POLLUTION, REGULATION, AND EVALUATION

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Understanding pollution is only partly a matter of becoming informed about technical variables and processes. It is also — or even predominantly — a matter of gaining knowledge about social and economic systems. As is the case with many other issues, we need to know why these systems "produce the results they do and how we can use understanding of them to produce more desirable ones" (Kneese, 1970: 190).

The current emphasis on environmental problems has resulted in the passage of new legislation and increasing public pressure upon individual companies seen as polluters. However, the factors which influence organizations to change their ways are rather hazy. In the absence of clear market controls, particular businesses may fight environment-oriented legislation, complying only when political and legal avenues have been exhausted. Other businesses may announce their intent to help clean up the environment and initiate action in this regard with relatively little prodding on the part of the public, state and federal bureaucracies, or conservation groups.

The confusion in this area is all too apparent. When leading industrialists were asked to evaluate the environmental performance of eight basic industries, only the electric-ultility industry was given reasonably high marks (Diamond, 1970). This would undoubtedly come as a shock to the public in New York and Chicago who have followed the wars waged by conservationists on Consolidated Edison and Commonwealth Edison.

This confusion inevitably hampers the ability of governmental agencies to develop guidelines, incentives, and/or pen-

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alties to pressure business into doing more about pollution. Are firms or whole sectors neglecting the environment because their own financial position is precarious? If this seems to be the case, tax credits, government subsidies, or matching grants may be called for. Are big firms and the more concentrated sectors of the economy doing a better or worse job? If the larger firms are being more responsive, perhaps an extensive educational campaign needs to be launched to pressure the more anonymous small firms and competitive sectors into compliance. In such a situation, local regulation may be more effective than national. Firms in a particular sector may have funds which could be diverted to pollution control but competitive pressures may dictate a follow-the-leader policy. Here sector-wide legislation may be most appropriate, with widely publicized target injunctions.

One way to try to generate such knowledge about pollution is to consider different kinds of systems, both alone and where they come in contact with each other. Such a focus emphasizes the interdisciplinary nature of the study of pollution. Not only are organizational and political factors important, but, as is pointed out later in this paper, at least a basic knowledge of various production processes is also useful in understanding the pollution problems associated with a particular industry. Data on two sorts of social systems, the business firm and state government, are presented in this research and that of Wenner (1972). This information is then combined to discuss the way in which company choices of production process and waste treatment may affect political systems.

A focus upon industrial pollution seems appropriate for the following reasons:

1 — Water use by industry is about ten times that of municipalities, and projections suggest that this ratio is likely to increase.

2 — The BOD (biochemical oxygen demand) load produced by industry may be over five times that generated by municipalities.

3 — Industrial pollution adds cyanide, mercury, etc. to the waterways.[1] Municipalities do not add these compounds to the nation's waters.

Much of the data currently being analyzed by these authors is from the pulp and paper industry. The choice of sector was

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partly fortuitous; a sizable body of data was available from the Council on Economic Priorities' study of pollution in this industry (1970).[2] At the same time, analysis of this industry is particularly useful because it has been a major industrial polluter. Over the 1964-1969 period firms involved in the pulp and paper industry were represented at more conferences dealing with the pollution of interstate waters than were companies in any other sector.[3]

Such research represents an effort to better understand an important new political issue in American society. If, as some theorists of social change have suggested, the pace of societal change is increasing, our ability to deal with new issues will become more and more crucial. The need for controlling pollution, for collectively dealing with the problem that "the individual waste disposer imposes important external costs on others by his activities," has only recently come to public attention (Kneese, 1970: 192). The pollution problem has wider implications because air and water are important collective goods.

Our investigation is particularly relevant to the "free rider" problem. As Frohlich and Oppenheimer have noted:

> Free rides occur because individuals acting in a self-interested fashion see incentives to withhold their resources hoping that the efforts of others will suffice to provide the good. By the collective nature of the good, individuals would receive the good even if they did not contribute toward its supply. Such a "free-rider" tendency can jeopardize the supply of collective goods (Frohlich and Oppenheimer, 1970:105).

Thus, this study is concerned with the interface between private and collective goods. A number of questions are posed by such a focus. Which firms might tend to be "free-riders"? How can such tendencies be checked? How does government with its responsibility for handling issues involving the public welfare deal with a problem with such major implications for private production, expenditures, and consumption?

This study can also be thought of as evaluation research.[4] It is important to evaluate the policy outcomes of the federal and state programs designed to help reduce air and water pollution. Moreover, environmental indicators are directly relevant to questions of the "quality of life" in contemporary America. Although measurement problems clearly exist, such difficulties

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may be treated with more facility than has been possible with respect to other social issues. Because measures both of water quality and of residuals discharged are available, it is easier to trace linkages between individual actors (potential polluters) and outcomes (air and water quality). Finally, statements by respected authorities that we have failed to mount a significant attack against the major contributors to pollution call for solid evidence and investigation of past failures.

Careful evaluation is important for other reasons. Some of the data with which we have been working have recently received wide publicity as showing that "the most successful companies in the pulp and paper industry are the very ones ranked highest in protecting the air and water environment."[5] Such publicity may well be counterproductive in terms of environmental protection. First of all, it is necessary to define "success" extremely carefully. "Success," as treated in terms of growth in earnings/share, may contribute to an exploitative "growth" mentality which has led to our present environmental situation. The analysis reported here considers how firms with comparatively high growth rates have treated the environment. We have also looked at "scale" factors, contrasting the behavior of relatively large and relatively small companies. In general, the relationships are rather weak and subject to varying causal interpretations.

A number of theoretical formulations could be suggested for describing the reality of pollution and pollution abatement in the United States at the present time. These formulations may be relevant to both the economic and political sectors; more specifically, the models should help point up important variables associated with industrial firms and local governmental units.

This analysis begins with a strong theoretical focus. The extensive literature on the theory of the firm should be relevant. We hope to explain some of the behavior of companies with regard to pollution control in terms of one of three approaches. Although the results are rather complicated, a mention of these approaches is appropriate:[6]

1 — innovation theory, which deals with how organizations innovate and makes predictions as to the type of company most likely to innovate.

2 — behavioral theory, which emphasizes a company's past

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practices and "satisficing" (finding a satisfactory as opposed to an optimal solution) as determinants of present behavior.

3 — compliance theory, which focuses upon effective regulation, suggesting variables which might help in understanding the successes and failures of enforcement efforts. Clearly, quite different conceptual frameworks are involved here. Is pollution control instigated as an innovation or in response to strong pressures for compliance? Our analysis helps to provide answers to these questions.

The study of regulation and compliance processes is particularly important because of businesses' indifferent record with regard to voluntary compliance. One business spokesman has suggested that:

> . . . the use of legal enforcement to require known and reasonable measures is often less than satisfactory. As a matter of fact, the most efficient "enforcement" in any of these areas is a mild blend of informed public opinion (not uneducated public fervor), salesmanship on the part of the control agency, and good faith on the part of management (Benson, 1968: 190-191).

But such a magic formula seems elusive. Analysis of oil and steel companies' voluntary compliance in the Gary, Indiana, area showed little change in water quality (as measured at a number of checkpoints immediately adjacent to plant outfalls) during the year after a voluntary compliance deadline had passed (Roos, 1971: 236-267). Case study data reported by Nader's group detail a number of abuses (Zwick and Benstock, 1971). Such findings are especially disappointing because, as Davies has noted, "Pollution laws, like all other laws, require a high degree of voluntary compliance for their success, and thus the private sector, considered collectively, has a veto power over the progress of much pollution abatement" (Davies, 1970: 91).

Despite the importance of this area, there seems to be relatively little available theory. People working in the field of industrial relations have long been concerned with the problem of regulatory agencies' obtaining compliance from negligent firms. The statements by political scientists working in this area suggest that such factors as the quality and effectiveness of the regulating agency are likely to be of particular importance. Abatement costs and political influence are also seen as a major factor in compliance or noncompliance.

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Data Analysis

Several different types of data are used in this analysis. The Council on Economic Priorities' study of the pulp and paper industry provided considerable information on both companies and individual plants. Company financial data were available, along with a fair amount of information on state pollution control efforts.

Two types of analysis are used. Within-level analysis is performed at the level of the factory, the firm, or the state in order to reduce the dimensionality of our data (through factor analysis) and to get ideas about possibly causal relationships within any single level. Perhaps even more important is the analysis between levels, exploring relationships between:

1 — Factories and states. Each factory is (obviously) located in a particular state and legally subject to the regulations of that state. One hundred and eight factories located in 27 states were used in the analysis. Wisconsin (with 17 factories) and Washington (with 10 factories) were heavily represented. Numerous questions of compliance and effective influence are raised by the relationships between factories and states.

2 — Factories and firms. Each factory is run by a company which has investments, including other pulp and paper factories, elsewhere. The company is faced with decisions involving the allocation of resources among a number of competing uses.

There are a series of expectations, of macro-hypotheses, present. As a "first cut" at the data, relationships among independent variables presumed to be important determinants of the dependent variables should be explored. Significant correlations between independent and dependent variables should be found. Such correlational information does not tell us a great deal about important processes which may involve feedback, time lags, and so forth. But at the same time, where considerable uncertainty exists, examining these correlations is useful in screening the data and eliminating some of the multitude of plausible hypotheses. A continuing effort is being made to obtain longitudinal data. Finally, data on statistical relationships may help in isolating the political and economic variables which are most highly related to outputs. Such information is particularly important, given the general level of knowledge concerning the effects of these factors.[7]

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The study of industrial pollution is complicated by the fact that two important sets of variables are involved at the factory level (Bower, Lof, and Hearon, 1971:622). The choice of production process is inextricably tied to the need for, and the choice of, treatment process. Underlying such choices is the demand for the outputs produced by the firm; such demand "is the 'driving force' behind residuals generation and consequent impacts on environmental quality in society."[8] Since different processes have different outputs — in terms of both the products which are sold and the residuals generated — demand, production, and residuals are closely linked.

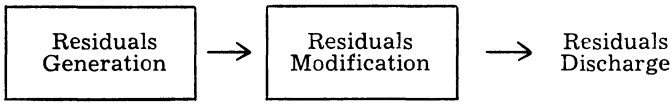
Residuals from production might be conceptualized in terms of three components:

1 — Residuals generation which is heavily influenced by the choice of production process

2 — Residuals modification by additional materials recovery and "waste treatment"

3 — Residuals discharge

This process can be diagrammed in rather simple terms:



The firm, perhaps prodded or influenced by various enforcement agencies, makes decisions about both residuals generation and residuals modification which determine the resid-relevant to try to measure all three components of the production-pollution process: residuals generation, modification, and discharge. The situation is complicated by the interrelationships between the components. Some production processes call for considerably more waste treatment than others.

Studying all the different components is important from another perspective. The use of multiple indicators is a well-established social science technique, necessitated by the fact that any single indicator measures imperfectly. If firms vary along an underlying dimension which has to do with their responsiveness to pollution problems, a multiple indicator approach might pick this up where using a single indicator would be inadequate.

This paper uses both single variables (indicators) and component variables based on factor analysis to study possible independent and dependent variables related to water quality.

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The use of a number of single variables is appropriate in that these indicators represent readily understandable variables which have been treated extensively in both the business and environmental literature; important policy decisions are often made on the basis of these variables. Whenever possible, our discussion refers to two or three such indicators rather than depending on just one; in this way we hope to avoid the pitfalls of single indicator analysis.

On the other hand, there are several reasons for producing variables derived from a number of indicators. Factor analysis is used to devise component variables from information on the relationships among a number of single variables. This technique assumes the existence of underlying traits ("factors") which are imperfectly tapped by the single indicators. By reducing the error variance implicit in working with single indicators, the precision of the analysis should be markedly improved. Moreover, the use of factors as variables aids in multivariate analysis by coherently reducing the amount of data being handled.[9]

When we move from conceptualization to operationalization, several problems present themselves. Measures of generation, modification, and discharge which were expressed in the same units would be desirable. Because residuals discharge equals generation minus modification, data expressed in comparable units would facilitate cross-checking. We need to derive measures for residuals generation by the basic production processes;" a basic production process is defined to include all such internal recirculation flows of materials and energy which would be instituted in the *absence* of pollution controls, i.e., are economically justified in relation to the costs of factor inputs" (Bower, Löf, and Hearon, 1971:613).

Although progress is being made in creating such a measure of residuals generation, this measure is not currently available.[10] The available data on factory residuals are of two types. The residuals management information is based on the factory's waste treatment facilities. Basic measures of treatment adequacy (primary, secondary, etc.) are employed, along with a summary score on this treatment variable. The residuals discharge information consists of two estimates of biochemical oxygen demand (BOD) in the plant effluent — BOD discharged per day of plant operation and BOD per ton of pulp produced by the plant.[11] The plants' scores on the treatment variables and on the BOD discharge variables were significantly corre-

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lated --.33 and —.31 for treatment with BOD/day and BOD/ton respectively.

There are two major production processes involved in pulping. The sulfate or Kraft process "is an 'universal' pulping process, being able to handle all types of wood" (Bower, Löf, and Hearon, 1971:618). On the other hand, the various sulfite pulping processes (calcium base, ammonia base, and magnesium base) produce a brighter unbleached pulp and have somewhat lower costs per ton of product. The two types of processes produce substantially different mixes of residuals; in the last 25 years there has been a substantial shift toward the Kraft process.

At a later stage in this research we will want to consider trade-offs among processes, effluent treatment, and company investment. This focus would move away from a correlation-regression framework toward an emphasis upon choice; such tools of micro-economics as linear programming might prove especially valuable. At this point, however, correlation techniques will be used to outline the main relationships among variables.

TABLE 1. FACTORY SIZE AND POLLUTION REDUCTION

	Measures of Factory Size	
Measures of Effort to Reduce Pollution	Pulp Production Per Day	Other Production Per Day
Adequate Primary Treatment	.26*	.24*
Adequate Secondary Treatment	.27*	.26*
Score on Treatment Variable	.31*	.32*
BOD Discharge in Pounds Per Day	.09	—.09
BOD Discharge/Ton of Production	—.27*	—.21*

Measures of association are Pearson product-moment correlations. N=108 factories. Factory data are from Council on Economic Priorities (1970). The treatment variable was constrtucted by assigning a score of 0 for no treatment (or inadequate primary treatment), 1 for adequate primary treatment, 2 for adequate secondary treatment, and 3 for tertiary treatment.
* Indicates statistical significance at the .05 level.

Looking first at the factory data, we find relatively low correlations between the size variables and various efforts to reduce pollution (Table 1). There does appear to be some relationship between size of factory and the presence of primary and secondary treatment. However, even when these relationships are "statistically significant," they are comparatively weak. Less than ten percent of the variance in the treatment variables is explained by each of the measures of factory size.

Preconceptions about business and environmental protection can also affect interpretation of these data. There is essentially no correlation between total BOD discharge and the

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measures of factory size. Larger factories do not discharge waste with smaller biochemical oxygen demand, but they do produce waste with less BOD per ton of pulp or paper.

The strength of the findings from the company data are less impressive than the findings from the factories alone (Table 2). Not only are the overall levels of correlation low, but the "moderate" correlations which do exist are predominantly for independent variables which measure scale. It is

TABLE 2. COMPANY SIZE, PROFITABILITY, AND FACTORY POLLUTION REDUCTION

	Measures of Company Size and Profitability				
Measures of Effort to Reduce Pollution	Sales	Assets	Net Income	Earnings/ Share	Growth in Earnings/ Share 1959-1969
Adequate Primary Treatment	.17*	.15	.21*	—.02	—.14
Adequate Secondary Treatment	.10	.05	.07	.00	—.02
Score on "Treatment" Variable	.20*	.17*	.21*	.01	—.03
BOD Discharge in Pounds Per Day	—.10	—.06	—.03	.06	—.20*
BOD Discharge/Ton of Production	—.08	—.05	.00	—.01	—.19*

Measures of association are Pearson product-moment correlations.
N = 108 factories.
* Indicates statistical significance at the .05 level.

particularly noteworthy that the correlations for earnings/share are essentially zero. The company data also differ from the factory data with regard to the treatment variables. The correlations between the treatment variables and company size are due to the primary treatment provided by relatively larger companies.

The information on growth in earnings/share will merit more detailed analysis at a later date. The information in Table 2 suggests that the fastest growing companies may be building plants using the Kraft (sulfate) method which recovers chemicals for internal use, thus reducing the BOD load on the receiving waters. The incentives for using this process are economic; rapidly growing companies are not particularly interested in installing treatment facilities, but they are interested in having modern plants.

Further study of the plant and company data indicates a pattern associated with relatively large, relatively new factories. Plants which are large and/or new tend to show stronger relationships between having treatment facilities and producing relatively low amounts of BOD/ton than do smaller plants;

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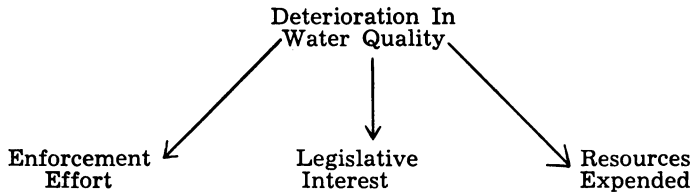
there seems to be a coherence in their pollution control operations which is lacking in smaller, older plants.

A recent analysis of water pollution control laws has suggested that deteriorating water quality has a number of consequences at the state level (Wenner, 1972). Such change in water quality seems to spur legislative interest in pollution problems, enforcement efforts, and expenditures on pollution. The basic causal model suggested by Wenner's work is shown in Figure 1. An additional correlational analysis used a measure of the importance of polluting interests in each state, but the causal role of this variable was unclear.

FIGURE 1. TENTATIVE CAUSAL MODEL FOR RELATIONSHIPS BETWEEN WATER QUALITY AND WATER POLLUTION CONTROL (LATE 1960s)



Working independently with the factory-level data, we arrived at a similar formulation. Much of Wenner's data has now been incorporated into the model, substantially improving our faith in both its internal and its external validity. The data from the single indicator analysis is presented in Table 3. The correlations are generally statistically significant, although

TABLE 3. FACTORY POLLUTION REDUCTION AND STATE CONTROL MEASURES

	State Water Pollution Control Measures	
Measures of Effort to Reduce Pollution	1969 Budget (including Federal grants)	1969 Personnel (in Man Years)
Adequate Primary Treatment	—.25*	—.29*
Adequate Secondary Treatment	—.22*	—.21*
Score on "Treatment Variable"	—.28*	—.29*
BOD Discharge in Pounds Per Day	.01	.09
BOD Discharge/Ton of Production	.16*	.22*

Measures of association are Pearson product-moment correlations. N=108 factories.

* Indicates statistical significance at the .05 level.

much of the variance in the "dependent" variable is not explained by the relationships. The direction of the relationships is, however, as important as their magnitude. Large state pollution control operations were associated with a lack of treatment facilities and a high BOD/ton discharge. Other data sug-

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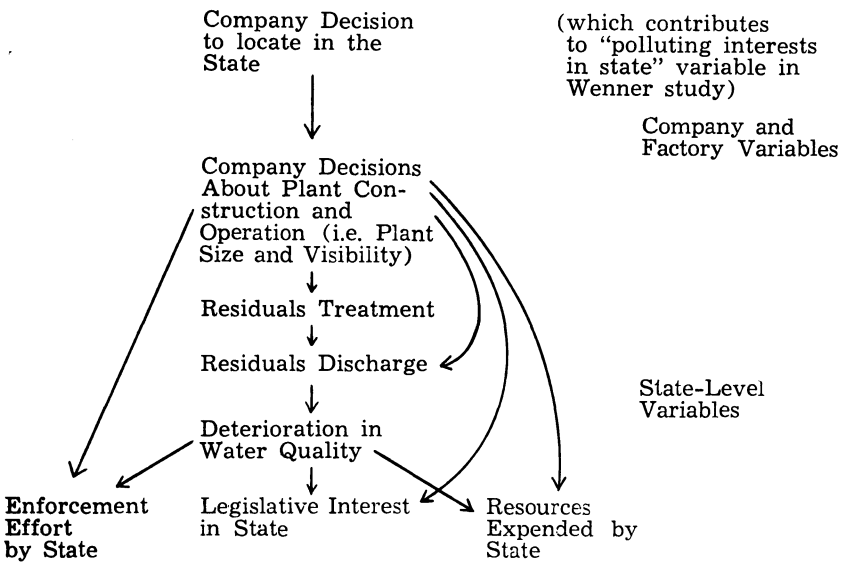
gest higher (but negative) correlations with several measures of plant size; the correlations between the factory-level variable of tons of pulp/day and the state's 1969 budget and personnel were −.41 and −.46 respectively. Our micro-level causal model is presented in Figure 2.

FIGURE 2. TENATIVE CAUSAL MODEL FOR RELATIONSHIPS BETWEEN COMPANY DECISIONS ABOUT RESIDUALS AND WATER POLLUTION CONTROL (LATE 1960S)



Causal paths beyond those shown here are likely. This model was suggested by analyses supplementing data presented in the tables.

A preliminary hypothesis from this research is that having small plants with inadequate treatment facilities located within their borders caused state governments to become more interested in water pollution problems. Clearly such data have to be examined controlling for various factors, but our initial proposition is that:

the presence of small plants with inadequate facilities → substantial pollution control efforts on the part of the states

Wenner's summary variables were incorporated into the analysis; the results are presented in Table 4. These findings are completely consistent with what has been discussed earlier. Fairly high correlations between the factory-level variable of tons of pulp/day and the state-level variables were recorded; these relationships ranged up to −.52 for that between tons of pulp/day and the state legislature's interest in water pollution.

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TABLE 4. FACTORY POLLUTION REDUCTION AND STATE ACTIVITIES

Measures of Effort to Reduce Water Pollution	State Activities					
	Enforcement Effort	Legislative Interest	Strictness of Law	Resources Expended	Quality Standards	Non-Polluting Interests
Adequate Primary Treatment	—.19*	—.33*	—.22*	—.40*	—.08	—.03
Adequate Secondary Treatment	—.10	—.30*	—.32*	—.44*	—.16*	—.20*
Score on "Treatment Variable"	—.22*	—.38*	—.36*	—.48*	—.18*	—.14
BOD Discharge in Pounds Per Day	.00	.10	.19*	.18*	.06	.04
BOD Discharge/Ton of Production	.09	.28*	.23*	.36*	.09	.07

Measures of association are Pearson product-moment correlations. N=108 factories.

*Indicates statistical significance at the .05 level.

The data on State Activities are taken from Wenner (1972). A comparison of states with pulp and paper factories with those without such factories indicates a number of differences, particularly regarding expenditures on water pollution control. As would be predicted on the basis of the discussion in the text, states with pulp-paper factories spend much more money on control agencies than do those without this industry.

Both the Wenner and the Roos formulations are characterized by the fact that feedback from state efforts to water quality is lacking. Given the nature of the available data, there were two sorts of rival hypotheses:

Type 1 — Problems with residuals discharge and water quality lead states to increase their pollution control efforts.

Type 2 — Pollution control efforts lead to increased problems with residuals discharge and water quality.

Research on panel and time series analysis has suggested a number of ways in which these types of hypotheses can be elaborated upon (Blalock, 1970; Howard and Krause, 1970: 220). The hypotheses might be rephrased to distinguish between static causality (the *level* of the variable is causal or determined) and dynamic causality (the *change* from one level to another is causal or determined). More complicated equilibrium formulations may also be appropriate. A state might act to reduce its pollution below certain levels, but then attract new industry and permit pollution levels to rise again. Although the Type 2 hypotheses seem implausible, efforts should be made to investigate these hypotheses on a more systematic basis.

One way to do this is to use information gathered from two or more points in time. Hindered by problems of accessibility, research efforts discussed here have relied predominantly upon cross-sectional data from one point in time. The Wenner study

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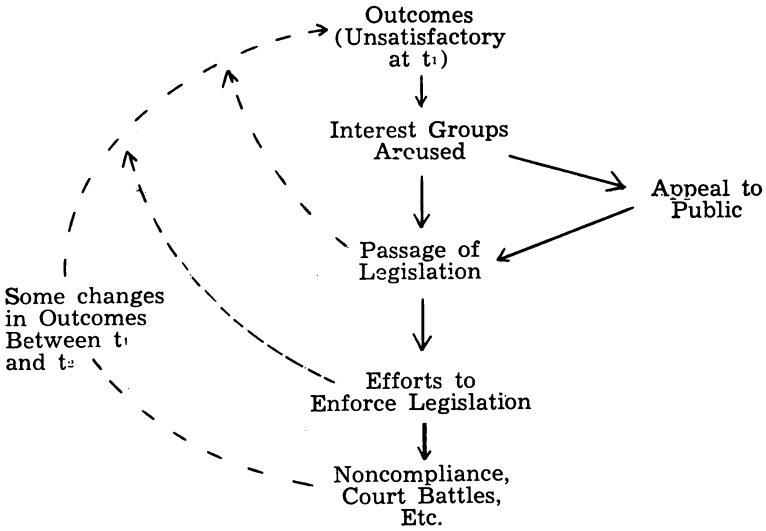
has used information on change in water quality during the 1960s, while we worked with growth in earnings/share in the 1959-1969 period. But in both cases the change data was treated as a single variable and correlated with the information from one point in time. This technique permits an initial screening of hypotheses, but makes it difficult to distinguish between a number of plausible rival hypotheses.

A time-series approach to data collection is necessary in order to separate static and dynamic elements of the residuals discharge and water pollution control processes. Over time, changes are expected in both the absolute levels of the variables and in the way they relate to one another. For example, it will be interesting to see whether the strength of the link-

FIGURE 3. SIMPLIFIED REPRESENTATION OF POSSIBLE CHANGES IN OUTCOMES BETWEEN TIME$_1$ AND TIME$_2$



Economic and political variables would be expected to enter in at various stages in this process.

ages between water quality and enforcement efforts increases or decreases over time. (See Figure 3.) Eventually, the analyses will have to be combined in order to express the effects of the different types of variables. The prospects are encouraging, however, in that rather different approaches have generated parallel results.

Moreover, the results are interesting in suggesting progress science research. As is indicated below, the level shifts in mov- in confronting the micro-macro problems which plague political ing from our study to Wenner's.

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Variable at the Firm Level (Roos)	Variables at the State Level (Wenner)
Residuals Discharge	Water Quality
Firm's Decision to Locate	Polluting Interests in the State

A number of techniques are available for treating such data from various levels, and it is hoped that progress can be made in integrating both the data sets and the conceptual frameworks.

This research also represents a rather different trend in public policy analysis. Few studies of the American states have dealt with how the magnitude of a policy problem has influenced governmental outputs. The fact that the environment is a "new" issue has facilitated such analysis here.

The results suggest that salient policy problems lead to both political and economic responses on the part of the states. This is of particular interest because of the controversy over the political, as opposed to the economic, determinants of policy outputs.[12] The salient problems of water quality and residuals management do not point clearly to more of a political than an economic response, or vice versa. The correlations between score on the "treatment variable" and the three measures of political response (enforcement effort, legislative interest, and strictness of law) ranged from −.22 to −.38. The correlation between "treatment variable" and the economic response variable of resources expended was −.48

From a larger perspective these data emphasize the need for analyzing policy as a multi-dimensional phenomenon.[13] The results of state expenditures, legislative interest, and enforcement efforts in terms of impact upon both water quality in general and pulp and paper factories in particular are unclear; the relationships between the state outputs and the outcomes need elaboration. Time-series information will be critical in determining, on the one hand, whether the response to this new issue will be primarily symbolic and fiscal or, on the other, whether it will substantially affect environmental quality. The strength of the feedback suggested in Figure 3 must be empirically evaluated.

The findings reported in this paper are relevant for several sorts of research. First of all, the evidence that small companies tend to be rather less concerned about water pollution accords with the literature on collective action (Olson, 1965). If the environment is thought of as a common property resource or collective good, the prediction that small actors will contribute less to the collective undertaking is borne out.

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The model presented in this paper is that unsatisfactory outcomes lead to a change in governmental outputs. This model has to be considered in the light of other findings. Crenson (1971) has presented data on several different kinds of air pollution; the model outlined here appears compatible with data on suspended particulates. But, according to Crenson, high levels of sulfur oxide emissions and gasoline consumption do not seem to have resulted in marked changes in governmental outputs. Thus, the conditions associated with the "unsatisfactory outcomes cause a change in governmental outputs" must be elaborated upon. Conceptions of "satisfactory" need to be probed; different issues may be involved in different political arenas.

These data do not provide strong support for any single theoretical orientation.[14] Models of innovation — as they have been discussed in the organization theory and state politics literature — do not seem directly applicable. Particular types of states do not appear to have come up with programs producing identifiably less pollution. If any model seems appropriate, it is the "satisficing" one. Businessmen may be responding to pressures for some minimal amount of pollution control, trying to avoid controversy by instilling better controls as new, more efficient plants are constructed. The findings suggest that, when a decision is made to construct a large plant, businessmen may be increasingly considering the fact that conspicuous pollution is bad. Progress seems to have been due to technical changes and some responsiveness on the part of large companies; further improvement is obviously called for. Any evaluation of the impact of specific programs is clearly premature; much better data are needed.

APPENDIX A

It seemed worthwhile to mention some preliminary work we have been doing at the sector level, using data provided by the National Industrial Conference Board and several government publications. The following sector-level categories and variables were available with 1965-1968 data:

Categories

Food & Kindred Products
Textile Mill Products
Paper & Allied Products
Chemicals & Allied Products
Rubber & Misc. Plastics Products
Petroleum Refining & Related
Fabricated Metal Products except Machinery & Transportation Equipment
Machinery except Electrical
Electrical Machinery, Equipment & Supplies

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Industries	Motor Vehicles & Motor Vehicle Equipment
Stone, Clay & Glass Products	Transportation Equipment except Motor Vehicles
Scientific Instruments, Photographic Equipment, Watches & Clocks	

Independent Variables	**Dependent Variables**
(I,C) Concentration Ratio (% Sector Assets in $250,000,000 + firm)	Capital Expenditure Ratio on Pollution Abatement (air & water)
(I) Profitability	Capital Expenditure on Pollution Research & Engineering
Return on Equity	Projected Change in Abatement Expenditures
Return on Total Capital	Absolute Expenditures on Pollution Research and Engineering
Rate of Growth	Projected Change in Pollution Research and Engineering
(NE) Past Investment in Abatement	
(NE) Social Responsibility (contributions or gifts)	
(C) Advertising Expenditure	

(I) designates a variable used to test hypotheses derived from innovation theory; NE, hypotheses taken from work on non-economic behavior; and C, hypotheses taken from compliance theory.

Some of the same independent and dependent variables will eventually be used for both sectoral and company analyses. Preliminary results of the sectoral analysis are presented on the following pages.

HYPOTHESES TESTED

Innovation Theory

Hypothesis 1: The larger the firm the greater the propensity to innovate. Thus the more concentrated the sector, the more likely the sector has been an early investor in pollution abatement.

— Related Research: Mohr (1969) and Rosner (1968).

— Roos data generally support this hypothesis.

Hypothesis 2: The more profitable the organization (the more organizational slack) the greater the propensity to innovate. Thus the more profitable the sector, the more likely the sector has been an early investor in pollution abatement.

— Related Research: Mohr (1969); Rosner (1968); Cyert and March (1963).

— Roos data do not support this hypothesis. The data suggest that the more profitable sectors are only investing in pollution abatement following the pressures of government controls.

Non-Economic Behavior

Hypothesis 3: A firm's allocation to projects or subunits whose output is difficult to evaluate in immediate economic terms

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is sensitive to historical precedent. In other words, in the absence of other guidelines (behavior of competitors, governmental pressure) a sector's past allocation to pollution abatement will determine its future allocation.

— Related Research: Cyert and March (1963); Davis, Dempster and Wildavsky (1969).

— Roos data generally support this hypothesis. The earlier the observation, the stronger the relationship between past and future allocations. Expenditures on water pollution abatement, the area which came under the greatest compliance pressure, show the weakest correlations over time.

Hypothesis 4: A firm's willingness to help clean up the environment is part of a more general social responsibility factor. Another measure of this social responsibility factor is the firm's propensity to give gifts and charitable contributions. Thus, a strong relationship between a sector's gift and contribution record and its pollution expenditure record is hypothesized, particularly in the pre-control period.

— Related Research: Bauer, Pool and Dexter (1963) who examine the degree to which ideology acts as a brake on economically determined interests.

— Roos data do not support this hypothesis. There is some indication that with the recent interest in pollution abatement, these sectors are conscious that better public relations can be obtained through pollution abatement and they are responding with changes in their investment policies.

Compliance Theory

Hypothesis 5: The larger the business the more visible and hence susceptible it is to public and governmental pressure. Thus the more concentrated the sector, the more rapidly we would expect it to respond to pollution control legislation.

— Related Research: Weiss (1967).

— Roos data do not support this hypothesis. The concentrated sectors were early investors in pollution abatement. They have not stepped up their investment with the onset of governmental controls.

Hypothesis 6: The larger the business (the more concentrated

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the sector) the more likely it is to have close ties to government and hence the better it is able to resist pressures not in line with its own self interest.

— Related Research: Mills (1956) and Marine (1969).

— Roos data suggest that the concentrated sectors have been less affected by the pollution controls than have the nonconcentrated sectors. However, given the concentrated sectors' early investment in abatement, the implication of these data are unclear.

Hypothesis 7: Brand name susceptibility. The greater the sector's attempt to influence the public through advertising, the more it has to lose from adverse publicity. Hence, the more the sector advertises, the more responsive the sector is to pressures for pollution abatement.

— Related Research: Hypothesis is suggested by professionals in Chicago's Department of Environmental Control.

— Roos data do not support this hypothesis. A consistent negative relationship was observed.

FOOTNOTES

[1] These figures are presented in Zwick and Benstock (1971).

[2] Detailed information on mills belonging to 24 relatively large companies was provided in this report.

[3] The authors analyzed attendance at these conferences over the 1964-1969 period. Information on 47 conferences was available.

[4] See the discussions of evaluation in Caro (1971).

[5] Cunniff is referring to the work of John Marlin and Joseph H. Bragdon, Jr. (Cuniff, 1971: 45). Our analysis of the discrepancies between the Bragdon-Marlin results and those reported here looked at two differences between the studies: the sample of companies selected and the indicators used. Differences seemed to be due to the choice of indicators. From a construct validity point of view, the indicators used in this study are markedly superior. Our indicators are correlated in the predicted directions with those of Wenner (1972).

[6] These models and their relevance for environmental concerns are discussed more extensively in Roos, ed. (1971: 269-272).

[7] See the discussion of the importance of variables in James, Bower, and Matalas (1969).

[8] Residuals are the material and energy outflows of the production process which "have zero prices in existing markets, or at least prices less than the variable costs of production. Management or the householder's objective is the disposal of these residuals at minimum cost" (Bower, Löf, and Hearon, 1971: 612).

[9] See the discussion of factor analysis in Sharkansky and Hofferbert (1969).

[10] The treatment and BOD data were taken from the Council on Economic Priorities (1970: 18).

[11] These are only estimates. Bower, Löf, and Hearon note that the relationships between BOD, on the one hand, and residuals in the form of dissolved and suspended organic solids are not always clear (Bower, Löf, and Hearon, 1971: 613).

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[12] See the discussion of this in Jacob and Lipsky (1968).

[13] A number of other variables were analyzed in both studies. Thus, we found very low correlations between factory water pollution measures and state variables which have been used in other research to identify "innovative" states. (These state data were kindly provided by Professor Jack Walker of the University of Michigan.) Wenner's paper reports on such variables as the representation of anti-pollution interests in the state, the stringency of the anti-pollution laws, and so forth.

[14] Additional exploration of the factory, firm, and state data was performed by means of factor analysis. This multi-variate technique is used to reduce dimensions, to see if correlations among a large number of variables can be expressed in terms of smaller numbers of underlying factors. This more sophisticated analysis isolated dimensions reinforcing the above discussion. The high correlations for the first three factors were produced by variables associated with each separate level in turn — the factory, the firm, and the state, respectively. None of the measures of business efforts to reduce water pollution was *strongly* associated with these dimensions. A preliminary analysis of state expenditure data from 1969, 1970, and 1971 showed few clear trends. Changes in expenditures in the 1969-1970 period were negatively correlated (−.50) with changes in the 1970-1971 period!

REFERENCES

BAUER, Raymond, Ithiel de Sola POOL, and Lewis DEXTER (1963) American Business and Public Policy. New York: Atherton Press.

BENSON, Donald V. (1968) "Pulp Mill Waste-Water Discharges into Puget Sound: An Industry Viewpoint," in Thomas H. Campbell and Robert O. Sylvester (eds.) Water Resources Management and Public Policy. Seattle: University of Washington Press.

BLALOCK, Hubert M. (1970) "A Causal Approach to Nonrandom Measurement Errors," 64 American Political Science Review 1099-1111.

BOWER, B.T., G.O. LÖF, and W. M. HEARON (1971) "Residuals Management in the Pulp and Paper Industry," 11 Natural Resources Journal 605-623.

BRAGDON, Joseph H., Jr., and John MARLIN (1971) "Is Pollution Profitable? The Case of the Pulp and Paper Industry," Paper presented at the 1971 Financial Management Meetings, Denver, Colo.

CARO, Francis G. (ed.) (1971) Readings in Evaluation Research. New York: Russell Sage Foundation.

THE COUNCIL ON ECONOMIC PRIORITIES (1970) Paper Profits: Pollution in the Pulp and Paper Industry. New York: Council on Economic Priorities.

CRENSON, Matthew A. (1971) The Un-politics of Air Pollution. Baltimore: Johns Hopkins University Press.

CUNNIFF, John (1971) "Ecology May Not Cut Profits, Could Raise Them, Study Shows," August 13, Chicago Daily News 45.

CYERT, Richard M., and James MARCH (1963) A Bahavioral Theory of the Firm. Englewood Cliffs, New York: Prentice-Hall.

DAVIES, James (1970) The Politics of Pollution. New York: Pegasus.

DAVIS, Otto A., M. A. H. DEMPSTER, and Aaron WILDAVSKY (1969) in Charles Cnudde and Deane Neubauer (eds.) Empirical Democratic Theory. Chicago: Markham.

DIAMOND, Robert S. (1970) "What Business Thinks," 81 Fortune 118-119, 171-172.

FROHLICH, Norman, and Joe A. OPPENHEIMER (1970) "I Get By with a Little Help from My Friends," 23 World Politics 104-120.

HOWARD, Kenneth L., and Merton S. KRAUSE (1970) 'Some Comments on Techniques for Estimating the Source and Direction of Influence in Panel Data," 74 Psychology Bulletin 219-224.

JACOB, Herbert, and Michael LIPSKY (1968) "Outputs, Structures, and Power: An Assessment of Changes in the Study of State and Local Politics," 30 Journal of Politics 510-538.

JAMES, I.C., B.T. BOWER, and N.G. MATALAS (1969) "Relative Importance of Variables in Water Resources Planning," 5 Water Resources Research 1165-1173.

https://doi.org/10.2307/3052946 Published online by Cambridge University Press

KNEESE, Allen V. (1970) "Protecting Our Environment and Natural Resources in the 1970's," in the Environmental Decade (Action Proposals for the 1970's): Hearings before a Subcommittee of the Committee on Governmental Operations, House of Representatives, 91 Congress, Second Session. Washington, D.C.: U.S. Government Printing Office.

MARINE, G. (1969) America the Raped. New York: Simon and Schuster.

MILLS, C. Wright (1956) The Power Elite. New York: Oxford University Press.

MOHR, L. (1969) "Determinants of Innovation in Organizations," 63 American Political Science Review 111-126.

OLSON, Mancur (1965) The Logic of Collective Action. Cambridge: Harvard University Press.

ROOS, Leslie L. (ed.) (1971) The Politics of Ecosuicide. New York: Holt, Rinehart and Winston.

ROSNER, Martin M. (1968) "Economic Determinants of Organizational Innovation," 12 Administrative Science Quarterly 615-625.

SHARKANSKY, Ira, and Richard I. HOFFERBERT (1969) "Dimensions of State Politics, Economics, and Public Policy," 63 American Political Science Review 867-879.

WEISS, Leonard W. (1967) Case Studies in American Industry. New York: Wiley and Sons.

WENNER, Lettie M. (1972) "Enforcement of Water Pollution Control Laws," 6 Law and Society Review 481-507.

ZWICK, David R., and Marcy BENSTOCK (eds.) (1971) Water Wasteland. Washington, D.C.: Center for Study of Responsive Law.

https://doi.org/10.2307/3052946 Published online by Cambridge University Press