit 3-4). Thus, their Total Media (Total PACENM)/New capital expenditure ratios have not risen much faster than the industrial average. In the non-manufacturing industries the Total Media (Total PACENM)/New Plant and Equipment ratios increased over the period, but at a slower rate than for the manufacturing industries (Exhibits 3-5 and 3-6).

The general trend in environmental expenditures has been a steady shift from expenditures reported as "End of Line" to those reported as "Changes in Product Processing" for the targeted manufacturing industries as well as for industry as a whole, which is demonstrated in Exhibits 3-2 and 3-3. The one exception is the chemicals and allied products industry, where the percentages have remained fairly constant. The largest percentage shift from "End of Line" (EOL) to "Product Processing" has been in petroleum and coal products, followed by primary metals. Over the 1984-1994 period, the percentage shift from EOL to Product Processing has, on average, been slower in the targeted manufacturing industries than for the average industry. The only industry which appears to be the exception is petroleum and coal products. Paper and allied products and petroleum and coal processing are more Product Processing-intensive than the average for all manufacturing industries, while chemicals and allied products and primary metals are more EOL-intensive relative to industry as a whole (see Exhibits 3-2 and 3-4). For the non-manufacturing industries, there have been large -- albeit erratic -- shifts from EOL to Product Processing, except for electric utilities, which has remained fairly constant (Exhibit 3-6).

3.2 INDUSTRY SPECIFIC CAPITAL INVESTMENT TRENDS

The U.S. Department of Commerce annually reviews factors affecting major U.S. industries, and trends in those industries. These reviews are published in the Industrial Outlook publication annually. We reviewed three representative years of Industrial Outlooks in the period of review for this analysis, as well as reviewing industry trade journals for a representative industry, Pulp and Paper. The Industrial Outlook has reported different industry sectors in somewhat different groupings over the period reviewed, resulting in some gaps in the reporting of developments in industrial subsectors. In addition, the Industrial Outlook does not report on the electric utility industry.

3.2.1 Metals Mining

This industry generally has lower levels of capital investment than the average for non-manufacturing industries. Only about 4 percent of its capital investments are directly related to pollution abatement activities. There is no indication in the Industrial Outlook publications over the period that this industry is investing heavily in new technological processes to reduce resource use or pollution production.

1988 Industrial Outlook

The metals mining industry is strengthening via streamlining of operations and plant modernization. This industry produces more than 1 billion metric tons of waste per year. The U.S. Occupational Safety and Health Administration (OSHA) strengthened its worker safety regulations, affecting operational costs. High prices of precious metals encouraged production at low-grade deposits via new technologies such as heap leaching, which accounts for 30 percent of domestic gold production. U.S. iron ore extraction continued to decline due to low-cost imports. In ocean mining, the long-term prospect is for closer-to-shore mining and open ocean mining. The U.S. Bureau of Mines and the U.S. Geological Survey is identifying federal lands with mining deposits to reduce US dependence on foreign sources. Under Superfund, the mining industry has been taxed $2.5 billion for cleanup costs. EPA will report in 1988 on regulations for various wastes, including aluminum smelter potlines, copper acid plant blowdown, lead surface impoundment solids, ferrochromium dust and sludge, zinc process wastewater sludge. Environmental regulations have increased the market for platinum group metals because 50 percent of the demand for these metals is for control devices for motor vehicles.

1991 Industrial Outlook

Trend toward joint ventures continues because of high costs and long delays of environmental compliance. Federally mandated cleanup and control of mining wastes should be resolved with the upcoming RCRA reauthorization in 1991. Proposed OSHA regulations on exposure to cadmium could severely affect the cadmium, zinc, lead, and copper sectors. The Basel Convention on the transport of hazardous wastes could hinder scrap metal use and recycling efforts, possibly resulting in costly trade disruptions in the mineral industry. Environmental pressure to change the status of federal lands from multi-use designation to wilderness, which would preclude mining opportunities on these lands.

1994 Industrial Outlook

Mining Act of 1872 proposed revisions of royalty provisions and cleanup fund for abandoned mines. The U.S. Department of Energy may increase royalties on ore produced on federal land, or introduce "severance" tax on mineral production. The classification of hazardous mining wastes is pending in RCRA reform. The 1990 Clean Air Act requires definition of "maximum achievable control standards" in late 1997. Concern continues over

federal land being withdrawn from mining via wilderness designation. Several metal producers have introduced new technologies in an effort to become more competitive with international companies.

3.2.2 Petroleum

The Petroleum industry consists of two primary components: crude petroleum and natural gas production, and petroleum refining. The former is included in the non-manufacturing sector in Exhibits 3-5 and 3-6, while refining is included in the manufacturing sector (Exhibits 3-2 to 3-4). The crude oil and natural gas industry has a somewhat larger than average proportion of its new capital expenditure going for structures, presumably related to investments in pipelines, drilling platforms, etc. This industry's investments in direct pollution abatement capital are approximately equal to the average for nonmanufacturing industries, but the proportion of investment in product process changes has been very high in recent years. The Industrial Outlook does not provide a basis for inferring that capital investments in this industry are strongly related to the development of new technologies that either reduce input use or pollution production.

The refining industry, however, is very different. While total new capital expenditures tend to be somewhat below the average for all manufacturing industries, the proportion that is spent on direct pollution abatement is consistently much higher than the industry average, and has exceeded 40 percent in some years. The proportion of "Product Process" expenditures is also very high with respect to "EOL" expenditures. In *addition* to the direct PACE expenditures, this industry has been expending a significant amount of capital to change its product line to include reformulated gasoline, as required by the Clean Air Act. To meet the Federal reformulated gasoline requirements, the industry has been estimated to need to have spent between $1.5 billion (Information Resources, 1994) and $3.0 billion (National Petroleum Council, 1993) in 1994-1995. The industry is further predicted to spend between $1.5 billion (Information Resources, 1994) and $2.5 billion (National Petroleum Council, 1993) in 1998-1999 (reported in $1990).

1988 Industrial Outlook

Petroleum Refining. Increase in downstream processing is expected to meet demand for lighter products and for lower-sulfur heating oil. Catalytic hydrotreating to remove impurities gained 300,000 barrels per stream day (a 3 percent increase) over the prior year. Catalytic hydrocracking has the greatest increase in 1987 (6 percent). This process increases the yield of high-quality gasoline from lower quality light gas oils.

Crude Petroleum and Natural Gas. Crude production is expected to decline, accompanied by an increase in natural gas production equal to the expected increase in aggregate U.S. energy production (1-2 percent annually between 1987-92). Oil and gas exploration has declined. The Tax Reform Act of 1986 expected to affect the tax liabilities of the oil and gas industry. Superfund taxes on crude oil were substantially increased. The Powerplant and

Industrial Fuels Act of 1987 may lead utilities to use more natural gas because it removes restrictions on the construction of gas boilers. The Natural Gas Policy Act of 1978 lifted price controls on natural gas produced from new off-shore wells.

1991 Industrial Outlook

Petroleum Refining. The industry is investing major capital over the next five years to meet Clean Air Act requirements. Gasoline reformulation will require capital investment of $10-30 billion during the next decade, thus adding 5-10 cents to price of gas. This may cause small refineries to close or be absorbed by major companies. Reformulated gas production may cause refinery configuration problems: less crude required but a surplus of aromatics and benzene, as well as less output of jet fuels and distillate fuel oils.

Crude Petroleum and Natural Gas. The U.S. continues to decrease crude production due to a decline in proven reserves and the constraint in off-shore drilling. Natural gas and coal production and renewable sources will more than offset lower crude production. U.S. natural gas reserves are large. Natural gas is expected to be fastest growing energy source partly because it produces less carbon and sulfur when burned, and because it is easier to control environmental hazards during production. Lease sales have been postponed on environmentally sensitive areas of California, Florida, and other coastal areas. Anticipated CAA revisions could lead electric utilities to use natural gas because of its low sulfur content. Horizontal drilling has increased production in once-marginal operations. Extraction of methane gas from coal seams increased due to a tax credit scheduled to expire in 1990.

1994 Industrial Outlook

Petroleum Refining. Large integrated companies with multiple refineries have committed significant resources to plant additions and reconfiguration due to the CAA (i.e., production of oxygenated fuels, low sulfur diesel and other specialized products). Production of low sulfur diesel (required as of Oct. 1, 1993) incurs higher operating and capital costs, and affects 8 percent of total US demand for petroleum products. Capital outlays for refining nearly totaled $11 billion in 1992. Between 1988 and 1992 investment per refined unit increased 49 percent. Crude quality is declining while demand for high-quality refined products is increasing, resulting in increased investment. Regulation continues to drive investment in "downstream" processes.

Crude Petroleum and Natural Gas. Increased natural gas pipeline capacity has been supported by a 6 percent increase in demand by utilities and 7 percent by industry. Natural gas consumption will continue to rise due to increased gas-fired electricity generating capacity. The Energy Policy Act (EPACT) of 1992 affects crude and natural gas production due to tax incentives and regulatory changes. The alternative minimum tax system helps independent producers' profitability and could cause a substantial increase in investment. EPACT created an independent power producer class with access to utility-owned transmission lines. Tax credits

under "Section 29" were extended for nonconventional fuels, including tight sand and coal seam drilling for natural gas. 1993 was the first year of settlements under the 1990 Oil Pollution Act, which uses taxes and subsidies to curtail consumption and improve the environment.

3.2.3 Primary Metals

New capital expenditures for this industry are among the lowest of the six industries analyzed, and are much lower than the average for manufacturing industries. Similarly, the proportion of new capital expenditures associated with direct pollution abatement activities has remained below the industry average. Of pollution abatement expenditures, the proportion going to end-of-line investments is consistently near 80 percent, and there has been little shift towards process improvements. The Industrial Outlook review indicates some shifts towards less resource intensive technologies, including both the steel and lead industries. There has also been a shift toward use of lower-grade ores, however, potentially resulting in higher pollution levels.

1988 Industrial Outlook

Steel. For steel, high costs of plant closures keep antiquated mills in production and lead to oversupply. The industry is experiencing a growth in the number of mini-mills, which use electric arc furnaces and scrap steel unlike conventional integrated mills. New production technologies will allow these mills to compete in the primary markets of integrated mills. Financing for one new integrated mill is coming from Japan. In integrated mills, there is an increased use of continuous caster process technology, raising yields and productivity. This process now accounts for 60 percent of production, up from 30 percent in 1980. 26 million tons of continuous caster capacity was added between 1983 and 1987, and more continuous caster capacity will be added in the future.

Aluminum. The cost of aluminum production depends on electric utility rates, which average 33 percent higher in the US than most other countries. In 1987 many hydroelectric utilities established variable power rates for aluminum smelters, linked to the price of aluminum. The maximum rate under the variable rate structure could prevent some smelters from accumulating the funds for modernization. Aluminum smelters may also have to pay additional disposal costs if the EPA classifies spent potliner, a byproduct of aluminum production, as a hazardous waste under Subtitle C of RCRA. More expensive smelters are staying in production through "tolling agreements" which may result in over-capacity.

Copper. Production has seen increases in solvent extraction electrowinning (SX-EW) production technology, which produces copper from low-grade waste or oxide ore deposits. Capital cost is half that of conventional technology, and environmental costs are low because the process recycles the plant leach water. SX-EW accounted for 10 percent of production in 1987 and an expected 18 percent in 1992. The industry experienced major restructuring between 1985-1987, including closure of antiquated plants, modernizing existing plants and equipment, and new investments in SX-EW. The Magma Copper Company is investing in a new smelter to

meet environmental regulations. Phelps Dodge closed its Douglas, Arizona smelter due to an inability to meet environmental regulations.

Lead. This industry underwent a rationalization process in the 1980s due to decreased lead consumption and environmental and other regulations, with only two U.S. producers remaining in production. Demand is tied closely to the demand for automobile batteries: warm winters reduce demand, while there are cycles tied to previous periods in which new automobile sales were strong due to the aging of original equipment batteries. Battery recycling declined due to classification under RCRA as hazardous waste: recycling rates dropped from 80-90 percent in 1979 to 70 percent after 1983. The number of secondary smelters has declined by two-thirds between 1982-1987, and many scrap dealers will no longer handle batteries. EPA began to review its recycling policy in 1987. A ban on leaded gas will affect 2 percent of lead consumption; some oil companies anticipating the ban have already discontinued use of lead. New potential uses for lead include: motive power batteries for industrial trucks, back-up power supply (UPS) for computers and communications, load-leveling batteries for electric utilities, use as a road asphalt stabilizing agent, and sheet lead roofing.

Titanium/Zinc. No major environmental regulations or new technologies are currently affecting the titanium industry. The industry looks to expand from its traditional base of the aerospace sector. Non-aerospace industrial uses are primarily power condensers and general chemical uses. No new environmental regulations are affecting zinc production. Use of zinc for galvanizing, its largest present use, is expected to increase 20-25 percent by the mid 1990s. The electrogalvanizing process is taking over the market, primarily because the auto industry demands electrogalvanized sheet steel. However, the amount of zinc used per car is declining.

1991 Industrial Outlook

Steel. The 1990 CAA amendments imposes tough standards on hazardous emissions from coke ovens, which may cause plant closings. The industry has been given until 2020 to meet a progressive timetable of carcinogenic emission reduction. This may be possible if production is converted to one-step or direct steel-making. A joint program by the American Iron and Steel Institute and DOE is spending $30 million on a direct steel making demonstration project. There is increased demand for low carbon steel, lighter weight steel, and coated steel for autos. Minimills are developing technologies to produce flat rolled steel at commodity grades. Steel can recycling is also increasing in furnaces.

Aluminum. An industry environmental concern is the Basel Convention that will limit some international trade in secondary and scrap metal, affecting the use of recycled aluminum.

Copper. U.S. imports are declining; the world market is shifting from equilibrium toward excess supply. Until fiber-optic cable can transmit electricity, however, demand for copper wire will increase in conjunction with increased use of fiber optic cable. Copper

producers have begun expansion and renovation of projects to reduce production costs and increase productivity.

Lead. The lead industry has shifted significantly from the 1980s to the 1990s: the industry is increasingly tied to a single end-use: lead-acid batteries. The secondary (recycling) sector has shifted from a position of near equality with the primary sector to become the dominant production regime. Recycling of lead-acid batteries rose from near 80 percent in 1985 to near 100 percent in 1989 due to higher lead prices and an increases in secondary lead smelting capacity. Secondary lead production accounts for 69 percent of unwrought lead as opposed to 55 percent of lead in 1980. The proposed Lead Exposure Reduction Act of 1990 would outlaw disposal of lead-acid batteries in landfills and restrict lead use in a number of applications: pipe fittings, pesticides, toys, and curtain weights. Other long-term prospects for lead use are electric vehicles, load leveling for electric utilities, use as an asphalt stabilizing agent, and as a waterproof roofing agent.

Titanium/Zinc. Non-aerospace industrial uses of titanium include pulp and paper manufacturing. Large investments in electrogalvanizing capacity by U.S. steelmakers in the last three years has affected the demand for zinc. Additional demands include 2-sided galvanizing for outer skin components, and electrogalvanizing for new products, such as appliances.

1994 Industrial Outlook

Steel. Demand is determined mostly by the automobile and construction markets, and strong growth is predicted after several years of declining value of shipments. A new sheet technology (thin slab caster) is less capital intensive and has lower operating costs, and is under development in minimills. Half of the sheet market is still beyond the capacity of minimill quality, however. Intense international competition also driving cost reduction. The industry and EPA agreed to emissions standards for coke-producing companies in 1993 to reduce toxic coke oven emissions, resulting in the shutdown of many facilities. The industry is actively promoting alternatives to the conventional coke-oven/blast furnace. A new technology (direct steelmaking) would reduce, melt, and refine iron in a single reactor. The LTV Steel Company's proposal to install Corex, a less radical cokeless ironmaking technology, would cost approximately $800 million. It may receive a $150 million grant from DOE under the agency's Clean Coal TDP. The industry is actively encouraging recycling. In 1992, 56 percent of steel came from ferrous scrap. Recycling cuts energy use by one-half to three-quarters.

Aluminum. The aluminum industry has three main end use sectors: packaging, transportation, and building construction. Total shipments increased in 1993, but the capacity utilization rate fell for primary aluminum due to a water shortage in the Pacific Northwest and an associated reduction of power service. The Bonneville Power Administration in the northwest also increased electricity rates 14 percent, including variable rates for smelters. Due to reductions in SO_2 emissions required under CAA of 1990, some coal-fired electric utilities' costs will be passed on to smelters. Measures to limit "greenhouse effect" produced by coal burning

utilities could also negatively affect the aluminum industry because approximately half of the smelter capacity in the U.S. depends on electricity from coal burning plants. There is no new domestic smelting capacity due to high cost of electricity. Aluminum reached a 62 percent recycling rate in 1992; one third of U.S. aluminum is recycled material. Recycling conserves 95 percent of the energy used to make aluminum. The industry is investing in research and development and in new facilities to facilitate the introduction of aluminum into new automobile applications to meet fuel economy standards. Automakers may build aluminum-intensive cars by 1996. Electric cars also likely to contain more aluminum. New aluminum-based matrix (metal and fiber) materials are being developed for cars, other transport, and other applications.

Copper. This industry has undertaken major renovations and expansions to increase productivity and efficiency. Kennecott Corporation is spending $880 million for copper smelter modernization. Cyprus Minerals Co. has a $200 million capital expenditure program to reduce copper production costs. Potential changes to U.S. Mining Law, domestic emission standards, and the use of leaded alloys in faucets and fittings are major issues. There is also concern about shipment of hazardous waste, foreign packaging, and trade in scrap.

Lead. Laws in California and nine Northeast states could increase the demand for lead due to the mandate that two percent of all vehicles have zero-emissions, since electric autos use lead batteries for power storage. Certain applications of lead may be eliminated due to the proposed Lead Reduction Act of 1993. The pending Lead Paint Hazard Abatement Trust Fund Act of 1993 would put a $0.45 per pound tax on domestic lead production and imported lead products, which could dramatically affect future consumption. The new technology of using large banks of lead-acid batteries for load leveling of electricity is being piloted in several projects, and may significantly increase demand for lead in the coming years. Lead is also being tested as a containment substance for high-level radioactive waste, a stabilizer for road paving asphalt, a component in magneto-hydrodynamics, a barrier to radon gas, an absorber of earthquake shocks in construction, and a component in micro-electronics and super-conducting materials. Legislation has been enacted in 34 states to prohibit disposal of batteries in municipal solid waste streams and to require acceptance for recycling. There has been an increase in the recycling rate from 88.6 percent in 1987 to 96.8 percent in 1991.

Titanium/Zinc. No new major environmental regulations are affecting the titanium industry. Consumption of titanium continues its gradually recovery from its fall in the early 1990s with the collapse of the defense industry (user of 75 percent of domestic mill products, and 4 percent of domestic titanium used). Pigments are the primary domestic end use (95 percent titanium used). New future uses for titanium are applications in flue-gas desulfurization, nuclear waste treatment, and land-based gas turbine engines for power generation. New "sponge" producing process uses vacuum distillation and produces a higher quality product at lower cost. There is one new production plant in the U.S. Galvanizing represents 53 percent of zinc consumption, while die casting represents 20 percent, brass and bronze 14 percent, and other uses 12 percent. There were large additions to capacity for sheet galvanizing in 1993. In 1992 Congress required EPA to conduct a study on metal recovery, which may affect current zinc

recycling efforts. The study is to examine current regulations and how they affect metal recovery, look at incentives for metal recovery, and examine how metal recovery should be regulated to protect human health and the environment. The study also will evaluate the best ways of achieving RCRA's resource conservation goals. Between 1983 and 1993 recycled zinc as a percentage of total domestic production jumped from 22.7 percent to 31 percent. New zinc-air battery technology may prove very competitive with lead-acid and nickel-cadmium batteries for electric vehicles. A prototype zinc-air battery permits automobile performance similar to gas powered cars, and requires minimal recharging.

3.2.4 Pulp and Paper

Industrial Investment Summaries

The PACE data indicate that the Paper and Allied Products industry is the second-most capital intensive of the industries reviewed, after the chemicals and allied products industry. Investment levels have remained relatively consistent since 1988. Direct pollution abatement expenditures have increased from about 5 percent of new capital in the mid 1980s to between 11 and 15 percent by the early 1990s. There has been a general trend toward product process investments, which comprised over 40 percent of PACE expenditures between 1990 and 1992.

Based on annual capital spending surveys conducted for the trade journal Pulp & Paper, industry capital investment follows a cyclical pattern. High prices and strong demand lead to high profit levels; these combined with capacity limits lead to high levels of investment. Investment lags a recovery after a downturn in demand, especially if excess capacity is in place. Large increases in long-term debt during the 1980s for capacity expansion have led to debt pay-down in the late 1990s rather than a large increase in capital investment. Environmental expenditures may not increase as much after promulgation of EPA's "cluster rule" as originally thought due to anticipatory investments. Pulping expenditures include a large degree of environmentally-related expenditures, largely in processes to reduce chlorine use. Much new technology was developed during the 1990s downturn, and is now being retrofitted into existing facilities. Paper mills have been investing heavily in de-inking facilities to enable use of waste fiber and production of recycled paper. Machinery rebuilds are largely implemented to change product lines, but also for cost reduction.

The industry capital expenditure plan surveys ask for data on the previous year's actual capital expenditures, and predictions for the current year and at least two additional years in the future. Exhibit 3-7a provides the results for the years 1988-1997. In general, the survey's predictions for capital expenditures for the current year are reasonably accurate compared to the surveys findings for actual expenditures the following year, but there is a major difference between the magnitude of the expenditures reported in the survey and those reported in the Annual Survey of Manufactures: the survey values are about half those reported in the ASM. Exhibit 3-7b uses the survey results to indicate the proportions of project-specific capital expenditures going to different types of capital (as opposed to the absolute amounts of

investment). This exhibit indicates that environmental expenditures constitute a maximum of nearly 18 percent of capital expenditures in the 1994-1996 survey. These expenditures closely mirror the PACE reported expenditures, and so do not necessarily reflect all of the process enhancements that also have environmental implications. Roughly 33-40 percent of capital expenditures are consistently for pulping facilities, which are continually being upgraded to reduce chlorine and energy use. Between approximately 18-30 percent of the capital expenditures are for new paper machines, which include investments in de-inking facilities. Overall, it is likely that as much as one-third of the capital investment in this industry has a direct impact on resource use and pollution production.

1986 Industrial Outlook. For the overall industry, the 1986 tax reform with respect to the investment tax credit was expected to negatively affect this industry. Equipment in the industry is cost effective and technologically advanced. For pulp mills, more production of mechanical high-yield pulp for newsprint and other paper is expected to result in the use of less chemicals, steam, and energy (excluding electricity). For paper and paperboard mills, increased capital expenditures are expected for new and improved facilities as well as ongoing cost-containment for energy and raw materials. In the corrugated board sector, capital expenditures are mostly for conversion or rebuilding existing machines, with a trend toward automation and energy conservation.

1991 Industrial Outlook. The pulp and paper industry ranks fifth in energy consumption, much self-generated. There have been sizable capital investments in the last several years, including large expenditures on environmental improvement, especially during 1970s. The industry has a self-imposed goal of 40 percent wastepaper recovery, which is expected to increase wastepaper consumption by 50 percent over the next few years. The industry is anticipating EPA rules on dioxin in the near future, which may cost $20 million per pulp facility. Pulp mills are continuing investment in mechanical pulp mills, many scheduled to be on line in 1990. Sheet paper mills are converting to alkaline sizing using calcium carbonate. All sectors are increasing their use of recycled materials.

1994 Industrial Outlook. The 1993 wastepaper recovery rate was over 40 percent, and 31 percent of fiber comes from recycled paper. Most mill additions in 1993 planned to use recycled fibers. Improvements and rebuilds exceeded installation of new machines; environmental programs account for 15 percent total spending plans, up from 14 percent in 1992. Requirements under both the Clean Water Act and the Clean Air Act are expected in 1995. Pulp mills have had an increasing trend toward chlorine-free bleaching. Other technological improvements include high-brightness bleaching; increased yield pulp processes; improved processing of recovered paper; and more efficient use of energy.

3.2.5 Chemicals and Allied Products

The chemical industry has consistently exhibited very high levels of new capital expenditures, nearly twice the industry average. The proportion of these expenditures attributed to pollution abatement is just slightly lower than the average for the manufacturing industries reviewed, resulting in very large pollution abatement expenditures in absolute terms. The industry's pollution abatement expenditures have been oriented more towards end of line abatements than product process changes, compared to the average, but there has been a small shift towards process enhancements. Largely because of the heterogeneity of this industry, the Industrial Outlook does not provide much information concerning the degree of process innovation that may be occurring the industry, and which may affect the degree of resource use or pollution production in the near future. The only industry that seems to have made major shifts is the Paints and Coatings segment, which has responded to technology-forcing environmental regulations by reformulating product lines. Nonetheless, the Industrial Outlook indicates that there has been a large increase in recycling of inputs and improved waste treatment technology in the industry overall.

1988 Industrial Outlook

Overview. The chemical industry is characterized by slow-growing mature products. The industry is undergoing a very significant restructuring. Foreign owned companies account for 30 percent of U.S. shipments. There is a long-term shift in the U.S. chemical industry towards specialty chemical products that are less dependent on the price of crude. Production costs will remain low for much of the industry as crude oil feedstock prices remain low. Several environmental statutes affect the chemical industry. In terms of specific regulations, under the Clean Air Act, hazardous air pollutant emissions standards were promulgated in 1987 for 11 chemical industry products. In 1984 the chemical industry incurred pollution abatement capital costs of $0.74 billion and associated operational costs of over $2.5 billion.

Organic Chemicals. These chemicals are used to produce plastics, synthetic fibers, solvents, and numerous other products. The industry is restructuring, resulting in plant closings and only 1 percent increase in capital spending. Firms are mostly expanding existing facilities rather than undertaking new construction. U.S. organic chemical producers are gradually moving towards the production of low volume, specialty chemicals. This shift will decrease the domestic chemical industry's use of crude feedstocks and should make the industry less dependent on crude feedstock price fluctuations.

Alkalines and Chlorine. Alkalines and chlorine make up 15 percent of the value of inorganic chemical shipments; chlorine, caustic soda, and soda ash are the dominant chemicals. This industry is decreasing its dependence on the high cost of electricity by increasing the use of the membrane process for chlorine and caustic soda production. This process requires 20-30 percent less energy and yields products of higher purity than conventional methods.

Industrial Gases/Inorganic Chemicals. Industrial gases include oxygen, nitrogen, carbon dioxide, hydrogen, acetylene, and specialty gases. Industrial inorganic chemicals are diverse. Demand for some industrial gases is increasing, driven by production of high grade steel and electronics, while demand for most industrial gases is declining. To maintain profitability in the face of high energy costs, international competition , and low demand, the industrial gas producers have invested in energy-efficient and automated plants. Low levels of R&D, declining productivity, and overcapacity characterize the industrial inorganic chemical industry. Demand for these products is tied to housing, automobiles, paper, fertilizers, and soap industries.

Paints and Coatings/Adhesives and Sealants. Demand for coatings is tied to architectural and original equipment sectors, while end markets for sealants and adhesives are diverse. The paints and coatings industry is characterized by several large multinational companies and numerous regional companies, while the adhesives industry is restructuring.

Fertilizers. There is a large amount of idle capacity in ammonia production, largely due to imports. The availability of natural gas is the most important factor in the production of nitrogenous fertilizers, including ammonia. Natural gas prices are expected to be low in 1988, which would help bolster the domestic production of nitrogenous fertilizers. The industry has experienced slow growth due to low grain prices and the reduction of planted acres. Users are switching from the use of ammonia to safer, more easily handled urea. The U.S. is the primary producer and consumer of phosphate fertilizers; world overcapacity is depressing prices.

Pesticides. Organic chemicals account for 93 percent of the active ingredients in pesticides. Reductions in planted acreage have led to reduced demand. Increasing stringency of environmental regulations and higher costs of R&D have cause new product development costs to increase significantly. These costs are not always recovered due to the international abuse of intellectual property rights. Cost increases have caused industry consolidation. Pesticide producers are preparing for future biotech developments by purchasing seed companies.

1991 Industrial Outlook

Overview. In 1990, the chemical industry is emerging from a massive restructuring. R&D expenditures increased nearly 5 percent over 1989, while capacity utilization decreased due to decreased demand. The industry will continue to move from low price commodity chemicals to high price specialty chemicals; R&D will increase, but at a slower rate. The industry is estimated to have spent $1.45 billion of its capital expenditures on environmental compliance in 1989. Annualized operational costs for pollution abatement accounted for another $3.35 billion. Environmental regulations may affect the industry's international competitiveness to the extent that other countries count environmental costs as social costs, not reflected in the cost of the production. Compliance with the newly signed CAA of 1990 is estimated to cost the industry $25 billion per year. Five regulations were promulgated under the CWA of 1987 that affect the chemical industry. In 1989, an Appeals Court decision remanded significant parts of one of these, chemical plant effluent standards. Others include storm water and sewage sludge

regulations and state identification of "toxic hot spots". States will establish water quality standards for 126 pollutants or have EPA establish them.

Organic Chemicals. Operating capacity was less than 80 percent in 1990. The value of shipments increased 4.3 percent over 1989, while imports are expected to be providing an increasing share of domestic demand. The industry is continuing to shift toward specialty chemicals. U.S. environmental compliance costs can not always be recouped in international markets, thus US chemicals are becoming less competitive. Basic organic chemical production is gradually shifting to countries where the availability and cost of petroleum and natural gas feedstocks are more advantageous. Price pressure is expected to increase as production increases in the Middle East and Pacific Rim. Domestic concern for the environment should increase demand of organic flocculants and coagulants use in water treatment.

Alkalines and Chlorine. Caustic soda is used to process organic chemicals (33 percent), make pulp and paper (25 percent), and in other industrial products. Soda ash is used for glass, water treatment, pulp bleaching, and manufacturing detergents. Chlorine uses are declining. High energy costs are leading to increased use of membrane processes, which use less energy and produce higher purity products. Heightened environmental concern has reduced the demand for chlorine and caustic soda products. Demand for soda ash is increasing, to replace caustic soda in pulp and paper and chemical manufacturing.

Industrial Gases/Inorganic Chemicals. The industrial gas industry is characterized by a few large producers (4) and a small number of regional producers. New large scale uses of industrial gases are being researched and developed. For example, the use of oxygen is increasing rapidly due to new uses in pulp bleaching and waste treatment. The inorganic chemical industry is characterized by hundreds of producers, many of which are very small.

Paints and Coatings/Adhesives and Sealants. There is a shift towards reducing the amount of organic solvents used in both industries. In coatings, powder coating technologies have lowered disposal and labor costs and are replacing old processes using organic solvents. New corrosion control processes for machinery are being developed, using coatings such as zinc-nickel. The paint industry is focused on revising federal OSHA labeling requirements, complying with CAA legislation at the federal and state level, and revising the DOT restrictions on the use and disposal of certain organic solvents under RCRA. In the adhesive and sealant industry, new processes including radiation curing and organic solvent-free formulations are being developed to replace organic solvents.

Fertilizers. The number of firms is declining sharply, affected by acreage reduction programs, economic trends, climate, and high raw material costs. The industry is restructuring. Nitrogen product production and sales are flat, while imports are increasing. Phosphatic fertilizer production is growing somewhat, but is expected to be affected by strong international competition. Proposed groundwater legislation at the state and federal level may affect the fertilizer industry.

Pesticides. The industry consolidation trend is continuing as a response to growing R&D costs, the abuse of intellectual property rights, and environmental regulations. The average development time for a new product line has increased to nine years since 1976. Slow growth is expected due to the more effective use of pesticides and environmental pressure on U.S. farmers to use less pesticides. In the future, genetically engineered, hardy crop varieties may eliminate the need for certain pesticides.

1994 Industrial Outlook

Overview. Chemical industry growth is strongly tied to the condition of the domestic and global economies. Resurgence in industries such as automobiles, housing, and electronics is required for shipments to increase. 1993 was a poor year for the industry, with less than 1 percent growth in the value of shipments. R&D expenditures stayed constant, but the goal switched from new product development to development of new manufacturing processes. Due to restructuring, the U.S. industry is likely to gain from the rebounding of the global economy. 1994 capital expenditures for pollution abatement are expected to rise 7 percent, mostly due to CAA requirements. The Toxic Release Inventory indicates that the industry reduced its toxic releases by 35 percent between 1987-1991. This decrease is partly due to improved waste treatment technologies and recycling of 54 percent of products covered by the TRI. The CAA is responsible for increased demand for some chemical products -- including methanol -- as fuel additives, resulting in some plant expansions. The December 1992 Hazardous Organic National Emissions Standards for Hazardous Air Pollutants (HON) are expected to reduce toxic air pollutant emissions at chemical plants by 80 percent. Companies are estimated to spend 1.6 percent of sales on hazardous waste site cleanup in 1994, up from 1.1 percent in 1993.

Organic Chemicals. The industry is still restructuring. Capital expenditures are estimated to rise in 1994 by 6 percent over 1993 levels. Most of the increase will be by firms with less than $1 billion in annual sales for environmental compliance. R&D expenditures are expected to remain flat. The U.S. petrochemical sector has an advantage over foreign competitors due to the low price, large domestic supply, and extensive pipeline distribution of natural gas and liquid feedstocks.

Alkalines and Chlorine. Chlorine market has significantly declined due to the Montreal Protocol and International Joint Commission of Great Lakes Water Quality phasing out of CFCs and other chlorine and chlorine containing compounds. Although bottle recycling has disrupted the link between demand for glass and demand for soda ash, demand for phosphate-free detergents has spurred demand for soda ash. The U.S. has huge reserves of high grade ore for natural soda ash production, currently out-competing European synthetic producers. Potential applications for additional reserves of low grade ore may cause a new two-tiered price structure in the soda ash market.

Industrial Gases/Inorganic Chemicals. Two new technologies, pressure swing absorption and membrane technology give an advantage to the big producers over small

producers who lack these technologies. In the distant future hydrogen and helium could prove environmentally benign fuels. Hydrogen peroxide is increasingly used as an alternative to chlorine as a paper bleaching agent. Specialty inorganic chemicals will find new, environmentally benign uses.

Paints and Coatings/Adhesives and Sealants. The paint industry continues to reformulate product lines to address concerns voiced in the CAA of 1990: reduction of VOCs and use of lower toxicity solvents. There have been swift and massive reformulations of product lines to use lower toxicity solvents. The industry has been working on the federal and state level in developing realistic emissions objectives for product lines. Public concern has focused attention on the recycling of lead-based paints and the reduction of toxic materials in marine and other paints. For the adhesives and sealants industry, restructuring is completed. Environmental concerns are driving product reformulation: solvent free application methods and aqueous-based and radiation cured adhesives are being developed.

Fertilizers. Restructuring of this industry is continuing. The dangers of handling gaseous anhydrous ammonium are causing an industry shift form direct application of ammonia to the use of nitrogen solutions. The U.S. is losing its share of world nitrogen fertilizer market and production because its international competitors have lower-cost natural gas sources. Major oversupply conditions for phosphatic fertilizers are reducing prices, but the U.S. is still the dominant producer.

Pesticides. Corporate restructuring in the 1980s has been driven by increasingly stringent environmental regulations. Industry consolidation continued in 1993. The high R&D costs and environmental compliance costs have increased the cost of new product releases from $6 million in 1976 to $50 million in 1993. Current designation of many pesticides as potential carcinogens may lead to increasing controls under the Delaney Clause. Increased use of preemergent herbicides has changed grower tillage practices, and has affected the extent of soil erosion. Biopesticides are expected to grow rapidly. Many product patents are expiring, which will lower prices and profits on commodity pesticides.

4. TAX ANALYSIS

In order to evaluate the potential impact of a change in accelerated depreciation on industry investments, a method for estimating the behavioral response to the change is needed. This phase of the project concentrated on establishing the basis for such an analysis, through a review of the theory and methods for analyzing the changes associated with alternative tax policies.

4.1 Basic Tax Policy Issues

Tax policies influence the level, the composition and the timing of capital investment in structures and durable equipment. Nonresidential fixed investment is largely determined by expansion of industry, the need to replace worn-out or obsolete equipment, and changes in relative prices of capital and labor. Accelerated depreciation schedules, tax investment credits, and interest deduction allowances affect the user cost of capital services and more generous allowances act as stimuli for capital formation.

From a public policy perspective, tax incentives are a two-edged sword. They can be used as a countercyclical tool to spur economic growth and counteract the negative effects of inflation but they can be costly to the Treasury and they can distort investment patterns. Two notions are crucial in assessing the appropriateness of tax policy: demand responsiveness and allocative efficiency.

First, if the investment stimulated by a subsidy is larger than the tax revenue loss--a result that occurs when the investment demand elasticity is great than one--the subsidy will be relatively cost effective stimulus. If on the other hand, the investment response is much smaller, then government spending increases, or transfers to individuals with relatively high short run propensities to consume, would be more effective.

Second, if the tax policy change makes the tax burden equal across sectors and industries, then through competitive market forces, a pattern of efficient capital investment will occur that should maximize national output. If on the other hand, tax policy favors one sector or industry over another, the maximum output from a given stock of capital may or may not occur. In short, two public policy goals, high growth rates in the short-run and sustained long-term productivity may conflict. Over time the business community has grown accustomed to tax incentives but in times of budgetary austerity, policy makers may legitimately strive to reduce the cost of the incentives or at the very least determine their cost effectiveness.

In the subsection that follows the concepts of accelerated depreciation and economic depreciation are introduced and explained. Because depreciation, or capital cost recovery allowances, is one of the fundamental factors in investment planning and at the same time one of the major reasons for less tax revenue collection, it is the focus of discussion relative to other tax

instruments such as capital gains taxes, statutory corporate income tax rates, and interest deductibility.

4.1.1 Capital Cost Recovery

In order to tax only the return to capital for an asset that wears out over time, tax rules must allow the investor-owner to recover his or her original cost free of taxes. Depreciation deductions are the means by which this objective is achieved. In theory depreciation is easy to assess but in practice it is very difficult to measure accurately, especially in the presence of inflation, rapid technical change, and a multitude of highly differentiated capital goods. Thus, tax depreciation codes tend to be complex and tax neutrality is elusive.

Since the repeal of investment tax credits with the passage of 1986 Tax Reform Act, the principal remaining corporate sector investment incentive has been the depreciation allowance.[1] Under the current tax code the original cost of a durable good can fully recovered over a specified life span. Under current law depreciable assets are assigned useful lives based partly on the type of asset and partly on the industry. Assets such as computers, office furniture, vehicles, and buildings are assigned the same useful lives regardless of the industry. Other more differentiated assets such as machine lathes are assigned useful lives based on the industry in which they are used. The value of the depreciation allowed depends on the method used. Historically, three common methods--straight-line, sum of years digits, and declining-balance--are used to calculate the yearly amount of the purchase price that can be deducted from tax liabilities.[2]

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[1] Interest deductibility, corporate statutory rates, and capital gains rules also influence marginal investment incentives but they are more indirect and less significant in the case of durable equipment investments. For example, interest payment deductibility may make debt financed acquisitions more attractive than equity financed ones, and helps subsidize equipment investment. However, the depreciation allowance for an asset of short to medium life is likely to be larger in magnitude given the prevailing nominal interest rates and thus is likely to have a greater impact on investment decisions.

[2] See Gravelle, 1994 , page 290 for detailed explanation of methods of calculation. The simplest method is the straight-line which requires equal deductions in each year. For example, if a structure was constructed for a cost of $100,000 and the life span is assumed to be 20 years, $5,000 could be deducted each year for twenty years. The sum-of-years digits method was used in the past but not now. It calculates depreciation as the remaining useful life divided by the sum of the digits in the useful life. For example with a three-year life the sum of digits is 6 (1+2+3=6), and depreciation in the first year would be 3/6, in the second year 2/6, and the third year 1/6. The declining balance uses a constant rate applied to the undepreciated balance. For example, in a 150% declining balance for a 10 year life, the depreciation rate would be 1.5/10 or 15 percent. The latter two methods allow proportionately more deductions in the early years of a durable product life cycle thereby compensating for obsolescence and stimulating businesses to replace equipment more frequently.

4.1.2 Concepts of Tax Neutrality and Allocative Efficiency

To the extent that firms are able to write off their capital investments at a rate faster than they actually age, the Treasury is able to collect lower tax revenues, resulting in a tax subsidy. The objective of this type of tax expenditure is to stimulate investment, but the result is generally to create inefficient investment patterns. The reason for this is that savers and businesses receive incentives to invest in industries where the prevailing capital mix used is more lightly taxed so as to maximize private after-tax returns. Accordingly, capital investment would be stimulated in industries or sectors that are not particularly high profit, efficient, or promising in the long-term.

Under the 1986 Act, the law that applies today, capital recovery was spread out over a longer period compared to the previous tax provisions thereby reducing the present value of cost recovery and lowering investment incentives. The 1986 Act provides for a 3,5,7,10,15, and 20-year capital cost recovery classes for equipment. The first four classes are depreciated under a double-declining balance and the last two under 150 percent of declining balance method that compensates somewhat for technological obsolescence (Gravelle, 1994). The Act also established two classes for structures, 27.5 years of residential rental property and 31.5 years for non-residential property (Jorgenson and Yun, 1991). The straight-line method of capital recovery is used for structures since obsolescence is less of a threat. In 1993 the depreciation period for non-residential buildings was increased to 39 years as a trade-off for relaxing the passive loss restrictions (Gravelle, 1994).

For most assets, the tax life span that allows the investor to recoup the original purchase price of the asset is shorter than the "true", useful life span of the asset. Thus, the acquisition of long-lived assets are favored. An another important bias is the use of historical cost as opposed to replacement cost in all but the first year which understates the value of the asset in an inflationary environment. Thus, reform proposals periodically surface that would either (1) offer greater accelerated deductions in order to check the negative effects of inflation, (2) use economic depreciation which is based on the current market value of the asset, or (3) first year capital recovery which permits the taxpayer to deduct the present value of economic depreciation as an expense in the year an asset is acquired. The first and third proposals may increase the tax subsidy and the second reduce it.

Ideally, equal tax rates should apply to all types of durable investments to assure neutrality of tax impact and efficiency in capital allocation. Tax rates should be such that projects that earn the highest pretax or social returns should also be the same ones that earn the highest after-tax or private returns (Gravelle, 1981). Because different industries utilize different mixes of capital goods, differential taxation of assets results in differential taxation of capital income by industry. A number of studies, notably Auerbach (1983) and Fullerton and Henderson (1984), have estimated the deadweight losses arising from the failure of the tax system to impose equal burdens. At 1981 price and output levels, the biases caused an estimated reduction in the effective capital stock of $40 billion and a lost of potential capital income of approximately $3.3

billion (Gravelle, 1981). In 1984 and in 1986, changes in the tax laws reduced much of the bias towards investments in structures but differences still remain (Hines, 1987).

4.2 Concept and Measurement of Economic Depreciation

Politically determined depreciation lives tend to contribute to distortions in the incentives to invest in various types of assets, and consequently can have a negative impact on the rate and pattern of productivity growth in an economy. Previous attempts to base tax allowances on actual depreciation practices have met with failure due to administrative cumbersomeness[3]. The central difficulty revolves around how to measure "true" depreciation.

Hulten and Wykoff in 1981 proposed using market price data for used business capital to estimate economic depreciation. They define economic or "true" depreciation as the decline in asset value associated with aging. Over time an asset value changes due to inflation and deterioration in an asset's physical productivity. Usually the two forces move in opposite directions making the calculation of depreciation difficult. Under the assumption of perfect foresight, the value of an asset is present value of capital user costs. A good approximation of this value is observed used market prices[4]. Used market values for business capital , however, only reflects the value of surviving assets and corrections have to made to the price data for censored sample bias or to take into account the equipment and structures that were retired from service before the end of their useful lives. The correction is made by multiplying the observed used market price for a particular vintage by the probability of survival. In econometrically estimating the price-age profiles for 34 durable equipment asset classes, Hulten and Wykoff found that assets in their sample seemed to have a geometric functional form, suggesting constant depreciation rates.

4.3 Cost of Capital Analytical Framework

Durable good investment decisions are influenced by a number of variables that can move in mutually reinforcing or offsetting directions. Some of the variables are expected returns, interest rates, inflation, discount rates, corporate income tax rates, personal tax rates, capital gains provision, rate of obsolescence, and depreciation allowances. If for example, market conditions for a product are not particularly favorable a very generous tax incentive for equipment investment may not necessarily convince a business manager to make the investment.

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[3] The Reserve Ratio Test of 1962 and the ADRIS system established in 1971 are two notable failures (Hulten and Wykoff, 1981).

[4] Some claim that used market prices for business equipment may be biased because mostly "lemons" are resold. For the criticism to be valid implies the presence of asymmetric information. Hulten and Wykoff do not believe that asymmetric information is a widespread problem and counter with the presence of a large resale and auction market for heavy construction equipment where both buyers and sellers are knowledgeable and where a geometric age-price profile was fitted. Ultimately, this is an empirical question.

However, if market conditions are favorable but corporate tax rates are deemed high, a generous depreciation allowance or a tax credit, could make an equipment purchase attractive. In order to make rational decisions, an analytical approach is needed that would permit the identification of at least the degree of incentive by simultaneously weighing all of these factors. The most common analytical approach used to assess how tax policy affects marginal investment incentives is the cost of capital model pioneered by Hall and Jorgenson in 1967. The cost of capital provides a comprehensive, forward looking measure of investment incentives. It can be interpreted simply as the rental value of a unit of capital. In more formal terms, it is the pre-tax return on a $1 investment needed to earn a required real rate of return taking into all tax policies, inflation, interest rates, and time preference. If we assume a perfectly competitive corporate firm contemplating a new investment with no uncertainty, the cost of capital or the real social rate of return can be written as follows:

$$\rho^c = r - \pi + \delta/(1 - u(1 - k - uz)) + w - \delta$$

where r = the nominal after-tax discount rate,
π = the constant inflation rate,
δ = the constant exponential depreciation rate,
u = the statutory corporate income tax rate,
k = tax investment credit,
z = the present value of depreciation allowances per dollar of marginal investment, and
w = property taxes.

To compute the discount rate, it is assumed that individuals hold debt and equity issued by the corporate, non-corporate, and owner-occupied housing sectors, and that they arbitrage away any differences in net rates of return.[5] If (i) is the nominal interest rate and (τ) is the debtholder's personal marginal tax rate, then under the arbitrage assumption, all assets must provide the real net return that individual could earn on his/her debt holdings:

$$s = i(1 - \tau) - \pi$$

where s= the net-of-all tax return in the corporate, noncorporate, and owner-occupied housing sectors.

[5] Arbitrage means the bidding away of any discrepancy in returns between investments corporate, noncorporate, and owner-occupied residential sectors. It holds if you assume perfect information, competitive market settings, and efficient financial/capital markets.

Investment incentives are properly measured by the marginal product of capital (p) but marginal effective rates are more easily interpreted. The marginal effective tax rate (t) is the difference between the pre- and post-tax rates of return, as a proportion of the pre-tax rate of return. It measures what fraction of the real pre-tax rate of return to a new investment will be collected as taxes. Because (s) is the return net of all taxes, the effective rate reflects the combined impact of corporate taxes, property taxes, and personal taxes. Using the above equations, the marginal effective corporate tax rate, (t) can be derived by setting the property tax (w) to zero and taking the gross-of -tax return (ρ) minus the net-of-tax return ($r-\pi$), all divided by the gross-of-tax return. It can be written as follows:

$$t=(\rho^c - s^c)/\rho^c$$

4.3.1 Theoretical Implications of the Cost of Capital Approach

Clearly if the cost of capital or the marginal effective tax rates increases for a firm or group of industries due to a change in tax policy, there will be less of an incentive for investment. By manipulating the above equations, several interesting theoretical results can be derived.

First, the effective rate (t) is equal to the statutory rate (u) if investment tax credit is zero and the depreciation allowances are based on replacement costs ($z=\delta(\delta+r+\pi)$). The implication of this proposition is that a tax reform that eliminates investment credits, a very distorting instrument, and goes from accelerated, "politically determined" depreciation allowances to "replacement cost" would serve to improve transparency and neutrality in the tax system but may increase the tax revenue lost if inflation were persistent.

Second, the effective tax rate can still be zero if expensing (full first year capital recovery) of new investment is adopted ($z=1$). This implies that capital recovery will be invariant to the rate of inflation but the revenue cost for the government would be very high. From the perspective of business the present value of tax savings in the presence of low to moderate inflation would be less than the present system. Businesses may delay investments in order to achieve tax savings in years of expected high liabilities which may not be necessarily the most efficient from the perspective of society as a whole. Thus the tax system would be neutral but with potentially serious timing flaws and high budgetary cost.

Third, uniform effective tax rates can be achieved at any rate between zero and (u), the corporate statutory tax rate, if all assets receive an investment tax credit that is proportional to (1-

z). In other words replace k in the equation (1) with k(1-z), where z is based on economic depreciation at replacement cost and the resulting effective tax rate is (u-k) on all assets.

In summary, the first two propositions show that uniform effective taxation of all assets can be obtained either through economic depreciation (t=u) or with expensing (all t=0). Adopting economic depreciation would tend to increase government tax revenue but dampen private investment. Adopting expensing would imply a drastic drop in tax collection but could stimulate investment. Relying highly on tax credits to achieve uniformity across sectors would be administratively difficult and quite costly to the Treasury.

4.3.2 Empirical Evidence

Historically, marginal effective tax rates have fluctuated as a result of tax policy reforms and inflation. Changes in the treatment of depreciation allowances and the presence of investment tax credits have powerfully affected tax burdens on investment During periods of high inflation, corporate marginal effective tax rates have tended to raise also. For the period 1953-89, marginal rates dropped sharply in the early sixties with the introduction of tax credits and shorter tax life spans in 1962, followed by the lowering of tax rates in 1964 and 1965, and generally low inflation. In the 1970s marginal rates rose due to higher inflation and then dropped sharply in 1981 with the Reagan administration provided generous depreciation allowances and lowered personal taxes. From 1983 to 1989, the rates have been steady. The 1986 Tax Reform Act essentially lowered tax rates but offset any changes in total marginal effective rate by eliminating the investment tax credit.

If policymakers decided to tighten depreciation allowances by lengthening life spans, marginal rates would rise all else equal. If policy makers, on the other hand, where to shorten life spans, then marginal rates would fall. If policy makers were to move to economic depreciation or full expensing and eliminate interest rate deduction, the effect on marginal rates will be ambiguous. Industry and asset specific asset calculations would have to be made. In the first case, pressure on the public deficit would be relieved and in the second it would be heightened.

In the next sections, the implications of moving from accelerated depreciation allowances to economic depreciation allowances are explored. Other tax reform options are not examined for the sake of tractability and space.

4.4 Likely Effect on Firm Investment Behavior by Shifting to Economic Depreciation

If the Hulten-Wykoff finding is true and widespread, the adoption of economic depreciation as opposed to politically determined tax life-spans would serve to reduce the social cost of differential taxation faced by different industry groups and promote a more efficient

allocation of capital stock in the economy. From the perspective of the Treasury, the budget cost would be less and more revenue would be generated. The impact on intersectoral and intertemporal gross investment growth would have to examined in a general equilibrium framework for a more definitive conclusions but based on a recent work by Jorgenson and Yun, it is likely that economic depreciation rates would be equal or lower for most asset classes reducing investment incentives. Jorgenson and Yun in 1991 used the best geometric approximation approach of Hulten and Wykoff (1981) to calculate economic depreciation rates for revised Bureau of Economic Analysis of the US Department of Commerce (BEA) asset classification scheme.

Below is a partial listing of some asset categories that are likely to be applicable to the 6 highly polluted industries under review. As can be seen, the most significant change occurred with "other electrical equipment". In the post-1986 tax reform period , the economic depreciation increased dramatically and the life span shortened for this asset class. In other cases the rates were relatively unchanged. The lengthening of life spans under the new law, however, implies substantially less tax savings in the case of steam engines and turbines, industrial buildings, and pipelines.

Exhibit 4-1

Economic Depreciation Rates

Assets	Pre-1986 Tax Regime		Post-1986 Tax Regime	
	Old Lifetime	Old Economic Depreciation Rate	New Lifetime	New Economic Depreciation Rate
Fabricated metal products	18	.09	18	.0917
Steam engines and turbines	21	.0789	32	.0516
Mining and oil field machinery	10	.1650	11	.1500
Electrical Transmission	14	.1179	15	.11
Other Electrical equipment	14	.1179	9	.1834
Scientific and engineering instruments	11	.1473	12	.1350
Industrial Buildings	27	.0361	31	.0361
Petroleum and natural gas	16	.0563	16	.0563
Other mining exploration	16	.0563	16	.0563
Petroleum pipelines	26	.0450	40	.0450

Source: Jorgenson and Yun (1991) op. cit. pp 79-80; Hulten and Wykoff(1981); Jorgenson and Sullivan (1981).

If the effective tax rates were set equal to the corporate statutory rate which in 1996 is y .35 and no tax credits were allowed, one can extrapolate from the calculations of Fullerton et. al (1987) as to what the new incentives might be. New summary incentive measures can be

calculated for the highly polluting industries by taking a monotonic transformation of the data on the sixty industries reported by Fullerton.[6]

Exhibit 4-2
Approximate Cost of Capital and Effective Tax by Selected Industries

Industry	1986 Tax Reform		New Reform	
	Cost of Capital	Effective Tax Rate	Cost of Capital	Effective Tax Rate
Metal Mining	0.091	0.449	0.0773	0.3814
Coal Mining	0.089	0.438	0.07561	0.372133
Oil and Gas Extraction	0.08	0.376	0.0679	0.3194
Nonmetalic Minerals	0.089	0.439	0.0756	0.3729
Primary Metal Industries	0.089	0.441	0.0756	0.3746
Paper Products	0.087	0.426	0.0739	0.3619
Chemicals	0.083	0.397	0.0705	0.3329
Petroleum and Coal Products	0.087	0.426	0.0739	0.3619
Electric Utilities	0.088	0.435	0.0747	0.3695
Note: Calculations are for a capital weighted average of the corporate and noncorporate sectors of each industry. Assume s(net of all tax required return)=.05 and π(inflation)=.04.				

Source: Fullerton, Gillette, and Mackie (1987) pg. 151

[6] See page 151 of Fullerton et. al (1987) for the full listing of the 60 industries. The methodology used to derive the effective rate of taxation (ETR) and cost of capital (CoC) in a hypothetical tax regime is to divide used is the post-1986 industry specific ETR by the overall ETR average, then then multiply this percentage by the corporate statutory of 35 percent. In the case of CoC, the post-1986 industry specific figure was divided by its corresponding ETR, then that percentage was multiplied by the hypothetical reform ETR. This scaling assumes the shape of the distributions are unchanged.

The 1986 tax reform served to generally raise cost of capital and effective tax rates (Fullerton, 1987). The hypothetical adoption of economic depreciation as opposed to accelerated depreciation indicates a fall in effective tax rates for each of the selected industries. Perfect neutrality would still not be obtained at the sector because of varying capital/labor ratios but the reduced standard deviations of the cost of capital measures (from .0032 to .00275) suggest a movement toward greater uniformity. For the available data, it seems that the two most favored industries would be the oil and gas extraction and chemical industries, with ETR below the corporate statutory rate.

From the PACE data and industry outlook prognoses (Section 3), we know that the chemical industry spends consistently more than the average for the entire manufacturing sector on new capital equipment. Much of the new capital expenditure has been on end-of-line pollution abatement technology. In the paint and coatings subsector, significant product changes has occurred. Overall the industry has improved with respect to recycling of inputs and treatment of wastes. Thus, if all else is held equal, one would expect the shift to using economic depreciation to favor increased investments in pollution control technology in this industry.

In the case of the oil and gas extraction industry (alternatively crude petroleum and gas), much of the new investment in the sector tends to be in structures such as drilling platforms and pipelines. However, the industry is only average with respect to investments in pollution abatement. In recent years, expenditures on product process changes have been increasing. Thus, with the presumed change in tax policy lead to more investment in pollution control.

In the case of the other industries, although the cost of capital measures will be lower in the new regime, suggesting an investment stimulus, because the effective rate of taxation is higher than the statutory rate, investors may be lured to sectors more lightly taxed.

5. CONCLUSIONS

This report found that the six selected industries--chemicals, primary metals, electric utilities, pulp and paper, petroleum products and mining-- do indeed enjoy substantial tax subsidies from the U.S. Government and that a change in tax policy make dampen capital expenditures on pollution control equipment in several sectors and it may encourage it in others.

The second section of the report reviewed the types and amount of subsidies currently available. Agriculture, transportation, and aerospace and high technology sectors received the most direct subsidies in 1995, $31.3 billion, $30.6 billion, and $16.7 billion, respectively. In the case of tax subsidies, energy and construction were the two most favored sectors, collecting $21 and $17 billion, respectively. If the agricultural and transportation sectors are excluded, given that they are outside the scope of the study, it becomes clear that tax subsidies, especially accelerated depreciation allowances, are far more important to manufacturing and extractive industries than direct subsidies.

In 1995, corporations claimed $23.3 billion in accelerated depreciation, which greatly exceeded the second largest tax expenditure category--$6.6 billion in tax free bond payments. Most of the depreciation allowances are claimed on equipment (77 percent of the total). Using 1988/89 figures in assessing the importance of depreciation allowances to the six industries of interest, it was found that the mining industry claimed $34.2 billion, the largest amount of depreciation write-offs, then came the electric utilities deducting $25.9 billion, and then followed by the chemical and allied products industry with $11.5 billion. Approximately 23 percent of U.S. capital depreciation occurs in the six selected industries. Therefore one can presume that they would benefit by a similar percentage of total accelerated depreciation subsidies.

In section three, the report identified trends in general capital investments and, to the extent possible, disaggregated new capital expenditures on pollution control into two categories: end-of-line abatement and product process changes. Any change in depreciation allowances would influence the types of capital investments made which in turn may affect levels of environmental protection. The total share of new capital expenditures that pertains to the selected industries was found to increase by 14 percent between 1984 and 1994. The ratio of pollution abatement expenditures to total new expenditures has increased steadily for the selected industries. Moreover, the target industries devoted a greater percentage of their capital to pollution abatement expenditures than the industry average since 1985. In terms of technique, there seems to be a steady shift from expenditures on end-of-line abatement technology to changes in product processing, with the exception of the chemicals and allied products industry.

In section four, the significance of such concepts as tax neutrality, capital stock allocative efficiency, economic depreciation, and the cost of capital analytical framework to tax analysis were introduced and explained. Using data from Fullerton, Gillette, and Mackie (1987) and the cost of capital methodology, it was assumed that depreciation allowances were liberalized. Instead of using historic cost and accelerated depreciations, "true" or economic depreciation would be used. New cost of capital and effective tax rates were approximated and interpreted. The oil and gas extractive component of the larger petroleum industry as well as chemicals and allied products were favored. Overall tax neutrality was improved and government tax revenue prima facie would increase.

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