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Media Attention, Political Processes, and Air Pollution in the United States: A Time-Series Analysis (1959-1998)

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Abstract

This study tests the effect of the environmental movement, political opportunities, and media attention on air pollution in a time-series analysis (1959-1998). It examines changes in national emissions of five types of air pollution: sulfur dioxide, carbon monoxide, and volatile organic compounds (combined into an index with Cronbach's $\alpha = .904$); nitrogen oxides; and particulate matter smaller than 10 μm. Results show that media attention to the environment is an important predictor of all three dependent variables. Additionally, the environmental social movement is only effective given specific political opportunities, namely, Democratic Party control of the federal government, media attention to environmental issues, and effective policy. The environmental movement also only appears to be effective at combating highly visible pollutants that are on the political agenda. This study demonstrates the complexity of air pollution, the importance of media attention, and the limited impact of the environmental movement on real-world outcomes.

Keywords

air pollution, policy, media, social movement, political process, environment, time-series

Introduction

Although sociology has historically ignored the ecological constraints on society, recent research in environmental sociology has begun to investigate human impact on the environment (Dunlap, 1982; Dunlap & Michelson, 2002; Freudenburg & Gramling, 1989; York, Rosa, & Dietz, 2003). The study of this relationship is increasingly important due to the growing concern that human society might be causing harmful and irreversible changes to both global and local ecosystems—changes such as global climate change, mass extinction of species, desertification, and pollution. This new literature in environmental sociology addresses the social factors that influence anthropogenic ecological damage. For example, researchers have identified various political and economic

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factors that influence variations in the ecological impact of different countries (York et al., 2003; York, Rosa, & Dietz, 2005). However, environmental sociology as a discipline is still new and much remains to be done.

One area of emerging research investigates the factors that lead to changes in the ecological impact over time within a single country. Many countries have implemented legislative and policy changes designed to reduce ecological impact, and the environmental social movement has tried to push these efforts further. Indeed, the environmental social movement could be the most critical driving force moving society toward a more sustainable relationship with the environment (Buttel, 2003), and it is important to test whether that is the case. Social research can thus test the effectiveness of social movements in achieving policy goals such as environmental regulation and ecological sustainability, as well as real environmental outcomes. Social research can also test the effectiveness of policy and thereby help legislators find effective solutions to social problems, including environmental problems. Additionally, the political agenda can influence the passage of environmental legislation and also the effectiveness of policy and social movements, therefore the media can also play an important role in determining environmental outcomes. Finally, social movement outcomes are an important component of social movement research, and the outcomes of the environmental movement include policy as well as real-world ecological results. This study thus examines the role of political processes and the importance of democracy theory with regard to environmental outcomes.

This research project will use multiple regressions in a time-series analysis to investigate political factors that lead to changes in the ecological impact of humans in the United States, focusing on air pollution. Air pollution is especially appropriate for empirically testing sociological theories of ecological impact because it is a major by-product of industrial processes with significant impacts on human health and the natural ecosystem. Additionally, air pollution is useful for testing the effectiveness of policy because national policies addressing air pollution have been in place in the United States since the 1950s. This research will therefore test whether air pollution policy influences some of its target pollutants and whether environmental movement mobilization enhances this process. Prior research on social movement outcomes has focused on policy outcomes, but it is important to also consider the real effects of movements, policy, and the media. This research therefore also tests whether the environmental movement and the democratic process can achieve actual environmental results.

What Is Air Pollution?

Air pollution has been a problem since the height of the industrial age when major cities battled smog. The U.S. Environmental Protection Agency (EPA) has estimated the prevalence of certain air pollutants yearly as far back as 1940, so the data on air pollution are ideal for a time-series analysis. Specifically, the EPA tracks six principal air pollutants harmful to public health and the environment: sulfur dioxide (SO_2), nitrogen oxides (NO_x), carbon monoxide (CO), particulate matter smaller than 10 μm (PM-10), ground-level ozone (O_3), and lead.[1] The EPA also tracks emissions of volatile organic compounds (VOCs), because they react in the air to produce ground-level ozone. Monitoring of these pollutants enables the EPA to track compliance with air pollution standards. In this study, I will include measures of air pollutants aggregated at the national level from 1959 to 1998.[2] Other than lead, each of the pollutants is emitted on a national scale and affects large geographic areas both immediately and after traveling across regional boundaries; therefore they are appropriate to this national-scale study. Additionally, the EPA does not track historical levels of ground-level O_3, but it does track VOCs. Therefore, VOCs are included in this analysis, but a direct measure of ground-level O_3 is not included. In order to

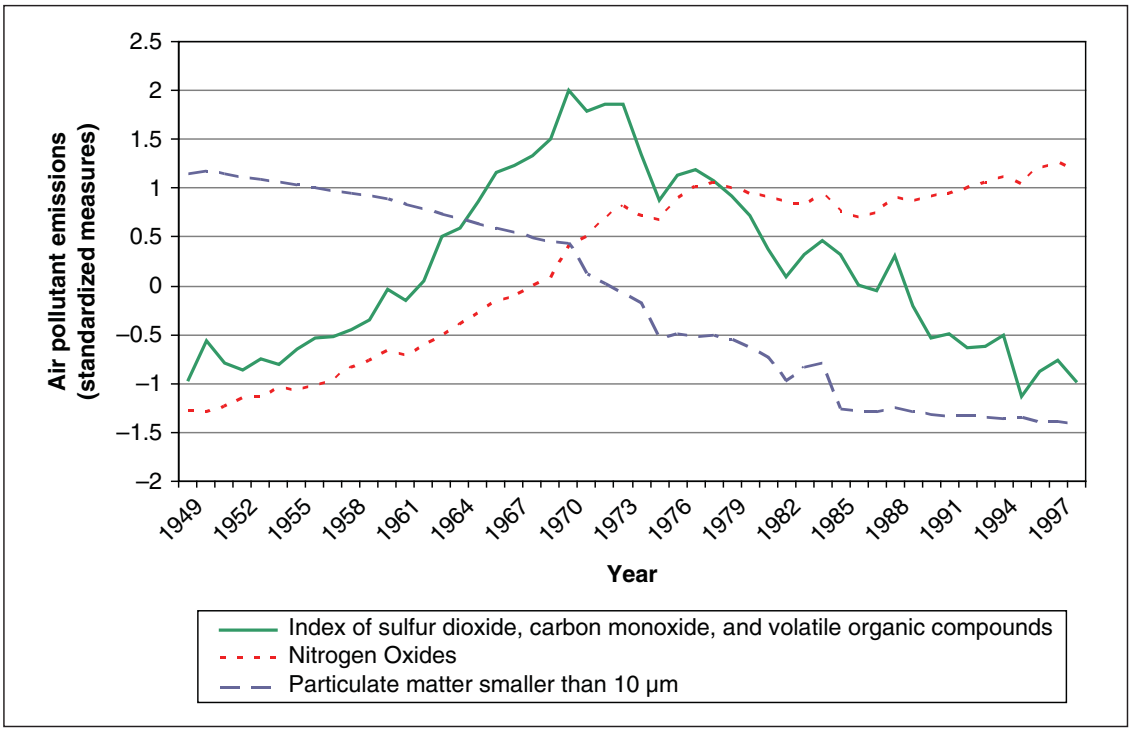

Figure 1. Yearly emissions of the three standardized measures of air pollution

understand the factors that influence different kinds of air pollution, it is first necessary to understand the different sources and health effects for these pollutants.

Although some pollutants have different specific health effects, overall air pollution can cause or exacerbate respiratory illnesses and it is especially dangerous to individuals with heart disease. SO_2, NO_x, and PM-10 react with other chemicals in the atmosphere to produce acid rain, which damages plants, soil, fish, and water systems. Long-term exposure to acid rain leads to changes in the diversity of plants and animals in the ecosystem and causes extensive soil damage. Ground-level O_3 damages plants directly, hurting both natural and crop ecosystems. Finally, NO_x emissions also contribute to water pollution when the nitrogen enters bodies of water. Excess nitrogen in water systems causes eutrophication, which causes oxygen depletion and can lead to mass fish kills. Clearly each of the air pollutants included in this study can have detrimental effects on the health of humans and the environment in which we live.

Although the different pollutants have similar harmful effects, they come from different sources (more information on the sources of air pollutants can be found at http://www.epa.gov/airtrends/). The two major sources of SO_2 emissions are currently: electric utilities (67%), especially coal-fired power plants; and industrial processes, primarily petroleum refineries, cement manufacturing, and metals processing (18%). Most NO_x is emitted from fuel combustion: motor vehicles (55% of emissions), electric utilities (22%), and industrial, commercial, or residential fuel combustion (22%). Although gasoline engines are a major source of NO_x emissions, changes over time are primarily due to diesel engines (see Figure 1; U.S. EPA, 2000). The largest contributor to CO pollution is motor vehicles (56%), followed by nonroad vehicles such as construction equipment, boats, and other gasoline engines (22%). PM-10 is primarily emitted as fugitive dust through construction, unpaved roads, and other dust-producing processes. Finally, ground-level O_3 is not emitted directly but is produced by atmospheric chemical reactions of other

pollutants such as NO_x, CO, and VOCs. A major source of VOC pollution is chemical solvent manufacturing. The EPA does not provide exact statistics on the sources of PM-10 or VOC pollution.

The EPA sets standards for the maximum allowable levels of each of these pollutants and it oversees programs to reduce emissions. For example, following previous efforts to install pollution control technology in coal-fired power plants, the EPA implemented a cap-and-trade pollution allowance program for SO_2 in 1995. Since the 1970s, the EPA has required motor vehicle manufacturers to install pollution control technology in new vehicles, which reduces NO_x emissions from motor vehicles. Overall, the EPA regulates both stationary sources such as power plants or manufacturing plants and more diffuse sources such as motor vehicles. Each county is regulated based on whether it has attained the standards set by the EPA, and counties that have been designated as "nonattainment" counties are regulated more strictly. The EPA has used these measures to reduce lead emissions so dramatically that they are no longer a national-level problem, and it also uses these enforcement techniques on the pollutants analyzed in this study. There are also specific policies for each major pollutant, and in this study these specific efforts and the general policies are combined into a variable testing the effect of policy.

The Role of Politics and Social Movements

Economic perspectives on environmental outcomes have been studied extensively by other researchers, and the bulk of the evidence seems to indicate that although economic development can reduce negative environmental impact there are unlikely to be significant improvements due solely to economic factors[3] (Barrett & Graddy, 2000; Bruvoll & Medin, 2003; Cole, 1999; Humphrey & Buttel, 1982; Schnaiberg et al., 2002; York et al., 2003, 2005). Economic factors will therefore be included in this study as a control. In addition to the economic perspectives, political processes might also influence environmental outcomes through policy measures, the political opportunity structure, and the environmental social movement (Burstein & Linton, 2002; Giugni, 1998; York et al., 2003). There are several theories on the outcomes of social movements that are relevant to the case of the environmental movement, but overall the political process model and democracy theory are the more important ones here.

Generally speaking, democracy theory argues that democratic political processes, especially public opinion and public attention, influence policy outcomes (Burstein, 2003). The political process model further details the political opportunities that are necessary for movements to achieve new advantages by examining the role of the overall political context in influencing movement outcomes. According to this perspective, the outcome of a social movement depends on the political environment in which the movement operates, including opportunity structures in the larger political sphere (McAdam, 1999). Several previous studies demonstrate that political opportunities for the movement can influence environmental policy outcomes (Agnone, 2007; Johnson, 2008; Olzak & Soule, 2009), but previous research has not investigated the effect of political opportunities on real environmental outcomes.

In this study, these theories are extended to apply to real-world outcomes instead of just policy changes. Specifically, there are two relevant processes influencing movement success: organizational characteristics, and the political context (Cress & Snow, 2000). First, internal organizational characteristics and the strength of social movement organizations might increase the power of movements for achieving their goals. Resource mobilization theory argues that monetary and human resources influence movement outcomes. Currently, the environmental movement benefits from broad public support, organizations with large membership, and significant monetary resources. Under this perspective, the environmental movement should be highly successful at achieving its goals.

There are two types of political opportunities outlined in democracy theory and the political process model that are relevant to this study: the strength of elite political allies and weak opposition (della Porta & Diani, 2006). For the environmental movement, elite political allies consist of Democrats in both houses of Congress and the Presidency. Democrats tend to be more liberal and more open to environmental protection than Republicans and therefore more sympathetic to the environmental movement (Ornstein, Mann, & Malbin, 2002). Nongovernmental opposition to the environmental movement primarily consists of business interests and business elites, so when business elites are politically weaker the movement encounters less opposition. Thus unified Democratic partisanship (the presence of elite political allies) and the strength of business interests (opposition to the movement) will moderate the influence of the environmental movement on air pollution.

There is one other type of political opportunity for the environmental movement—media attention to environmental problems. As argued in democracy theory, it is an opportunity for political influence because politicians are more likely to cater to environmental interests when their constituents are aware of environmental problems. Media coverage encourages both mobilization and legislation by putting environmentalism on the political agenda (Cobb & Elder, 1972). Media coverage also legitimates the movement's goals by publicizing environmental problems and coverage by media outlets with a broad readership like magazines listed in the *Reader's Guide to Periodical Literature* can validate political action on the environment (McLaughlin & Khawaja, 2000). Furthermore, media coverage is independent of actions taken by the environmental movement because the media chooses stories based on ratings, which means they choose stories based on their dramatic potential and their ability to draw in readers. Large environmental disasters are dramatic, and the health risks of pollution could incite fear in media viewers. Therefore, media coverage of the environment acts as an independent political opportunity by providing the environmental movement with a popular agenda for political debate. Additionally, the correlation between media attention and environmental movement actions is only .3, which indicates that they are not closely related. Thus, the media enables the movement to more effectively push for policy goals, including reductions in air pollution.

Finally, although much previous research has focused on policy as an outcome of the environmental movement and democratic processes, it is important to remember that policy is designed to serve a purpose. Whether that purpose is successfully served is not a given and must be explored empirically. Policy could have a direct effect on air pollution regardless of movement effects. Although the influence of policy on environmental outcomes is disputed, there is some evidence that policy measures like the Clean Air Act have reduced air pollutant emissions (Greenstone, 2004; McKitrick, 2007). However, even ostensibly environmental policy is not always designed for effective ecological protection. Browne and Keil (2000) analyze a case where discourses of local environmental policy making centered around economic forces and regional growth, rather than the environmental issues of ecological and human health. Arguably, this policy is less likely to be effective at improving environmental quality, and it is thus important to test whether policy achieves actual ecological outcomes.

These mixed results about the effect of policy could also be due to differences in policy implementation—without continuous mobilization of the environmental movement even good policy might not be enforced (Bardach, 1977). Political opportunities could also play a role, since the movement might require opportunities to succeed at ensuring policy implementation. Implementation of policy is also important because it could moderate the relationship between social movements and policy outcomes. For instance, Burstein and Linton (2002) found that, although social movement organizations had a positive effect on policy, this effect was less consistent than expected. This result could be due to the effect of implementation, and this research

will clarify the influence of policy on air pollution by analyzing the role of the environmental movement in ensuring that policy is rigorously enforced.

This research will contribute to sociological theory on politics, social movements, and the environment. Although the theories outlined above have been tested in other studies, the results are not conclusive. This study's focus on real-world outcomes rather than policy will help inform the debate about the effectiveness of social movement outcomes. Although previous research has often focused on policy outcomes, this research will also investigate the influence of policy implementation.

Hypotheses

This study tests a series of hypotheses predicting the influence of political processes on air pollutant emissions. First, I hypothesize that political opportunities for the environmental movement will reduce air pollution, either directly or by interacting with environmental movement actions. These political opportunities are Democratic unity, congressional hearings on the environment, a high level of corporate taxes (as a proxy for the power of business interests), and media attention. Thus, the relationship between the environmental movement and air pollution is moderated by political opportunities. Additionally, I predict that better air pollution policy and more funding to support that policy will reduce air pollutant emissions. Policy implementation also moderates the relationship between policy and air pollution such that there might be an interaction between air pollution policy and budget to reduce air pollutant emissions. If the relationship between the environmental movement, political opportunities, policy, and policy implementation persists when controlling for economic factors, the political process model would be supported. Overall, these hypotheses center around the theory that democratic political processes matter for real environmental outcomes.

Data

I use yearly, national-level data from 1959 to 1998 for all variables (after first-differencing to detrend the data, $n = 38$). For the dependent variable, I include estimates of emissions of five of the six criteria air pollutants produced by the U.S. EPA: SO_2, NO_x, VOCs, CO, and PM-10.[4] I combined SO_2, CO, and VOCs into an index (Cronbach's $\alpha = .904$) because they are highly correlated (.89 and above). Additionally, these three types of pollutants follow a similar pattern over time (see Figure 1 for a graph of pollutant emissions over time). The strong similarity in emissions of these pollutants at different times implies a possible theoretical connection between them. Although they do come from different sources, it is possible that the economic and political processes shaping emissions of these pollutants might be similar, so it makes theoretical sense to combine them into an index. PM-10 and NO_x do not correlate closely with the other air pollutant measures and do not follow a similar pattern over time; therefore they are analyzed separately. Further details on the operationalization of all measures are listed in Table 1.

For the economic controls, I use real gross domestic product and gross domestic product squared to control for linear or quadratic effects. I operationalize political opportunities for the environmental movement as: Democratic unity in the House of Representatives, the Senate, and the Presidency; a count of the total number of Congressional hearings on the environment in each year; strength of business interests as measured by the taxes paid by corporations; and media attention to environmental issues. Democratic unity is constructed as a dummy variable, coded 1 when all three centers of federal power (both houses of Congress and the Presidency) are controlled by Democrats, 0 in all other cases.[5] Congressional hearings provide opportunities for the movement to present its views formally to Congress and are thus a measure of Congressional

Table 1. Operationalization of Variables

Variables	Operationalization	Data Sources
Air pollution: SO_2, NO_x, VOCs, CO, and PM-10	The majority of air pollutant emissions were measured indirectly. Indirect emissions estimates were constructed using formulae based on industry production, fuel consumption, technology, and known pollution control measures. Prior to 1985, these models were used to calculate emissions estimates at 5-year intervals. Annual data were constructed using nonlinear interpolation, incorporating data on annual changes in fuel consumption and production. After 1985, the EPA used more detailed state-level data to produce annual estimates from a national air emissions model. The EPA provides separate estimates for each of the five types of air pollution.	U.S. EPA: http://www.epa.gov/air/airtrends/index.html More information on the models used to measure air pollution can be found in the U.S. EPA's *National Air Quality Emissions Trends Report* (2000) and *National Air Pollutant Emission Trends* (1900-1998).
Index of SO_2, CO, and VOCs	The mean of the z scores of SO_2, CO, and VOC emissions (Cronbach's $\alpha = .904$).	U.S. EPA
NO_x	The measure described above, standardized into z scores.	U.S. EPA
PM-10	The measure described above, standardized into z scores.	U.S. EPA
Real GDP/capita	Measured in billions of chained 2000 dollars, per 1,000 people.	Bureau of Economic Analysis: http://www.bea.gov
Environmental social movement actions	These event data were coded from the *New York Times Annual Index* to describe the development of social movements in the United States between 1959 and 1998. Codable movement events must be (a) movement initiated, (b) have an identifiable beginning and end (typically within the boundaries of a 24-hour clock), and (c) advance the goals of the various movement groups or core movement constituencies. The events coded are the following: information actions (symbolic actions such as conferences, speeches, general endorsements, public reports), resource mobilization actions (membership drives, public education drives, fund raising, planning of movement events), institutional actions (court cases, proposed legislation, lobby efforts, petitions, voter registration campaigns), protest actions (marches, rallies, sit-ins, economic boycotts), and violence (any action or event involving violence, either by the environmental movement participants, opposition, or police). These data are not specific to air pollution due to time constraints but, instead, include movement actions targeting any environmental issue.	National Science Foundation Grant #SES-0455215, "Civil Society & the Environment" (Dr. J. Craig Jenkins, The Ohio State University)
Political opportunities for the environmental movement		
Democratic unity	Dummy variable coded 1 when Democrats control the House of Representatives, Senate, and the Presidency; 0 when Republicans control at least one of those three bodies.	Congressional Quarterly data (Ornstein, Mann, & Malbin, 2002)

(continued)

Table 1. (continued)

Variables	Operationalization	Data Sources
Congressional hearings	Congressional Information Service Abstracts were coded using the policy content coding system developed by the Policy Agendas Project. This measure includes all congressional hearings on any environmental issue held each year, in both houses (not specific to air pollution).	Policy Agendas Project: http://www.policyagendas.org/
Corporate taxes (proxy for strength of the anti-environmental countermovement	Federal income tax revenue from corporations, as a percentage of all federal income tax revenue. Measured in thousands of dollars.	*Historical Statistics of the United States, Millennium Edition Online* Series Ea609-635—Federal government internal tax revenue, 1940-1999
Media attention	These data were coded from the *Reader's Guide to Periodical Literature*, an index of recent magazine articles. It includes a count of all articles published in a given year related to any environmental issue, environmental agencies, or environmental problems. Contact the author for a full list of keywords.	Dr. Robert J. Brulle, Drexel University
Air pollution policy	These data were coded from a history of air pollution legislation (Reitze, 2001). Laws were coded based on three criteria: enforcement powers (weighted twice as important as either of the other criteria), whether money was earmarked into the bill, and broad versus narrow scope (it was not possible to specify the target pollutants for each law because air pollution laws often target the actions of individuals or businesses instead of pollutants). The Clean Air Act and amendments were coded separately and weighted more to reflect the dramatic improvements in air policy with each major upgrade. Second, harmful laws or laws reducing the power of beneficial laws were coded using the same criteria. After assigning a quantitative value to each positive and negative law, the yearly data were constructed by summing the value of the positive laws minus the value of the negative laws in effect each year.	Constructed by the author
Implementation of policy: Real budget for air pollution regulation	Prior to 1963, this measure is constructed as the amount of money earmarked into air policy laws for each year (Reitze, 2001). Between the passage of the 1963 Clean Air Act and the creation of the EPA in 1970, it is assumed that the air budget did not decrease, since the federal organization in charge of air pollution received funds to operate. After 1970, this measure is constructed as 13% of the EPA Budget. In 2003-2006, approximately 13% of the yearly budget was allocated to air pollution, and this percentage was assumed to be similar for all previous years (See the EPA's "Budget In Brief" (documents for more information on the allocation of budget resources: http://www.epa.gov/ocfo/budget/index.htm). These data were then standardized into real 1996 dollars. After first-differencing, a constant of 200,000,000 was added to allow this variable to be logged.	Constructed by the author using EPA budget data: http://www.epa.gov/history/org/resources/budget.htm. Standardization data: *Historical Statistics of the United States, Millennium Edition Online*. Series Ca9-19—Gross domestic product: 1790-2002 (Continuous annual series)

Note: SO_2 = sulfur dioxide; NO_x = nitrogen oxides; VOCs = volatile organic compounds; CO = carbon monoxide; PM-10 = particulate matter smaller than 10 mm; EPA = Environmental Protection Agency; GDP = gross domestic product.

willingness to listen. The data on Congressional hearings was coded for topic by the Policy Agendas Project, and it consists of a count of the number of hearings on the environment in both houses of Congress each year.[6] Strength or weakness of business interests is defined as the percentage of all income tax revenues that are paid by corporations. If corporations have the power to influence tax codes, it stands to reason that they also have the power to influence other legislation. Therefore, if corporations pay fewer taxes then business interests are strong. Media attention to the environment consists of a yearly count of articles related to the environment from the *Reader's Guide to Periodical Literature*. This is an effective measure of media attention because magazines have a broad readership among many segments of society, and thus even though it does not control for available media space, it serves as a proxy for public attention to the environment.

I constructed an original measure for air pollution policy. The policy measure was coded from a comprehensive history of air pollution legislation (Reitze, 2001). Laws were coded based on three criteria: enforcement powers (weighted twice as important as either of the other criteria because they are so critical to the capacity for implementation), whether money was earmarked into the bill, and broad versus narrow scope. The Clean Air Act and amendments were coded separately and weighted higher to reflect the dramatic improvements in air policy with each major upgrade.

Second, harmful laws or laws reducing the power of beneficial laws were coded using the same criteria. These laws included the extension of deadlines for compliance of other laws, reductions in EPA enforcement capabilities, compliance exemptions for particular issues or industries, and similar issues. Each positive and negative law was thus assigned a value, and its value was assumed to by constant as long as that law was in effect. After assigning a quantitative value to each positive and negative law, the yearly data were constructed by summing the value of each positive law minus the value of each negative law in effect in a given year. Although assuming a constant value for each law could by problematic, it is unlikely that it significantly influenced the analysis. There were only a handful of laws that had built-in variations in enforcement, scope, or money, and these were considered when assigning values to those laws.[7]

Implementation of air pollution policy was defined as real dollars spent to fund agencies responsible for research, regulation, and enforcement of air pollution laws.[8] Prior to 1963, this measure is constructed as the amount of money earmarked into air policy laws for each year (Reitze, 2001). Between the passage of the 1963 Clean Air Act and the creation of the EPA in 1970 it is assumed that the air budget did not decrease, since the federal organization in charge of air pollution received funds to operate. After 1970 this measure is constructed as 13% of the EPA budget. In 2003-2006, approximately 13% of the yearly budget was allocated to air pollution, and this percentage was assumed to be similar for all previous years (see the EPA's "Budget In Brief" documents for more information on the allocation of budget resources: http://www.epa .gov/ocfo/budget/index.htm). These data were then standardized into real 1996 dollars.

Strength of the environmental movement is operationalized as the count of all movement actions taken, using either institutional or noninstitutional tactics. This measure was coded from the *New York Times Annual Index*, and it is the count of all actions taken by environmental movement groups in a given year. Media stories in the *New York Times* are selectively reported as they are in all media outlets (Earl et al. 2004), so this measure captures the movement actions that are more likely to be politically influential because more people are aware of them. In a study analyzing environmental outcomes, this measure focuses on the most relevant events, so media selectivity is not so much a problem as an advantage.

All variables are first-differenced to correct for autocorrelation (see Methods section for a full discussion of the detrending of these data). I ran a *t* test looking for skewness in all variables and

logged two nonnormal variables after adding a constant. I then reran the skewness *t* test on the transformed variables to confirm that they were normal.

Method

Initial Phillips–Perron unit root tests confirm that these data are nonstationary. Although theoretically it would be better to examine the overall level of air pollutant emissions, it was not possible here due to the results of the unit root tests.[9] The most reasonable explanation for the trending of these data is through a stochastic trend process, since the value of these variables at a given point in time is likely to be a result of the prior history of changes and disturbances in each variable (Raffalovich, 1994). To correct for the nonstationarity of the data, each variable was first-differenced. After detrending by first-differencing the Phillips–Perron unit roots tests showed that all variables were generated by a stationary process (the null hypothesis that the variables contain a unit root was rejected for all variables at $p < .001$). This correction for nonstationarity and autocorrelation was also confirmed by the Durbin–Watson statistics presented for each model.

This analysis consists of two stages: (a) an ordinary least squares regression on each of the three dependent variables, using a base that includes each independent variable and (b) a series of regressions testing for interactions between variables, with one interaction in each model. One-tailed tests are used when the direction of the relationship is predicted. Two-tailed tests are used when the direction is not predicted and also in cases where the results are not in the expected direction. Additionally, since there are several predictors in this analysis that are quadratic or interaction effects, the standardized coefficients will not be discussed because they do not make sense with interactions or quadratic relationships. Due to first-differencing, the coefficient sizes will be very small, but this mathematically induced constraint does not indicate a small effect. Finally, all of the predictors in this analysis will be lagged 1 year. Lagging will provide a more conservative model and allow for a tentative consideration of causality.

Results

Main Effects

Table 2 shows results of ordinary least squares regression models predicting change in the three measures of air pollution: the index of SO_2, CO, and VOCs; NO_x; and PM-10. The only significant predictor of the index is media attention to the environment, which has a significant negative effect on all three measures of air pollution. In fact, media attention is the only political factor that influences air pollution in these models. This highlights the importance of media attention to an issue that could remain invisible without active efforts to make it visible.

Interactions

In addition to the base models, there are several significant interactions between environmental movement actions and various political opportunities. Table 3 shows the significant interactions for NO_x and PM-10. Each interaction model includes the base model with the interaction term. There were no significant interactions for the index of SO_2, CO, and VOCs. For NO_x, there are two significant interactions: environmental movement actions interact separately with both air pollution policy and democratic unity to reduce NO_x emissions. Finally, environmental movement actions interact with media attention to reduce PM-10 emissions. These results suggest that visible air pollutants can be reduced by media attention to the environment combined with the environmental movement and political opportunities for the movement.

Table 2. OLS Regressions Results Predicting Change in Three Measures of Air Pollution

Variable	Index, Coefficient (*SE*)	NO_x, Coefficient (*SE*)	PM-10, Coefficient (*SE*)
Real GDP/capita	153.90 (166.68)	102.45* (49.44)	60.92 (61.03)
Real GDP/capita, squared	−276383.60 (197982.6)	−207072.5** (58725.54)	−134972.5* (72487.17)
GDP and GDP squared *F* test for joint significance ($p > F$)		**	
Democratic unity	−0.073 (0.128)	−0.038 (0.038)	0.030 (0.047)
Congressional hearings on the environment (logged)	9.79×10^{-4} (2.00×10^{-3})	5.94×10^{-4} (5.86×10^{-4})	2.55×10^{-4} (7.29×10^{-4})
Corporate taxes	-1.66×10^{-2} (3.32×10^{-2})	1.16×10^{-3} (9.72×10^{-3})	8.81×10^{-4} (1.21×10^{-2})
Media attention (logged)	-6.18×10^{-4}* (2.96×10^{-4})	-2.05×10^{-4}* (8.65×10^{-5})	-1.96×10^{-4}* (1.08×10^{-4})
Air pollution policy	-3.64×10^{-3} (1.13×10^{-2})	-3.93×10^{-3} (3.29×10^{-3})	-4.40×10^{-3} (4.10×10^{-3})
Real budget for air pollution regulation	0.320 (0.223)	0.080 (0.066)	0.184 (0.082)
Environmental actions	3.72×10^{-3} (2.23×10^{-3})	1.88×10^{-3} (6.53×10^{-4})	5.96×10^{-4} (8.13×10^{-4})
Constant (standard error for constant)	−6.106 (4.270)	−1.436 (1.266)	−3.555* (1.563)
Adjusted R^2	.110	.470	.198
Durbin–Watson *D* statistic	1.705	1.618	1.762

Note: OLS = ordinary least squares; NO_x = nitrogen oxides; PM-10 = particulate matter smaller than 10 μm; GDP = gross domestic product. All variables are first-differenced and all independent variables are lagged 1 year ($n = 38$).
***$p < .001$. **$p < .01$. *$p < .05$, one-tailed.

Table 3. Results of Significant Interactions From OLS Regression Results Predicting Changes in Air Pollutant Emissions

Interaction Variable	Coefficient	Main Effects	Coefficient	Adjusted R^2
Nitrogen oxides				
Environmental actions * Air pollution policy	-4.30×10^{-4}**	All environmental actions	2.15×10^{-3}aa	.560
		Air pollution policy	-3.04×10^{-3}	
Environmental actions * Democratic unity	-2.51×10^{-3}*	All environmental actions	1.44×10^{-3}a	.512
		Democratic unity	-5.18×10^{-2}	
Particulate matter				
All environmental actions * Media attention	-7.09×10^{-6}**	All environmental actions	1.12×10^{-3}	.330
		Media attention	-4.85×10^{-5}	

Note: OLS = ordinary least squares; GDP = gross domestic product. Measures are real GDP, real GDP squared, Democratic unity, Congressional hearings on the environment, corporate taxes, media attention, air pollution policy, real budget for air pollution regulation, and environmental movement actions. All variables are first-differenced and all independent variables are lagged 1 year ($n = 38$).
***$p < .001$, **$p < .01$, * $p < .05$, one-tailed. aaa$p < .001$. aa$p < .01$. a$p < .05$, two-tailed. Used when the hypothesis does not predict the direction of the relationship or the relationship is not in the expected direction.

Discussion and Conclusion

Although this is a very conservative model, it is still surprising that the only directly significant political opportunity for the environmental movement was media attention. The impact of media attention can be explained by the theory of agenda setting without relying on the movement to capitalize on an agenda set by the media. Media attention to the environment puts environmental concerns on the political agenda, so politicians and the public pay more attention to preventing air pollution.

Despite the lack of independent, direct movement effects, the environmental movement does have some influence when combined with other factors: the interactions between environmental movement actions and political opportunities are very interesting. For NO_x, the environmental movement is effective under two conditions: when air pollution policy is strong and when Democrats control the federal government. These results demonstrate the importance of elite political allies for some movement outcomes. Additionally, the interaction between movement actions and policy problematizes the link between policy and real-world outcomes. Not only should we avoid assuming that this link exists, but we should also investigate how the movement might influence this link. Rather than assuming that better policy is an unequivocal success for a social movement, we should investigate the role that movement actors play in enforcing new and existing policy. This opens up an entirely new direction of research on policy implementation that social movement scholars can pursue. Future research on social movements and policy should always consider the implementation of policy and previous research that does not find an effect of policy should be reanalyzed in light of implementation issues. Studies on movement outcomes should consider policy and its implementation as a research question rather than as an unquestioned indicator of movement outcomes.

Environmental movement actions also interact with media attention to reduce PM-10 emissions. This interaction further emphasizes the importance of media attention. Media attention renders a somewhat invisible problem visible, and the environmental movement can capitalize on that visibility. The importance of visibility could also explain the difference in results for the three measures of air pollution. Air pollution is clearly not a homogenous concept, and there are

glaring differences in the results for the different measures. However, both NO_x and PM-10 are more inherently visible than the three pollutants included in the index. Particulate matter is a highly visible pollutant that can literally be seen in the air at high concentrations, and NO_x pollution can have significant immediate harmful effects on human health and the ecosystem, including acid rain and water systems. This visibility could make these two kinds of air pollution easier to address politically. Thus, political action, either institutional action or social movement action, might only be effective at combating more visible forms of pollution (Cavlovic et al. 2000; Dinda, 2004). Overall, the difference in results for the three measures of air pollution calls into question the generalizability of research findings across different types of pollution. This contradicts previous studies that assumed generalizability across different types of air pollution, including various studies testing the efficacy of the Clean Air Act or testing for an Environmental Kuznets Curve in air pollution emissions (Humphrey & Buttel, 1982; York et al., 2003).

Although these contributions are important, there are some limitations in this analysis that are worth correcting and investigating further in future research. First, several measures of independent variables in this analysis focused on any environmental issues, not targeting air pollution in particular. For example, the measure of congressional hearings includes hearings on any environmental issue, and the measure of environmental movement actions includes actions targeting any environmental concern. If these measures only included air pollution, it is possible that they would have had a significant result. However, it is important to remember that many different environmental issues are interrelated. For example, legislation protecting of old-growth forest habitat for engendered species would influence the levels of particulate matter emissions, since dirt roads and logging can both contribute to that type of pollution. Additionally, during most of the time period in this analysis, air pollution was one of the most important environmental problems and received high priority in terms of public debate and legislation. It is therefore possible that measures focusing on any environmental problems could act as a proxy for air pollution–specific measures. Future research should explore this possibility and also whether hearings or movement actions have an effect on only the issues they target or on broader environmental goals.

Second, the mechanism for the effect of media attention is unknown. This effect could be due to the influence of media on public opinion or salience, or it could be a more complicated process involving a relationship between media attention and movement mobilization or political accountability. Determining the mechanism for this effect is thus an important direction for future research to explore. Future research should also investigate whether there is a direct influence of public opinion or public attention to environmental issues. This would help determine whether media attention acts as a proxy for public attention or whether it acts in some other fashion. Alternatively, public attention to the environment could help explain some of the unexplained variance in this analysis.

There are other issues that could also drive some of the unexplained variance in this study. For instance, environmental concerns vary in the importance they are given relative to other political concerns, and this variance could influence environmental outcomes. Economic downturns and wars both draw political attention away from environmental issues, and when public attention is divided between the environment and many other issues defined as very important, then environmental outcomes might suffer. The influence on environmental outcomes of the number and relative importance of political issues is thus a factor that is worth exploring in future research. Given the difficulty in studying some of these issues quantitatively, it is worth considering the use of qualitative analysis to explore the deeper details of these political processes. A case study examining a movement group or an important historical event would add depth to the scholarly understanding of political processes influencing environmental outcomes.

In conclusion, these results show that the environmental movement is only effective at influencing air pollution under very specific circumstances. The political opportunity structure determines the influence of the environmental movement, and different opportunities were effective for different kinds of pollution. Additionally, the political agenda was found to be very important in determining which kinds of air pollution are influenced by political processes. Political processes are more likely to be effective in combating highly visible forms of air pollution, and the role of media attention also supports the importance of agenda setting. Future research should examine whether this finding on political agenda setting is generalizable to other environmental problems. Although political efforts like agenda setting might be theorized as the means to achieve environmental objectives, reductions in air pollution require the convergence of specific political conditions. This study therefore demonstrates the importance of testing the theories of environmental impact empirically and teasing out the details of political processes that affect this society's environmental impact.

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Notes

1. There is a debate about whether to count CO_2 as an air pollutant, but this has yet to be established legally so it is not included in this analysis. It has also not been regulated as an air pollutant, so an analysis of CO_2 could not effectively test policy. Future research on air pollution should evaluate CO_2 and other greenhouse gases to determine whether the same theories might apply.
2. Lead emissions will not be included because the EPA does not provide continuous measurement of lead emissions, and because lead emissions have declined so dramatically that lead is no longer a national problem outside of localized areas. Localized pollutants are not appropriate in a national aggregate trend study.
3. Studies of the impact of economic growth on pollution have shown mixed results, with some studies linking affluence to increased ecological efficiency and some showing increased environmental impact with increased affluence, but very few studies find any net declines in pollution that can be linked to affluence. Despite this uncertainty, economic effects are important in this study as a control to ensure that any significant findings are not an artifact of affluence.
4. These data are available at http://www.epa.gov/air/airtrends/reports.html.
5. Other measures of Democratic control were also tested, specifically a dummy variable for a Democratic President and percentage of Democrats in the Senate, the House of Representatives, and the two combined. However, these measures showed no effect either directly or in interaction with other factors.
6. Models were also run using congressional hearings on the environment as a percentage of all congressional hearings, with no difference in significant results.
7. Although some laws do not take effect immediately and others include "grandfather" clauses that enable older businesses or manufacturing plants to avoid compliance, this measure nonetheless captures the overall quality of air pollution legislation. Grandfather clauses and phase-in time periods were considered when assigning values to the Clean Air Act and its amendments, and extensions of compliance deadlines were coded as negative laws. Lengthy compliance deadlines and grandfather clauses built into the original passage of a bill were also considered when assigning values for scope or enforcement, whichever was more appropriate given the details of the law in question.
8. Other measures of implementation were considered, specifically a measure of EPA fines and violations related to air pollution. Unfortunately historical data on air pollution fines and violations were not available

to the author at this time. Additionally, fines and violations do not capture the full extent of EPA activity or air pollution legislation prior to the existence of the EPA, which includes education, research, collaborative efforts, and other measures. This budget measure, while imperfect, does not emphasize fines over other actions taken by legislative bodies or the EPA.

9. Results of these unit root tests and all other results not presented are available on request.

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