PROCEEDINGS

BEYOND COMPLIANCE: WHAT MOTIVATES ENVIRONMENTAL BEHAVIOR?

SESSION TWO: OVERCOMPLIANCE WITH ENVIRONMENTAL REGULATIONS

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Session II: Overcompliance with Environmental Regulations

REGULATION AND SUSTAINABLE DEVELOPMENT: THE MANAGEMENT OF ENVIRONMENTALLY CONSCIOUS TECHNOLOGICAL INNOVATION UNDER ALTERNATIVE MARKET CONDITIONS

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Prof. Sharfman's paper was not available for publication. The following is an editor's summary of his presentation.

Mark Sharfman's and his colleagues' research examined the effects of regulation and other factors on environmental innovation through four case studies. In each case, the business went beyond compliance to address both a business and an environmental problem. The researchers developed a series of hypotheses or propositions that predicted when firms would pursue innovation. They then looked at whether the four cases confirmed the propositions.

The researchers' propositions deal with four general themes found in the social science literature. The first theme is cost.

> Proposition 1: Under low levels of regulation, the more the development of any given environmentally friendly technological innovation decreases operating/transaction costs or allows the firm to increase prices, the more likely it is to occur.
>
> Proposition 2A: Under high levels of regulation, firms are less likely to perceive economic incentives for environmentally conscious technological innovation development.
>
> Proposition 2A.1: Under high levels of regulation, the higher the costs of pollution, the more likely the firm is to perceive economic incentives for environmentally conscious technological innovation development.

The second theme is the internal structure and flexibility of the firm. Proposition 2A.2 begins to deal with this theme.

> Proposition 2A.2: Under high levels of regulation, the more flexibility that a firm has to innovate the more likely it is to perceive economic incentives for environmentally conscious technological innovation development.

The third theme is institutional pressures. For example, industrial sociologists have found firms affected by coercive isomorphic pressures — institutional pressures that tend to make firms all look alike. Several of the propositions deal with the broad range of institutional pressures.

> Proposition 3: Under low levels of regulation, the relationship of environmentally conscious technological innovation development to external institutional pressures will be positive.
>
> Proposition 4: Under high levels of regulation, the more that a firm perceives coercive isomorphic pressures for improved environmental management, the more likely it will be to develop environmentally conscious technological innovations.
>
> Proposition 5: The greater the degree of technology lock-in, the less likely that firms will be willing to develop environmentally conscious technological innovations.

> Proposition 6: Under low levels of regulation, the more that political structures reduce the level of available resources to research and development, the less likely that environmentally conscious technological innovations will occur.

The next two propositions again relate to the theme of flexibility.

> Proposition 7: Under low levels of regulation, the more that firms use rigid decision-making rules and tools for evaluating environmentally conscious technological innovations, the less likely these innovations are to occur.

> Proposition 8: Under high levels of regulation, the more flexible the internal response to external isomorphic pressures, the more likely the firm will develop environmentally conscious technological innovations.

The fourth theme is the relationship between the regulated party and the regulator. The last proposition focuses on this theme.

> Proposition 9: The more participative a regulatory process, the higher the likelihood of environmentally conscious technological innovation development.

The researchers classified their four cases as to whether they described process or product innovations and whether they occurred in high or low regulation environments. The case studies are described and analyzed below.

Case 1: Post-Consumer Recycled Material in DuPont TYVEK – Low Regulation Process Innovation

In this case, as a result of market pressures, DuPont introduced 25% post-consumer recycled material into the TYVEK plastic used to make mailing envelopes. The primary end users of TYVEK in the envelope market, Federal Express and the U.S. Postal Service, wanted recycled content in their envelopes. DuPont's manufacturing arm resisted the idea. There were technical problems in using recycled source materials and market problems in finding recycled materials of high enough quality. DuPont had to assist a supplier to develop the high quality recycled source material that TYVEK required. Interestingly, DuPont only uses the recycled material for TYVEK envelopes. The customers using TYVEK in home construction materials and protective clothing do not demand recycled content.

The TYVEK case seems to support the propositions concerning institutional pressures, cost of pollution (in this case, the cost of a product's poor environmental performance), flexibility in decision-making, and internal politics. It seems to argue against the cost of innovation proposition. It also raises a new issue: the role of market pressures.

Case 2: Conoco Biodegradable Lubricants – Low Regulation Product Innovation

In this case, Conoco scientists identified a waste from their then parent corporation (DuPont) that they were able to turn into a biodegradable lubricant. The product resulted from collaboration between scientists in the two companies. The DuPont scientists had large quantities

of an interesting chemical waste from nylon manufacture. The Conoco scientists were looking for new lubricants that offered competitive advantages. Also, they knew that customers in the mining business were eager to find lubricants that did not lead to expensive clean-ups when they leaked or spilled from mining equipment.

Conoco had to put together a major effort to perfect the new lubricant. They had problems with the continuity of their research team. In the end, they did produce a lubricant with performance characteristics similar to petroleum-based lubricants but that biodegrades after use. Whether this product will succeed in finding a large market remains to be seen.

The Conoco lubricant case seems to confirm the propositions about internal politics, rigidity in decision-making, cost of pollution, and cost of innovation. It also raises a new issue: the role of the customers' desire for flexibility in operations. One reason that people innovate is to avoid government regulatory pressures.

Case 3: DuPont Fortress Pesticide – High Regulation Product Innovation

In this case, DuPont acquired rights to an organophosphate pesticide, Fortress. As a matter of policy, EPA wishes to decrease exposure to organophosphates and ordinarily would want to discourage use of pesticides in this class. However, Fortress is effective against corn borers when applied in very low concentrations. Working with partners, DuPont developed a "Smartbox" closed application system, which sharply reduced the amount of the pesticide applied to the soil and essentially eliminated worker exposure to the chemical. In an interactive regulatory process, EPA worked with DuPont to approve the new product.

The Fortress case seems to confirm the propositions about the presence of regulation/technology lock-in, the perception of economic incentives/cost of pollution, coercive institutional pressures, interactive regulatory process, internal flexibility, and internal politics. It also raises a new issue: the effect of a desire to preserve freedom of action. The DuPont team wanted the freedom to bring their innovations to market, and they were willing to pay a price in one area (in terms of meeting EPA demands) to gain freedom in another.

Case 4: Conoco Vapor Recovery – High Regulation Process Innovation

In this case, Conoco introduced vapor recovery technology that took 16 natural gas wells to essentially zero emissions. The innovation prevented hundreds of tons of volatile organic compounds (VOCs) from being emitted and saved the company millions of dollars in compliance costs.

Conoco had concerns about complying with hazardous air pollutant standards under the 1990 Clean Air Act Amendments. An internal audit showed major compliance problems at batteries of natural gas wells. Because of the remote location of some wells, the company needed solutions that used no power. A creative team came up with a new approach. A $560,000 investment yielded $60,000 per year in saved product and over $2 million in savings in compliance costs. The resulting wells are so clean, they do not need Clean Air Act permits.

The Conoco Vapor Recovery case seems to confirm the propositions dealing with regulation, costs of pollution, technology lock-in, and coercive institutional pressures. It seems to argue against the proposition concerning perception of economic incentives. It also raises the issue of preserving freedom of action. Conoco has always been a technological leader; they have always wanted to do things their own way.

Conclusions

The researchers found that the case studies supported most of their propositions. In particular, they drew the following conclusions:

- Innovation under high regulation is quite different from innovation under low regulation.

- Cost is ***the*** factor regardless of the level of regulation — innovations have to make sense economically.

- Behavior under regulation shows threshold effects. At what level does cost become significant enough to drive innovation? At what level does regulation become burdensome enough to make businesses seek innovative ways to meet requirements? These would be fertile areas for future research.

When do firms go beyond compliance? All four cases demonstrated that the move must make economic sense. The two Conoco cases and the DuPont Fortress case suggest that a desire for autonomy and flexibility can also be a driving factor. The DuPont TYVEK case shows that customers — a firm's market — can drive a firm to exceed standards. In other research that Sharfman is pursuing, he is finding that when firms expand to global markets, they face increasing pressure from customers to be green. The Conoco Vapor Recovery and DuPont Fortress cases show that onerous regulatory systems can paradoxically push firms beyond compliance, as the firms seek to get out from under expensive or restrictive regulation. The Conoco Vapor Recovery case demonstrates the value of allowing firms flexibility in the method of compliance, even if the performance targets are rigid. And the DuPont Fortress case shows the value of flexible and helpful staff at the regulatory agency.

OVERCOMPLIANCE WITH THE CLEAN WATER ACT?

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A simple glance at aggregate water pollution data shows what appears to be substantial and widespread overcompliance with a key element of the Clean Water Act. Plants in a variety of industries – sewage treatment, chemical manufacturing, and pulp and paper, among others – have BOD discharges (a common pollutant, measured as a concentration) that are substantially below what the EPA rules allow. The Patuxent Water Reclamation Facility (hereafter PWRF), a sewage treatment facility in southern Maryland, provides an example of this behavior close to home. The PWRF currently releases wastewater with BOD concentrations that are roughly thirty percent of the allowed concentrations – concentrations around 8 mg/l, where the permitted concentrations range from 20 mg/l to 30 mg/l, depending on the season. Such behavior is typical across the U.S. Figure 1 shows actual and permitted BOD concentrations averaged over all plants in our data set. Figures 2 through 8 show the ratios of actual to permitted concentrations for a representative set of plants. All of these figures show remarkable levels of overcompliance with the relevant regulations.

It is more difficult than one might expect to determine whether this behavior truly constitutes overcompliance. An unexpected theme for this EPA workshop has been how to determine whether firms are overcomplying; that is, what is "overcompliance?" This short presentation cannot deal fully with all of the issues and subtle arguments that need to be explored. We cover only a portion of the issues involved.

Regardless of whether plants' behavior constitutes "overcompliance," our plant-level study of discharges provides important evidence about the performance of environmental regulations, the behavior of regulated firms and, perhaps, the possibility of voluntary (nonregulatory) pollution control. We have found relatively few studies that examine plant-level discharges for a large set of plants over a relatively long period of time.

There are several possible reasons for overcompliance, were it to occur. Perhaps the regulations are redundant, either because they are not very stringent or because the plants have taken the initiative themselves to reduce discharges and are "ahead of the curve." Or perhaps the plants are responding to some less obvious (and possibly unintended) aspect of their regulatory environment. Any of these explanations could suggest a different approach to future regulation. Although overcompliance and "voluntary compliance" have been observed in other contexts (such as the 33/50 program), the Clean Water Act case appears to be the most concrete and substantial and occurs on the largest scale. It therefore should be particularly valuable for understanding compliance behavior.

Of course, the fact that analysts must debate whether overcompliance is occurring is itself insightful: What is the nature of the regulation that makes overcompliance with it difficult to establish?

We start first with a brief discussion of possible explanations for overcompliance. In the second part of this short paper, we describe the discharges data. Since the patterns we observe are fairly robust (that is, they occur with many different pollutants and different measures of pollution), it is possible to dissect the general nature of water pollution discharges before tackling the specific evidence that we analyze. In section 3, we discuss the problem of testing for overcompliance when discharges are random. Section 4 presents a preliminary analysis of current BOD discharges. Section 5 has conclusions.

1. Why Overcomply?

In a seminal theoretical paper, Winston Harrington showed that plants might comply with pollution regulations even when fines for violations are relatively small. His model, however, did not allow for overcompliance, merely for "compliance." Indeed, most of the academic literature has focused on violations and the role of fines and sanctions. Because overcompliance has apparently gone undetected, it has not received much analytical attention.

There are several reasons why plants might overcomply. The most basic reason is that the regulatory standards might simply be too loose. This would occur if the EPA had written regulations that allowed more discharges than an unregulated plant would emit.

We do not think this is the case here. For one thing, common sense dictates against it. In its strongest form, this "non-binding standards" explanation implies that abatement costs are zero. This implication is clearly contradicted by pollution cost data, news articles, and the amount of pollution control equipment that plants in the U.S. have installed.

A weaker implication is that *marginal* abatement costs are zero. While the evidence on marginal abatement costs is scarce, it does not seem to suggest anything close to a zero marginal cost. McClelland and Horowitz, for example, measured abatement costs in the pulp and paper industry in 1992 and estimated the marginal cost to be $13,000 per ton of BOD. The overall evidence about abatement costs is meager, however, and would seem to point out a need for further study. But we reject, for now, the non-binding standards explanation.

A second possible reason is that there are discrete control technologies. The non-binding standards argument mentioned above is more complicated when control technologies are discrete. If this were the case, plants might overcomply because they had a choice only between violating their discharge permit or polluting less than the permitted amount.

The discrete-technology argument appears reasonable, but the evidence is weak. The discharges profiles included here (Figures 2 through 8), which are typical, show a gradual, rather than discrete, trend toward greater compliance. Only one shows what might be construed as a structural change in discharges behavior (the Mount Laurel sewage treatment plant). The full set of data shows a few such plants, but not many. More importantly, the Mount Laurel plant appears to be substantially overcomplying even before the apparent structural change.

A third possible reason for overcompliance is that plants are reacting to community or management pressures. Another form of pressure, market pressure, some-times mentioned as a reason for pollution sources acting "green," is not present here, since the great majority of these plants are publicly owned utilities.

A fourth possible explanation is that the self-reported data are falsified and the true discharge behavior is much worse, so that the overcompliance in Figure 1, for example, is an illusion. We can, unfortunately, make little headway with this explanation, since it requires a much different set of data than we have. We can only note that the penalties for falsification appear large enough to strongly discourage it.

A fifth possible explanation is that there is some other pollutant whose regulation is binding and whose control is closely tied to control of BOD concentration. This explanation is closely tied to the discrete-technology explanation: the control of BOD is not "smooth," and therefore the plants are not free to adjust it on the margin. A related explanation is that plants are anticipating future, stricter regulation and have put in control technologies that would be appropriate for those regulations.

In summary, possible reasons for overcompliance are (i) non-binding standards; (ii) discrete control technologies; (iii) non-regulatory pressures, particularly community or management pressure; (iv) data are falsified; (v) other pollution regulations are binding; and (vi) future regulations are binding. These explanations are not disjoint and many of the relevant factors may be intertwined.

2. Data

Our investigation is based on discharges data from the EPA's Permit Compliance System (PCS). These publicly available data contain water pollution discharges and permits from major point sources that discharge directly into a water body; that is, do not discharge to public water treatment facilities. There are roughly 8500 such sources. About half of the records are manufacturing plants and half are sewage treatment plants. A wide variety of pollutants are covered. For each pollutant there may be several limits (on average quantity, maximum quantity, average concentration and maximum concentration, for example, and for various periods over which the averages are recorded.) Although the regulated plants are issued *permits* for these discharges, the permits are not tradeable across plants or bankable within a plant.

Economists call this permit-based regulation a "performance standard." A performance standard does not specify the control technology that a plant must have in place or the procedures it must undertake, only the level of discharges it is allowed. (Permits do require plants to have a general sort of control technology, either secondary or tertiary water treatment.) The flexibility afforded to plants reduces the costs of these regulations. They are the most desirable of the non-market-based regulations.

For any given pollutant and type of limit, there are many holes in the data. Some plants face discharge limits but do not report actual discharges, a problem also mentioned by Laplante-Rilstone and Magat-Viscusi. This appears primarily to occur when there is little threat to the receiving water body. In this case, these observations can probably be neglected without affecting our inferences. In other instances, reports may be missing because the plant was not required to file because of previous good behavior. Because of this, there may actually be greater overcompliance than we measure. We do not deal with this issue. Still, differences in data coverage, whether reports or limits, are a particularly odd and vexing element of how this regulation is administered.

Monthly Average BOD Concentration. We focus on the monthly average BOD concentrations in plants' wastewater. There are four terms in this measure and therefore four decisions involved in selecting the pollutant to analyze. As far as we can tell, however, the compliance pattern is essentially the same regardless of our selection, with one exception (discussed below).

We look at concentration rather than quantity of pollutant because concentrations are measured more precisely. Quantities are calculated indirectly by multiplying the concentration by some measure or estimate of water volumes. More plants report more data on concentration than quantity. There are some problems with using concentration; for example, it cannot properly be aggregated across plants without knowing each plant's water volume.

We believe the EPA's enforcement is directed mostly toward average concentrations.

We look at the monthly average concentration because yearly averages mask a substantial amount of variation. The data cover an eight-year period, so there are potentially 96 observations for each of approximately 2100 plants. Because some plants do not report in some months, most plants have fewer than 96 observations.

Finally, we focus on biochemical oxygen demand, BOD. BOD and TSS (total suspended solids) have been the pollutants that regulators have typically focused on, although public attention has recently been shifting to nitrogen, phosphorus, and heavy metals. The data on discharges other than BOD and TSS is quite scarce. Our preliminary examination shows that there is not the same widespread or substantial overcompliance with other pollutants, but the number of observations is too small to conduct analysis.

The behavior of BOD and TSS, on the other hand, is quite similar. Figure 9 shows TSS data for the Washington DC wastewater treatment plant. It shows the same degree and pattern of overcompliance as the BOD data of the plants in Figures 2-8. Figure 10 shows TSS data for Westvaco, a western Maryland pulp mill that we chose to highlight because it has been in the news for its discharge problems. Although this pattern looks different from the other plants' behavior, it is probably due to management problems at the plant rather than to a difference between factors affecting TSS and BOD compliance.

A few commenters have remarked that because of the technology of wastewater treatment, TSS standards are more likely to be binding than BODs. We have found no evidence for this in the data. Since the number of observations for BOD is higher than for TSS, we used BOD data.

3. Examining Overcompliance When Discharges Are Random

Because plants cannot control discharges exactly, they aim to pollute below their permitted levels, so that when they have a stretch of exceptionally high discharges they will still likely be in compliance with their permits. This factor leads discharges to be below the permitted level on average. It also makes other factors affecting compliance more difficult to tease out. When discharges are random, a probability of violation always is present. The main question for regulatory compliance is, what probability is reasonable? What probability of violation is so small as to constitute overcompliance? Much of our analysis, therefore, focuses on the imputed probability of a violation.

It is important to recognize that discharges are quite variable even at the monthly level. McClelland and Horowitz speculated that most discharge randomness is short-term, say on the order of a couple of days to a week. It would therefore be expected to disappear at the monthly level. However, when we looked at monthly average BOD concentrations over an eight-year

period, we found substantial variability from month to month. Figures 2 through 8 show these concentrations (relative to the permitted levels) for the PWRF and six other representative sewage treatment plants. These Figures show substantial randomness even at the monthly level.

We feel that monthly data are the appropriate ones to examine. For most of our data period, EPA's enforcement efforts were putatively aimed at the long-run average of discharges; that is, at chronic violators. Again, McClelland and Horowitz interpreted this to mean yearly averages or quantities, with some justification. In this paper, we look at the shorter monthly averages. We have not yet attempted to reconcile these two views.

Several commenters believe we should have focused on an even shorter daily or weekly period, and therefore on maximum concentrations, despite the chronic-violator argument. We so far disagree. Although plants face limits on daily and weekly maximum concentrations, the EPA's permit-writers' manual states that those limits are for record-keeping and guidance only and that plants should be designed to meet the monthly average limit. We remain open, however, to learning more about how EPA interprets and enforces the regulation.

Because of randomness, maximum concentrations will be substantially above average concentrations. The EPA sets limits on average concentration at roughly forty percent of the limits on maximum concentration. Therefore, exact compliance with the limit on maximum concentration (were it to be enforced) does not imply overcompliance with the limit on average concentration. The forty-percent rule is designed so that a plant that is in compliance with the average concentration limit will be in compliance the same proportion of the time with the maximum concentration guideline.

Of course, if this ratio is set too low, then a plant that has the "right" maximum concentration would often have lower average concentration than its permit allowed. Since the maximum concentration limits are merely guidance, however, and since discharge randomness is both already accounted for and apparently becoming smaller, this relationship between maximum and average concentration is not the reason for such low levels of average concentration.

Note that if maximum concentrations are a source of concern for both the plant and the EPA (for reasons not covered by the previous arguments), then our analysis remains valid, although our imputed probabilities of violation may be too low.

4. The Evidence So Far

Measuring Compliance

We constructed the ratio of reported concentration in plant i in month t, z_{it}, to the permitted concentration, denoted r_{it}. This ratio is the compliance measure for each plant for each month:

$$c_{it} = \frac{z_{it}}{r_{it}}$$

The condition $c_{it} < 1$ indicates compliance. The condition $c_{it} > 1$ indicates that the plant is out of compliance.[1] To summarize the behavior of an individual plant, we calculate for each plant its mean and median c_{it} over the period 1992-1999. Summary statistics are given in Table 1.

The data show that discharges were substantially below the permitted levels across all states and industries. Discharges are around forty percent of the allowed levels.

Table 1. Summary statistics for ratio of reported discharges to permitted discharges for BOD for selected states and SIC codes for 1992 to 1999.

	# Plants	Ave. Obs.[b]	MEAN	MEDIAN	MIN[c]	MAX	per plant STD[d]
CA	109	69	0.37	0.27	0.00	22.93	0.27
IL	59	85	0.38	0.28	0.01	7.99	0.26
LA	99	77	0.54	0.41	0.01	77.70	0.39
MA	52	85	0.44	0.31	0.01	19.33	0.35
MD	52	87	0.35	0.23	0.02	46.90	0.28
NC	134	89	0.40	0.32	0.00	24.14	0.27
NY	184	86	0.44	0.37	0.00	20.33	0.23
PA	29	61	0.32	0.22	0.02	15.17	0.32
TX	196	68	0.36	0.25	0.02	35.94	0.20
SIC-2	220	70	0.36	0.25	0.00	33.07	0.31
SIC-3	77	77	0.38	0.25	0.00	14.01	0.33
SIC-4	2233	78	0.41	0.32	0.00	77.70	0.24
SIC-28	96	70	0.31	0.22	0.00	15.14	0.28
SIC-29	29	66	0.31	0.20	0.00	9.64	0.32
SIC-49	2231	78	0.41	0.32	0.00	77.70	0.24
All	2530	77	0.40	0.31	0.00	77.70	0.25

SIC-28 is chemicals and allied products. SIC-29 is petroleum and coal products. SIC-49 is wastewater treatment plants.
[b]Average observations per plant. Maximum possible = 96.
[c]Zeros are due to rounding off. These discharges are quite small, on the order of 0.00006.
[d]Standard deviation over time, on a per plant basis, then averaged over plants.

The Randomness Argument

There is a simple test for the role of discharge randomness. Plants that have more variable discharges should have lower discharges on average. We find substantial evidence that this hypothesis is true. The test of this hypothesis involves some subtle distinctions, which we discuss below.

[1]There is not a one-to-one correspondence between $c_{it} > 1$ and a record of violation.

We constructed for each plant a measure of discharge variability. Because of seasonal variation in permitted discharges, we looked at the standard deviation of the log of compliance (over time), c_{it}, rather than of discharges. (We used logs because discharges are presumed, by EPA, to be distributed log-normally.) Denote the standard deviation as $\sigma_{\ln c}$. There is one $\sigma_{\ln c}$ for each plant.

Discharges reports are filed at irregular intervals. In order to use information from as many plants as possible, we include all plants that have at least fifteen data points. Analysis based on more restrictive samples (*e.g.*, at least fifty months of data) showed identical results.

If plants undergo substantial investments or other changes during the sample period that change their average discharges, their $\sigma_{\ln c}$ may appear quite large. But such variation in discharges is not the kind of randomness that our hypothesis refers to. Including this change in discharge behavior in our measure of variability would complicate our tests.

To avoid this problem, we focus on two sets of plants: (i) plants for which there are no discrete changes in discharge behavior, as captured by the CUSUM test, a statistical test designed to identify structural changes in the data; and (ii) plants that are within a single permit cycle. Permits must be renewed whenever a plant undertakes a major change, so examining plants within a single permit cycle guarantees that they have not undergone a major change. Space prevents us from presenting all of the results for these subsamples. A separate-but-related issue is to explain why a particular plant has undergone a substantial, discrete change in its discharge behavior.

For each of these sets of plants, we calculated the appropriate $\sigma_{\ln c}$; that is, a measure of discharge variability during the period in which there were no discrete changes in discharge behavior. Our aim in each case is to make sure that this statistic measures "true" discharge variability.

To test the randomness explanation, we looked at whether "planned" compliance was higher – that is, whether c_{it} was lower – for plants with higher discharge variability (higher $\sigma_{\ln c}$). Plants with higher discharge variability should overcomply more in order to compensate for the higher probability of bad day.

We use the median compliance as a measure of the plant's planned level of compliance. Note that we do not observe either planned discharges nor discharge variability exactly; we must construct them based on our data series. Errors in measuring these variables will be especially problematic if they are correlated. Median discharge provides a better measure of planned discharges based on these considerations.[2] Denote median discharge by m_i.

[2]Suppose a plant had a very large discharge episode. When there are just a small number of discharge observations, this episode would lead the plant to have both a large observed mean and standard deviation. Focusing on the median discharge allows us to avoid this problem.

Table 2 shows the log of median discharge regressed against $\sigma_{\ln c}$ and a measure of plant water volume.[3] Only wastewater treatment plants are included. We ran separate regressions for each of the three most prevalent permitted concentrations (20 mg/l, 30 mg/l, and 45 mg/l.) In other words, we take all of the plants that have a permitted concentration of 20 milligrams per liter (plus or minus some seasonal variation) and then look at the relationship between the plant's median concentration and its $\sigma_{\ln c}$, controlling for plant water volume. We repeat this regression for plants with permitted concentrations of 30 mg/l and 45 mg/l.

The data clearly show an inverse relationship between discharge variability and median discharges.

Table 2. Discharge variability and median discharges

Dependent variable: ln(median z_{it})

	r = 20 mg/l	r = 30 mg/l	r = 45 mg/l
Constant	-1.41	-0.81	-1.01
	(12.12)	(13.20)	(9.29)
$\sigma_{\ln z}$	0.09	-0.95**	-0.50**
	(0.44)	(8.48)	(2.64)
Volume	0.03	0.05**	0.03
	(0.69)	(3.28)	(1.03)
R^2	0.002	0.09	0.03
N	239	952	268

(It is not clear why the relationship between m_i and $\sigma_{\ln c}$ varies in this manner across r_i, with small r's having no discernible m-σ relationship or large r's having a lower, although still large and significant, one.)

5. Conclusions

The remaining question is whether this is the end of the story. That is, are average emissions low *only* because plants are compensating for randomness in their discharges?

We show elsewhere that demographic characteristics of the community in which the sewage treatment plant is located have significant effects on average emissions even when we take into account the discharge variability. As one might expect, richer communities tend to have lower discharges relative to the permitted levels, and this is not due simply to their having better abatement technology. We regret that lack of time and space prevents us from describing the demographic results.

[3]Table 2's results are for $\sigma_{\ln z}$, not $\sigma_{\ln c}$.

In discussing our "overcompliance" findings with regulators, other interested parties, and at the NCER conference, the core of this argument is often misunderstood. That plants compensate for randomness is a predictable and sensible response to the regulation, and regulators should (and do) recognize its role. (However, it has not previously been shown econometrically to our knowledge.)[4] That other *non-regulatory factors* – mainly the economic and social status of the communities – lead plants to reduce emissions beyond this compensation-for-randomness is unexpected, not well understood, and certainly important in understanding how this regulation performs. This is the phenomenon that is important for our conference.

[4]Whether it constitutes overcompliance is a more difficult issue.

Figure 1

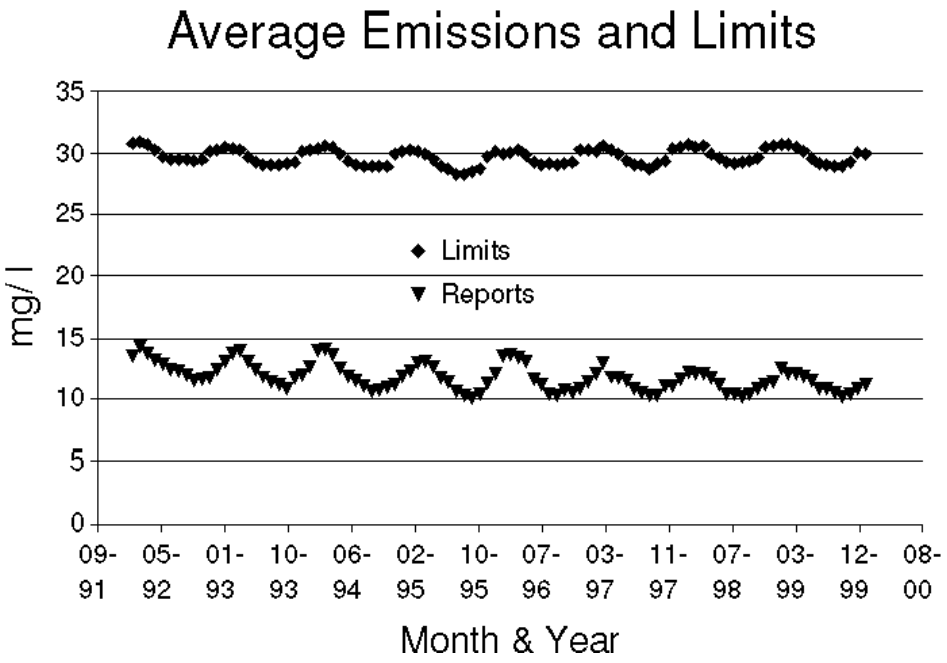
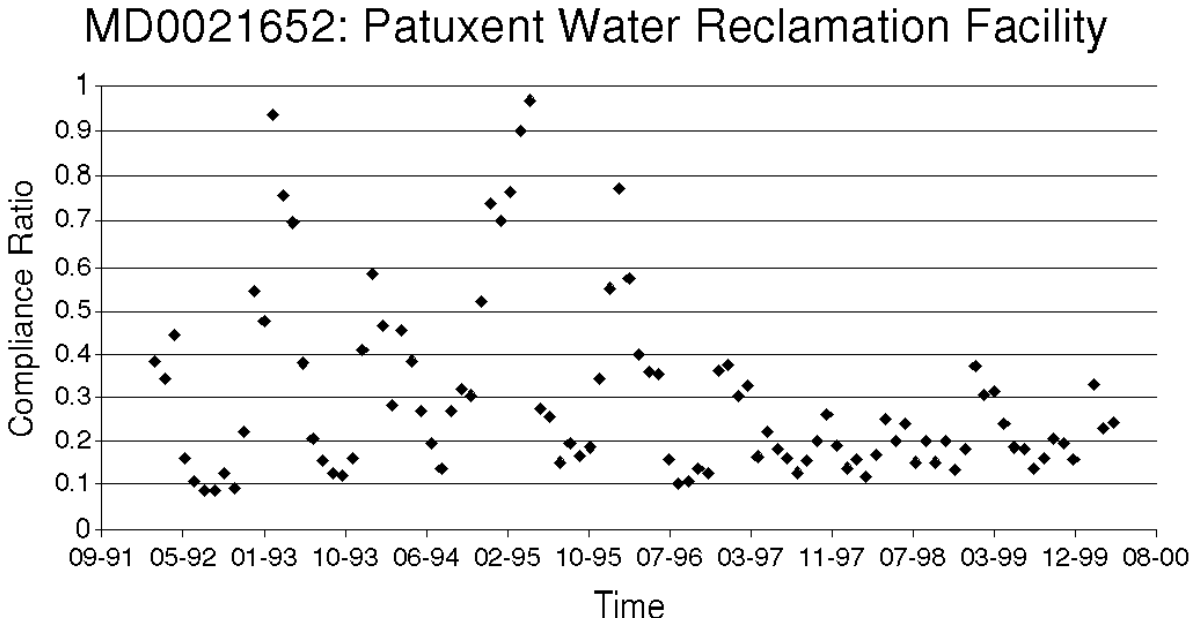


Figure 2



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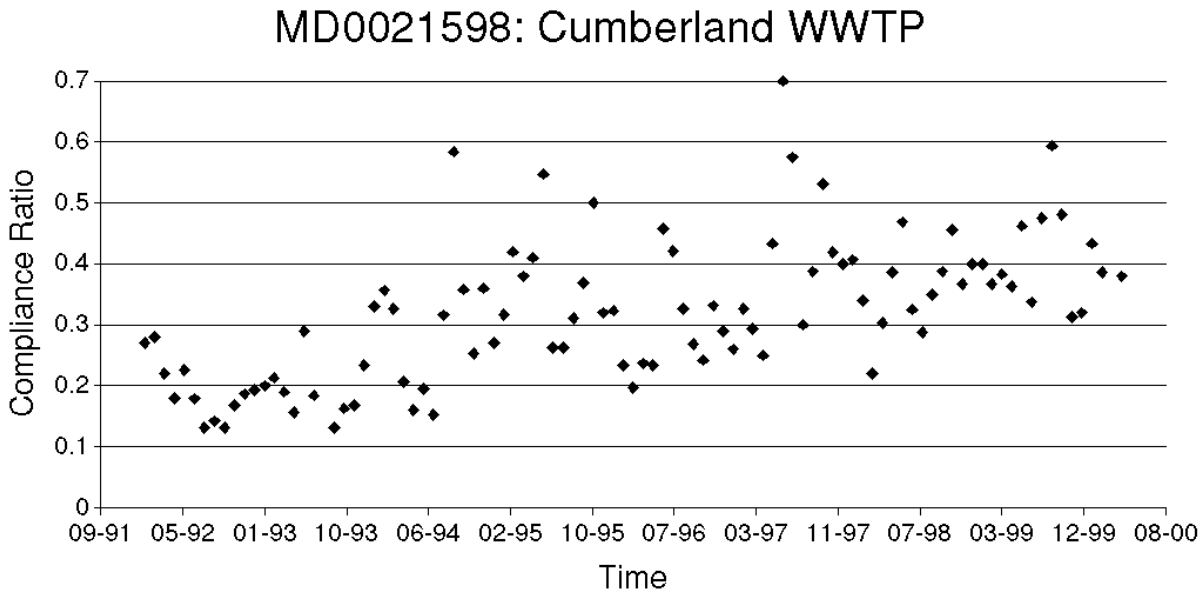

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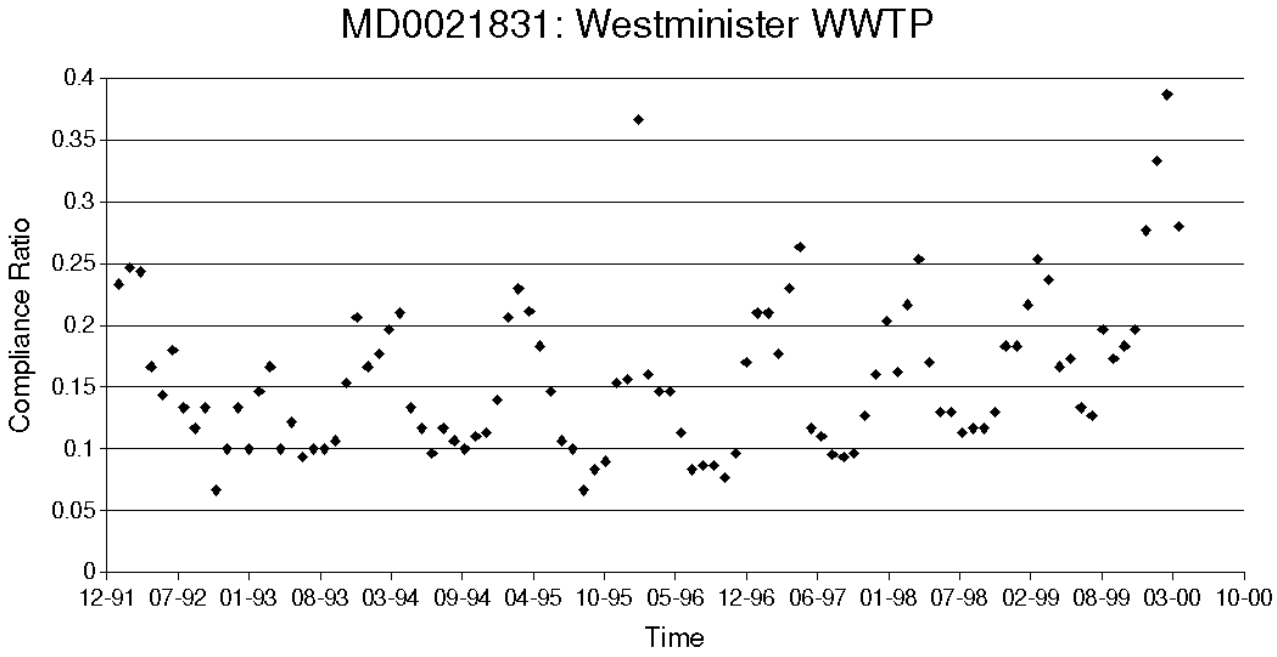

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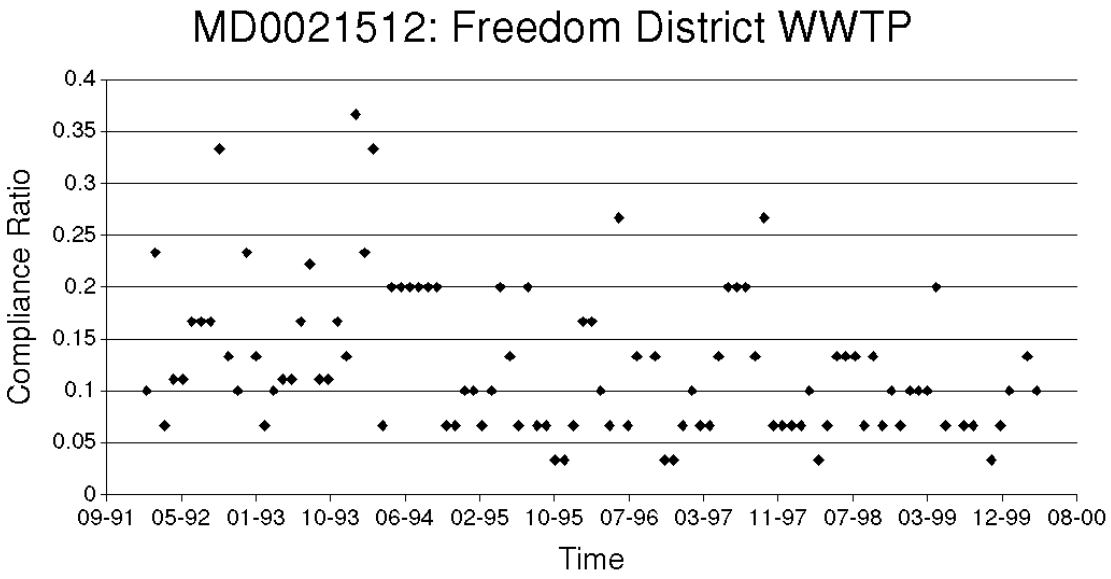

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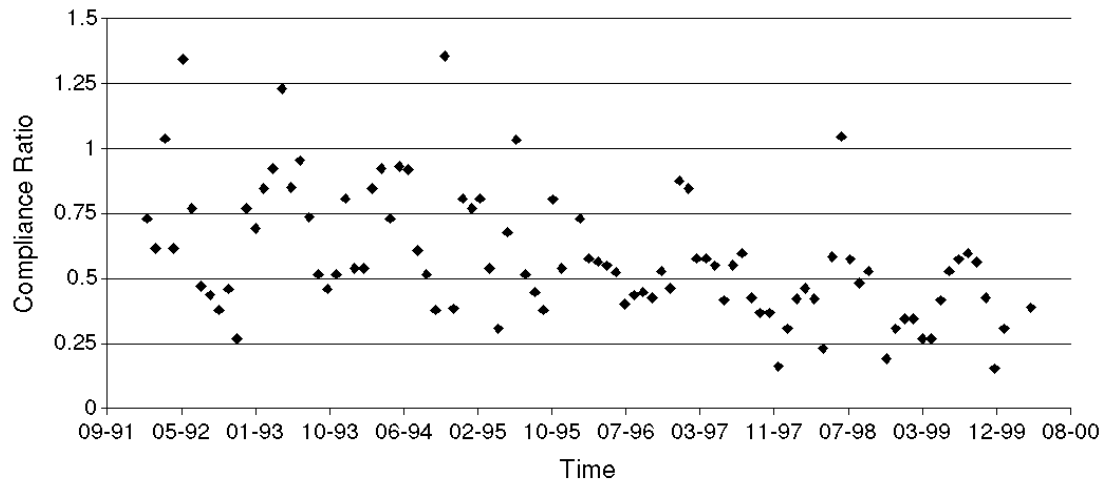

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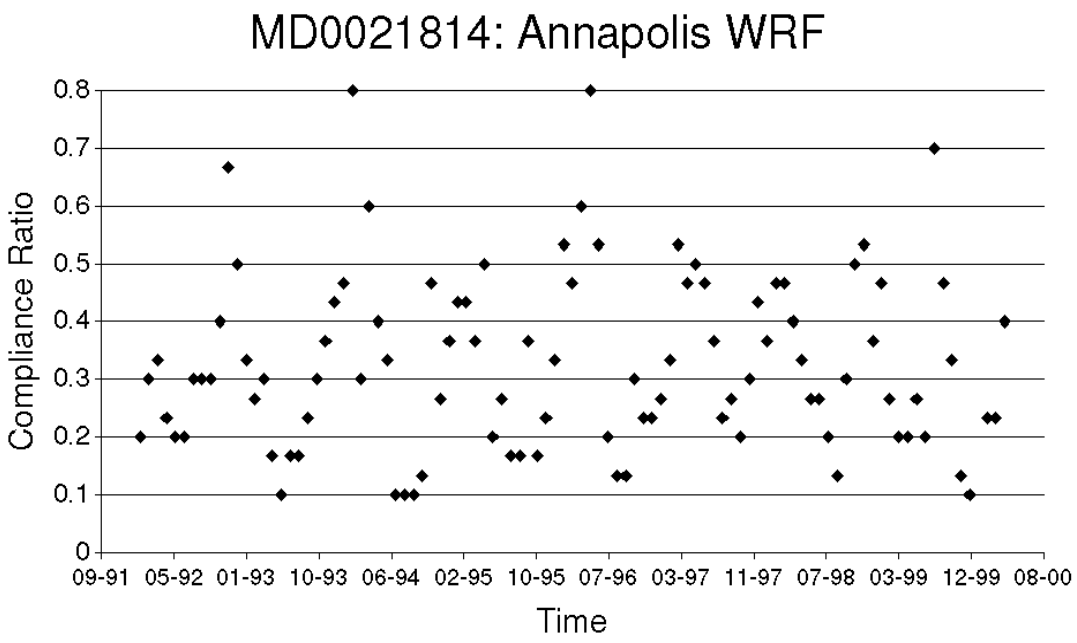

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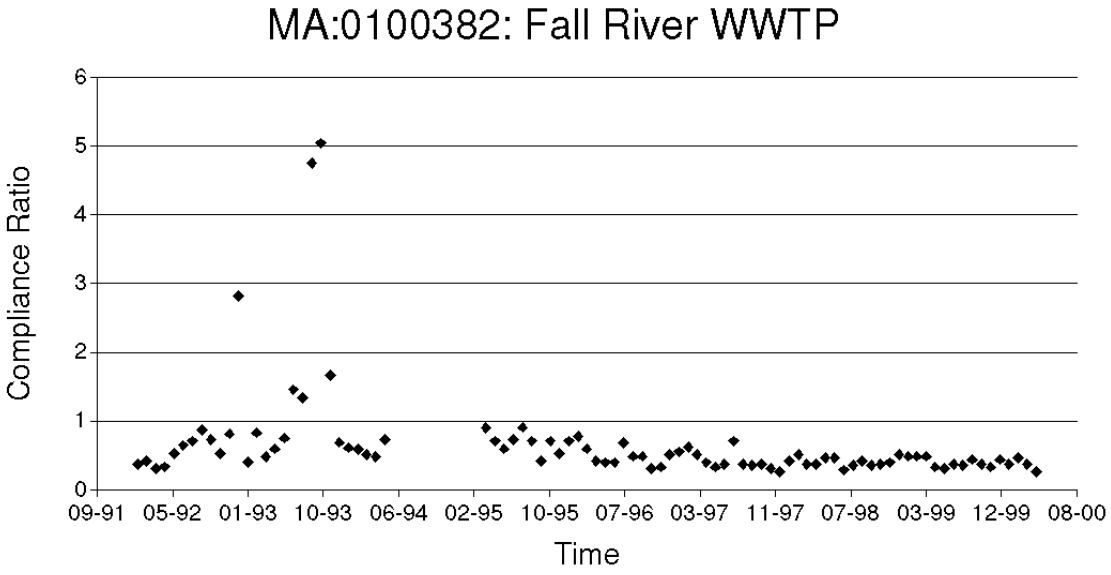

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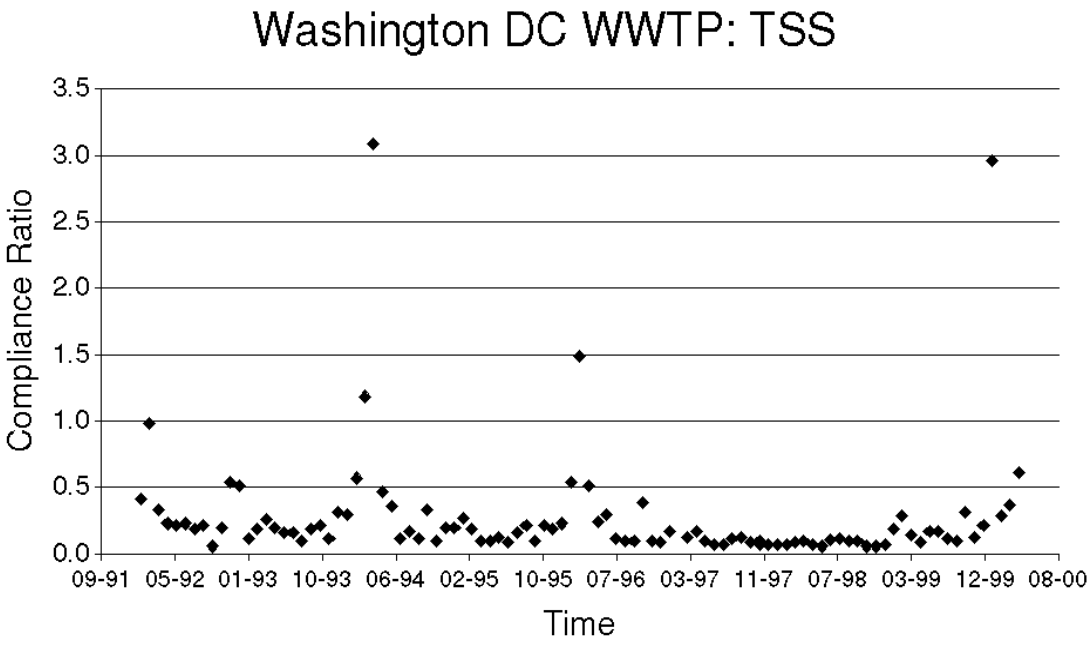

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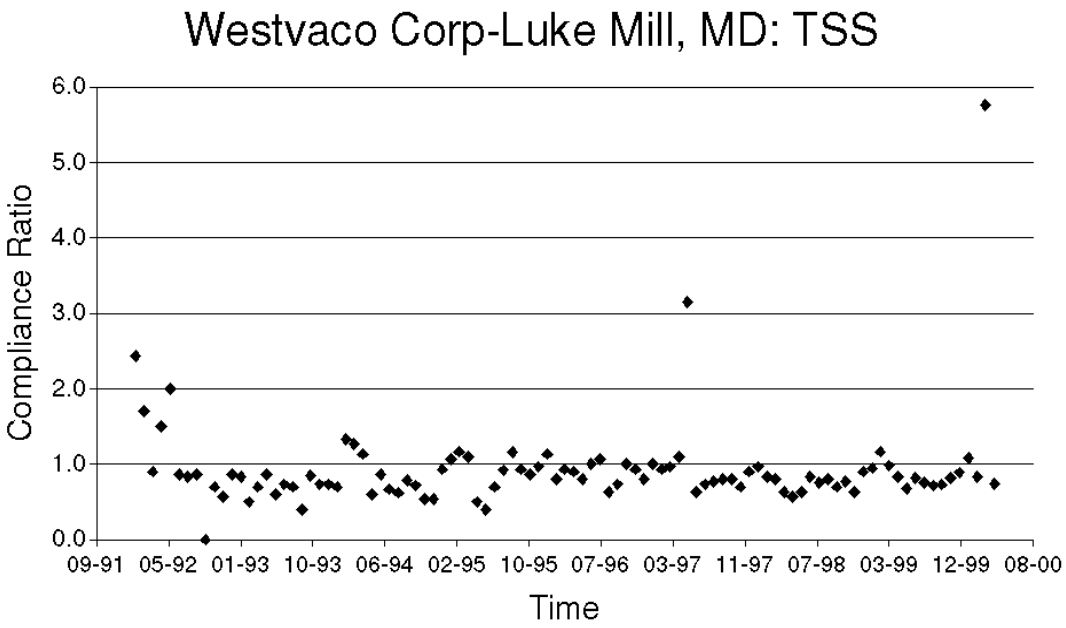

REGULATORY COMPLIANCE AND AIR QUALITY PERMITTING: WHY DO FIRMS "OVERCOMPLY?"[1,2]

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[2] The authors wish to acknowledge the valuable input of four anonymous referees.

Abstract

Industry overcompliance with pollution standards has puzzled economists, leading to a variety of hypotheses about the objectives companies expect to achieve in doing so. This paper examines the possibility of overcompliance with a different type of environmental regulation: the paperwork requirements for completing a federal Title V air operating permit application. We suggest that a unique set of political circumstances set the stage for companies to overcomply with their Title V permit application requirements, including tremendous regulatory uncertainty, stiff penalties for intentional corporate noncompliance, and consultants allegedly eager to capitalize on both circumstances to sell their services. This regulatory context led us to hypothesize that corporate Title V overcompliance was driven by four factors: (1) a complying organization's internal control processes and "red tape", (2) its permitting experience, (3) the quality and quantity of contact with state regulators, and (4) whether the company subcontracted its compliance-related activities. To test the influence of these factors, we analyzed survey data from 500-plus companies in four states. The results indicate that, while internal red tape and permit inexperience were insignificant cost influences, increased contact with regulators and the use of consultants both corresponded with higher Title V costs and, by extension, the probability of overcompliance. In contrast to expectations, the presence of regulated facilities in other states was associated with significantly higher Title V costs, perhaps due to inflationary effects of cross-state permit coordination. While caution is warranted in interpretation, the results spark the possibility that communicating extensively with regulators and subcontracting compliance tasks — particularly under conditions of regulatory uncertainty and high perceived noncompliance risks — may lead companies to overly expansive compliance with permit processes.

Introduction

In the environmental economics literature, "overcompliance" is typically measured by the cost differential between pollution control strategies minimally required by law and those implemented by industrial firms (McClelland and Horowitz, 1999). Economists have been surprised by the tendency of some companies to spend more money and to commit more resources than required to comply with environmental regulations. This phenomenon has stimulated a range of hypotheses on the objectives of overcompliance — enhancing public image, increasing competitive advantage, and preparing for future regulatory requirements.

The very notion of "*over*compliance*"* may well strike some as bizarre. One might ask "just how is it possible to *overcomply* with environmental regulations?" Since reducing pollution is in the public interest, a company choosing to exceed environmental requirements is perhaps best viewed as a good corporate citizen as opposed to an overcomplying and, at least by implication, inefficient firm. While this point certainly has some merit, the issue is generally more complicated. In some instances (including the policy examined here), exceeding environmental regulatory requirements does not necessarily have a direct effect on pollution abatement. Furthermore, if companies overcomply there is always the possibility that the excess resources could have been put to better use, either by the company itself or for some alternative pollution abatement activity (e.g. purchasing pollution control equipment). Moreover, we cannot in this paper take a clear stand on the public interest implications, positive or negative, of overcompliance. But information about the degree and causes of overcompliance may prove useful to both regulators and the regulated community.

To test hypotheses about overcompliance, we examine corporate compliance with Title V of the 1990 Clean Air Act Amendments. The legislation requires firms to document their emission sources, pollution control equipment and applicable regulations in a single operating permit. The legislation has "teeth," including most particularly a penalty for providing false or misleading information, with the highest corporate official in offending companies criminally liable. With gallows humor, this has come to be known as the "designated felon" provision. Complicating industrial compliance with Title V requirements is the timing of regulatory implementation in the mid-1990s, when the nation was debating the value of regulation and the funding of the U.S. Environmental Protection Agency (EPA), the implementing federal agency was jeopardized. This turbulence led EPA to backslide on Title V compliance requirements as a matter of political survival, which in turn fostered uncertainty at the state regulatory level as to the exact nature of the Title V requirements. In this context, we employ questionnaire-based data from more than 500 Title-V regulated firms in four states. We expect four factors will influence overcompliance: (1) a complying organization's internal control processes and "red tape", (2) its degree of general permit experience, (3) its level of interpersonal contact with state and federal regulators, and (4) whether the company subcontracted its compliance-related activities. Specifically, we expect companies with a higher level of internal control and red tape to more risk averse and, consequently, more likely to overcomply with the Title V permitting regulations. We hypothesize that companies with a higher level of permitting experience will be less likely to overcomply due to their familiarity with regulatory compliance and lesser initial costs of information. By contrast, we anticipate that companies with higher levels of interpersonal contact with state regulators will tend to overcomply because they are negotiating more, possibly ambiguous information. Finally, we expect companies subcontracting their

compliance requirements to overcomply because contractors have incentives (e.g. billable hours) to do more than legally required on their client's behalf.

Before explicating further and testing our hypotheses, it seems useful to provide some additional information about the history of Title V permitting. We also provide information about the research project from which this study emerged.

Pathway to a National Permit System

Title V of the 1990 Clean Air Act Amendments significantly changed the way states conducted a key aspect of enforcing air pollution control regulations: the issue of industrial operating permits. Such permits are traditionally designed to enable a state to enforce industrial air quality regulations by detailing the terms of company compliance. However, prior to 1990 states varied drastically in program design, permit content, and enforcement levels. Many lacked operating permit programs completely, requiring paperwork only for construction or modification of pollution-emitting processes. Others, such as Wisconsin, attempted to devise operating permit programs that ultimately went underfunded and unenforced. States with operating permit programs, such as Louisiana and Oregon, often featured designs that differed significantly from that to be ultimately required by Title V. Only a handful of states (such as California) had operating permit programs similar to the scope of Title V.

Without a central document specifying firm-level compliance requirements, it was difficult for companies to determine the air quality regulations to which they were subject.[3] The only source of this information — the state implementation plans (SIP) that map out how a state will achieve federal air quality standards — was typically inaccessible and complex, burying applicable requirements in hundreds of pages of regulatory detail that states rarely distributed. The difficulties in determining a company's applicable requirements from the SIP contributed to the proliferation of compliance agreements negotiated by sources, the state, and EPA, which sometimes served to revise state plans (Landy, et al, 1994, p. 205). This pattern was particularly common before 1977, when the nation faced economic recession and regulatory compliance was the last issue on the minds of state governments.

Thus, confusion and ambiguity over standards, negotiated compliance agreements between industry and regulators, and lack of political will by the states for pursuing aggressive enforcement led Congress — with the strong support of EPA and the Bush Administration— to include in the 1990 CAAA the highly detailed Title V legislation for state operating permit programs. While much of the Title V language outlines minimal requirements for establishing and enforcing operating permit programs, the legislation also addresses permitted companies directly through requirements for permit application content, monitoring and record keeping. The regulatory "hammer" for corporate Title V compliance comes from Title I of the 1990 Clean Air Act Amendments: the "designated felon" clause. This section of the statute addressing enforceability of the entire Act empowers the federal government to hold the highest corporate

[3] According to a lawyer with EPA's Office of General Counsel, "You might think it reasonable to assume that sources know their compliance requirements, but they just don't. Many sources have never had a reason to take a comprehensive look at their emissions. Those that did take that look were frustrated by having to go through dozens of notebooks (the SIP)." (Personal interview, anonymous official, April 1996).

official criminally liable for misleading or false information provided in the permit application (42 U.S.C. 7412). The clause seeks to capture the attention of corporate executives in a regulatory arena where compliance is perceived ancillary to operations (Heyes, 1998).

The Rocky Road from Legislation to Regulation

Title V was a blunt instrument designed to mold recalcitrant states and crafty companies into regulatory compliance. Given the breadth of its reach — from economic sanctions against states to the criminal liability of chief operating officers— it should come as no surprise that many were fearful of its ramifications. In the pre-legislative discourse, state and local regulators voiced opposition to EPA review and veto (Bryner, 1995, p. 180), a fear that went unheeded. Their opposition intensified after EPA issued the final Part 70 regulations that specified even further the program requirements to which states were subject.[4] As of 1995, the states, industry, and environmental groups had sued EPA over nearly 60 parts of the final rules (Novello 1995, p 1).

EPA responded to this turbulence in two ways. First, the agency reproposed the most controversial aspects of the final rules, dealing with operational flexibility[5] at facilities. Second, the agency released two "white papers," non-binding and non-regulatory guidance documents that increase the flexibility with which states implement their operating permit program requirements (USEPA 1995a and USEPA 1995b). These responses were also driven in large part by the political drama playing out in Congress during the height of Title V implementation, when Republicans won a majority of seats in the Senate and House and a majority of the nation's governorships in the November 1994 elections. With the first Republican-dominated Congress in 40 years and the first Republican majority of governorships since 1972, the new Republican majority focused on a range of legislative initiatives to reduce general regulatory burden and federal discretion.

More poignantly, Title V became the target of reform in two draft bills that sought to limit EPA's power over states in permit program design and to give companies production flexibility in permitting. Senator Lauch Faircloth (R-NC), chair of the Senate Environment and Public Works Committee subcommittee on clean air, drafted "The Clean Air Simplification and Efficiency Act of 1995." The draft bill would have required state Title V programs to be acceptable prima facie to EPA, thus eliminating the need for a possible EPA takeover in the event that an acceptable program was not designed. The bill would also have limited EPA's ability to require review and approval before businesses made changes to processes or products and limited sanctions to recalcitrant states, not just those working in good faith with EPA. A broader range of technical changes were also unsuccessfully proposed by Rep. Joe Barton (R-TX), in a draft bill that called for simultaneous operating permit revisions and process changes

[4] While it is technically correct to refer to these new operating permits by their regulatory origins, Part 70, it is the vernacular of the regulatory and regulated communities to refer to them as Title V permits, as will be done throughout the remainder of this paper.

[5] Operational flexibility describes the degree to which companies can make operational changes at a facility without noting those changes in a revision to their air emissions permit. The greater the permit's operational flexibility, the more changes can be made without a permit revision.

and shorter delays for sources increasing production or revising manufacturing processes. Had these bills been passed into law, they would have required alterations in some Title V programs that had already been authorized by state legislatures, submitted to EPA for review and approval, and partly implemented by state air quality agencies.

Hypothetical Determinants of Title V Overcompliance

The stormy political climate of Title V implementation provides a unique setting for studying regulatory overcompliance. Building on the history just outlined, this section discusses the anecdotal evidence and theoretical foundations that support four hypothetical overcompliance determinants: (1) a complying organization's internal control processes or "red tape", (2) its degree of experience with permit application processes, (3) the quantity and quality of contacts with state regulators, and (4) whether the company subcontracted its compliance-related activities. The anecdotal evidence derives from interviews conducted as background research for this project, while the supporting theories are pulled from a range of scholarship governing organization behavior. But first, we begin with a discussion of regulatory overcompliance.

Title V and Overcompliance

The environmental policy literature has historically assumed that companies will minimally comply with environmental regulations (Blinder, 1987). Recent research has contradicted this assumption with the finding that many companies overcomply with pollution standards. While this overcompliance may be in conjunction with intra-industry agreements (Lyon and Maxwell, 1999) or voluntary programs devised by regulators (Welch, et al, 2000), companies have also been found to overcomply without such overt external influences (McClelland and Horowitz, 1999). The response has been to hypothesize the benefits of overcompliance, including pre-empting or weakening future regulations (Arora and Carson, 1995; Maxwell, et al, 1998); avoiding the risk of closer surveillance (Harrington, 1988); triggering tougher standards to disadvantage the competition (Barrett, 1991 and Salop and Scheffman, 1983); enhancing corporate image in public reporting requirements (Arora and Gagopadhyay, 1995), and increasing production efficiency (DeSimone and Popoff, 1997; Schmidheiny, 1992). McClelland and Horowitz (1999), in an attempt to explain why pulp and paper firms studied emitted below 50 percent of allowable levels, offer the additional possibility that plants compensate for uncertainties in production technologies and emissions. These hypotheses share the broader concept that overcompliance is a strategy for minimizing uncertainty: of regulatory interference, lower competitiveness, poor public image or current and future noncompliance.

In the context of Title V, companies may overcomply with permit application requirements to minimize the probability that the highest corporate executive will be held criminally liable for misleading permit misinformation, via the CAAA's "designated felon" clause. Since the mid-1980s, environmental regulators have sought to raise the perceived risks of noncompliance — and thus motivate compliance — by criminalizing environmental violations (Heyes 1998). Under this trend, dozens of corporate executives are tried each year and imprisoned for environmental damages (Heyes 1998: 9). While the number of convictions remains small, the intent is to generate a disproportionate sense of importance that high-level employees can face prison for the failings of the firm. (Heyes 1998: 9). Thus, the CAAA's

designated felon clause seeks general deterrence that captures the attention of all violators (Reiss, 1984 and Scholz and Wei, 1986). This strategy may lead many polluters to overestimate the probability of wrongful conviction and consequently invest a higher level of effort in compliance (Heyes 1998).

Overcompliance with Title V permit application requirements is expected to comprise excessive information generation and documentation meant to communicate conscientiousness, transparency, and trustworthiness to regulators. Herein lies one major difference between overperforming an environmental standard versus overcomplying with environmental paperwork: the likelihood of the resulting environmental benefit. Under most (but not all) scenarios, emission reductions are anticipated from environmental overperformance. For example, some scholars theorize that firms will emit at levels below regulatory standards but above what is technically possible, in the hopes of influencing regulators to pre-empt regulations (Maxwell, et al, 1998) or set lower future or pending standards than their potential performance (Lutz, et al, 1998). In contrast, overdocumenting environmental paperwork (such as the Title V permit application) does not automatically lead to emission reductions. This is not to dispute the possibility that excessive information can enhance source awareness of emissions or identify pollution prevention opportunities. However, the likelihood of environmental information leading to voluntary emission reductions in the absence of a pre-existing corporate motivation to do so appears small.

Anecdotal Evidence of Title V Cost Determinants

The political turbulence surrounding Title V implementation contributed to a shifting regulatory landscape that contributed to unintentional overcompliance (Bozeman and DeHart-Davis, 1999). By the time EPA had released white papers softening its stance on documenting insignificant emission sources and requiring permit revisions for minor operational changes, many companies had already undertaken related work that would have been exempt under the new policies. For example, one permit engineer at a large Georgia chemical manufacturer reported spending half her time for several months documenting insignificant emission sources, time which could have been devoted to other tasks had the white papers been released earlier.[6]

In addition to federal backsliding on provisions of the original regulation, there is anecdotal evidence that confusion among state regulators over Title V requirements also contributed to overcompliance behaviors by leading complying companies to overdocument emissions information. At least one EPA official acknowledges this possibility, noting that "There has been great speculation among state regulators on the level of detail required, even though it should be clear that there is not a need to document every gram on every stack." The operations manager of a small label manufacturer noted that, "We attended several state-sponsored Title V workshops, and with each session, the information changed."[7] Perceptions of an unstable regulatory information environment may also have been exacerbated by high turnover rates among permit engineers, many of whom were hired specifically for Title V

[6] Personal interview with operations engineer of a Southeastern chemical firm, January 1996.

[7] Personal interview, May 1996.

implementation only to be lured away by higher salaries in the private sector[8]. As one chemical company engineer conveyed,

One of the difficulties in completing the application is that the compliance officer keeps changing. Replacements tend to be young with little experience in the field. It's kind of sad when big brother comes to check on you and their not capable of doing so.[9]

Perhaps the frustrations of obtaining compliance information led many companies – 75 percent in the survey conducted for this research — to hire consultants to assist in the permit application process. The role of consultants in Title V permitting has been widely criticized by state and federal regulators, with the accusation that such firms use the designated felon effect to scare companies into overcompliance. A central Title V figure at EPA headquarters notes that:

"There often is a big difference between what Title V costs and what it should cost. A lot of times I run into costs that companies have and I wish I could have talked to them first. They retain consultants and pay way too much money, if they talk to the right person on the state they can often do much better and can cost a phone call or price of paperwork."[10]

In fairness to consulting engineers that provide a reasonable scope of work on their client's behalf, it is not certain that government officials such as this one are particularly well-informed regarding appropriate scopes of work for Title V tasks. Furthermore, a philosophical objection to profiting from regulatory compliance may make some officials excessively pessimistic about the role of consultants. After all, if rampant overcompliance by consultants is truly the norm, it begs the question of why companies hire consultants at all for Title V work. Part of the answer may be the lack of in-house expertise to complete the permit application. This explanation jibes with the testimony of an environmental vice president for a major Atlanta printing manufacturer, whose company only uses consultants when in-house staff lack the experience to perform a particular job.[11] Alternatively, competing organizational priorities may present an alternative explanation, one in which a company could have relevant expertise and still subcontract the job.

The informal evidence also suggests that companies using in-house resources to complete the Title V application are quite capable of overcomplying by themselves, with particular assistance from the designated felon clause. According to a seasoned engineering consultant, "Companies can create costs for themselves by overcomplying with the rules, out of fear of noncompliance." The experience of one Atlanta converting manufacturer supports this

[8] The Air Protection Bureau of the South Carolina Department of Health and Environmental Quality experienced particular problems retaining permit engineers, who were being lured by the larger salaries of consulting firms anticipating years of Title V work. Personal interview with assistant bureau chief, November 1996.

[9] Personal interview, January 1996.

[10] Personal interview with staff attorney in Environmental Protection Agency's Office of General Counsel, March 1996.

[11] Personal interview, January 1995.

assertion[12]. The firm's general manager, who was responsible for compiling the permit application, was driven by the fear that an innocent mistake in the permit application would send his company's president straight to jail. This fear was built, in part, by his predecessor's warning that Title V would be a paperwork nightmare with dire consequences for noncompliance. Consequently, the manager estimated spending half of his time the year before the permit application was due on air-related monitoring and documentation activities.

Theoretical Foundations of Title V Cost Determinants

The background interviews for this project suggest that regulatory uncertainty and perceived noncompliance risks were background factors in a company's decision to invest effort in the Title V permit application. The informal evidence is consistent with the notion that compliance is a calculated outcome (Stigler, 1970) measurable on a continuous scale, with companies choosing higher or lower levels (Heyes 1998). This section formalizes the research hypotheses, using a range of theories to explicate permit application cost determinants.

Noncompliance Risks and Title V Permit Application Cost Determinants. Assuming that the CAAA's "designated felon" clause did indeed foster perceptions of high noncompliance risks, what factors increase the probability that companies will respond with overcompliance? One possibility is that overcompliance will be a function of an organization's internal process control systems and red tape. The organizational literature imparts the notion that companies use internal process control systems, defined as "carefully prescribed decision-making processes" (Ouchi, 1977), to reduce risk. For years, red tape and other forms of bureaucratic pathology have been explained in terms of ineffective means of uncertainty reduction (e.g. Thompson, 1961; Caiden, 1991; Bozeman, 2000). Further, diverse relationships between red tape and organization strategy have been documented in a variety of policy domains (Lan and Rainey, 1992; Pandey and Bretschneider, 1997) including environmental policy domains (Bozeman and DeHart-Davis, 1999). Applying this notion to Title V, we expect that companies with greater internal control and more red tape will overcomply.

Proposition 1. Companies with higher levels of internal control and red tape will be more likely to overcomply with their permit application requirements and thus have higher Title V costs.

This proposition views internal control systems as institutional responses to risk (Douglas, 1985, Douglas and Wildavsky, 1982) which use traditional procedures and routines to control uncertainty and ambiguity (Bozeman, Reed and Scott, 1992) and limit employee discretion (Wintrobe, 1982). Organizations emphasizing adherence to process have been thought as having risk-averse cultures (Deal and Kennedy, 1982; Bozeman and Kingsley, 1998) that provides important guidelines for decisionmakers in uncertain situations (Douglas & Wildavsky, 1982, Hofstede, 1980.) Consequently, companies with higher levels of red tape are assumed to be inherently more risk averse than those with lower levels of red tape, and thus will respond to the Title V permit application process with a higher level of financial effort to minimize noncompliance.

The organizational literature also names "problem domain familiarity" as a key determinant in risk minimization strategy (Sitkin and Pablo, 1992). Organizations tend to

[12] Personal interview with operations manager of small Southeastern printing firm, May 1996.

interpret new tasks using familiar problem categories (Cohen, March & Olsen, 1972, Dearborn & Simon, 1958) or to apply pre-existing approaches to current problems (Langer, 1978, March & Simon, 1958). Generalizing from past experience to present tasks can lead to positive outcomes, particularly when prior tasks have similar requirements to present ones (Hearst and Koresko, 1968; Kamin, 1969). Furthermore, individuals improve on various manual tasks through repetition (Thurstone, 1919), a process of learning and experience that contributes to knowledge and continually improves performance (Dutton, et al, 1984; Lieberman, 1987). Consequently, organizations with more permitting experience are expected to be less likely to overcomply because they have prior knowledge of similar permitting tasks to which they can appeal. More specifically:

Proposition 2: Companies that perceive permit inexperience to have hindered their Title V permit application process will be more likely to have overcomplied with their permit application requirements and thus have higher Title V costs.

When there is no prior experience on which to base current task approaches, then cost savings yielded by tapping existing information fail to materialize and, in fact, additional resources may be required to obtain and apply new information (Mazur, 1994). In contrast, when previously completed tasks are similar to presently required ones, past behaviors will likely be generalized to current situations (Pinder, 1984): that is, behaviors learned in past situations are applied to a variety of similar new situations, thus providing a readymade response and precluding unnecessary learning (Nye, 1979).

Organization scholars have asserted that firms favor internal over external information sources (Aguilar 1967, Keegan 1974), particularly when the information is technical (Choudhury and Sampler, 1997). Consequently, experience can be gained by separate members of an organization engaging in the same task and building concurrent knowledge (Klimecki and Lassleben, 1998). This assumption is supported by the tendency for companies with regulated facilities in multiple states to attempt to coordinate permit activities.[13] Consequently, we expect that:

Proposition 3: Companies with Title V-facilities in other states will be less likely to have overcomplied with Title V permit application requirements and thus have lower permit application costs.

Companies with sister facilities in other states may share information on Title V problems, allowing them to leverage informational economies of scale and eliminate potential duplication in intelligence efforts (Gilad and Gilad, 1986). This assertion jibes with the empirically supported tendency of organizations to divide knowledge over subunits (Cohen and Levinthal, 1990).

Regulatory Uncertainty and Title V Cost Determinants. Economists have predicted that regulatory uncertainty can also influence corporate compliance effort, although they disagree on the direction of alteration. Some argue that regulatory uncertainty leads companies to minimally comply, leaving "fat" in the emissions budget for future regulatory trimming (Baumol and Oates, 1988). Others argue that regulatory uncertainty motivates companies to overcomply in

[13] Personal interview with Southeastern packaging firm's environmental manager, January 1995.

anticipation of tighter future regulations (Arora and Cason, 1995) or in fear of unintentional noncompliance (Heyes, 1998).

In the Title V context, regulatory uncertainty has literal meaning, with ambiguous and contradictory information emanating from a variety of official and nonofficial sources. This leads to the hypothesis that companies pursuing "richer" information channels with state and federal regulators will have higher compliance costs from attempting to resolve information ambiguity. This assertion actually contradicts traditional notions of information richness, defined as the information carrying capacity of data (Daft, et al, 1984). Face-to-face communication channels are the richest and considered to offer the highest probability of resolving information ambiguity, albeit in small increments of information (Daft, 1995). Impersonal documents, such as informational brochures, are considered lean, offering high quantities of information but slim prospects for resolving information ambiguity (Huber and Daft, 1987). Notions of information richness and the potential for resolving uncertainty rest on the existence of clarifying information in the environment, an assumption contradicted by the Title V story and criticized by scholars arguing for a stronger consideration of social context (Markus, 1994). In contrast, Title V implementation was marked by confusion among state regulators over the exact nature of Title V compliance, rendering the pursuit of rich communication channels a potential source of higher costs from the need to negotiate more ambiguous information, not less. This leads to the following expectation:

Proposition 4: Companies that gather compliance information through "richer" state regulatory information sources will be more likely to overcomply with their permit application requirements and thus have higher Title V costs.

In addition to pursuing rich information channels, organizations operating in uncertain environments may pursue higher volumes of information to resolve uncertainty (Leifer and Huber, 1977). Organization theorists call this activity boundary spanning, which generates data ultimately used to craft messages back to the environment (Daft, 1995: 87). Where boundary spanning is generally expected to clarify ambiguity (At-Twaijri and Montanari, 1987), this research argues that ambiguity may be compounded if the information environment itself is equivocal. Specifically, higher volumes of information may increase costs if the resulting information is contradictory or ambiguous. Thus, it is expected that:

Proposition 5: Companies in more frequent contact with state regulators will be more likely to overcomply with their permit application requirements and thus have higher Title V costs.

Interactions between regulated enterprises and state regulators represents a third dimension of information gathering under regulatory uncertainty. The information gathering process typically requires organizations to interface with one another in a goal-directed fashion (Fahey and King, 1977). Further, organizations seeking information expect to satisfy their quest, and thus may be frustrated with the information source when such efforts fail. In the Title V context, ambiguous and conflicting compliance information may contribute to perceived intelligence failures, as well as increase the cost of interpreting compliance requirements. Thus, one might expect that:

Proposition 6: Companies that perceive interactions with state regulators to be a hindrance in the Title V permitting process will be more likely to overcomply with their permit application requirements and thus have higher Title V costs.

This hypothesis assumes that companies perceiving state regulators as hindrances do so from frustrations with information ambiguity, which is supported by background interviews with Title-V compliant firms.

Subcontracting is a strategy for Title V firms to avoid directly negotiating informational uncertainties. The typical rationale for eliciting third-party assistance is that the vendor has an advantage over the contracting organization with respect to the provision of information services, since they reap the benefits of scale and scope (Ghoshal and Westney, 1991). While subcontracting Title V compliance requirements reduces firms' information acquisition needs, it creates a principal-agent relationship that may increase costs for firms (Eisenhardt 1989). Third-party agents that routinely perform tasks for a range of clients typically have more information about task requirements than their clients, resulting in asymmetric information that can be used for shirking and distortion (Eggerston, 1990). Another aspect of the principal-agent relationship is opportunism (Fama, 1980), or in the case of Title V, task routines that go beyond what is legally required for the client firm. These possibilities lead to the expectation that:

Proposition 7: Companies hiring consultants to assist in developing their Title V permit application will be more likely to overcomply with their permit application requirements and thus have higher Title V costs.

The differing profit objectives of clients and vendors (Elizture and Wensley, 1999) — particularly vendors seeking billable hours — can lead companies hiring subcontractors to invest more money than necessary in compliance. While economists would frown on this scenario as a suboptimal outcome for the firm, it is perfectly reasonable that third-party compliance and its attendant financial cost are well worth the benefit of reducing noncompliance risk. This notion jibes with evidence that companies subcontract to spread risk between parties, but contradicts evidence that cost efficiency is the primary motivation for subcontracting (Benson and Ieronimo 1996, Lacity and Hirscheim 1993).

The scholarly literature on subcontracting behavior raises the alternative hypothesis, that companies who subcontract Title V permit application requirements could incur lower costs for those tasks. External contractors are generally assumed to be a more economical provider of standardized goods and services because they accommodate the demand of multiple clients for similar tasks and thus tap internal economies of scale (Ghaoshal and Westney, 1991). Furthermore, subcontractors seeking repeat work are expected to have strong incentives against overcharging and overwork (Richmond, et al, 1992). Finally, subcontracting firms can use consultants to avoid the significant costs of hiring new personnel, thereby offloading the risk of economic uncertainties (Elger and Smith, 1994). While these are all plausible possibilities, the episodic nature of the Title V permit application requirements (an initial application process with renewal every five years) combined with the controversial role of consultants in the Title V permit application process favor a hypothesis based in principal-agent theory.

Data and Measures

To test our hypotheses of Title V overcompliance, we use data collected from a cross-sectional mail survey of representatives from Title V-regulated firms in Georgia, Oregon, South Carolina, and Wisconsin. These states were chosen after a review of standard industrial classifications revealed that they were home to a mixture of industry types and sizes. A pre-test mail questionnaire to Georgia firms initiated the survey process, enabling us to clarify ambiguous wording and eliminate questions with nonvariant responses. The final survey instrument entailed 10 pages and 28 questions, including queries on estimates of categories of Title V compliance costs, corporate information gathering patterns, characteristics of internal compliance resources, and basic organizational information, such as company size and average administrative processing times.

The four state air quality agencies provided the databases that comprised the sampling frame. With the exception of the Oregon database, we drew a random sample of companies and verified addresses and contact information. The random sampling process yielded 498 Georgia companies, 414 South Carolina companies, and 441 Wisconsin companies. (Because Oregon has a small Title V regulated community, 242 sources, that all were sampled.) An alert letter conveying the research goals and inviting survey participation was distributed to target firms one week prior to the first survey mailing. Nonrespondents were sent another survey package one month after the first mailing. One month after this second mailing, the remaining nonrespondents were sent a cover letter enabling them to decline participation by calling a member of the research team. They were also alerted that we would follow up by phone to encourage their participation. These telephone calls marked the end of the survey process.

Response rates were calculated by dividing the number of completed surveys by the adjusted sample size, which excludes surveys returned due to an incorrect address. Response rates by state were 31 percent (Wisconsin), 35 percent (Georgia), 40 percent (Oregon), and 43 percent (South Carolina). While this is a response rate somewhat below our initial aspirations, it is consistent with other national administrative surveys, including the response rate for the National Administrative Studies Project (e.g. Bozeman and Kingsley, 1998; Lan and Rainey, 1992). Moreover, the questionnaire was administered at a time when many government agencies were seeking information from the regulated communities and, given constraints, the response rate could not have been greatly increased in the absence of enormous additional research resources.

The ideal test for nonresponse bias would be to compare characteristics of the Title V sample with that of the Title V population. Unfortunately, population data do not exist. Further, available data — such as U.S. census data on manufacturing firms — include many small firms who are exempt from Title V regulations, rendering such data of limited comparability to the study sample. Given that nonresponse bias can adversely impact a study's external validity, a "wave analysis" was conducted instead to identify differences in early versus late responders to the survey. This exercise assumes that late responders are more like nonrespondents and comparisons between them and early responders reveal potential nonresponse bias (Bozeman, et al, 1992: 319f8). Taking the top and bottom one-third of respondents ordered by date of survey receipt (on average one year apart by state), the wave analysis of Title V data revealed no

statistically significant differences between early and late responders for Title V costs ($p<0.37$), number of facility employees ($p<0.78$), or 1995 sales ($p<0.63$).

Title V Overcompliance

Because it is impossible to identify the "minimum compliance" requirements for a Title V permit application — states vary in their requirements and firms can have drastically different compliance requirements — overcompliance is indirectly measured using the total firm-level costs for developing the Title V permit application. This measure assumes that higher permit application costs equate to overcompliance, an assumption rendered plausible only by the inclusion of key variables (discussed in the following sections) that control for the most obvious rival explanations.

To estimate the total cost of applying for a Title V permit application, we summed up corporate cost estimates in six categories: hiring consultants, hiring administrative personnel, hiring scientific and technical personnel, diverting work activity, and changing administrative systems[14]. These categories were identified by the pretest survey and during background interviews as capturing the bulk of corporate costs. Missing data were replaced with zeros based on the assumption that no cost had been incurred for that cost category to date.

Since there was no possibility of surveying companies only at the completion of their Title V activities, companies were asked to estimate permitting costs to date. This approach risks underestimating total costs, given that missing data and zeros could eventually be replaced with expenses. However, all of the companies included in this analysis had filed their Title V permit applications prior to the survey date. Assuming that the lion's share of application costs was incurred during the permit application process, the risk of significant underestimation appears small.

Title V permit application costs are exponentially distributed (Figure 1). Consequently, the data features a concentration of firms with costs up to $25,000, followed by rapidly declining numbers of firms with Title V costs beyond that amount. Due to the data's skewness, the resulting cost variable has a mean of $62,067, a 5% trimmed mean of $45.021, and a median of $26,000.

Table I presents the mean of respondents' direct expenditures incurred for Title V. The results indicate that the costliest item is hiring consultants (mean: $35,044) and that the next major expense diverting the work activity of existing personnel ($13,544). Hiring new administrative ($2,928) and technical ($4,028) personnel are relatively modest expenses. The standard deviations of each cost category are large, indicating the skewness of the cost data and a wide divergence of permitting experiences and facility types.

Bivariate correlations between Title V cost categories reveal three significant relationships (sig (ρ)<0.01) that support the validity of these cost measures (Table II). The costs of administrative and technical personnel are significantly positively related ($\rho<0.46$), suggesting

[14] The original survey question is listed in Appendix Table A-I.

that clerical workers were hired in support of technical permitting staff. Consulting costs are strongly positively correlated with administrative system upgrades ($\rho<0.39$) and existing staff time ($\rho<0.37$). These relationships suggest that the use of consultants does not involve total "delegation," but rather requires internal resources in support of its activities.

To verify the reliability of respondents' consulting cost estimates, a second question was asked in a separate section of the survey about the cost of hiring consultants. The Cronbach's Alpha between the separate consulting cost estimates is 0.97, indicating acceptable internal consistency. The average difference in the estimates is $1,500, with a 5% trimmed mean of $243 and a median of zero. A t-test conducted on the paired variables indicates no statistically significant difference in the estimates ($p>.48$).

To check the internal consistency with which companies estimate the costs of diverting work activity, a new variable was created that subtracted respondents' estimates of the internal personnel costs to work with *only consultants* from the cost of deploying existing personnel. Because the former variable is specific to outsourcing, it is reasonable to expect it to be a subset of the overall cost of diverting existing employees, and thus a dollar amount smaller than the general costs of diverting existing employees. Removing from consideration originally missing estimates, the average estimate for diverting existing employees towards general Title V activities is nearly $5,000 higher than the average cost of employees working only with consultants. Furthermore, the two estimates are identical in forty-four percent of the cases, indicating that for these companies internal costs were entirely devoted to supporting consultant activities.

To check the validity of the internal personnel cost measure, a new variable was created that divides the cost of existing staff time by the number of employees devoted to the Title V permit application. The resulting ratio assigns an average dollar amount to each employee diverted to work on Title V, thus indicating their degree of involvement in the permit application process. Examining only nonzero estimates of internal labor costs, the average cost per existing employee working on the Title V permit application is $5,166, with a trimmed mean of $4,226 and a median of $2,500. The minimum cost per employee is $80 and the maximum is $37,500. Assuming an hourly cost of $20[15] for the average employee involved in preparing the permit application, the result suggests that Title-V dedicated employees have worked as little as four hours ($80/$20) up to twelve months (37,500/$20/40 hours per week<47 weeks), with an average time requirement of nearly six weeks. The upper range of these results coincide with the high end of industry group estimates of six to twelve months for completing the average Title V permit application (Congressional Record, 1990).

Another external comparison of Title V costs was made by extrapolating the total permit application costs reported in the survey to the population of 20,000 Title V facilities. This exercise yielded an estimated cost of $1.7 billion dollars, which is only $300,000 below industry estimates of such costs (Clean Air Implementation Project, 1999: 7). This result, combined with

[15] According to the Bureau of Labor Statistics in the U.S. Department of Labor, private industry employer compensation (including wages and benefits) averaged $19.85 per hour worked. This figure combines blue and white collar workers, both of which are anticipated to have participated in the Title V permit application process (March 2000).

the time estimates derived from existing staff costs, is consistent with recent findings that industry groups tend to overestimate aggregate regulatory costs (Harrington, et al, 2000).

Organizational Control and Red Tape

We measure internal control and red tape by summing the number of weeks required to obtain approval for seven standard administrative activities: hiring and firing employees, purchasing more and less expensive equipment, reorganizing departments, and initiating major and minor projects[16]. While there are many possible constructions and measures of red tape (Bozeman, 2000), the most common approach to measuring red tape among public administration scholars has been to examine number of weeks required to perform core administrative tasks, either in absolute terms (e.g. Bozeman and Crow, 1991; Bozeman, Reed and Scott, 1992) or in relation to a baseline such as the average for an industry (e.g. Bretschneider and Bozeman, 1995; Pandey and Bretschneider, 1997; Pandey, 1995). This study conceptualizes organizational control and red tape in terms of the weeks required for core administrative tasks.

The approval times for purchasing low-cost equipment, firing and hiring, and initiating a minor project have mean values in roughly the same range (three to five weeks) and variances of a similar magnitude (Figure 2). The clustering of these tasks may reflect more frequent administrative events with shorter approval times and lower estimation error. In contrast, the higher means and standard errors of approval times for more costly equipment purchases, departmental reorganization, and major project startups imply episodic events for which estimation is more difficult and consequently higher in error. Cronbach's Alpha for the individual red tape measures is 0.80.

The mean approval times for a subset of administrative tasks — hiring and firing personnel and purchasing higher and lower-cost equipment — are compared in Table III with those from a prior study's sample of research-oriented organizations in the public and private sectors (Bozeman, et al, 1992). The Title V sample has a much lower average approval time for firing full-time employees than the government, industry or university organizations in the study, possibly due to freedom from personnel constraints posed by government-funded research (Bretschneider and Bozeman, 1995; Bozeman and Bretschneider, 1994). Title-V regulated firms resemble the government organizations in approval times for low and high-cost equipment purchases, with an average time nearly double that of industry and university research organizations. This result may be due to difference in the types of equipment being purchased: capital expenditures by manufacturing firms may take longer to approve because they impact organizational productivity, whereas equipment purchases by university, government, or even research-oriented private organizations may be more project-specific and less relevant to key organizational functions.

Regulatory Communications

Title V-regulated companies that pursue more frequent and interpersonal information sources from state regulators were also expected to be more likely to overcomply with Title V permit application tasks. This expectation is based on the ambiguous information environment

[16] The original survey question is listed in Appendix Table A-II.

surrounding Title V implementation, in which more interpersonal information from state regulators may have led companies to greater confusion and higher costs from attempts to resolve that ambiguity. In contrast, traditional media richness theory holds just the opposite: that more interpersonal communications have the ability to change human understanding, overcome differing conceptual frames of reference, or clarify ambiguous issues in a timely manner (Daft and Lengel 1984, 1986) than less interpersonal communications. Furthermore, tasks higher in equivocality (Daft, et al, 1987, p 357) or involving conflicting of interest (McGrath and Hollingshead, 1993) are held by the theory to require more rich information media. Given that Title V permit application tasks were both equivocal and, for some firms, conflict-ridden, it follows that firms would pursue richer communications.

The media characteristics that determine "richness" levels are (1) the opportunity for timely feedback; (2) the ability to convey multiple cues; (3) the tailoring of messages of personal circumstances; and (4) language variety (Huber and Daft, 1987, p. 152). These characteristics enable a hierarchy of traditional media in terms of information richness, including face-to-face contact, telephone conversations, personal written communications, formal written communications, and formal numeric communications (Daft and Lengel 1984). Thus, a three-level ordinal measure sought to capture the "richness" of state-level Title V information sources. The resulting variable assigned companies a score of "3" if their information gathering efforts included attending meetings or workshops (n=292); "2" if it included informally communicating with regulators (n=87); "1" if they used printed materials only (n=32); and "0" if they gathered no Title V information from the state agency (n=38)[17].

A second aspect of regulatory communications expected to influence Title V costs is the level of contacts between regulated firms and state air quality agencies regarding their Title V permits.[18] These interactions can be classified as boundary spanning behavior, in which organizations gather information from their environments, among other reasons, to solve specific problems (El Sawy and Pauchant, 1988, Cyert and March, 1963, Fahey and King, 1977). Furthermore, boundary spanning is expected to occur in more uncertain environments (Leifer and Huber, 1977; Duncan 1972). Consequently, Title V's ambiguous information environment is suspected of inflating Title V costs by requiring companies engaged in more intense boundary spanning activities to negotiate more equivocal information. Title V boundary spanning is measured by the sum of Title V-related contacts initiated by the state regulatory agency and the firm. Companies averaged eight contacts with regulators: states contacted companies on average six times, while companies contacted states on average ten times

The final variable in this category of hypotheses reflects a respondent's perception (yes=1, no=0) that state regulators hindered the Title V permit application process.[19] Perceptual variables have the advantage of providing a subjective assessment of more objective measures, and in some cases have provided contradictory evidence (Bozeman and Kingsley, 1998). The perception that interactions with state regulators proved a Title V hindrance intended to provide

[17] The original survey question is listed in Appendix Table A-III.

[18] The original survey question is listed in Appendix Table A-IV.

[19] The original survey question is listed in Appendix Table A-V.

some measure of the outcome of higher or more interpersonal communications regarding permit application requirements. Eighty-seven percent of respondents (n=421) did not perceive state regulators to be a hindrance in the Title V permit application process, whereas 13 percent did (n=66).

Permitting Experience

In contrast to the other hypotheses, firms more experienced with regulatory permitting are expected to have lower Title V compliance costs. Experience is defined as direct or indirect participation in events that contribute to an organization's knowledge stock regarding similar events (Dretske 1981). Organizational knowledge, in turn, increases an organization's capacity to absorb related knowledge and thus its informational economies of scale (Cohen and Levinthal 1990).

Two variables measure permitting experience related to Title V. The first is a dummy variable that designates companies with Title V facilities in other states.[20] The measure assumes that experience can be gained by separate members of an organization engaging in the same task and building concurrent knowledge (Klimecki and Lassleben, 1998). This assumption is supported by the tendency for companies with regulated facilities in multiple states to attempt to coordinate permit activities.[21] A little over half (53%) of responding firms have Title V facilities in other states.

The second variable is also a dummy measure, delineating companies that perceive that their lack of permitting experience hindered the Title V permit application process. This provides a more direct measure — albeit a perceptual one — of the relationship between experience and the ease of completing the Title V permit application. Twenty percent of companies (n=92) perceived their own lack of permitting experience or technical capacity as hindrances in the Title V permit application process, whereas eighty percent did not (n=357).

Subcontracting

Companies were expected to have higher Title V costs if they hired consultants to assist in part or all of permit application preparation. Delegating permit application tasks creates a principal-agent relationship between the contracting firm and its delegatee (Jensen and Meckling, 1986) which sets the stage for some divergence between subcontractor decisions and decisions that would maximize the contracting firm's welfare (Baiman 1982, 1990; Gurbaxani and Whange 1991; Jensen and Meckling, 1986). In the Title V setting, divergence of interests may include the quest for billable hours or standardized permit application routines that result in extraneous tasks (and thus costs) included in firms' permit application processes.

Survey respondents were asked whether they used consultants to handle the entire permit application or only part of the permit application; nonrespondents to this question were

[20] The original survey question is listed in Appendix Table A-VI.

[21] Personal interview with environmental vice president of a major Southeastern packaging manufacturer, April 1996.

interpreted as not having hired a consultant[22]. Seventy-five percent of respondents (n=326) hired a consultant for some type of assistance, whereas 20 percent (n=111) hired no consultant. Of the 75 percent hiring a consultant, 44 percent (142) elicited partial consultant support and 56 percent (184) contracted out for total "turnkey" consulting support. Two dummy variables measure the three types of subcontracting support: none, partial, and full.

Statistical Control Variables

Basic variance in permitting cost may be attributable to company size, various characteristics of the home state, and the firm's emission characteristics. Six statistical controls were used to capture these influences, including four variables to measure environmental scale, one variable to measure facility size and a set of dummy variables to partial out the influences of the survey state.

Small manufacturers tend to have less complex permit needs than large manufacturers (Robinson 1999, p. 247). Furthermore, production scale is generally correlated with the size of onsite personnel (Chelius and Smith, 1987, p.193). To control for permit complexities attributable to manufacturing scale, the number of facility employees was included as a statistical control.

Three dummy variables were used to represent the four states in which the surveys were administered: Georgia, South Carolina, Oregon and Wisconsin. The inclusion of survey state in the model is meant to capture a range of unobservable influences (e.g., timing of permit applications, pre-Title V operating permit program history, implementation resources, regulatory stringency, etc.) that defy a single classification.

Firm-level emission characteristics — while not necessarily linearly associated with permitting costs[23] — are nonetheless an obvious choice for statistical controls. Four measures were used to capture emission characteristics. Two dummy variables represented service providers, manufacturers, and raw material producers, which were expected to capture escalating production volume and, by extension, emissions.[24] Another dummy variable designated companies by permit type.[25] The last two environmental variables were the natural logarithm of 1995 environmental regulatory costs and the number of employees devoted at least half-time to environmental management. The latter variables assume that the scale of air quality emissions is probably not wholly unrelated to the amount of other types of environmental emissions (water,

[22] The original survey question is listed in Appendix Table A-VII.

[23] Personal interview with Ollie Ficke, permit engineering consultant and project advisor, April 1996.

[24] Personal conversation with Michael O. Rodgers, principal research scientist with the School of Civil and Environmental Engineering at Georgia Institute of Technology (April 3, 2000).

[25] Companies in this data pursued either synthetic minor or major source permits. Synthetic minor sources by definition have lower emissions from legally enforceable restrictions on production that keep their emissions below Title V-triggering thresholds. Major sources have emissions above thresholds specified by pollutant and air quality of the facility location.

hazardous waste, etc.)[26] and that specialized staff will be added in proportion to general environmental size (Robinson 1999).

Analysis

The study used an ordinary least squares (OLS) regression model to test the hypothetical determinants of Title V overcompliance. The OLS model explains 40 percent of the adjusted variance in Title V permit application costs (Table IV). The presence of Title V facilities in other states had a significant positive influence ($p<0.00$) on permit application costs, running the opposite direction hypothesized, and incurring 55 percent higher permit application costs than single-site facilities. The number of company-agency contacts also had a significant positive influence ($p<0.00$), conforming with expectations and generating a two percent Title V cost increase with each additional contact. The use of consultants for all permit application costs was a significant positive influence as expected ($p<0.02$), resulting in 53 percent higher costs over that of facilities conducting Title V activities in-house. However, partial consultant usage was not significantly different from firms using no consultant at all ($p<0.79$). The remaining explanatory variables — red tape, inexperience, interpersonal information sources, and perceived agency hindrances — were insignificant cost determinants.

With the exception of the dummy variable representing manufacturing firms, raw material producers and South Carolina and Wisconsin responses, all control variables proved to be significant and positive: the number of facility employees ($p<.00$), the number of environmental employees ($p<0.00$), the type of permit sought ($p<0.02$), and Oregon responses ($p<0.00$). Each additional facility employee is associated with a 0.01 percent increase in Title V costs. Each additional environmental employee is associated with a two percent increase in Title V costs, whereas a one percent increase in 1995 environmental costs is associated with a 14 percent increase in Title V costs. Major source permits, required for larger emission sources, have nearly 60 percent higher emissions than synthetic minor permits, which are by definition below specific emission thresholds. And finally, Oregon facilities have 81 percent higher Title V costs than Georgia facilities.

An examination of the original model's residuals revealed nonnormal and heteroskedastic distributions. To address these violations of the OLS assumptions, Title V permit application costs were transformed into a "semi-logarithmic" form, which takes the natural logarithm of the dependent variable to stabilize the variance (Mendenhall and Sincich, 1996: 397) and has the ancillary benefit of normalizing the residuals by eliminating their skewness (Mendenhall and Sincich, 1996: 411).[27] The semi-logarithmic Title V cost model yields normal and homoskedastic residuals and explains 41 percent of the variance (based on an adjusted R^2) in the transformed cost data.[28] Individual variable performances change little, with two exceptions: the

[26] When asked the reasonableness of this assertion, a senior industrial engineer with CH2MHill, notes: "All things being equal, this is probably a reasonably fair generalization. Emissions across media tend to be correlated. There are obviously many exceptions to this, but on average it should hold true." April 19, 2001.

[27] In addition to transforming the dependent variable, the natural logarithm transformation was also applied to 1995 environmental costs, which have an "intrinsically linear" relationship to total Title V costs and are subject to the same scaling issues – large firms with large costs and small firms with small costs – as total Title V costs.

[28] It would be inappropriate to compare the explanatory powers of the original Title V cost model with its semi-logarithmic sister because they feature different dependent variables. One alternative approach is to transform the

environmental regulatory cost variable and the dummy variable representing raw material producers both become significant Title V cost determinants ($p<0.00$ and $p<0.05$ for one-tailed tests, respectively).

Prior to running the semi-logarithmic Title V cost model, we ran correlations among all the explanatory variables to detect any colinearity problems that might jeopardize the inferential capacity of the model coefficients. Colinearity was a particular concern given that several model variables — particularly total environmental compliance cost and monthly permit hours — would logically be strongly correlated. These concerns proved unfounded, as the highest pairwise correlation (between the number of facility and the number of environmental employees) was $\rho=0.24$. An additional diagnostic performed after running the regression model — specifically the variance inflation factor — suggested colinearity among explanatory variables was not a problem[29].

Discussion

An ordinary least squares regression (OLS) model of Title V permit application costs using internal corporate red tape, permitting experience, regulatory communications, and organizational scale variables explains 40 percent of the data's variance. This model also produced heteroskedastic and nonnormal residuals, leading to the generation of a semi-logarithmic model that transformed the dependent cost variable by taking the natural logarithm of its individual values. The semi-logarithmic model explains 41 percent of the adjusted variance in the transformed Title V cost variable, in addition to stabilizing the model residuals to meet OLS assumptions. Two separate diagnostic approaches suggested that multicolinearity was not a threat to the precision of the OLS estimators.

Corporate red tape is a highly insignificant influence on Title V permit application costs. The original hypothesis – that companies with higher internal red tape would invest more resources in permit application tasks to reduce noncompliance uncertainties — is unsubstantiated. There are several possible explanators for this result. First, approval times for administrative tasks may not measure red tape or corporate risk aversion, an explanation contradicted by the significant positive correlations demonstrated in previous studies between the red tape measures and perceived red tape and organizational risk aversion (Bozeman and Kingsley, 1998). Second, uncertainty reductions presumably sought by red tape may focus on internal organizational goals — stronger accountability of individual members (Clegg, 1981) or explicit internal decision processes (Ouchi, 1977) — as opposed to externally imposed goals, i.e., regulatory compliance. Thus companies with higher levels of red tape would be expected to have

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predicted values of semi-logarithmic model back to their original dollar increments (by raising e to those values as exponents) to generate a "pseudo-R2" value (Mendenhall and Sincich, 1996: 226). The results of this exercise indicate that the semi-logarithmic model explains 40 percent of the variance in Title V costs, as opposed to 39 percent of the variance explained by the original model.

[29] The variance inflation factor (VIF) method regresses each individual explanatory variable (X_j) against the model's remaining predictor variables and extracts the coefficient of determination (R_J^2). The difference between 1 and the R_J^2 is then inverted, so that highly correlated variables will have large VIF values from a small denominator and variables with low correlation will have a small VIF from a large denominator. While the rule-of-thumb VIF value indicating multicollinearity is ten (Neter, e al, 1996: 387), none of the individual variables have a VIF score of over 2.3.

higher costs for internal financial audits or nonregulatory environmental management systems, but not for federally required occupational safety record keeping. This alternative explanation is consistent with economic views of firm-level regulatory response as exercises in cost-minimization, generally impervious to the effects of organizational structure (Blinder, 1987).

The variables operationalizing regulatory communications produced mixed results. As expected, the quantity of firm-agency communications proved a significant positive influence on permit application costs, with each additional contact increasing Title V costs by two percent (Table IV). This result supports the notion that an ambiguous information environment increased permit application costs by requiring companies to negotiate conflicting data. However, several phenomena other than information ambiguity may be driving the result. One possibility is that permit complexity drives both Title V costs and communication levels, resulting in a spurious relationship between the latter two. Permit complexity may encompass unresolved noncompliance issues or disputes over monitoring requirements that transcend systematic measures such as company size or industry segment. Another explanation shifts responsibility for compliance confusion from state regulators to the complying firms, who may be too incompetent, careless, or distracted by nonregulatory matters to adequately decipher permit application tasks. A final possibility is that intensive communication is a result of limited internal capacity that transcends company size or environmental staffing, where internal environmental resources are devoted to other regulatory matters and companies compensate by accelerating communications with regulators.

Firms that perceived that interactions with state regulators hindered their Title V process were expected to be frustrated primarily by ambiguous and conflicting Title V compliance information from state agencies. That such a perceived hindrance bore no relationship to Title V cost may indicate that aspects of regulator interactions not related directly to compliance costs — such as personality conflicts or a general resentment of regulators — contributed the impediment. The null effect also negates the rival hypothesis that companies with more costly permit application processes were simply irritated by Title V's resource requirements and thus more likely to perceive hindrances from regulatory interactions.

Both permitting experience variables contradicted expectations. Perceived permit inexperience was an insignificant influence on cost, whereas the presence of Title V facilities in other states was associated with 55 percent higher, rather than lower, permit application costs (Table IV). This result may be attributable to the complexities of coordinating permit applications across states: differences in state permitting requirements are a common frustration among regulated firms, particularly for companies with facilities in multiple states.[30] While Title V sought a standardized permitting approach across states, air quality agencies had considerable leeway in the details of permit application requirements (Kingsley, et al, 1998). Thus companies attempting to coordinate Title V permit applications across multi-state facilities may incur higher costs from attempting to streamline diverse tasks. The implication for policymakers is that Title V may have raised minimum standards for permitting requirements, but failed to standardize those requirements across states, as intended.

[30] Personal interview with environmental vice president of a major Southeastern packaging manufacturer, April 1996.

One explanation for the null relationship between perceived permit inexperience and permit application costs is that Title V instituted permit application requirements so different from those previously required by state agencies that permit inexperience was irrelevant to the process, i.e., *every* company was inexperienced in Title V. This possibility jibes with assertions of behavioral theorists that experience does not always yield positive returns (Nye, 1979).

Companies using consultants for all Title V tasks had 53 percent higher permit application costs than those not using consultants, a significant result in the direction predicted. However, companies subcontracting only part of their Title V tasks did not have significantly different costs than those firms using no consultant at all. Perhaps partial delegation mitigates expansive compliance by enabling subcontracting companies to retain sharper awareness of the scope of delegated tasks. This interpretation warrants caution, however. In the absence of a big-ticket expenditure to reference, companies not using consultants may have underestimated internal costs by failing to account for fringe benefits and overhead, which are built into consulting fees. To control for this possibility, we applied a fringe benefits multiplier of 1.30[31] to the costs of new and existing staff working on Title V permit application tasks and regenerated the semi-logarithmic model. The model's explanatory power decreases by four percent (to an adjusted R^2 of 0.36), while producing only slight changes in the value or significance of the beta coefficients (Table V). However, regenerating the model with an overhead multiplier of 2.0 applied to permit application costs eliminates the significance of full consulting services.[32] The latter result fails to eliminate the possibility that companies without consulting assistance underestimated internal costs.

The dummy variable representing Oregon firms is highly significant and positive, indicating Title V costs eighty percent higher than that of Georgia firms. This is a provoking finding given that Oregon permit applications were due before the first EPA White Paper — which reduced the requirement for documenting insignificant emission units to a checklist — was issued. (The remaining states had permit application deadlines well past the issuance of this white paper). The unfortunate timing of Oregon's deadline meant that sources that had taken the time to individually document insignificant emission units had wasted resources on a paperwork task that ultimately was not required (Inside EPA, 1995b). The Oregon result may be evidence of overcompliance due to a shifting regulatory landscape, or it could be a function of some other local characteristic not captured by the model's controls.

A final implication of the research is that survey questionnaires can be used to elicit regulatory cost estimates. The method is not without its perils, as companies may exaggerate costs in an attempt to manipulate the regulatory process or provide thoughtless answers in the haste of survey completion. However, the existing evidence tends to contradict both possibilities. Title V cost estimates generated from the survey are generally consistent with two

[31] Zweig and White Associates estimate that the average fringe benefits multiplier for environmental consulting firms to be 1.30 (1999).

[32] At the suggestion of an anonymous referee, we ran a sensitivity analysis building in various overhead rates to survey respondents' Title V cost estimates. The range of overhead rates began at 2.0, with the intention of working up to the median overhead rate of 2.5 for architecture, engineering and planning firms (Zweig and White, 2000). Escalating the overhead rate proved unnecessary, as the differences between companies fully subcontracting and not subcontracting permit application costs disappeared at the 2.0 multiplier.

separate industry group estimates. And while systematic upward biases in cost estimates are difficult to locate, data analysis revealed logical relationships (for example, between permit application costs and firm size) that support data validity. The risk of thoughtless estimation is mitigated, to a certain extent, by the high levels of internal consistency displayed by respondents in several cost categories. Available evidence thus supports the feasibility of using survey questionnaires to estimate regulatory costs, provided data analysis is accompanied by thorough scrutiny of the responses and cautious interpretation of the results.

Conclusions

A skeptical reader may wonder, "just how is it possible to *overcomply* with environmental regulations?" Arguably, since diminishing pollution is in the public interest, a company choosing to exceed environmental requirements is simply a good corporate citizen. In the case of Title V, at least, overcompliance does not equate to good corporate citizenship; it may relate more closely to such factors as bad management and generate excess cost to no desirable social end. This is not to say that improved facility information is an unworthy goal; after all, regulatory enforcement and compliance are weak in the absence of valid records. The larger question raised by Title V is how much additional information is necessary for improving enforcement and compliance. Quite possibly there are important thresholds of information needs and effects may well diminish, or even change in quality, after those thresholds are met. Finally, even if all the additional information gathered in Title V lowered air pollution, economists (not to mentioned unemployed timber workers and fishermen) remind us that even the most noble environmental quality goals are not to be approached without limit. Environmental goals are easily cast in relief against social and economic goals.

For all these reasons, the notion of overcompliance is a useful research concept, even if a difficult one to measure. If companies are complying at highly different levels it is important to know the causes of those differential compliance rates, the information and communication needs associated with them, and (not addressed here) the possible implications for equity and a "level playing field." Our results suggest that there is, indeed, reason to suspect overcompliance and that overcompliance is predictable. To some extent, and perhaps to no one's great surprise, the consultants' profit margins may well be a considerable transaction cost in regulating industry and a cause of a particular type of overcompliance.

What does one make of the finding that increased communication with state regulators leads to overcompliance? There is always the "IRS metaphor": people interact with state regulators at their peril. But much more likely is that intensive communication is a result of either intense problems or limited internal capacity, or both. The state regulator seems to benefit little from increasing the hours and costs of complying, especially when the result is more data not less pollution.

In sum, the very notion of overcompliance interjects some concern with balance. If it is possible to overcomply, perforce it is possible to undercomply. The regulators' mission is not maximum compliance but effective compliance. Studies of reasons for overcompliance, when set against studies of undercompliance and noncompliance, give the entire picture and, perhaps, a better basis for regulation.

Table I. Descriptive Statistics for Individual Title V Cost Categories

	Admin Staff	*Consultants*	*Existing Staff*	*Tech Staff*	*Admin Systems*
Mean	$2,928	$35,044	$13,544	$4,028	$7,818
95% Confidence Interval for Mean	$1,666	$28,298	$10,666	$2,160	$4,837
	$4,190	$41,791	$16,423	$5,895	$10,799
5% Trimmed Mean	$760	$24,079	$8,982	$583	$3,081
Median	$0	$15,000	$3,000	$0	$0
Std. Deviation	$11,689	$62,489	$26,660	$17,299	$27,610
Minimum	$0	$0	$0	$0	$0
Maximum	$100,000	$500,000	$150,000	$160,000	$250,000

Table II. Correlations Among Title V Cost Categories

		AdminStaff	Consultants	Existing Staff	Technical Staff	Admin Systems
Admin Staff	Pearson Correlation	1.000	.148*	.045	.459*	.256*
	Sig. (2-tailed)	.	.003	.373	.000	.000
	N	392	392	392	392	392
Consultants	Pearson Correlation	.148*	1.000	.372*	.160*	.390*
	Sig. (2-tailed)	.003	.	.000	.001	.000
	N	392	392	392	392	392
Existing Staff	Pearson Correlation	.045	.372*	1.000	.206*	.307*
	Sig. (2-tailed)	.373	.000	.	.000	.000
	N	392	392	392	392	392
Technical Staff	Pearson Correlation	.459*	.160*	.206*	1.000	.220*
	Sig. (2-tailed)	.000	.001	.000	.	.000
	N	392	392	392	392	392
Admin Systems	Pearson Correlation	.256*	.390*	.307*	.220*	1.000
	Sig. (2-tailed)	.000	.000	.000	.000	.
	N	392	392	392	392	392

**. Correlation is significant at the 0.01 level (2-tailed).

Table III. Comparing Red Tape Measures Across Sector

Red Tape Measure	Title V Firms	Government R&D	Industry R&D	University R&D
Equip (<$10K)	3.22	3.08	1.28	1.32
Equip (>$10K)	7.43	7.69	4.70	4.26
Firing	2.96	37.49	7.34	10.19
Hiring	4.72	13.37	3.85	6.14

Source: National Administrative Procedures Project

Table IV. Modeling Title V Overcompliance

	Title V Costs		LN Title V Costs	
	Beta	P-Value	Beta	P-Value
(Constant)	-72213.94	0.01	6.95	0.00
Red Tape	0.42	0.99	0.00	0.99
Out-of-State TV Sources	44383.93	0.00	0.55	0.00
Inexperience	-1711.61	0.90	-0.14	0.42
Rich Communications	8293.31	0.19	0.02	0.82
Number of Contacts	2160.83	0.00	0.02	0.00
Agency Hindrance	13394.80	0.44	0.04	0.84
Part Consult	3924.75	0.79	0.14	0.46
All Consult	33332.98	0.02	0.53	0.00
Facility Employees	21.68	0.00	0.00	0.01
Enviro Employees	2905.94	0.00	0.02	0.02
95 Enviro Costs	0.00	0.68	0.14	0.00
Permit Type	26831.43	0.02	0.58	0.00
Manufacturer	4147.22	0.80	0.14	0.47
Raw Materials	11562.38	0.50	0.36	0.10
SC	15425.45	0.28	-0.05	0.76
WI	5634.66	0.68	-0.08	0.65
OR	58938.25	0.00	0.81	0.00
Adjusted R^2	0.4		0.41	

Table V. Modeling Title V Overcompliance Using Fringe-Adjusted Personnel Costs

	LN Title V Costs	
	Beta	P-Value
(Constant)	7.08	0.00
Red Tape	0.00	0.91
Out-of-State TV Sources	0.51	0.00
Inexperience	-0.15	0.37
Rich Communications	0.02	0.81
Number of Contacts	0.03	0.00
Agency Hindrance	0.01	0.98
Part Consult	0.02	0.91
All Consult	0.39	0.03
Facility Employees	0.00	0.00
Enviro Employees	0.02	0.02
95 Enviro Costs	0.15	0.00
Permit Type	0.57	0.00
Manufacturer	0.15	0.46
Raw Materials	0.40	0.07
SC	-0.04	0.81
WI	-0.09	0.61
OR	0.83	0.00
Adjusted R^2	0.36	

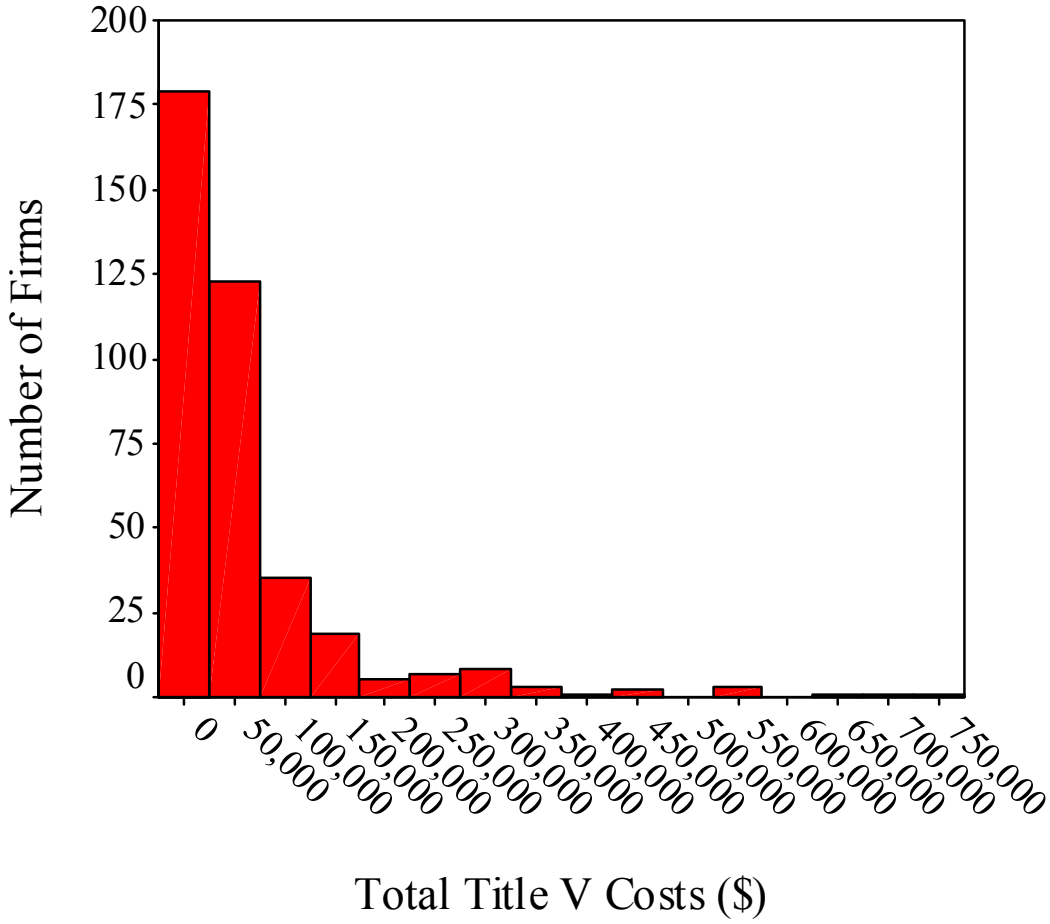

Figure 1. Distribution of Title V Costs

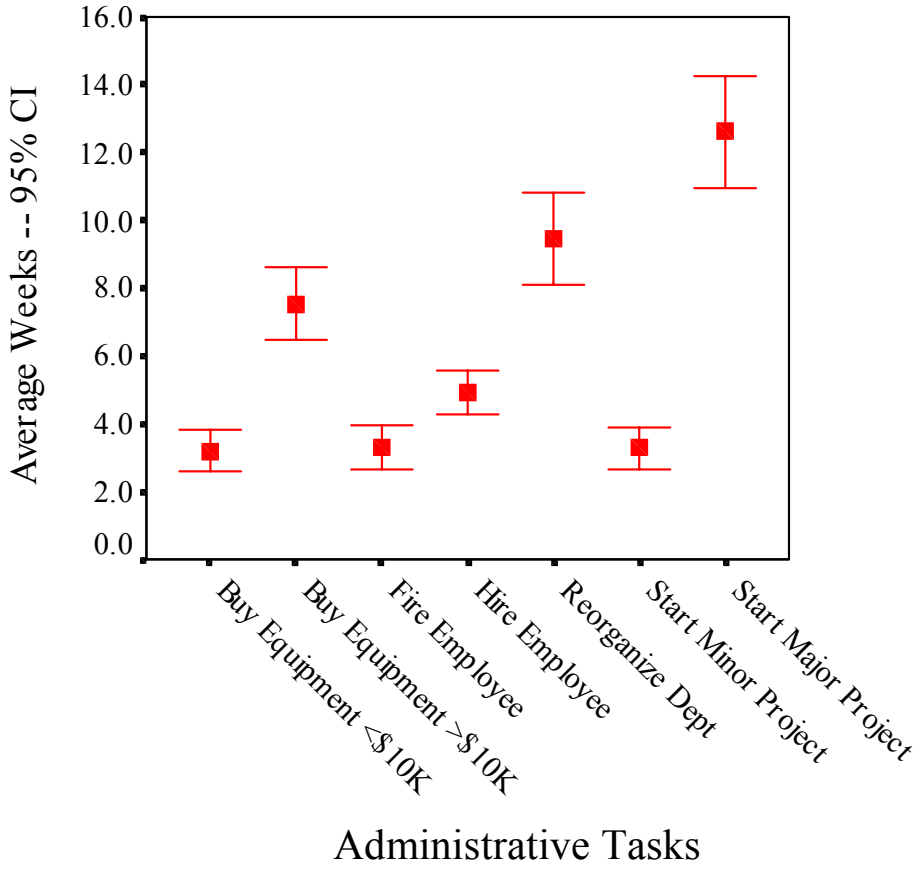

Figure 2. Average Approval Time (Weeks) For Red Tape-Relevant Activities

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Discussion of Session II Papers

by Wayne B. Gray, Clark University

A discussant has many roles at an occasion such as this. If one is discussing a single paper, one should say nice things about the paper (that the author is too modest to say), point out errors (that the author didn't want to mention or didn't notice), and to suggest future work in the area. When discussing multiple papers, there is an added task of synthesizing the results of the papers and coming up with a more or less coherent whole.

In this case, I will begin with the last task, synthesizing the papers. This is not because it's the easiest one — in this case, it may be the most challenging. The three papers take three very different approaches, making it difficult to find a common ground from which to examine them. The title of the workshop as a whole speaks of going "Beyond Compliance" and understanding environmental behavior — presumably the behavior of polluting firms (at least, that's the behavior all of the papers are examining). This afternoon session narrows the focus to "Overcompliance" with environmental regulation, but that doesn't make it any clearer.

I think the best place to start is by providing a careful look at what isn't included in the topic, providing a definition of today's topic by means of contrasts. The topic that is not included is "Compliance" (that which we are going "beyond" or "over" today). This I understand as meaning the "traditional" approach to environmental regulation, and the one most studied by academic researchers. The regulatory agency wants to clean up the environment and does so by setting emission limits (Q*) that apply to each plant. Plants are expected to comply — to keep their emissions below those limits. The regulatory agency uses enforcement activity (inspections and fines) to identify and punish those who are not in compliance, thereby providing incentives for firms to comply.

This traditional model has provided plenty of opportunities for economic research. Regulators need to somehow identify an appropriate emission limit (Q*) for each polluter. In principle these depend on the benefits and costs of pollution control at each plant: if these are suitably "smooth" the optimal quantity of abatement will ordinarily be set where MC=MB (the marginal cost of cleaning up another ton of pollution being equal to the marginal benefits from that cleanup). Economics texts about environmental regulation often contain a diagram showing marginal cost and marginal benefit curves and pointing out the MC=MB intersection. Economists have repeatedly noted that in most cases this implies there should be different limits at each plant, but that regulators seem inclined to set common standards at many different plants. Alternatives to traditional regulation, such as tradable emissions permits, have been advocated as an alternative and occasionally adopted, harnessing the power of markets to provide incentives for firms to clean up pollution — one way of going "beyond compliance."

In the traditional model, having decided the emissions limits for each plant (whether optimally set or not) the regulator is generally assumed to allocate enforcement activity in order to maximize compliance with those limits. A simple deterrence model suggests that profit-maximizing firms will comply if the expected penalty (probability of being caught times penalty amount) is greater than cost of compliance. Given expensive pollution control equipment, few inspections, and low fines, it is commonly noted with surprise that most firms comply with these regulations, since compliance doesn't seem to be economically worthwhile. Models allowing

more complex regulatory strategies (notably those due to Harrington) can increase the incentives for compliance, but the basic model of the situation persists: if a regulatory agency wants to reduce pollution it sets more stringent limits; if it's having trouble getting polluters to comply it increases its enforcement activity.

In a simple setting, with well-understood costs and benefits from pollution abatement, smooth curves in the diagrams, no uncertainty for either regulators or firms, and sufficiently stringent enforcement, we get a straightforward outcome. Regulators should set emissions limits (Q*) so MC=MB. Firms' emissions should be just equal to Q*. No firm should do more cleanup than required, since overcompliance provides no benefit to the firm, and the additional cleanup presumably raises the firm's costs — so there will never be any overcompliance. In fact, we can go further than that — in this simple model, if Q* has been optimally set, each additional ton of pollution cleanup beyond Q* results in cleanup costs exceeding cleanup benefits (MB<MC) — so not only isn't overcompliance likely, it isn't even desirable.

Of course, that is based on a very simple and unrealistic model of regulatory compliance. Let's now consider some potential pitfalls for this compliance model, considering both positive issues (what regulators and firms actually do) and normative issues (what they should do).

The first problem for the simple compliance model is that there can be a great deal of uncertainty in pollution emissions. This can affect the model in several ways — consider adding measurement error, using the analogy of police deterring speeders. There is uncertainty for the police (errors in radar guns) and for the drivers (errors in speedometers). How this affects the equilibrium depends crucially on the behavior of regulators. The usual approach (judging empirically) is for the police not to ticket speeders until they exceed the limits by some wide margin (10 or 15 mph above the speed limit) and to impose monetary fines. Drivers respond to this by "pushing the envelope" — driving at 75 in a 65 mph zone, hoping that both their expectations of police behavior and their speedometer are accurate – and there is widespread undercompliance.

Suppose instead that police only rarely stopped speeders — but then imposed capital punishment! I suspect that we would observe rampant overcompliance, as drivers chose to play it safe and include a sizable margin of error in their behavior. Thus, overcompliance is especially likely when penalties are large. Overcompliance can also result when there are large fluctuations in pollution emissions relative to permitted levels over time. These fluctuations could be due to seasonal factors or accidents and upsets in the production process, but if the firm does not want to found be in violation fairly frequently, it may need to operate well within the boundaries of its permitted level most of the time. The result of this uncertainty is that we cannot expect to observe Q=Q* all of the time, and whether we observe Q>Q* or Q<Q* depends in large part on the firm's perceptions of the cost of being caught in violation.

A second potential pitfall for the simple compliance model is that pollution control is a dynamic process. A large part of pollution control is accomplished by installing pollution abatement capital that will last for decades. Firms cannot be sure that today's stringency levels will remain constant. In fact, past experience suggests that regulations tend to get stricter over time. Firms might also like to have some leeway for expanding output in the future. Either of

these factors might lead firms to overcomply when designing and installing their pollution abatement capital, incorporating their expectations of the future in their current decisions.

A third potential pitfall for the simple compliance model is the presence of technological innovation in pollution control. New control technologies could provide dramatic reductions in abatement costs, raising the optimal level of pollution abatement. If so, it may be especially important for pollution regulations to encourage the development of new technologies. When these new technologies are adopted, it may look like overcompliance (the firm's pollution falls well below its current requirements), but the gains from encouraging innovation might outweigh any temporary departure from MB=MC.

A fourth potential pitfall for the simple compliance model is the cost of the regulatory system itself. There can be enforcement and compliance costs to the firm and to the regulatory agency. These can include paperwork costs to the firm of documenting compliance, or legal costs to both sides when rules are challenged in court. If the cost of forcing firms to get to Q* is high, there could be a sizable advantage to regulators pursuing strategies where firms are encouraged to reduce their emissions below the required levels. Thus voluntary overcompliance might be desirable as a way to reduce regulatory costs.

A fifth potential pitfall for the simple compliance model can arise from political pressures on the regulators. Regulated industries attempt to mobilize political support for weaker regulations by raising fears that high pollution abatement costs might lead firms to locate elsewhere. This may constrain regulators to set pollution limits that are less strict than would be socially optimal. Here encouraging overcompliance would be desirable because it will generally move towards the optimal Q*.

The net result of these pitfalls is to undermine the predictions of the simple compliance model that polluters will not — and should not — overcomply. That's a good first step, but it provides many possible ways to justify and interpret the existence of overcompliance. Which is the best approach? It's not clear that any one approach will always be the best. Our other discussant, Jon Silberman from EPA, will have more to say about that from the perspective of the regulatory agency, and I'll have a few suggestions in my closing comments. For now, let's just examine each paper in turn, sorted in order of their closeness to the traditional analysis.

The first paper by Horowitz and Bandyopadhyay examines "Overcompliance with the Clean Water Act." The authors compare the actual discharges of BOD from large water polluters with their permitted levels, and find that most are heavily overcomplying: the typical plant discharges only 30% of the permitted amount. The authors then note that in the simple compliance model this behavior doesn't make any sense, providing no benefits to the polluters — why not put much less effort into compliance and save money?

The answers may lie in some of their diagrams, particularly those showing sizable fluctuations over time in BOD discharges (whether seasonal or accidental). If the firm and the regulator both want to avoid any violations (perhaps due to negative publicity), they might agree on a permit level with a sizable amount of leeway, to reduce these "costly" occasions of non-compliance. The paper presents an example of a plant with mean discharges only 38% of the permitted amount but in violation 8% of the time, corresponding to one month in violation each

year, which might well be unacceptably high. The paper also finds some more formal confirmation of this hypothesis in an analysis comparing the variability and median levels of discharges. Plants with greater variability tend to have their median actual discharges further below the permitted levels, as would be expected if permits are set to avoid violations.

The authors might examine their data on variability and median discharge levels in light of a simple model of regulator behavior — set permits so that violations will occur on average only once every X months — and try to calculate what X would be. They might also talk a bit with the regulators and firms responsible for negotiating these permits, to identify what they are doing and why. The paper hypothesizes about structural shifts at particular polluters (Fall River, Patuxent) — they know the names, and could presumably call and find out what happened to cause those shifts. A key puzzle for the model (not given much attention in the paper) is that the picture for Patuxent shows much lower variability after the structural shift. If variability is a choice variable for the polluter, why don't polluters just invest in lower variability and then pollute much closer to their limits? A likely answer is that this would result in negative consequences from the regulators, but could best be found out directly from the parties involved.

Finally, the authors might consider examining the determinants of discharge performance more comprehensively. As it is now written, the paper is primarily about showing that overcompliance exists (relative to permitted levels). It might be interesting to understand why some polluters seem to achieve lower actual discharges: is it better abatement technology, better management, or greater regulatory pressures? When combined with additional information about how the permit system actually works, this paper could provide greater insights into why the observed degree of overcompliance exists and indirectly provide evidence on the desirability of overcompliance in this context.

The second paper by DeHart-Davis and Bozeman examines "Regulatory Compliance and Air Quality Permitting: Why Do Firms Overcomply?" The authors examine data on the costs expended by different plants in applying for Title V air pollution permits during the 1990s. Controlling for all other observable differences across plants that might be expected to affect the complexity of each plant's permit, they find substantial differences in spending. Despite some equivocation in the paper, the sense is that firms are wasting money, spending more than they need to in preparing their applications, which doesn't make sense in a traditional profit-maximizing model. The situation appears to be even worse than in the water pollution case, because there is no clear environmental benefit from the extra spending. This is apparently a classic example of "deadweight costs" — costs to the firms that don't result in any real benefits to society. This provides an example of the "uncertainty" explanation for overcompliance that I mentioned earlier, since there is sizable uncertainty about the regulatory requirements, combined with the equivalent of "capital punishment" in the form of the criminal liability of corporate executives for errors in the permit.

The key problem I see in the paper is that the results depend crucially on the model's ability to control for differences in permitting costs across plants. There are limited controls in the model for permit complexity (industry, employment, environmental employees), which may or may not capture much of the variability across plants. The authors use theory to suggest certain characteristics that would lead firms to overspend on their permit (using consultants, having lots of contact with regulatory agencies, or having more corporate red tape). They then

interpret positive coefficients on those characteristics as proving that these firms are spending "too much" on their permits — and hence overcomplying.

An alternative interpretation of the paper's results is that many of the characteristics that are identified as determining overspending are really endogenous and represent reverse causality. That is, they are caused by differences in permit complexity rather than causing permit overspending. For example, firms that have especially difficult permits might find it necessary to spend more time working with regulators and might also have a greater need to hire consultants. Their greater spending could be due to their more complex permits, not to any overspending on their part — if so, there is no evidence for overcompliance.

This problem may be difficult to overcome, given the limited data available. A wider range of control variables for permit complexity might be included, such as interactions between employment size and industry type, or tests for non-linearity in employment size effects. If there is a measure of corporate-level risk aversion available (e.g. debt-equity ratio), that could be used as an additional control for factors influencing overspending. If state regulatory agencies behave differently, there could be interactions between state dummies and various firm and plant characteristics and interpretations of those results based on known differences across state agencies. There could also be a greater variety of empirical specifications of the model presented, to convince the reader that the results are invariant to specification changes.

There may be other ways to address the issue of permit complexity. It might be possible to take a few permits that appear to differ greatly in spending and examine whether the spending differences seem to be driven by differences in permit complexity, or whether the extra spending on the more expensive permits does not seem to have any justification. This may be valuable evidence even if analyzing all the permits in the sample would require too much effort. In any event, there should be greater effort paid to justifying the characteristics that are supposed to affect only overspending and not permit complexity. There could also be a clearer motivation behind the analysis, to help clarify the interpretation of the results: is spending more of a proxy for greater environmental concern by firms (which might be good) or is it just wasting money (presumably bad)?

The third paper by Sharfman examines four case studies of environmental innovations, seeking to find out how regulatory stringency, organizational flexibility, and other factors affect the process of adopting an environmental innovation. The case studies mix high and low intensity regulations with product and process innovations, to compare differences in results across the different settings. A model of the determinants of innovation is applied to the different settings, comparing its theoretical implications with the actual results of each case.

In one sense, this paper is more about "beyond" compliance than "over" compliance. Environmental innovation shifts the set of choices available to the firm. It can produce a new product or produce an old product in a new way. It is often characterized as a "win-win" situation and provides less of a sense of tradeoff between benefits and costs when compared to the traditional model. There is also a sense of discontinuity and inframarginal decisions, as compared to the smooth curves in the traditional compliance model with its MC=MB equilibrium.

One of the four case studies in the paper does identify a novel way of thinking about overcompliance. By introducing a new vapor recovery technology, Conoco was able to reduce emissions from sixteen natural gas wells to essentially zero, thereby removing them completely from the regulatory requirements (by becoming such small sources of pollution that they were no longer covered by the regulations). In effect, Conoco innovated "out from under" the regulation, and could be said to have engaged in "infinite overcompliance" (so compliant that they're not even regulated). This sounds like it might be an unusual situation, but it has parallels in other settings where firms might choose to lower their operating levels (or choose not to grow) in order to fall below some lower limit for regulated plants and hence avoid the regulation entirely.

Although many interesting details about the cases are presented, the very different regulatory environments faced across the case studies limits the sense of a "controlled 2x2" experiment that seems to have been desired. It might have been useful to study failures as well as successes or to have examined other companies that were less "high-performing" in terms of innovation. Still, the paper's results underscore the importance of considering the institutional setting in which environmental innovation occurs when deciding how best to encourage that innovation.

Having examined three papers on the topic of "overcompliance," what have we learned? First, that it is difficult to define what is meant by "beyond" or "over" compliance. It is also not always obvious why we (academics, regulators, firms, or society) should necessarily care about the papers' results — should we expect firms to be always at the limit of their water discharge permits; is spending more money on air pollution permits a bad thing? These papers point out the need to define the research agenda carefully, both its terms and its goals, to try to ensure that the research results will be useful.

There are some research questions that emerge. When do firms "voluntarily" reduce emissions or go beyond the minimum legal requirements and why? When do firms develop environmental innovations and why? There are reasons why we should care about these questions. Voluntary reductions may be cheaper, both politically and technologically. Environmental innovations may provide bigger and cheaper pollution reductions than can be obtained by ever-greater applications of existing control technologies. There are also problems that arise. What about firms that won't act voluntarily? What about the opportunity costs of focusing R&D effort on environmental controls rather than other technological advances?

These papers have raised many important research questions, some of which can be answered with revisions to their current analyses, and others of which will require new datasets and new analyses. All in all, an interesting start on a difficult topic.

Discussion of Session II Papers

by Jon Silberman, US EPA Office of Enforcement and Compliance Assurance

A written version of Mr. Silberman's remarks was not available for publication. The following is an editor's summary.

Jon Silberman began by observing that he was an enforcement attorney, not an economist, statistician, or engineer. As such, he directed his comments more to the practical policy implications of the research than to statistical or methodological issues.

Mr. Silberman distinguished between the terms "overcompliance" and "going beyond compliance." Overcompliance is a term of art unique to economists. The rest of the world – government, industry, NGOs, and citizens all speak of "going beyond compliance." That is important, because each term carries its own biases. Like over-eating or over-sleeping, over-compliance has a negative connotation of excess and inefficiency. "Beyond" has a positive connotation. Going beyond compliance connotes "pushing the envelope" and "surpassing preconceived limitations" to achieve better and more protective results than ever before.

He noted a widespread acknowledgement today among most commentators that going beyond compliance is a positive outcome both for the environment and the "bottom line." EPA and many states have come to see promoting results that go beyond the minimum requirements of current and prospective rules as the only route to environmental sustainability. Progressive industries are addressing sources of both regulated and unregulated pollution.

From a legal standpoint, the policy behind some pollution laws, notably the Clean Water Act, calls for zero pollution. The law considers a firm that elects to discharge at any level below its maximum permitted levels to be complying, not overcomplying. From a practical standpoint, no engineer would design a facility to put out precisely the maximum amount of pollution allowed. Such a design would not allow for growth or operational changes. It would not allow for the inherent variability of pollution control systems, especially ones like publicly owned treatment works (POTWs) that rely on living organisms to treat the waste. And it would not allow for unpredictable variations in internal and external factors.

Turning to DeHart-Davis and Bozeman's Clean Air Act Title V study, Mr. Silberman found the paper troubling in several respects. First, he took issue with the assumption that higher permit application costs equate to over-compliance. Second, he criticized the "compromise" proxy controls that the study authors used to account for differences in permit complexity, declaring the compromises to be blunt and unsupported by empirical evidence.

To get an accurate picture of the complexity of the permit application, one needs to know specific details of the applicant's circumstances. A key detail is how well the applicant understood its emissions and obligations before it started the Title V process. One of Congress's purposes in passing Title V was to make firms aware of the complete set of requirements they had under the Clean Air Act. For many facilities, getting a Title V permit was like making a long-postponed trip to the dentist — costly and painful, like a root canal for firms that were not already on top of their clean air obligations.

He noted that full compliance with Title V has benefits for the applicant, as well. After getting a permit, the applicant maximizes its legal certainty. It knows, in writing, exactly what operating requirements it will be expected to comply with, what it must do substantively to comply, as well as what it must do, in terms of monitoring and recordkeeping, to prove that it is in compliance. Many companies also learn quite a bit more about their processes and the potential for enhanced pollution prevention opportunities in the process.

Turning to Sharfman's paper, Mr. Silberman found many of the hypotheses, such as that people will do less of something when doing so becomes more costly or risky, to be straightforward, perhaps even obvious. But there is great practical value in exploring the decision-making processes inside the corporate "black box," to understand the impact of external factors on internal corporate policies that promote or retard environmental innovation.

For example, in the TYVEK case, production personnel originally resisted use of recycled materials. Silberman expressed a wish for more specifics in the final version of the study as to precisely how these objections were overcome on personal, financial, and institutional levels. In all the case studies, it would be interesting to learn more about how management became sold on the innovations, given how problematic it can be to quantify the future economic benefits of environmental initiatives.

Such research could have practical implications for EPA. In setting best management practices, EPA traditionally has focused more on capital equipment and its operation rather than on corporate policy and management. EPA might consider additional steps to promote management practices should include broadly transferable planning and decision-making practices that result in better environmental performance.

Regarding Horowitz and Bandyopadhyay's Clean Water Act presentation, pointed out some practical reasons why discharge levels are often considerably below permit levels.

But first he addressed some incidental points. He pointed out that "emissions," a term used throughout the paper, is an air term. Under the Clean Water Act, releases are referred to as discharges. This is important because it suggests the need for further peer review of the paper by Clean Water Act experts. Also, he raised some legal matters, noting that not all permits are based on currently available technology (e.g., when total maximum daily loads are involved) and that EPA can and sometimes does enforce daily and weekly concentration limits, not just broader averages, providing several examples of specific enforcement actions where that was the case.

To understand why facilities almost always discharge well below their permit levels, Mr. Silberman explained, you must appreciate how permit writers actually set the levels and why facilities need to be designed to discharge below their permit maximums. Mr. Silberman gave a short overview of POTW technologies. Based on that, he offered some technical reasons for discharging below permit biochemical oxygen demand (BOD) limits. First, BOD may drop as a side effect of reducing total suspended solids (TSS) below permit requirements. Second, operators may tighten BOD controls to improve the performance of tertiary treatment for ammonia. Third, the tertiary treatment itself may lower BOD levels.

Next, he offered some reasons based on foreseeable trends in regulation and urban growth. Over time, effluent limits will tighten and urban areas will grow. Permit writers, plant designers, and operators understand this. POTW designers build their plants anticipating the need for future capacity and the probable need to meet tighter future regulatory standards. Permit writers often base maximum discharge limits on the plant's full design capacity, even if it is running well under capacity. The result is that most plants can function well below permit limits during normal operation.

Further, some plants are running under outdated permits. When permits expire after five years, busy regulators sometimes extend them administratively rather than immediately rewriting them. Meanwhile, the plant operator may be anticipating changes in the standards or may be replacing worn systems with new, more efficient ones. The result is a facility that operates well below its maximum permit limits.

Mr. Silberman also noted that the compliance test for BOD is relatively more variable than tests for some other water pollutants, for example, TSS. The BOD test can take five days and involves placing the sample in a biological incubator. A wise operator adds a safety cushion in projecting his discharges, to avoid being knocked over the limit by a high test result.

He also pointed out that POTWs are complex systems combining physical equipment and human operators. System performance tends to improve as the operators gain experience with the system or adopt better management and operation techniques. At the same time, operators and designers know that complex systems sometimes behave in unexpected ways, and so they design and operate them conservatively. They avoid pushing the permit limits.

Finally, reported BOD levels may not always correspond to actual levels. For example, recent research by Nadeau of the Eastern Research Group found, among other things, that BOD levels seemed to actually increase following some federal inspections. If correct, this may be due to the inspectors correcting improper sampling methods, not because pollution is truly increasing. Rather, compliance is increasing.

Question and Answer Period for Session II

The following editor's summary describes an exchange that occurred after one of the presentations as well as the discussion during the Question and Answer Period.

At the end of Leisha DeHart-Davis and Barry Bozeman's presentation, Ronnie Levin of EPA Region I asked them how they knew whether firms were over-complying with the Title V requirements.

DeHart-Davis replied that they were measuring over-compliance indirectly and defining it procedurally, as excessive information in the permit application.

Levin asked how they measured the amount of information.

DeHart-Davis replied that they measured the amount indirectly using the sums of facility permitting costs.

Levin asked, did they simply decide that the firms spending more than average were over-complying?

DeHart-Davis said no.

Levin then asked how they decided what was over-compliance.

DeHart-Davis replied that they did not gauge what was over-compliance. They just looked at factors driving up costs and tried to see if those costs made sense from a compliance standpoint.

Bozeman explained that they looked at the costs of various items and noted that some firms were far from the median costs, even with other factors such as size controlled. Of course, one could ask whether they had indeed controlled for all the relevant factors. Perhaps there are some random costs that are very high. They are aware of the possibility.

Levin expressed doubt that the study really spoke to over-compliance.

Bozeman said he believed that the issue here was simply a matter of concepts, and what they measured was evidently not the questioner's notion of over-compliance.

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After the discussants' presentations, Ann Bostrom, the moderator, invited the speakers to respond to the discussants' comments.

John Horowitz said he found the discussants' comments encouraging. Obviously, we have much still to learn. However the idea that plants are building in capacity because they want

flexibility corresponds to what he and his co-investigator Sushenjit Bandyopadhyay were finding.

Bandyopadhyay generally concurred with Horowitz.

Barry Bozeman remarked that over-compliance with the process requirements of Title V is not in itself good. On the other hand, it is not necessarily bad. It is good to the extent that Title V promotes pollution control. However, we do not know if it does. Silberman had said that applying for your first permit can be like going to the dentist after many years of neglect — you may discover a number of painful problems, but you are better off in the end. Bozeman said it was more like going to the dentist to be part of a research project, providing data, but not being sure you would get any benefits from the research.

Bozeman supported the discussants' call for further research, though he noted some of the issues they raised would be difficult and expensive to analyze.

Leisha DeHart-Davis also questioned Silberman's dental analogy. She noted that their research only looked at the permit application process — the preparation for the dental visit. The evaluation of problems by the "dentist" at the state agency had not occurred yet.

Jon Silberman saw DeHart-Davis's point, but argued that some self-evaluation takes place while preparing the permit application. Firms do not want to risk submitting data that look bad.

DeHart-Davis noted that state agencies were so backlogged, there really was not much of a price to pay for a submitting poor information. Only the regulators suffered.

Bostrom asked Mark Sharfman about suggestions for future research.

Sharfman noted that he had other studies underway. One thing he hoped to do was to involve non-governmental organizations in surveying their members and affiliated organizations to help generate data for the studies. Businesses are so overwhelmed by surveys they often don't want to respond.

From the audience, Paul Buellesbach of the Eastern Research Group asked DeHart-Davis if their study just covered the application process or looked at expenses through full approval.

DeHart-Davis replied that the study just looked at application costs.

Buellesbach wondered if the research correlated costs with the quality of the permit application. Firms often face further costs if they submit poor quality applications. He would not be surprised to find that those who paid less up front paid more later.

DeHart-Davis agreed that it was an interesting research question, but one they couldn't cover in their study.

Buellesbach noted that there was a wide variety in the quality of permit applications.