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CENTER FOR THE STUDY OF THE ECONOMY AND THE STATE

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ENVIRONMENTAL REGULATION: WHOSE SELF INTERESTS ARE BEING PROTECTED?

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"The very areas of the country most affected by this (prevention of significant deterioration) provision are those rural and nonmetropolitan areas which have experienced a dramatic increase in growth and population."

Representative Carter of Kentucky debating the section on the prevention of significant deterioration of the 1977 Clean Air Amendments[1].

"The geographically specific character of most environmental problems invites a regional or local solution, but the constraints on local policy imposed by interjurisdictional competition may seriously inhibit the implementation of the appropriate measures."

William Baumol and Wallace Oates[2]

The first quotation is taken from the House debate on Section 108 of a proposed bill dealing with the prevention of significant deterioration (PSD). The second quotation is from a leading text on environmental economics. Both quotations emphasize the impact of environmental policy on local or regional development. Section 108 prohibits areas with air quality superior to the minimum national standards from allowing a significant deterioration of local air quality by placing controls on economic development. With PSD policy in place the nation has in effect developed a double standard on environmental issues. On the one hand, minimum national standards have been promulgated. These standards are supposed to be met by

all air control regions but in fact are violated particularly in densely populated central cities of the developed regions — the so-called non-attainment areas. The air quality in areas with little or no industrial development and low population density often far surpasses these minimum standards. In these areas economic development is controlled by a permit system which prevents a significant deterioration of the higher air quality in these areas. Why this double standard became an integral part of environmental policy is the central question posed in this paper. The major premise advanced and tested is that PSD policy should be viewed as a means of attenuating the locational competition between developed and less developed regions and between urban and rural areas[3].

The regulation of environmental conditions by the federal government began in earnest in 1970 with the passage of the Clean Air Act of 1970. Efforts had been made to improve air quality particularly in northern industrial cities with particulate and sulphur dioxide problems and in cities with automobile emission problems. Unfortunately information about the effects of these early local clean ups is not readily available. The scraps of evidence that do exist suggest these local efforts were partly responsible for the improvement in particulate concentrations in central cities during the nineteen sixties. But as Baumol and Oates have noted, these individual local efforts would have been costly to some local residents if factors moved to evade compliance costs caused by more stringent local regulations. If the rents of the remaining factors specific to a locality fell or would fall when factors left, the owners of the remaining factors would support policies that reduced the fall in location specific rents and yet would allow for an improvement in local environmental conditions. A federal policy could have merely establish uniform <u>minimum</u> standards for all parts of the country and

would have improved air quality in areas that did not meet these standards. It would not reduce the flight of plants to locations with superior air quality and with lower compliance costs. Residents in cities with low air quality would look more favorably on a federal policy that not only imposed minimum standards but also more demanding performance standards on new than on existing plants and permitted no significant deterioration of air quality in clean air areas. By raising the cost of mobility, owners of factors specific to a low air quality area could obtain a given improvement in air quality but with a smaller reduction in rents. Under this interpretation the double standard evolved because of a demand for improved environmental conditions by residents in cities with low air quality, the (potential) loss of factors caused by independent local clean up efforts and the political strength of states with lower air quality. The political strength of the developed regions allowed northern urban residents to obtain any given improvement in environmental conditions at a lower cost via federal regulation than through local regulation.

This hypothesis will be referred to as the locational competition hypothesis. The body of this paper presents some tests of this hypothesis. Evidence consistent with the locational competition hypothesis would include:

(1) Congressmen from northern states with more severe air quality problems should offer more support for PSD policy than Congressmen from states with higher air quality.[4]

(2) Congressmen from urban Congressional districts should offer more support for PSD policy than Congressmen from rural districts.[5]

(3) There should be larger differences between regions in the support given to PSD policy than in the support given on other environmental issues.

(4) The enforcement of environmental laws should raise the per unit pollution abatement costs relatively more in clean air states than in states with lower air quality.

In Section I Congressional votes on the Nondegradation Amendments and on the Automobile Emission Control Amendments are examined to determine if northern, urban, and Democratic constituencies provided more support for PSD policy. The constituencies supporting PSD policy are found to differ from those supporting automobile emission controls. Positions on environmental issues appear to shift as self interest changes. In Section II per unit pollution abatement costs incurred by manufacturing plants are found to differ across regions. States with higher per unit abatement costs have opposed more stringent PSD policy. Section III investigates the major determinants of state per unit abatement costs. States with higher past growth rates have been penalized and have incurred higher per unit abatement costs under the federal regulatory program. The paper ends with a brief summary.

I. Political Support for Prevention of Significant Deterioration

One objective of the 1970 Clean Air Act was "to protect and enhance the quality of the nation's air resources so as to promote the public health and welfare and the productive capacity of its population." This language highlights the twin objectives of environmental legislation. The enhancement language was directed at improving air quality in nonattainment areas, i.e., in the industrial cities located in the North and in cities with pollution problems caused primarily by mobile sources. Superior air quality in less developed rural areas and smaller cities and towns was to be protected from industrial development and not allowed to deteriorate toward the minimum standards. The protection language satisfied the demands of environmental groups who opposed the spread of environmental pollution from urban to rural areas and of residents of northern cities who feared the loss of factors through the enforcement of environmental policy.[6]

The significance of the language was unclear until the EPA translated this language into regulatory policy. An earlier interpretation, rendered by the National Air Pollution Policy Control Administration (NAPCA), a predecessor agency of the EPA, had set the stage for a strict interpretation of degradation. In 1971, EPA promulgated a preliminary ambient air quality standards and included a no significant deterioration clause. Vocal industry opposition forced EPA to back down and to eliminate the no significant deterioration (NSD) clause. Environmental groups brought suit and obtained a favorable ruling in Sierra vs. Ruckelshaus that permitted no significant deterioration. The Supreme Court on appeal affirmed the lower court decision by a split vote.

In 1974, EPA issued NSD regulations for suspended particulates and sulfur oxides. Each area of the country was placed into one of three classes

and assigned a permitted increment in pollution level from a baseline level. In Class III areas deterioration up to the primary standard was allowed. The NSD regulations were challenged by environmental organizations, by industry organizations and by coal producers. Congress attempted to resolve this and other controversial issues when a major overhaul of the Clean Air Act was attempted in 1976 by the 94th Congress. Numerous amendments were voted on but the final conference bill was killed by a Senate filibuster led by Senators Moss and Garn of Utah. The next Congress repeated the ritual and this time passed a bill in 1977. The votes cast in 1976 and 1977 on the Nondegradation Amendments offer the first opportunity to know which members of Congress supported PSD policy. After these amendments are briefly reviewed, the votes on these amendments are analyzed first by region and then by Congressional district so that the constituencies who supported PSD policy can be identified.

A. The 1976 Amendments

In 1976 the Senate Public Works Committee approved and reported Senate Bill S3219. This bill declared the intent of Congress to prevent clean air from deteriorating even if it remained above the primary and secondary standards (minimum standards). Two types of clean air areas were defined. Class I areas include national parks, wilderness areas and other areas added by the states and would be allowed the smallest increment in pollution levels. The remaining areas were included in Class II. States would issue construction permits to all major new pollution sources -- plants emitting 100 tons per year -- and require new plants to use "best available control technology" (BACT). The permit system would be used to enforce the incremental limits and encourage planned growth in Class II areas.

In the House the Interstate and Foreign Commerce Committee reported out a clean air bill that gave the states and local government more powers and set aside fewer pristine areas. Both bills allowed certain increments from existing baseline emissions for sulfur dioxide and particulates. Under the House bill most clean air areas would begin in Class II where pollution increments of up to 25 percent would be allowed. Class I listing was reserved for national parks and wilderness areas in excess of 25,000 acres. Class III, to which areas could be transferred, would allow pollution increment levels of up to 50 percent. States could reclassify lands after public hearings, assessment of the economic, environmental and energy impact and the approval of the legislature. Once the bill reached the House floor, two amendments by Chappel of Florida and Carter of Kentucky to delay or weaken and one by McKay of New Jersey to strengthen the nondegradation section were defeated. Amendments were also offered in the Senate and were defeated. The 94th Congress did not pass any bill because of the Senate filibuster mentioned above. A brief description of and vote on each of the 1976 Amendments are in Appendix A.

B. The 1977 Amendments

The 95th Congress passed the Clean Air Amendments. The House bill established three classes: Class I areas included national parks in excess of 25,000 acres, national memorial parks and wilderness areas in excess of 5,000 acres; Class II included all other clean air areas; Class III areas would be designed after hearing and studies. Increments for particulates and sulfur dioxide above baseline levels were 2 percent for Class I areas, 25 percent for Class II and 50 percent for Class III. Areas could be reclassified (except Class I areas) after hearings were held. New or modified stationary sources

emitting in excess of 100 tons per year were required to obtain permits. The House considered two amendments by McKay and by Breaux of Louisiana to weaken the nondegradation section. It adopted the one submitted by Breaux which allowed state governors to permit Class I and Class II areas to exceed pollution levels for 18 days per year. The Senate considered and rejected three amendments to weaken the nondegradation section of the bill. The 1977 Nondegradation Amendments are summarized in Appendix B.

C. Logit Analysis of Votes

The formal vote analysis is limited to the House votes. The regional pattern of Senate votes on the Nondegradation Amendments parallels that of the House. Each of the five House amendments offered during 1976 and 1977 may be interpreted so as to favor a more stringent PSD policy.[7] The combined votes on the five Nondegradation Amendments are shown by Census region in Table 1. The political support for PSD policy does vary across regions. The strongest support for a more stringent PSD policy comes from the New England, Middle Atlantic, Pacific, and East North Central regions while the regions mounting the strongest opposition to PSD policy are the East South Central, West South Central and South Atlantic. Congressmen representing constituencies in areas with relatively dirty air were the strongest defenders of the relatively clean air in other parts of the country. Congressmen from New England and other northern states exhibit more concern about the degradation of air quality in Oklahoma and South Carolina than did Congressmen from these states. The poltical support for PSD policy not only varies by region of the country but also increases with population density and degree of urbanization in the Congressional district. The locational competition hypothesis predicts greater support for PSD policy by Congressmen representing urban

Table 1: Percentage of House Votes in Favor of More Stringent PSD Policy[1] by Census Region

	Region	Percent of Votes in Favor of More Stringent Policy	Total Votes Cast[2]
		(1)	(2)
1.	United States	46.1%	1905
2.	New England	78.8	113
3.	Middle Atlantic	72.0	346
4.	East North Central	50.7	383
5.	West North Central	40.4	146
6.	South Atlantic	29.9	291
7.	East South Central	10.0	130
8.	West South Central	11.5	182
9.	Mountain	38.0	79
10.	Pacific	58.3	235

[1] Votes taken during 1976 and 1977 on 5 Nondegradation Amendments.

[2] Includes Paired Votes.

constituencies. Table 2 shows the percent of votes supporting a more stringent PSD policy by population density and by degree of urbanization in the Congressional district for the nation and for selected Census regions. These simple comparisons suggest that PSD policy has been supported by urban constituencies and opposed by rural constituencies.

A logit model is used to explain the probability that a Congressman would support a more stringent PSD policy. The statistical model was designed to explain 1,905 Congressional votes cast on the five Nondegradation Amendments. The independent variables may be grouped into four classes. The first class includes economic and demographic variables. These variables distinguish between urban and rural districts (Pop. Density and Urban), between growing and stagnant districts (Pop. Grow), between high and low income districts (Per Capita Income and Capital), and between older versus younger constituents (Percent Senior). The effect of the party of the representative is captured through a dummy variable which equals one if the member was a Democrat. The next group of independent variables measures the relative importance of selected industries in the district. Selected three digit industries were chosen because they had incurred relatively high pollution abatement cost or because they had testified on or had been affected by environmental legislation. The share of district employment in each industry is used as the independent variable. The purpose of introducing these industry variables is to determine if the composition of industry in the district affected the vote cast on the Nondegradation Amendments. The last group of independent variables includes the Census regions as dummy variables. The variable definitions are presented in Appendix C.

Table 2: Percent of Votes Supporting More Stringent PSD Policy by Urbanization and Population Density in Congressional District[1]

Area	Percent of Population Within Urbanized Areas in Congressional District			
	0-34%	35-62%	63-98%	>98%
United States	26.6 (110)	34.0 (109)	50.8 (104)	75.3 (112)
Middle Atlantic	51.2 (10)	45.5 (17)	67.2 (17)	92.5 (35)
East North Central	33.9 (23)	51.2 (19)	53.3 (19)	67.0 (25)
South Atlantic	16.5 (20)	16.0 (18)	45.8 (19)	62.5 (8)
Pacific	35.3 (5)	48.9 (12)	56.7 (15)	67.3 (25)

Area	Population Density in Congressional District		
	0-500	500-2,135	>2,135
United States	30.5 (251)	58.0 (75)	76.5 (109)
Middle Atlantic	49.6 (26)	58.2 (14)	90.7 (39)
East North Central	40.4 (47)	56.4 (14)	70.0 (25)
South Atlantic	19.4 (48)	67.3 (12)	52.4 (5)
Pacific	44.7 (20)	60.4 (13)	68.1 (24)

[1]Numbers within brackets represent the number of Congressional districts.

The regression coefficients are presented in column 1 of Table 3 and the associated chi square values are in column 2. The results in column 3 and 4 are discussed later. The coefficient of urbanization is positive and significant at the one percent probability level while the coefficient of population density is positive but is only significant at the eight percent probability level. Residents of urbanized areas are stronger supporters of PSD policy than are residents of nonmetropolitan areas. A second interesting finding is that faster growing districts opposed the Nondegradation Amendments[8]. The younger, less developed but growing areas opposed PSD policy as did districts with a larger percentage of senior citizens. Support for PSD policy also comes from those districts where dividends, rents and interest income make up a large share of total income.[9] PSD policy received more support from Democrats than from Republicans. Other researchers have reported similar results. Party and region are correlated since Democrats are over represented in the North and South and Republicans come from the West. The effect of party could be measuring the effect of region. A different test of the effect of political party is discussed below.

The results for industry composition of district are mixed. The coal and mining industries supported PSD policy while the natural gas and oil extraction industries opposed PSD policy. The latter industries are located in the south and west and would oppose bills that limited expansion in these areas. Among the manufacturing industries only the nonferrous smelter industries opposed PSD policy. The overall results indicate industry composition in the district had some but not a pronounced effect on the Nondegradation votes.

Table 3: Logit Analyses of Votes on Nondegradation and Auto Emission Amendments

	Nondegradation		Auto Emissions	
	(1)	(2)	(3)	(4)
	Estimated Coeffient	Chi Square[1]	Estimated Coeffient	Chi Square[1]
1. Intercept	-1.209	3.4		
2. Population Density 1980	$.320X10^{-4}$	3.1	$.566X10^{-4}$	9.1**
3. Percent Urbanized, 1980	.011	13.0**	$.752X10^{-2}$	4.9**
4. Population Growth Rate	-.014	7.5**	-.020	12.5**
5. Capital	.285	15.5**	.312	16.6**
6. Per Capita Income, 1980	$.955X10^{-4}$	1.8	$.115X10^{-3}$	2.3
7. Percent Senior	-.132	8.9**	-.134	8.3**
8. Democrat	2.021	180.1**	1.969	121.2**
9. Industry Variables				
a) Coal	.088	12.2**	.089	9.8**
b) Fuel	-.193	11.2**	-.467	19.9**
c) Mining	.116	5.9**	.065	1.7
d) Paper	.080	4.4*	.109	6.8**
e) Chemical	-.052	1.5	-.082	2.7
f) Petroleum	.066	.7	.085	1.0
g) Cement	-.111	2.1	.071	.7
h) Foundries	-.061	1.5	-.229	7.8**
i) Smelters	-.264	8.3**	-.330	9.8**
j) Rolling Mills	.012	.5	-.011	.3
k) New Car	.019	2.0	-.053	7.3**
l) Used Car	.086	.3	.088	.3

Table 3: Continued

	(1)	(2)	(3)	(4)
10. Census Region Variables				
a) Middle Atlantic	-.678	4.7*	-.729	5.7**
b) East North Central	-1.369	19.4**	-1.729	29.7**
c) West North Central	-1.734	25.5**	-1.464	17.7**
d) South Atlantic	-2.610	68.3**	-1.526	24.2**
e) East South Central	-3.225	59.1**	-1.882	19.8**
f) West South Central	-3.169	55.7**	-1.796	14.6**
g) Mountain	-1.649	12.8**	- .639	1.7
h) Pacific	-1.625	24.3**	- .459	1.9
11. -2 log liklihood	1786.7		1443.6	
12. Number of Votes	1905		1607	

[1]One asterisk indicates chi square value is significant at the 5 percent probability level and two asterisks indicate the chi square value is significant at the one percent probability level.

The coefficients of the regional dummy variables are all negative because New England was the strongest supporter of PSD policy and is the excluded dummy variable. House members from the South Atlantic, East South Central and West South Central regions opposed the Nondegradation Amendments. Other than New England, greater political support for the Nondegradation Amendments came from House members from the Middle Atlantic and East North Central regions.

These regression results generally confirm the first impressions gathered from Tables 1 and 2. The strongest supporters of PSD policy are residents located in northern cities with Democratic representatives and the strongest opponents are southerners located in rural areas with Republican representatives. These results are generally consistent with the locational competition hypothesis. However, they may not convince a skeptic who believes votes on such critical issues as the quality of life and environment are determined by ideological position. Testing for the effects of ideology is difficult because there is no accepted theory of ideology and ideology is seldom defined. If a Congressman voted the same way on the issue of environmental quality regardless of the price paid for environmental quality, one could say ideology explained the voting behavior of the Congressman or the constituents in the district. The demand curve for environmental quality would be perfectly inelastic. On the other hand, the position taken by a Congressman on the issue of environmental quality could change as the price paid for environmental quality increased. If so, one could conclude that the Congressman is reacting to self-interest since the Congressman responds to incentives. The ideology hypothesis could be tested by discovering an issue where the price of protecting or maintaining environmental quality has increased for an affected constituency and then seeing if political support for environmental quality does or does not decline.

In 1976 and 1977 four amendments to tighten automobile emission controls were voted on by the House.[10] The price of environmental quality increases the most for House members from districts with greater employment in automobile manufacturing and automobile retailing industries. If ideology plays an important role in explaining the votes cast on environmental issues, the votes cast by Congressmen from automobile districts on the Automobile Emission Amendments should not be different from those cast on the Nondegradation Amendments. Columns 3 and 4 of Table 3 present the results of a logit analysis of these amendments. The relevant finding is that support for the Automobile Emission Amendments decreases as the share of district employment in the auto industry rises. In contrast, the share of district employment in the auto industry had no significant effect on the votes cast for the Nondegradation Amendments. While this test is limited to the comparative voting records of Congressmen representing the auto districts, it does suggest positions taken on environmental issues change as the price paid for environmental quality changes.[11]

Two other comparisons invite comment. The regression coefficient for population density is larger and is statistically significant at the one percent probability level for the Automobile Emission Amendments. Automobile emissions are a more serious problem in many central cities with high population densities. This may explain why districts with high population density opposed a relaxation of automobile emission controls.[12] A comparison of the pattern of coefficients for the regional variables on these two issues is very informative. On the Automobile Emission Amendments the Pacific and Mountain regions matched the support given by New England for stricter automobile controls. The California delegation would be expected to support a more stringent national auto emission policy since California has had an even

more restrictive state automobile emission policy. The political support given by the Mountain region is less easily explained although a few metropolitan area in this region have severe automobile emission problems e.g. Denver. Relative to the positions taken on the automobile emission issue one would expect a closer harmony of interest between New England, Middle Atlantic and East North Central regions on the nondegradation issue. In contrast, the regional coefficients for the less developed regions should deviate more from New England on the nondegradation issue than on the automobile emission control issue. This is precisely the observed pattern for the regional coefficients. The regional coefficients on the two issues are reproduced in columns 1 and 2 of Table 4 and the ratio of the coefficients for each region is shown in column 3. Regions in the South and West deviate more from New England on the nondegradation issue than on the automobile emission issue. On the other hand, the East North Central and the Middle Atlantic regions deviate less from New England on the nondegradation issue than on the automobile emission issue.

The comparative analysis of the votes cast on two environmental issues suggests that the competition among regions was a more important factor affecting the vote on the Nondegradation Amendments than the vote on the Automobile Emission Amendments.

D. The Role of Political Party

Democrats offer more support for PSD policy than do Republicans. The effect attributed to party could be due to location since Democrats are often located in the North and in parts of the South and Republicans often come from the West. There is another way to test for the effect of political party.

Table 4: Ratio of Regional Coefficient on Automobile Emission Amendments to Regional Coefficient on Nondegradation Amendments by Region

	Coefficient on Nondegradation Amendments	Coefficient on Automobile Emission Amendments	Ratio (2)/(1)
	(1)	(2)	(3)
1. Middle Atlantic	- .678	- .729	1.08
2. East North Central	-1.369	-1.729	1.26
3. West North Central	-1.734	-1.469	.85
4. South Atlantic	-2.610	-1.526	.58
5. East South Central	-3.225	-1.882	.58
6. West South Central	-3.169	-1.796	.57
7. Mountain	-1.649	- .639	.39
8. Pacific	-1.625	- .459	.28

The votes on the Nondegradation Amendments were taken in 1976 and 1977. The party of representative changed in selected districts after the elections in the fall of 1976. In some districts the incumbent was defeated. By comparing the votes in 1976 and 1977 in those districts where the incumbent was defeated, it will be possible to test for the separate effect of political party. Table 5 shows the vote in 1976 and 1977 in districts where there was no change in party between 1976 and 1977 and in those districts where there was a change from Democratic to Republican or from Republican to Democrat. The top panel reports the percentage of votes supporting the Nondegradation Amendments in districts with Democrats in both 1976 and 1977 and in districts with a Democrat in 1976, and a Republican in 1977. The bottom panel reports percentages in those districts with a Republican in 1976. In districts with a Democrat in both 1976 and 1977, 59.1 percent of votes cast in 1976 favored a stricter PSD policy and 55.0 percent did in 1977. In districts that swung from Democrat to Republican, 44.8 percent of votes cast by Democrats favored a stricter PSD policy. The Democrats who were defeated in the next year were somewhat less supportive of a stricter PSD policy in 1976. The Republicans who replaced the Democrats in these districts cast only 11.1 percent of the votes in support of a stricter PSD policy in 1977.[12] The defeated Democrats voted differently in 1976 than their Republican replacements in 1977. In districts where Republicans were replaced by Democrats, the difference between the percentage of Republicans voting restrictive in 1976 and the percentage of Democrats voting restrictive in 1977 is smaller.

A logit analysis indicated the vote cast by a newly elected Democrat in 1977 (in a district with a Republican in 1976) was significantly different from a vote cast in 1977 by a reelected Republican. Similarly, a vote cast by a newly elected Republican in 1977 (in a Democratic district in 1976) was

significantly different from a vote cast in 1977 by a reelected Democrat. For brevity these results are not presented.

Districts with a change in party of representative provide a natural and powerful way of testing for the effects of political party. The results of these tests indicate the party of House member had a significant and independent effect of the vote cast on the Nondegradation Amendment.[13] This finding means the votes on the Nondegradation Amendment cannot be solely explained by the locational competition hypothesis. Party does make a difference.

II. Pollution Abatement Costs and Political Support for PSD Policy

If the regulation of stationary sources is designed to improve air quality in nonattainment areas, i.e., urbanized areas in the North, then per unit compliance costs should rise relatively more for plants located in the North than in the clean air regions of the country. On the other hand, if the regulation of stationary sources is designed to protect developed locations from the loss of factors as air quality in nonattainment areas is improved, per unit pollution abatement costs should rise more for plants located in clean air areas than in industrialized areas. State pollution abatement data are unavailable before 1973 so a before and after regulation test is not possible. The analysis of pollution abatement cost has by necessity more limited goals. First, per unit pollution abatement costs are shown to be higher in the less developed regions than in the developed regions. A related inquiry will show that greater political support for the Nondegradation Amendments has come from states with lower per unit pollution abatement costs and with lower air quality.

Table 5: Change in Party of Representative and Vote on PSD Policy

Party in 1976	Year of Vote	Same Party Holds Seat in 1977				Other Party Holds Seat in 1977			
		Party of Rep.	R	N	P	Party of Rep.	R	N	P
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Democrat	1976	Democrat	406	281	59.1%	Democrat	13	16	44.8%
	1977	Democrat	293	240	55.0%	Republican	3	24	11.1%
Republican	1976	Republican	101	230	30.5%	Republican	10	13	43.8%
	1977	Republican	37	207	15.2%	Democrat	15	9	62.5%

R = Vote in favor of more stringent PSD policy.

N = Vote against more stringent PSD policy.

P = Restrictive votes as a percent of total votes.

The measure used for per unit pollution abatement costs is gross pollution abatement operating costs (by manufacturing plants) per $1,000 of value added in manufacturing (PACVA).[14] Column 1 of Table 6 shows the annual average of PACVA for the United States for each region. Air pollution abatement costs per $1,000 of value added are shown in column 2. The industrial and more developed regions of the country have incurred smaller pollution abatement costs per $1,000 of value added than have the more rapidly growing areas. New England, East and West North Central regions are well below average and the Middle Atlantic region is slightly below average while the East and West South Central and Mountain regions are well above average. These results indicate pollution abatement costs per unit of output have been higher in the South and parts of the West than in the industrialized North. If the purpose of regulating manufacturing plants and other point sources is to improve air quality and public health in northern urbanized areas. with more severe air quality problems, then one would expect higher per unit compliance expenditures by plants located in the North.[15]

The locational competition hypothesis predicts states with lower air quality and states that incurred smaller percentage increases in per unit abatement costs under the federal program would support the Nondegradation Amendments.[16] States with lower air quality would have a larger demand for improved air quality and these states would support the federal environmental policy if the per unit compliance costs in clean air areas were expected to increase by a greater percentage. These hypotheses are tested by regressing the logit of the vote on the Nongradation Amendments on a measure of state air quality and on the state PACVA. Good air quality statistics are not available on a state basis. Two imperfect measures have been used.

Table 6: Gross Pollution Abatement Costs per $1,000 of Value Added[1] (1974-1977)

Region [2]	Pollution Abatement Operating Costs Per $1,000 of Value Added	Air Pollution Abatement Operating Costs Per $1,000 of Value Added
	(1)	(2)
1. United States (45)	8.32	3.40
2. New England (6)	4.18	1.15
3. Middle Atlantic (3)	7.81	3.41
4. East North Central (5)	7.42	2.85
5. West North Central (6)	5.36	1.97
6. South Atlantic (8)	9.12	3.18
7. East South Atlantic (4)	9.74	3.93
8. West South Atlantic (4)	15.09	6.30
9. Mountain (6)	10.66	7.12
10. Pacific (3)	8.33	3.85

[1]In each year the weighted average ratio was calculated for each region. A simple yearly average of these ratios is reported in this table.

[2]Number of states used to calculate mean in brackets. Deleted states were Alaska, Hawaii, New Mexico, South Dakota and Wyoming.

Source: U. S. Bureau of Census, Pollution Abatement Costs and Expenditures, Current Industrial Reports, MA-200 (74-77).

The first is the simple state average of the nonattainment percentage for the air quality control regions in the state in 1976. The EPA reported the 1976 attainment status in each air quality control region for five pollutants -- suspended particulates, sulfur dioxide, carbon monoxide, oxidants and nitrogen dioxide.[17] A nonattainment percentage was calculated for each state by weighting each pollutant and each air quality control region in the state equally.[18] Another measure of air quality is the total tons of pollutants (particulates, sulfur dioxide, nitrates, hydrocarbons and carbon monoxide) per acre.[19] The share of total tons of pollutants made up of particulates and sulfur dioxide is used to measure the relative importance of industrial pollutants. These data are used to test the hypothesis that state support for the Nondegradation Amendments is inversely related to air quality and PACVA. Columns 1 and 2 of Table 7 show the regression results for the state logit analysis. States with higher nonattainment percentages (lower air quality) were stronger supporters of the Nondegradation Amendments. States with lower total or air pollution abatements costs per $1,000 of value added were also stronger supporters of the Nondegradation Amendments.[20] In column 3 the nonattainment percentage is replaced by the total tons of pollutants (particulate, sulfur dioxide, nitrates, hydrocarbons and carbon monoxide) per acre in each state and with the share of total tons made up of particulates and sulfur dioxide. States with more tons of emissions per acre are stronger supporters of a stricter PSD policy. However, support for a stricter PSD policy is lower in states with particulates and sulfur dioxide accounts for a larger share of the total pollutants. So, the level and the composition of pollutants affected the position taken on PSD policy. Support for a more stringent PSD policy is stronger as the pollution mix shifts toward carbon monoxide, hydrocarbons and nitrates and away from industrial pollutants.

Table 7: The Effect of Relative Pollution Abatement Cost per $1,000 of Value Added and Air Quality on Support for Nondegradation Amendments - State Logit Analysis (N = 1,879) (Chi Square in Brackets)

		(1)	(2)	(3)
1.	Constant	-1.71	-1.87	.31
		(56.2**)	(9.45**)	(3.3**)
2.	State PACVA	-54.63		-84.19
		(14.0**)		(37.3**)
3.	State Air PACVA		-108.83	
			(17.5)	
4.	Nonattainment Percentage	.054	.056	
		(174.8**)	(197.5**)	
5.	Total Tons of Emissions per Acre			.0032
				(124.5**)
6.	Share of Total Due to Particulates and Sulfur			-2.84
				(38.0**)
	-2 log L	2306.2	2302.3	2326.4
	Chi Square	287.5	291.4	264.22

This last result is unexpected but may merely reflect the fact that states where particulate and sulfur dioxide emissions are relatively more important are located in the South and West e.g. Kentucky, Nevada and Arizona.

These results offer a partial explanation for the opposition to PSD policy by southern and western states. Plant in these states incurred relatively high per unit abatement costs from 1974-1977. A reasonable inference is that these states expected to fare still less well under a stricter PSD policy and hence their opposition to the Nondegradation Amendments.

III. Interstate Differences in Per Unit Pollution Abatement Costs

Under the locational competition hypothesis per unit abatement costs should have increased relatively more in less developed areas of the country under the federal program. As noted above, a direct test of this implication is not possible because abatement cost data are unavailable by state or region before 1973. While per unit pollution abatement costs were higher in less developed than in developed regions from 1974-77, they may, and probably were, relatively high in the nineteen sixties as well. Because comparisons over time are not possible, the analysis focused on interstate comparisons at a point in time and identifies the major determinants of the logarithm of state per unit pollution abatement costs. The independent variables are (1) the relative importance of industries with more serious emission or water discharge problems (2) the relative use of dirty fuels (3) the relative use of water in the production process and (4) the growth of manufacturing value added prior to the federal environmental regulation program. The industry composition variables and the magnitude and the types of fuel and water used are expected to raise per unit pollution abatement costs. The growth rate in

state manufacturing during the pre regulatory period, 1963-1972, is expected to raise per unit state abatement costs if faster growing states were penalized under the federal regulatory program.

Table 8 presents the regression results and the definitions of the variables. The only independent variables in column (1) are the regional dummy variables. Most of the regions in the South, the Mountain, and the Pacific regions had higher per unit costs compared to New England. The effects of industry composition, fuel and water use, and growth rate are included in column 3. Not surprisingly, the composition of industry in a state has an important effect on per unit abatement costs. Per unit costs are higher in states where the chemical, petroleum and primary metals industries are relatively more important, The more intense use of water relative to output raises per unit costs but the more intense use of dirty fuels does not have a statistically significant effect on per unit costs. Perhaps, the most interesting result is that states with higher growth rates prior to federal regulation (1963-1972) incurred higher per unit abatement costs from 1974 to 1977. If the state growth rate between 1972-77 is substituted for the growth rate between 1963-72, the state growth rate between 1972-77 is not a significant determinant of per unit abatement costs. Per unit abatement costs in a state depends on how fast the state was growing before the federal program began and not on the state growth rate between 1972-77. The inclusion of the industry, fuel and water variables reduces the absolute size of regional coefficients. The regional coefficient of the West South Central region falls the most from 1.26 to -.08. A plausible reason for this large decline is that the coefficient for the petroleum industry is capturing the regional effect. The share of state employment in the petroleum industry will be relatively high in all states in the West South Central region. Hence, the

Table 8: Determinants of the Logarithm of Pollution Abatement Costs per $1,000 of Value Added (Weighted Regression)

Independent Variable	Regression Coefficient	t	Regression Coefficient	t
	(1)	(2)	(3)	(4)
1. Constant	-5.51	28.5	-4.96	8.6
2. Paper (Pa)			1.03	.9
3. Chemical (CH)			3.99	3.6
4. Petroleum (Pet)			14.69	2.5
5. Primary Metal (PM)			2.37	1.9
6. Dirty Fuel			.03	.2
7. Water Use			.25	4.2
8. Value Added Growth (G)			.41	3.0
9. Regional Dummies				
a. Middle Atlantic	.59	2.6	.33	3.0
b. East North Central	.60	2.8	.27	2.5
c. West North Central	.27	1.0	.18	1.3
d. South Atlantic	.66	2.8	.18	1.3
e. East South Central	.87	3.2	.24	1.4
f. West South Central	1.26	5.0	-.08	.3
g. Mountain	.90	2.4	.53	2.4
h. Pacific	.70	2.9	.63	5.0
10. R^2	.471		.916	
11. Mean Square Error	1141		226	

Table 8: (Continued)

Definition of Variables

I. Dependent Variable:

1. Log of mean of state pollution abatement costs per $1,000 of value added from 1974-77.

II. Independent Variables:

1. Composition of Industry in State

a)	Paper (Pa):	Mean share of total state manufacturing employement in S.I.C. 26, Paper and Allied Products, 1974-77.
b)	Chemical (CH):	Mean share of total state manufacturing employment in S.I.C. 28, Chemicals and Allied Products, 1974-77
c)	Petroleum (Pet):	Mean share of total state manufacturing employment in S.I.C. 29. Petroleum and Coal Products, 1974-77.
d)	Primary Metal (PM):	Mean share of total state manufacturing employement in S.I.C. 33, Primary Metal Industries, 1974-77.

2. Use of Dirty Fuels: Log of total BTUs consumed in state manufacturing less BTU's from natural gas, hydroelectric and purchased electricity per $ million of value added, 1974-77.

3. Water Use: Log of millions of gallons of water intake in state manufacturing per million of value added, 1972-77.

4. Value Added Growth: Proportionate growth rate of value added in manufacturing, 1963-72.

5. Regional Dummy: Nine Census regional dummy variables.

Sources: U.S. Bureau of Census Pollution Abatement Cost and Expenditure, Current Industrial Reports MA-200.
U.S. Bureau of Census, Census of Manufacturers, 1963, 1972, 1977.
U.S. Bureau of Census, Annual Survey of Manufacturers, 1970-1980, (non census years).
U.S. Bureau of Census, County Business Patterns, 1974-77.
U.S. Energy Information Agency, State Energy Data Report, 1981.

petroleum industry variable could mimic a dummy variable.

These regression results can be used to predict some of the possible effects of environmental regulation on per unit abatement costs. The regression results show states with past growth rates were penalized . Once again, New England can be used as a reference region. The weighted average growth rate in value added of the states in the New England region was substituted for each states's growth rate to determine how much lower the state's per unit abatement costs would have been if the state had grown as fast as New England from 1963 to 1972. Then a weighted average per unit abatement cost was calculated for the states in each Census region. Column (1) of Table 9 shows the predicted per unit abatement cost using the regression coefficients in column 3 of Table 8 and the value of the independent variables for each state. Column 2 shows the predicted per unit costs if each state had New England's growth rate. Column 3 shows the percentage change in per unit costs due to the difference between the growth rates of the state and that of New England. States in the East South Central and West South Central would have had the larger percentage reductions in per unit costs. Percentage declines in per unit costs would have been relatively small in the Middle Atlantic, East North Central and Pacific regions. These findings are altered somewhat if the effects of environmental regulation are not only reflected in the coefficient of the growth rate variable but are also included in the coefficient of the regional variables. It is instructive to estimate per unit abatement costs for each state if it had New England's past growth rate and if it was located in New England (while holding the state's industrial composition constant). Column 4 shows the estimated per unit cost and column 5 shows the percent reduction in per unit costs. The largest percentage reductions in per unit costs are in the Mountain, Pacfic, and East

Table 9: Percentage Reduction in Per Unit Costs Due To Growth and Region Effects

	Estimated Per Unit Abatement Costs				
	From Regression Equation	With New England Growth Rate	Percent Change (2)-(1) / (1)	With New England Growth Rate & Regional Effect	Percent Change (4)-(1) / (1)
	(1)	(2)	(3)	(4)	(5)
1. Middle Atlantic	$7.71	$7.78	1%	$5.61	-27%
2. East North Central	7.54	7.28	- 3	5.49	-27
3. West North Central	5.31	4.73	-11	3.84	-28
4. South Atlantic	8.28	7.25	-12	5.88	-29
5. East South Central	9.79	7.87	-20	5.91	-40
6. West South Central	15.66	12.26	-22	13.51	-14
7. Mountain	10.42	9.24	-11	4.95	-52
8. Pacific	8.23	7.96	- 3	4.12	-50

South Central regions. Smaller but still sizeable reductions would occur in all other regions except the West South Central region. The apparent reason for the quite modest percentage reduction for the West South Central region is that the petroleum industry is relatively more important in Texas, Louisiana and Oklahoma.

This analysis of the per unit abatement costs indicate a state's past growth is a significant determinant of per unit abatement costs even after the effects of industry composition and fuel and water use are controlled for. This finding combined with the earlier finding that faster growing states opposed PSD policy suggests that per unit abatement costs have increased relatively more in the faster growing parts of the country than in the developed regions under the federal regulatory program.

Conclusions

The results of the paper indicate the self interest hypothesis is useful for explaining the reason for PSD policy. The analysis of voting records and abatement costs suggest PSD policy has attentuated the locational competition between developed and less developed locations. The comparative analysis of voting on the PSD issue and the automobile emission control issue indicates locational competition was a more prominant factor affecting the position taken on the PSD issue.

A skeptic could still argue voters in the Northeast, Middle Atlantic, and East North Central regions favor a strict PSD policy because they have positive option values for national parks and wildlife areas. There are two deficiencies with this position. Positive option value might explain why the preservation of air quality in Class I areas would be supported. However, the

applicability of the Nondegradation Amendments was not limited to Class I areas i.e., national parks and wildlife areas, but included all clean air areas. The presence of positive option values cannot explain why PSD was applied to all clean air areas and not limited to Class I areas. A second limitation of this hypothesis is the arbitrary assumption that residents of the North have positive option values while residents of the South and West do not have option or existence values. This alternative hypothesis might be considered more seriously but only after evidence shows northerners have higher option values than do southerners and westerners.

Because the underlying self interests of a region change slowly, one can expect the political strength of the competing groups to also change slowly. Rapid changes in PSD policy are unlikely. Over the long run the shift of the population to the South and West and out of the northern cities indicates political support for new performance standards and PSD policy will slowly diminish. It would be ironical but not surprising if the growing political strength of the South and West not only reduces the support for the PSD policy but also results in stricter compliance with the primary standards in nonattainment areas of the North.

Appendix A

Summary of 1976 Nondegradation Amendments

A. House Amendments

1. Amendments to Weaken the Nondegradation Section of House Bill:

   a. Chappell (D, Florida) Amendment to delete from the bill provisions to require protection of pristine air and direct the National Commission on Air Quality to conduct a one year study of the issue. Rejected 156-199 (R 77-38; ND 20-142; SD 59-19)(530).

   b. Carter (R, Kentucky) Amendment to set less stringent overall pollution limits in clean air areas covered by the nondegradation provisions. Rejected 100-183 (R 53-481 ND 5-116; SD 42-19)(538).

2. Amendment to Strengthen the Nondegradation Section of the House Bill:

   a. Maquire (D, New Jersey) Amendment to delete Class III nondegradation category from the bill, thus requiring more stringent protection of air in areas where it had not deteriorated to the minimum air quality levels required by national standards. Rejected 107-247 (R 18-98; ND 79-80; SD 10-69)(528).

3. Passage of House Bill:

   a. Clean Air Act Amendments to revise air pollution clean up requirements and shedules for automobiles and stationary pollution sources and to establish new regulations for protection of clean air areas. Passed 324-68 (R 93-38; ND 173-9; SD 58-21)(560).

Appendix B

Summary of 1977 Nongradation Amendments

A. House Amendments

1. Amendments to Weaken the Nondegradation Section of the House Bill:

   a. McKay (D, Utah) Amendment (substitute) for the Breaux (D, Louisiana) Amendment to allow sulfur dioxide pollution to exceed permissible levels for 18 days of the year in high terrain Class II areas. Rejected 170-237 (R 17-115; ND 132-56; SD 21-66)(262).

   b. Breaux (D, Louisiana) Amendment to allow state governors to permit Class I and Class II areas to exceed pollution levels for 18 days in a year. Adopted 237-172 (R 112-23; ND 56-131; SD 69-18)(263).

2. Passage of the House Bill:

   a. Revision of the 1970 Clean Air Act to set new standards for automobile exhaust emissions, regulate new sources of pollution in clean air areas including national parks and allow limited industrial expansion in areas that have not yet achieved national health standards for clean air. Adopted 326-49 (R 108-10; ND 149-31; SD 69-8)(268).

Appendix C

Definition of Variables for Table 3

1. Population Density, 1980 = population per square mile in 1980.

2. Percent Urbanized, 1980 = Percent of population of district living in urbanized areas in 1980.

3. Population Growth Rate = Percentage change in population, 1970-1980 for boundaries in effect from 1973-1982.

4. Capital = Percent of aggregate household income received from interest, dividends and net rental income in 1979.

5. Per Capita Income, 1980 = Per capita income in 1979.

6. Percent Senior = Percent of population aged 65 or more in 1980.

7. Democrat = Dummy variable equal to one if vote was cast by Democrat.

8. Coal = Percent of district employment in anthracite mining (111) and bituminous coal mining (112).

9. Fuel = Percent of district employment in crude petroleum and natural gas (131), natural gas liquids (132) and oil and gas field services (138).

10. Mine = Percent of district employment in iron ores (101), copper ores (102), lead and zinc ores (103), gold and silver ores (104), bauxite (105), ferroalloy ores (106), metal mining services (108), miscellaneous metal ores (109), dimension stone (141), crushed stone (142), sand and gravel (144), chemical minerals (147), non-metallic minerals (148), and miscellaneous non-metallic minerals (149).

11. Paper = Percent of district employment in pulp mills (261), paper mills except building paper (262), paperboard mills (263).

12. Chemicals = Percent of district employment in industrial inorganic (281), industrial organic (286), agricultural chemicals (287) and miscellaneous chemical (289).

13. Petroleum = Percent of district employment in petroleum refining (291).

14. Cement = Percent of district employment in cement (324), concrete, gypsum and plaster (327), and miscellaneous non-metallic mineral (329).

15. Foundries = Percent of district employment in iron and steel foundaries (332) and non ferrous foundries (336).

16. Smelters = Percent of district employment in primary nonferrous metals (333).

17. Rolling Mills = Percent of district employment in blast furnaces and basic steel (331) and nonferrous rolling (335).

18. New Car = Percent of district employment in motor vehicles and equipment (371) and new and used car dealers (551).

19. Used Car = Percent of district employment in auto and home supply retail stores (553) and automobile repair shops (753).

Sources:

Economic Information Systems, Congressional District Business Patterns, U.S. Bureau of Census, 1980.

U.S. Bureau of Census, 1980, Census of Population Advance Reports; U.S. Summary, Table 2 (COP 80).

U.S. Bureau of Census, 1980 Census of Population and Housing, Summary Tape File 3-C, U.S. Summary File.

U.S. Bureau of Census, Congressional District Data Book for the 93rd Congress (and revisions for 94th Congress for California, New York and Texas).

Footnotes

1. Congressional Record, May 24, 1977, 16200.

2. William Baumol, and Wallace Oates Economics, Environmental and the Quality of Life, (1979), 227.

3. The positive theory of government regulation is designed to explain the reasons for and the beneficiaries of government regulation. The pioneering paper of this flourishing literature is George Stigler, "The Theory of Economic Regulation," 2, Bell Journal of Economics and Management Science, 3, (1971). The theoretical literature on environmental economics has assumed the only role of the regulatory institution is to correct for external effects and ignored the importance of self interest groups. Virtually every price theory text teaches the reason for pollution regulation is to correct for externalities. This approach is not wrong but is too narrow and is incapable of explaining some forms of environmental regulation. There are a few studies that have adopted the self interest approach to environmental policy, see Michael Maloney and Robert McCormick, "A Positive Theory of Environmental Quality," 25, Journal of Law and Economics, 99, (1982); B. Peter Pashigian, "The Effect of Environmental Regulation on Optimal Plant Size and Factor Shares," 27, Journal of Law and Economics, 1984 (forthcoming); and Robert W. Crandall, Controlling Industrial Pollution, Brookings Institution, (1983).

4. Although there are exceptions, air quality is inferior in northern states. Estimates of tons of emissions of suspended particulates, sulfur oxides, oxides, hydrocarbons and carbon monoxide are made by each state. To adjust for scale emissions of suspended particulates and sulfur dioxides per square mile (excluding federal and state parks) and tons of all other pollutants per square mile are shown below for the leading ten states in 1972:

State	Particulates & Sulfur Oxides (Tons Per Square Acre)	State	All Other Emissions (Tons Per Square Acre)
1. Ohio	211	1. New Jersey	875
2. Delaware	180	2. Rhode Island	750
3. Pennsylvania	156	3. Massachusetts	660
4. New Jersey	149	4. Connecticut	498
5. Indiana	128	5. Indiana	363
6. Massachsetts	126	6. Maryland	355
7. Illinois	102	7. Delaware	323
8. Rhode Island	98	8. Ohio	311
9. Kentucky	90	9. New York	265
10. West Virginia	87	10. Pennsylvania	256

Industrial states have more severe problems with particulants and sulfur emissions while Massachusetts, Connecticut and New Jersey have more problems with hydrocarbons, carbon monoxide and other oxides. A more disaggregated picture would reveal some metropolitan areas in California, Texas and Colorado with severe air quality problems.

5. Data published by the Environmental Protection Agency shows suspended particulate concentrations at 18 non urban locations were about one-third of the concentration levels at 95 urban locations from 1960 to 1971. See U.S. E.P.A. The National Air Monitoring Program: Air Quality and Emissions Trends Annual Report, Vol. I, (1973).

6. For a representative statement, see the testimony of Lawrence Moss, President of the Sierra Club before the Senate Subcommittee on Air and Water Pollution. U.S. Congress, Senate, Subcommittee on Air and Water Pollution of the Committee of Public Works, Nondegradation Policy of the Clean Air Act, Hearings, 93rd Congress, 1st Session, 46-51.

7. Whether an amendment tightens or relaxes a standard was often but not always easily determined. For example, the McKay Substitute Amendment (262) is a weaker relaxation than incorporated in the Breaux Amendment (263). (The number in the brackets represent the number assigned by the Congressional Quarterly.) The vote on 262 attracted considerable support form representatives of districts located in the Northeast and Middle Atlantic regions as a means of staving off a favorable vote on 263. In this case, a yes vote on 262 was interpreted as favoring a more restrictive PSD policy. While there could be some disagreement over this interpretation, there can be little disagreement over the interpretations given the other amendments.

8. Crandall also found faster growing states opposed environmental policy, Crandall, op. cit. Chapter VII.

9. This finding indicates the PSD policy received more support in districts where capital's share of income is high. Owners of property in declining areas would presumably favor PSD policy. On the other hand, owners of physical capital would prefer fewer restrictions on the location of that capital.

10. The 1976 Automobile Emission Amendments and CQ numbers were Waxman (D, California) Amendment (556) and the Dinghall (D, Michigan) Amendment (557). In 1977 Congress voted on the Preyer (D, N.C.) Amendment (266) and the Dingell (D, Michigan) Amendment (267).

11. Another result suggests that the position taken on environmental issues does depend on the price of paid for environmental quality. The coefficient of the East North Central region variable deviated more from New England on the automobile emission votes than on the nondegradation issue. Automobile output is more heavily concentrated in this region.

12. Rural and less densely populated areas generally opposed a tightening of automobile emission standards. Rural residents were reluctant to pay higher automobile prices so that air quality in central cities could be improved.

13. The newly elected Democrats and Republicans tend to mirror their respective party positions. Under the median voter hypothesis a change in party would not be expected to cause such large shifts in voting position since the tastes of the median voter are not likely to change appreciably in a short period.

14. The Bureau of Census has sampled manufacturing establishments since 1973 and collected annual pollution abatement costs and capital expenditures for air, water and solid waste, U.S. Bureau of Census, Pollution Abatement Cost and Expenditures, MA (200). Only manufacturing plants are sampled. The respondents are asked to estimate gross pollution abatement annual costs (payments to government for water and solid waste, depreciation on equipment, labor, equipment leases and materials purchased). These data are reported by type, industry, region, state and for selected SMSS's and these data serve as the raw material of the analyses of pollution abatement costs.

15. A possible explanation is that there are economies of scale in pollution abatement. If plants located in the North are larger they will have lower per unit abatement costs. However, the variance in state abatement costs per unit of output is explained better by the variance in state tons of pollutants removed per unit of output than by the variance in abatement costs per ton of pollutant removed. Hence, states differ more in the amount of pollutant removed per unit of output than in the per ton cost of removing a pollutant. There is little evidence of economies of scale in pollution abatement. The higher per unit pollution abatement cost in the South and West is because of tons of pollutants removed per unit of output is higher in these regions and not because the cost per ton removed is higher.

16. Under this hypothesis support for the Nondegradation Amendments, v, should be directly related to the change in relative pollution abatement costs before and after federal regulation, $C_{post} - C_{pred}$ and to nonattainment status, N, i.e.,

$$V = \alpha + \beta(C_{post} - C_{pre}) + \gamma N \quad \text{where} \quad \beta > 0 \quad \text{and} \quad \gamma > 0 .$$

C_{pre} is unobserved. The actual regression run is

$$V = a + bC_{post} + cN$$

The probability estimate of b is

$$\text{est } b = (+)_B + (?)_{w_1}(-)_B + (?)_{w_2}(+)_\gamma$$

where w_1 and $_2$ are the coefficients of the regression

$$C_{pre} = w_0 + w_1 C_{post} + w_2 N$$

Without knowing w_1 and w_2, it is impossible to know whether the estimate of b will differ from b . If the regulatory program merely raised state per unit abatement costs by the same amount so that $w_1 = 1$ and $w_2 = 0$, then the estimate of $b = 0$. So, per unit abatement would not be a significant determinant of the vote. On the other hand, if the enforcement efforts of EPA raised the cost in the high per unit abatement costs states by more than in the low per unit states so $0 < w_1 < 1$ and $w_2 = 0$, then the estimate of b will exceed zero but will be biased downward. Hence, a significant coefficient for PACVA is consistent with a rise in the coefficient of variation in state per unit costs with regulation.

17. See, U.S. Environmental Protection Agency, State Air Pollution Implementation Plan Progress Report, January 1 to June 30, 1976.

18. Every violation of an applicable National Ambient Air Quality Standard was counted in the calculation of nonattainment status even though no revision of a State Implementation Plan was called for. The nonattainment percentages were calculated from data reported in U.S. Environmental Protection Agency, State Air Pollution Implementation Plan Progress Report, January 1 to June 30, 1976.

19. Tons of emissions in 1972 by type of pollutant are reported in J. Golden, R. Ouelletle, S. Saari and P. Cheremisinoff, Environmental Impact Data Book, Ann Arbor Science Publishers, 1979.

20. Air or water quality was not a significant determinant of votes cast from 1975-1980 on environmental issues in Crandall's study, see Crandall, op. cit. Chapter VII.