PROCEEDINGS

BEYOND COMPLIANCE: WHAT MOTIVATES ENVIRONMENTAL BEHAVIOR?

SESSION ONE: SELF-REGULATION OF ENVIRONMENTAL BEHAVIOR

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Session I

Introduction

Introduction to the Workshop

by Peter Preuss, Director, US EPA National Center for Environmental Research

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

Director Preuss welcomed the participants to the "Beyond Compliance" workshop, the seventh in a series of environmental policy and economics workshops sponsored by the EPA and the National Science Foundation. He noted that their joint effort had been going on for some time. The National Center for Environmental Research was created in 1995 as part of a reorganization of EPA. It immediately began a partnership with the NSF to bring together different scientific communities and focus them on issues important to both organizations. He praised these efforts as producing both extremely successful and groundbreaking work. Both sponsors are pleased, he said, about what has been accomplished over the past five to six years. For the past few years, this work has been done together with one of EPA's offices, the Office of Policy, Economics and Innovation. He credited them with having the lead role in the agency in applying the kind of research the participants have been doing in order to assist EPA in trying out innovative approaches and methods. The cooperative effort has been a wonderful amalgam of the work of people inside and outside the agency, Preuss concluded.

Keynote Remarks
by Jay Benforado, Deputy Associate Administrator, US EPA Office of Policy, Economics and Innovation

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

Administrator Benforado prefaced his remarks by saying that he believes the EPA and the country's environmental protection system are one of the great successes of the United States, indeed one of its top five, post–World War II successes. The country had a problem, environmental quality, and in 1970 began to build a system of laws, regulations, standards, permits, monitoring, inspection, and enforcement that produced enormous strides in the quality of our lives. The reason he was excited about this conference, he said, is that increasingly in the policy debate about the environment there is a feeling that compliance as an end point no longer makes sense. While compliance is critically important for the system, it is no longer the goal.

To set the stage for his own comments and the day's discussions, he turned first to some of the criticisms of EPA and how it operates. Philip Howard in his book "The Death of Common Sense" says that regulatory agencies have become so prescriptive that what lawyers tell them to do doesn't make sense. The thesis of "The Environmental Protection Agency: Asking the Wrong Questions: From Nixon to Clinton" is that we have become so technocratic in how we protect the environment that we have lost the social values that need to be embedded in environmental policy. Also, the author says EPA needs to do more outreach to people as it designs programs. Malcolm Sparrow in his book "The Regulatory Craft" says as agencies age they ossify and loose the ability to problem solve. Stephen Breyer, before he became a Supreme Court Justice, wrote in his book "Breaking the Vicious Circle" that the system is out of sync — public concern drives legislation which in turn creates agency programs addressing problems that are not fully understood.

Second, Benforado pointed to the emerging set of new programs, such as the 33/50 Program, Indoor Air, Energy Star programs, and Performance Track programs. He said he would argue that EPA is operating essentially two systems — the current system of standards, regulations, permits, inspections, and enforcement and increasingly a new and evolving system. He sees trends towards place-based solutions (designed specifically, for example, for water sheds, cities, or ecosystems), whole facility solutions, and a change in roles for regional, state, and local programs in relation to national programs. He also sees the new power of information, which is driving some of these changes.

Cataloging some other trends, he began by quoting Amory Lovins, the founder of the Rocky Mountain Institute: "The Stone Age didn't end because we ran out of stones." In other words, the system changed because we found a better way to do it. That, Benforado said, was what he thought this conference was really about. Business and society are changing and we are seeing an increasingly interconnected world. NGOs are communicating more effectively with each other and are becoming more sophisticated in communicating with business. Businesses are beginning to understand the value of corporate accountability and responsibility. Initiatives changing the paradigm of environmental protection are proliferating. Environmental compliance, while important, is no longer the primary goal. All of these trends have profound implications — for the business community, for researchers in how they frame studies, for government in how it sets up its programs, and for NGOs in terms of how they participate in the process.

He gave some examples to illustrate these changes. First, he pointed to Baxter, a global medical products and services company with over $7 billion in sales and 40,000 employees. They have begun in the last couple of years to do environmental reporting through an innovative "environmental financial statement." Baxter has reduced CFC and toxic air emissions by 72 percent since 1996 and is on track to reduce regulated wastes — hazardous, medical, and radioactive — by 35 percent between 1996 and 2005. More importantly, they are measuring waste per unit of production, a more accurate measurement than other methods. They have set a goal to reduce packaging volume by 20 percent between 1995 and 2005. Water use is up because of new facilities coming on line but they have done better with energy use. Having achieved their original net energy reduction of 10 percent by 2005, they set a new goal of 30 percent. The company has brought in outside environmental auditors; 35 of their facilities are certified in ISO 14001. Their efforts go beyond the environment, which Benforado sees as a promising trend. Baxter has employment standards in place to ensure fair treatment of employees, and despite a 6 percent increase in workplace injuries in 1999, they report an overall 28 percent reduction since 1996 and have set a goal of a 60 percent reduction by 2005.

Other examples he gave were Royal Dutch Shell Group, which has done similar types of reporting and Ford Motor Company, which has issued its 2000 "Corporate Citizen Report." Johnson and Johnson and IBM recently signed up for EPA's Performance Track Program. The program is a new effort at EPA that is emblematic of the topic of this conference, he said. Companies need a strong compliance history to get into the program and once in must have a documented EMS, an outreach program, and measurable goals that go beyond compliance.

He stated his belief that the information revolution underlies the current trends in environment and sustainability policies. First, investors, regulators, neighbors, and NGOs use information to get a more complete picture of a company's economic, social, and environmental performance. A second trend is the development of new institutions organized around information — groups such as Business for Social Responsibility, the World Business Council for Sustainable Development, the Coalition for Environmentally Responsible Economies, or CERES, the Global Reporting Initiative, and the Dow Jones Sustainability Index. Another trend is work on performance measurements to create metrics that are reliable, accurate, and comparable. The fourth is the growing sophistication of the activist NGO community, from socially responsible investment funds to groups focused on particular environmental and social issues, targeting companies such as Nike, Monsanto, and Shell.

Benforado posed the question: "What is it that motivates companies?" In his opinion, from the company's perspective, it always comes down to cost. The initial motivation is cost reduction. The second motivation is revenue opportunity — creating new products, new ways to deliver services, and the building of new markets. Increasingly organizations are motivated to create goodwill. Recognition and image are important in a competitive world. Though difficult to quantify, businesses are finding that openness, even with all of its challenges, generates a lot of valuable goodwill.

The conference, he said, can be an important step in helping understand these trends of going beyond compliance and in reflecting on the implications of the participants' work.

He concluded with four thoughts epitomizing why change is happening in environmental protection. First, environmental problems are changing. This is key, he said. When EPA was founded there was a set of problems arising mainly from large point sources of pollution. Now the problems tend to be those of smaller sources, as well as habitat, products, land use, fisheries, and endangered species. Second, EPA has a new array of tools in its toolbox, such as information and market-based tools. The third is changing roles. It is not just the government's job to protect the environment. There is a huge role for business and increasing roles for different levels of government — regional, state, and local — as well as for communities, and most importantly, for citizens. The fourth change is the shifting paradigm of environmental protection towards the concepts of pollution prevention and sustainable development.

He closed his remarks saying that he would be particularly interested in the participants' thoughts about the role of government in these issues and how EPA could play a positive role in the changing nature of environmental protection.

Additional Remarks
by Rachelle Hollander, Program Director, Division of Social and Economic Sciences, Directorate for Social, Behavioral and Economic Science, National Science Foundation

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

Dr. Hollander welcomed the participants on behalf of the National Science Foundation and Margaret Leinen, Assistant Director of the Directorate of Geosciences at the NSF. She welcomed the researchers and thanked them for going through the long and arduous process necessary to receive funds from the program and for the work they were doing. She noted that the cooperative agreement between the EPA and the NSF is an important and long standing one. For two federal agencies to work together in this way over a number of years, she said, while not unprecedented, is certainly impressive. She thanked her colleagues at the NSF and at the workshops, and in particular, at the EPA for promoting these kinds of events, which help assess the merits of the program's activities and chart its future direction. It takes a lot of goodwill on behalf of the agencies and their staff to have these programs succeed. The EPA and the NSF have a common interest in fostering research in the social, economic, and behavioral sciences on environmental issues, she observed. Both agencies recognize the importance that citizens of the United States place on environmental health and benefits. Both recognize that results from this research can be used to identify and assess solutions to environmental problems. In closing, she said she looked forward to their continuing cooperation.

VOLUNTARY ENVIRONMENTAL STANDARDS: FURTHERING MORAL SUASION WHILE PREVENTING MORAL HAZARD *

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Abstract

Industry self-regulation, the voluntary association of firms to control their collective action, has been proposed as a complement to government regulation. Proponents argue that the establishment of such structures may institutionalize environmental improvement, while critics suggest that without explicit sanctions such structures will fall victim to opportunistic behavior. In a study of the Chemical Manufacturer Association's Responsible Care program we investigate the predictions of these two contradictory perspectives. Our findings highlight the potential for opportunism to overcome the isomorphic pressures of even powerful self-regulatory institutions and suggest that effective industry self-regulation is difficult to maintain without explicit sanctions.

Editor's Note

Besides the research presented in Prof. King's paper, Prof. King's talk also touched on recent work he and colleagues have done on ISO 9000 and 14000 standards. They have looked at how initial adopters affect subsequent adopters under ISO 9000. As expected, they found that if initial adopters in a particular industry were low-quality operations, other firms in that industry were discouraged from adopting the standard. To their surprise, though, they found a similar effect when initial adopters were especially high-quality operations. The reasons remain unclear.

Prof. King has also been studying what encourages firms to adopt the ISO 14001 standard. He is exploring possible factors such as industry size, foreign ownership, prior adoption of ISO 9000, and environmental performance of the firm and the industry.

Readers can find papers dealing with these topics on Prof. King's web site, http://www.stern.nyu.edu/~aking.

New types of environmental regulation are emerging. The old antagonistic "command and control" relationship between government and industry is changing, and opportunities now exist for new actors to create "a middle way between government regulation and laissez-faire prescriptions (Rees, 1997)." Industry self-regulation is emerging as one important component of this "middle way". In industries as different as television broadcasting and chemical production, firms are discovering that by banding together and self-policing they may placate concerned stakeholders and forestall government regulation. Over a dozen industry associations have formed environmentally oriented self-regulatory programs in the last ten years (Nash & Ehrenfeld, 1995).

Despite growing interest, few large-scale studies have systematically explored the effect of industry self-regulation. To meet the need for systematic evidence, researchers at the Stern School of Business (supported by an EPA grant) have begun to investigate several examples of industry self-regulation. To date, the team has most completely investigated the chemical industry's Responsible Care program. The team chose to begin with this program because Responsible Care has been called "the most significant and far-reaching self-regulatory scheme ever adopted (Gunningham, 1995: 61)." It is now being copied by many industries worldwide.

Proponents of industry self-regulation argue that it will provide a more effective means of compensating firms for environmental improvement. Firms will choose to participate in these programs either to obtain some direct benefit from the required practices or to provide evidence of superior environmental performance to investors, consumers, and other stakeholders. If industry self-regulation is to achieve its promise, it must encourage firms to improve their environmental performance so as to meet the requirements of membership or it must encourage low performing firms to improve their performance once members. It also must provide participating firms a financial reward for this improvement.

In our research we have found evidence that the program does not yet meet these criteria for success. We find that firms participating in Responsible Care have higher emissions than similar non-participating firms, and we find that they reduce their pollution more slowly. In my presentation, I will summarize our research on Responsible Care. I will then discuss some of the implications of these findings, what new questions they raise, and how we plan to answer these questions through our ongoing research.

The paper below first presents the method used to perform our analysis and presents some of our findings. Finally, it discusses how these findings improve our understanding of industry self-regulation.

DATA & MEASURES

Sample

To analyze the performance of Responsible Care, we collected data from a number of sources. Environmental performance data were collected from the EPA's Toxic Release Inventory (TRI). These TRI reports constitute one of the few longitudinal data sets of facility environmental performance in the Unites States. Previous research using TRI data has been performed predominantly at the company level (Levy, 1995; Hart & Ahuja, 1996). In part, this is because the TRI does not include information about the production volume of facilities, making it difficult to control for size differences. Fortunately, TRI does report Dun and Bradstreet (D&B) numbers. Matching the D&B number with the Duns Database, we were able to acquire data concerning the number of employees at each facility in 1996. To fill in employee data for earlier years, we calculated the size of the facilities using the ratio of production in one year to the previous year as specified in the TRI. For years prior to 1990, when the production indexes were first required, we used facility trend information from Dun and Bradstreet and industry trend information from the National Bureau of Economic Research to estimate facility size information. With these data in hand, we were able to construct two databases: 1) a facility level database, and 2) a company level database constructed from aggregate facility level data.

The chemical industry is usually defined as those facilities and firms in SIC 28, and we restricted our sample to this set. The final sample consisted of 22,476 observations at the facility level and 12,829 observations at the firm level over the entire period, 1987-1996. Those observations correspond to 3606 facilities belonging to approximately 1500 firms. Of the total number of firms, 130 were members of the CMA and participated in Responsible Care in 1990. By 1996, that number had grown to 160. Responsible Care participants, due to their size, account for a much larger share of facilities, representing roughly one third of all facilities in any given year. A small number of Responsible Care participants (l0) were not included in the analysis because they did not actually produce in the chemical industry (as defined by facility-level SIC codes). For example, some petroleum companies (SIC 29) are members of Responsible Care even though they have no direct chemical production.

Measures

Environmental performance (*Relative Emissions, Sector Emissions*). Two hundred and forty-six chemicals have been consistently a part of the TRI database. Although all are nominally "toxic" at some dose, they differ widely in their impact. The TRI database includes, for example, chlorine gas and phosgene (both chemical war agents) and food color and methanol. To correct for these differences, we weighted each chemical by its toxicity. The weighting scheme we chose was developed by the EPA to serve as a threshold for reporting accidental spills — the "reportable quantities" (RQ) database in the CERCLA statute. For highly toxic chemicals (e.g. arsenic), emergency action must be taken for any accidental release of one pound or more. For relatively benign chemicals like isopropyl alcohol, the limit is 5000 pounds. Reportable quantities may take on a number of values in between. The toxicity weight for an individual chemical is calculated as the inverse of its reportable quantity. Aggregate releases for a given facility in a given year (E_{it}) were constructed by summing the weighted releases of the 246 common chemicals in the TRI database.

$$E_{it} = \sum_{\forall c} w_c e_{cit} \quad (1)$$

where E_{it} is aggregate emissions for facility i in year t, w_c is the toxicity weight for chemical c in year t, and e_{ci} is the pounds of emissions of chemical c.

Previous research at the company level has simply aggregated toxic emissions from the facility level. This ignores however, that toxic emissions are strongly influenced by facility size and the product being manufactured. We chose instead to construct a standardized measure at the facility level (*Relative Emissions*) and then to aggregate these comparisons to create firm performance. The first step in this process was to develop an environmental performance measure for each facility that allowed for meaningful comparisons across facilities. To do this, we estimated the production function between facility size and aggregate toxic emissions for each 4-digit SIC code within each year using standard OLS regression. The relative environmental performance of a facility (RE_{it}) is given by the standardized residual, or deviation, between observed and predicted emissions given the facility's size and industry sector. Thus, if a facility emits more than predicted given its size and SIC code, it will have a positive residual and a positive score for environmental impact.

$$RE_{it} = E_{it} - E^{*}_{it} \quad (2)$$

$$E^{*}_{it} = \alpha_{jt} + \beta_{1jt}\, s_{it} + \beta_{2jt}\, s_{it}^{2}$$

where E^{*}_{it} is predicted emissions for facility i in year t, s_{it} is facility size, and α_{jt}, β_{1jt}, and β_{2jt} are the estimated coefficients for sector j in year t. Note that our facility measurement does not directly consider environmental impact. Rather it measures a facility's performance relative to its sector in that year. The average of these facility scores thus gives a good estimation of how well a firm manages its facilities with respect to emissions.

To create a corporate level of performance, we created a weighted average of these facility-level scores. We weighted the scores by the percentage of total production that each facility represented for the company.

$$RE_{nt} = \sum_{\forall i \text{ in } n} (s_{it}/s_{nt}) RE_{it} \quad (3)$$

where RE_{nt} is weighted relative emissions for firm n in year t, s_{it} is facility i size in year t, and s_{nt} is firm size. Note that our measure of corporate performance does not consider whether or not a company has chosen to operate in dirty or clean segments of the industry. Sectors differ widely in their emissions. Some like industrial gases (SIC 2813) have few emissions, while others like cellulosic manmade fibers (SIC 2823) emit dangerous chemicals. We calculate the dirtiness of the sector as the total emissions for the sector divided by the total number of employees in the sector, i.e., emissions per employee. We create a firm-level measure (*Sector Emissions*) by aggregating the dirtiness of the mix of sectors in which a company owns a facility. In performing this aggregation, we use a weighted average, using the percentage of the company's total production in each sector for weights.

$$IE_{nt} = \ln\left(\sum\nolimits_{\forall i \text{ in } n} (s_{it}/s_{nt})E_{jt}\right) \tag{4}$$

$$E_{jt} = \sum\nolimits_{\forall i \text{ in } j} E_{it}$$

where IE_{nt} is weighted industry emissions for firm *n* in year *t*, and E_{jt} is total toxicity-weighted emissions for industry *j* in year *t*.

Environmental improvement (*Absolute Improvement*, *Relative Improvement*). To explore Responsible Care's influence on the environmental performance of chemical firms, we created two measures of annual improvement in environmental performance. *Absolute Improvement* (AI_{nt}) is measured as the percent change in total weighted emissions over a one-year period.

$$AI_{nt} = -\left(E_{n(t+1)} - E_{nt}\right)/0.5\left(E_{n(t+1)} + E_{nt}\right) \tag{5}$$

$$E_{nt} = \sum\nolimits_{\forall i \text{ in } n} E_{it}$$

where E_{nt} is total emissions for firm *n* in year *t*. *Relative Improvement* (RI_{nt}) measures the change in relative emissions over a one-year period.

$$RI_{nt} = -\left(RE_{n(t+1)} - RE_{nt}\right) \tag{6}$$

Responsible Care participation (*Responsible Care*). CMA membership, and thus participation in Responsible Care, is coded as a binary variable. Using data provided by the CMA, a firm, and/or its facilities, is coded as a participant in Responsible Care in each year of membership. 1990 was chosen as the base year for participation since Responsible Care was not ratified by CMA members until October of 1989. In some rare cases, facilities or business units but not entire companies are members, and we coded these accordingly.

Organization size (*Size*). Organization size (*Size*) was measured using employee information from Dun and Bradstreet. Firm size is simply the log of the sum of all employees at all of their facilities. While there are other acceptable measures of firm size (e.g., assets and sales), employee data is the best information available for both public and private firms. For the firm data for which we have both asset and employee data (343 publicly traded corporations), the logs of employees and assets were highly correlated (75.5%).

Focus within chemical industry (*Focus*). To estimate the degree to which each firm focuses on chemical production, we created a variable that is the ratio of the log of the total employees in facilities within the chemical industry over the log of employees in the total company. Thus, the variable grows with the degree to which the company is focused within the chemical industry.

Firm visibility (*Visibility*). Firm visibility is coded as a continuous variable. Students at the Stern School of Business were asked to indicate if they recognized a company's name or knew any of its brands. To keep the surveys small enough to maintain the student's interest, companies were randomly distributed among seven surveys, and these surveys were randomly distributed to Stern MBA students. Between 25 and 35 students responded to each of the seven surveys. Visibility represents the percentage of those students who recognized a company's name and/or brand over the number who were asked to respond for that company. Visibility varies from zero to one where one signifies that all respondents recognized the company.

TABLE 1a
Descriptive Statistics (1990-1996)

Variable	Description	Mean	Standard Deviation	Minimum	Maximum
Responsible Care	Whether or not a firm participates in Responsible Care	0.086	0.281	0	1
Relative Emissions	Average relative emissions of facilities based on sector and size	-0.103	0.800	-3.760	5.629
Sector Emissions	Average total emissions of sectors	1.326	1.167	0	6.217
Focus	Ratio of chemical production to total production (using natural log of employees)	0.774	0.400	0	1
Visibility	Degree to which a firm's name or its brands are recognizable	0.037	0.132	0	1
Size	Natural log of firm employees	4.921	2.061	0.018	12.965
Absolute Improvement	Annual percent improvement in total weighted emissions	0.094	0.761	-2	2
Relative Improvement	Annual improvement in relative emissions	-0.008	0.397	-3.579	3.437

Note: n = 10832, except for *Absolute* and *Relative Improvement*, where n = 8908

TABLE 1b
Correlations (1990-1996)

	1	2	3	4	5	6	7
1. Responsible Care							
2. Relative Emissions	0.079 *						
3. Sector Emissions	0.270 *	-0.039 *					
4. Focus	-0.071 *	-0.044 *	0.039 *				
5. Visibility	0.271 *	0.025	0.017	-0.179 *			
6. Size	0.300 *	-0.011	0.039 *	-0.595 *	0.385 *		
7. Absolute Improvement	-0.005	0.116 *	-0.013	-0.028 *	0.020	0.042 *	
8. Relative Improvement	-0.004	0.255 *	-0.006	-0.015	0.014	-0.004	0.514 *

Note: $n = 8908$, * $p < 0.001$

ANALYSIS & RESULTS

Formation and Membership

To explore what kind of firms join the Responsible Care program we used a probit model. Our model specifies the likelihood that a given firm within the chemical industry will be a member of CMA and participate in Responsible Care, and this is our dependent variable. Our independent variables include our measures of environmental performance, firm focus, firm visibility, and firm size. The specification of the probit model is as follows:

$$\text{Prob}\ (\textit{Responsible Care} = 1) = \Phi(\beta' \boldsymbol{x}) \qquad (7)$$

where the vector $\boldsymbol{x}$ includes *relative emissions*, *industry emissions*, *focus*, *visibility*, *size*, and a constant. We estimate the model for three samples: all chemical firms at the inception of Responsible Care (1990), subsequent entrants to Responsible Care and non-Responsible Care firms from 1991-1996, and exiters from Responsible Care and non-Responsible Care firms from 1991-1996. The latter two analyses are included to see if entrants and exiters post 1990 shared the same characteristics of firms participating in Responsible Care in 1990.

Our analysis suggests that those firms that are more greatly influenced by the industry's reputation will more frequently participate in Responsible Care. As shown in Table 3, we found that in 1990, the time of formation of Responsible Care, larger companies within the chemical industry participated disproportionately often. Our data also suggested that firms whose business was focused in chemicals would more frequently be members of Responsible Care. We also found evidence that more well-known companies more frequently joined Responsible Care.

Our data also suggest that "dirtier" firms participate in Responsible Care. We found that companies with weaker environmental performance relative to their sectors (*Relative Emissions*) were more likely to participate in Responsible Care. Likewise, companies in dirtier sectors (*Sector Emissions*) were more likely to participate.

TABLE 2
Probit Estimates of Responsible Care Participation

	1 Responsible Care (Membership in 1990)		2 Responsible Care (Entrants: 1991-1996)		3 Responsible Care (Exiters: 1991-1996)	
Relative Emissions	0.237	***	0.128	*	0.198	*
	(0.069)		(0.066)		(0.091)	
Sector Emissions	0.448	***	0.256	***	0.207	***
	(0.049)		(0.046)		(0.061)	
Focus	0.468	**	0.532	**	-0.027	
	(0.160)		(0.172)		(0.226)	
Visibility	1.235	***	0.237		0.526	
	(0.314)		(0.332)		(0.436)	
Size	0.244	***	0.240	***	0.131	**
	(0.032)		(0.036)		(0.049)	
constant	-4.027	***	-4.735	***	-3.916	***
	(0.292)		(0.335)		(0.422)	
n	1508		8552		8507	
c^2 (*df*)	242.38 (5)	***	87.50 (5)	***	32.32 (5)	***
R^2 (pseudo)	0.2911		0.1557		0.1197	

Note: Incumbent Responsible Care participants are not included in the entrant and exiter models.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

We found no evidence to suggest that the membership of Responsible Care is changing over time. As also shown in Table 3, we find little evidence that companies entering or exiting are different from incumbent members. We find no evidence that dirty companies are rushing to join Responsible Care or that clean companies are leaving to avoid being "tarred by the same brush". With respect to the measured attributes, the characteristics of the members are relatively stable.

Effect on Environmental Performance

We estimate a number of models to explore the effect of Responsible Care on environmental performance in the chemical industry. As dependent variables, we use our two measures of improvement in environmental performance: *Absolute Improvement* and *Relative Improvement*. We estimated models using both a robust GLS regression with White's correction for heteroskedasticity (White, 1980) and a fixed-effects specification. The specification for the robust GLS model is:

$$Improvement = \beta' \boldsymbol{x} + \delta \, Responsible\ Care + \varepsilon \qquad (8)$$

where the vector $\boldsymbol{x}$ includes *relative emissions*, *industry emissions*, *focus*, *visibility*, *size*, and a constant. White's correction for skadasticity is employed to address concerns that for some independent variables, variance may increase with the size of the variable; specifically, that any measurement error in the extrapolation of firm size data will be more pronounced in larger firms.

A common issue arising during the analysis of longitudinal data sets is unobserved heterogeneity in the units under study. Unobserved heterogeneity may result in incorrect inferences concerning the magnitude and significance of individual effects. To control for unobserved heterogeneity, we estimated a fixed-effects model with specification:

$$Improvement = \alpha'\boldsymbol{d} + \beta'\boldsymbol{x} + \delta\, Responsible\ Care + \varepsilon \quad (9)$$

where the vector ***d*** is a set of dummy variables corresponding to each unit (e.g., firm or facility) under observation. Note a random effects specification was rejected because the assumption that the random error associated with each cross sectional unit is not correlated with the other regressors did not hold under a Hausman test (Hausman, 1978).

TABLE 3
Estimates of Relative Improvement Since Inception of Responsible Care (1990-1996)

	Firm Level		Facility Level	
	1 Robust GLS	2 Fixed Effects	3 Robust GLS	4 Fixed Effects
Responsible Care	-0.045 **	-0.070	-0.021 **	-0.009
	(0.014)	(0.040)	(0.008)	(0.021)
Relative Emissions	0.127 ***	0.663 ***	0.094 ***	0.647 ***
	(0.008)	(0.011)	(0.004)	(0.008)
Sector Emissions	0.004	-0.011	0.004	0.025
	(0.004)	(0.021)	(0.003)	(0.015)
Focus	-0.004	-0.008	-0.004	0.137
	(0.014)	(0.032)	(0.011)	(0.089)
Visibility	0.045		0.017	
	(0.026)		(0.016)	
Size	0.000	0.056 ***	0.003	0.034 ***
	(0.003)	(0.010)	(0.003)	(0.007)
constant	0.004		-0.012	
	(0.023)		(0.016)	
n	8908	8908	18108	18108
F (*df*)	54.55 (6) ***	717.26 (5) ***	94.59 (6) ***	1401.52 (5) ***
R^2: within		0.3329		0.3259
between		0.0186		0.0103
overall	0.0659	0.0623	0.0479	0.0473

Note: *Visibility* does not vary over time and is therefore dropped in the fixed-effects models
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Our data provide no evidence that Responsible Care has positively influenced the rate of improvement among its members. Indeed, we found evidence that members of Responsible Care are improving their relative environmental performance more slowly than non-members. In both of the robust GLS models (models 1 & 3), *Responsible Care* was significant and negative. Regressions on the firm level provided the strongest evidence. It is possible, however, that our measures do not capture all of the variance among facilities and that some of this variance is associated with Responsible Care. To correct for this possibility, we used the fixed-effect model. When this is done, the effect of Responsible Care is no longer significant. This lack of significance is do in large part to the specification of the fixed-effect model. In a fixed-effect specification the Responsible Care variable can only provide additional explanatory power if it varies over the 1990-1996 time frame. The lack of a significant effect in the fixed-effect model suggests that the late entrants (or early exiters) did not significantly change their performance after entering (or leaving). The lack of a significant effect in the fixed effects suggests caution in strongly asserting a negative influence of Responsible Care. The continuance of the same direction of influence suggests greater confidence that Responsible Care has not had a *positive* impact on rates of improvement versus non-members.

As one might expect, poor performers (*Relative Emissions*) were likely to improve faster than good performers during the next year. This may simply be the result of random fluctuations (a firm that has an accidental release one year will be a poor performer, and if this accident does not occur the next year its performance will improve). It may also be the result of increased managerial and external pressure on poor performers. Finally, poor performing firms may not have captured the "low-hanging fruit", i.e., easy, inexpensive improvements in environmental performance, making it easier for them to improve. The strong relationship between size and improvement suggests that existence of economies of scale in pollution reduction.

Note that while all four models were significant at the $p < 0.001$ level, our models explain very little of the variance (i.e., our overall R^2 statistics are small). In the case of the fixed-effects model, this may be because the cross sectional dummy variables are capturing much of the variance. This is supported by our substantially higher "within" than "between" R^2 statistics. The explanatory power is further reduced by what appears to be the "discrete" nature of emissions reductions. Emissions reductions are often the result of the implementation of new manufacturing processes or new pollution control technologies such as scrubbers. Consequently, annual improvements in environmental performance may be relatively flat for a number of years before and after a significant reduction.

Overall Rates of Improvement

To explore the effect of Responsible Care on the improvement rates for both members and non-members, we divided our panel into two periods (1987-1989 & 1990-1996) by creating a dummy variable for the years 1990-1996 and an interaction variable between our dummy and *Responsible Care*. Prior to 1990, *Responsible Care* indicates that a firm was a member of the U.S. Chemical Manufactures Association. The dummy variable for 1990-1996 indicates whether there has been a change in the industry's rate of improvement since the inception of the Responsible Care program. The interaction term captures whether there has been a change in improvement in CMA members since the inception of Responsible Care. In this way, we investigate Responsible Care's impact on the industry as a whole. Note, since *Relative Improvement* measures the change in performance relative to the industry, it cannot be used to measure changes in the rate of improvement throughout the industry. By definition, the mean improvement in relative emissions is zero in any given year for any given sector. Thus, we only estimate the impact of Responsible Care on absolute emissions.

TABLE 4
Estimates of Absolute Improvement (1987-1996)

	Firm Level		Facility Level	
	1	2	3	4
	Robust GLS	Fixed Effects	Robust GLS	Fixed Effects
Responsible Care[+]	-0.019	-0.022	0.006	0.046
	(0.034)	(0.085)	(0.021)	(0.045)
Dummy for year 1990-1996	0.108 ***	0.119 ***	0.131 ***	0.193 ***
	(0.016)	(0.017)	(0.016)	(0.015)
Responsible Care X	-0.091 *	-0.108 *	-0.074 **	-0.086 ***
Dummy for year 1990-96	(0.038)	(0.053)	(0.024)	(0.026)
Relative Emissions	0.139 ***	0.595 ***	0.145 ***	0.778 ***
	(0.009)	(0.018)	(0.006)	(0.013)
Sector Emissions	0.012	0.058	0.011 *	0.113 ***
	(0.006)	(0.034)	(0.005)	(0.026)
Focus	0.020	-0.058	0.034	0.045
	(0.021)	(0.055)	(0.019)	(0.169)
Visibility	0.014		0.031	
	(0.040)		(0.026)	
Size	0.023 ***		0.024 ***	
	(0.004)		(0.004)	
constant	-0.139 ***		-0.183 ***	
	(0.038)		(0.029)	
n	12829	12829	22476	22476
F (*df*)	42.84 (8) ***	150.28 (7) ***	91.55 (8) ***	559.29 (7) ***
R^2: within		0.0913		0.1691
between		0.0066		0.0032
overall	0.0250	0.0223	0.0343	0.0310

Note: *Visibility* does not vary over time and is therefore dropped in the fixed-effects models

[+] Prior to 1990, *Responsible Care* represents membership in the U.S. Chemical Manufacturers Association

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

We find that the rate of improvement in the entire chemical industry improved following the inception of Responsible Care (see the 1990-96 dummy variable in Table 4). However, as we found in our earlier analyses, Responsible Care firms improved more slowly over this time period. Looking at the coefficients, one sees that in the period from 1990 to 1996, Responsible Care members were improving no faster than they had previously. In other words, the interaction term (*Responsible Care X Dummy for 1990-96*), largely counteracts the main effect of 1990-1996, when the rest of the industry increased its rate of improvement. One interpretation of this result is that Responsible Care had a greater positive effect on non-members than on its members — perhaps by focusing the attention of stakeholders on non-members.

CONCLUSION

In this article, we evaluate the conflicting forces that help and hinder industry self-regulation. We analyze whether, in the absence of explicit sanctions, opportunism will impede the functioning of other coercive, normative, and mimetic forces. We test how these conflicting forces influenced the membership and behavior of firms participating in one of the leading attempts at industry self-regulation, the Responsible Care program. Our research demonstrates that both privileged companies and those in need of protection and help might chose to join a voluntary initiative.

Our research exposes the difficulty in establishing and maintaining industry self-regulation. Responsible Care has operated up to now without explicit sanctions for malfeasance. As a result, our data suggest, it has fallen victim to enough opportunism that it includes a disproportionate number of poor performers, and its members do not improve faster than non-members. Thus, the institutional pressure that Responsible Care exerts on its members appears to have inadequately counteracted opportunism. Since Responsible Care represents a leading example of self-regulation in the world, our findings highlight the difficulty of creating self-regulation without explicit sanctions.

The difficulty in establishing effective self-regulation in the case of Responsible Care may be a product of the nature of the commons being protected. With Responsible Care, the commons being protected is one step removed from a real physical commons. The chemical industry alters a physical commons — clean water, clean air, and healthy ecosystems — but it was not the threat to this commons that motivated its initial attempts at self-organization. Rather, it was a threat to a second "reputational" commons that sparked the creation of Responsible Care. Excessive polluting by chemical firms influences members' welfare only to the extent that it influences this reputational commons (unlike the direct impact of over-fishing on a community of fishermen). A trade association such as CMA, unlike a local fisherman's union, can protect its members by working to influence perception rather than the problem itself.

Despite the thousands of firms in our study, our research represents a single case. Thus, we must be cautious in forming general theoretical conclusions. A comparison with another powerful self-regulatory institution provides additional guidance. Joseph Rees (1994) claims that the Institute of Nuclear Power Operations (INPO) was highly successful in reducing the risk of accidents in Nuclear Power but notes several important differences with Responsible Care. In particular, an even smaller number of companies were involved, government regulation reduced economic competition, and the Nuclear Regulatory Commission provided a "regulatory gorilla in the closet" which could be used to sanction opportunism and act as an outside auditor for the program (Rees, 1997). Thus, the INPO may have been successful because the threat of opportunism was reduced by enforceable sanctions.

This leads us to hypothesize that explicit sanctions administered by "informed outsiders" may be needed to avoid opportunism within an industry self-regulation. Overseeing parties must be "outsiders" to ensure that their assessments are unbiased and that sanctions are levied and are not used for individual strategic means. Trade associations, as insiders, are limited as enforcers both legally and practically. In contrast, an active state-run regulatory body, as was the case with INPO and the NRC, may provide the enforcement behind a trade-association sponsored standard. Other candidates include various types of third-party certifiers who operate independently of both the state and the trade association. For example, the Motion Picture Association of America (MPAA), the primary trade association of the movie industry, uses a wholly independent Ratings Board to assign movie ratings. One final candidate may be the press or non-governmental organizations who disseminate information. By publicizing firm performance data, they may bring other forces to bear such as public ire or regulatory scrutiny.

Whoever these outsiders may be, they must also be “informed” in the sense that they may effectively investigate the performance of individual firms to hold them up for scrutiny. Becoming informed in this way may prove very difficult. Our research was conducted in a country with elaborate rules for public reporting and on one of its most measured industries. In many industries, an investigation such as ours would be almost impossible. If industry self-regulation is to achieve its promise, systems must be put in place to improve the ability of outsiders to audit improvement. To its credit, the Chemical Manufacturer's Association is working to create mechanisms for measuring performance on other aspects of the codes.

We should not forget that industry self-regulation is a dynamic process, and that its eventual outcome is not yet certain. Responsible Care may still evolve into a more effective industry self-regulatory scheme. There are a few hopeful signs that Responsible Care is beginning to change. Leaders within the industry are publicly recognizing that Responsible Care performance has been disappointing and that a “velvet glove” may not be enough to change behavior (Reisch, 1998). The program has been moving toward a third-party verification system that might help differentiate clean firms from dirty ones, allow effective sanctioning, and finally allow Responsible Care to achieve its promise.

REFERENCES

Gunningham, N. 1995. Environment, self-regulation, and the chemical industry: assessing Responsible Care. Law & Policy, 17(1): 57-108.

Hart, S., & Ahuja, G. 1996. Does it pay to be green? An empirical examination of the relationship between emissions reduction and firm performance. Business Strategy and the Environment, 5.

Hausman, J. 1978. "Specification Tests in Econometrics," Econometrica, 46: 1251-1271.

Levy, D. 1995. The environmental practices and performance of transnational corporations. Transnational Corporations, 4: 44-67.

Nash, J. & J. Howard. 1995. Responsible care: A study of the dynamics of shaping firm practices and values. *Working Paper* of the Technology, Business, and Environment Program, Massachusetts Institute of Technology. Cambridge, MA.

Radner, R. 1981 Monitoring cooperative agreements in a repeated principal-agent relationship. Econometrica, 49(5):1127-1148

Rees, J. 1997. The development of industry self-regulation in the chemical industry. Law and Policy, 19(4).

Rees, J. 1994. Hostages of each other: the transformation of nuclear safety since Three Mile Island. Chicago: University of Chicago Press.

Reisch, M. 1998. Industry ponders future of Responsible Care. Chemical & Engineering News, May (5/11): 13.

White, H. 1980. A heteroskedasticity-consistent covariance matrix estimation and a direct test for heteroskedasticity. Econometrica, 48: 817-838.

BUSINESS-LED ENVIRONMENTAL MANAGEMENT: REGULATORY AND MARKET-BASED INCENTIVES

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Business-led Environmental Management: Regulatory and Market-based Incentives

The corporate approach to environmental protection has been evolving from a regulation-driven reactive mode to a more proactive approach involving voluntarily adopted management practices that integrate environmental concerns with traditional managerial functions. A behavioral model of firm decision-making is developed to obtain econometrically testable hypotheses of the factors influencing firms to undertake proactive environmental management. These hypotheses are tested using survey data for a sample of S&P 500 firms. The analysis shows that economic factors such as the threat of environmental liabilities and high costs of compliance with anticipated regulations as well as market pressures on firms that produce final consumer goods and have large capital-output ratios play a statistically significant role in inducing corporate environmentalism among these firms. Additionally, high costs of off-site transfers of toxic releases and public pressures on firms with high on-site toxic emissions per unit output are significant in influencing the adoption of innovative environmental management practices.

JEL classification: L5, Q2

1. Introduction

The U.S. has traditionally relied on mandatory command and control environmental regulations to protect environmental quality. While this has helped protect the environment, it has resulted in a policy framework that is inflexible and costly and whose effectiveness in further improving the environment may be diminishing (see Esty and Chertow, 1997). This realization has led to increasing use of market-based instruments, like marketable emissions permits, public disclosure of environmental information and voluntary programs, that seek to provide flexibility to firms to choose their methods of pollution control (National Center for Environmental Economics, 2001). Of these incentive based instruments, information disclosure and voluntary programs encourage non-mandatory actions by firms to control their pollution.

Provision of information about the environmental attributes of products and environmental performance of firms, by the regulatory agency to the public, such as through the Toxics Release Inventory (TRI)[1], has the potential to trigger product and capital market reactions and community actions that can create market based incentives for firms to improve their environmental performance. Additionally, voluntary programs that seek to engage firms in self-regulation are becoming a major policy tool for the USEPA. In 1999, there were 54 such programs at the federal level, up from 28 just 3 years earlier (NCEE, 2001). These non-mandatory approaches are considered by many policy analysts as launching the "next generation of environmental policy" that goes beyond a confrontational "government-push" approach to relying on proactive efforts by firms themselves and on active public involvement, by citizens and communities, in environmental protection (Esty and Chertow, 1997).

This trend towards self-regulation is also evident in the growing number of "business-led" initiatives being taken by firms to develop environmental management systems (EMSs) to systematically integrate environmental considerations into their production decisions. Several firms (3M, Dow Chemical, Dupont, AT&T) have crafted environmental programs to prevent pollution by redesigning products and processes (Schmidheiny, 1992; Batie, 1997), others are voluntarily seeking ISO 14001 certification by adopting standardized practices for environmental management and eco-labeling of products (Kuhre, 1995). EMSs represent an organizational change within corporations and a self-motivated effort at internalization of environmental concerns into the objectives of the firm. This has sparked interest in EMSs among policy makers since they reflect a fundamentally altered corporate view of environmental concerns. Two reports released by the USEPA (1999a,b) state that the agency plans to promote the adoption of EMSs (to complement the existing regulatory system in the U.S.) through offers of technical assistance, recognition and other benefits to achieve environmental protection goals, improve compliance, and prevent pollution. The interest in investigating the potential of EMSs as a policy tool can be inferred from the broad participation in the 1999 National Research Summit on EMSs organized by a multi-state working group (MSWG, 1999) of eleven state environmental agency officials and the USEPA that highlighted the need for more research on factors that motivate firms to adopt EMSs and on the extent to which EMSs can be relied upon to lead to environmental improvement[2].

Anecdotal evidence indicates that the state and federal regulatory climate, environmental concerns among consumers, reputation with shareholders and the public are motivating corporate environmentalism[3] (Florida and Davison, 2000). The growing stringency of environmental regulations during the 1980's, rising costs of compliance with inflexible technology-based regulations and threat of liability for environmental damage led many firms to examine the environmental impact of their products and processes. Concerns about the adverse effects on a firm's reputation, if perceived as environmentally unfriendly, are becoming important for firms[4]. Public opinion polls show growing environmental consciousness among consumers but there is mixed evidence about the extent to which this has led to a willingness to pay a premium for products with an environmental label (Cairncross, 1995; Gutfield, 1991). Most companies, however, expect that when goods are comparably priced, environmental attributes can break the tie. As a result, companies are increasingly using environmentalism as a marketing tool (Hoffman, 1997). Several studies show that investors react negatively to public disclosures about poor environmental performance reported in the TRI, resulting in significant abnormal stock market returns for firms (Hamilton, 1995; Khanna et al., 1998). Bankers are recognizing that they might be held legally responsible for environmental mistakes of their corporate borrowers. As a result, they are beginning to include environmental considerations in their lending decisions and viewing poor environmental performers as financially risky (Hoffman, 1997).

However, very few studies have systematically analyzed the factors that are motivating firms to adopt an EMS (see survey by Khanna, forthcoming). This paper seeks to fill that gap by developing a behavioral framework to provide econometrically testable hypotheses about the economic incentives motivating firms to adopt an EMS. In particular, the empirical analysis here seeks to quantify the extent and relative importance of external pressures from consumers, investors and a competitive market, and of regulatory pressures from existing and anticipated mandatory regulations faced by firms in inducing them to undertake environmental management. This analysis is based on survey data on EMSs and observable firm-specific characteristics for a sample of S&P 500 firms. The EMSs of these firms consist of multi-faceted efforts to varying degrees to proactively manage their impact on the environment. These efforts include conducting internal environmental audits, linking employee's compensation in part to environmental performance, centralizing decisions with environmental implications higher up in the corporate hierarchy, and applying the principles of Total Quality Management (TQM) to environmental management. This paper focuses on analyzing the observed diversity in the comprehensiveness of the EMS adopted by firms rather than the decision to adopt individual practices because there are synergistic relations between these practices and an individual practice by itself may achieve little (Cairncross, 1995)[5]. Firms are therefore more likely to be choosing a system of practices rather than a practice by itself.

A growing theoretical literature on environmental self-regulation demonstrates that firms may have incentives to voluntarily improve their environmental performance because it can lead to private benefits in the form of direct or indirect payoffs (see Segerson and Li, 1999; Lyon and Maxwell, 1999). These benefits could arise from the potential to preempt the threat of mandatory standards (Segerson and Micelli, 1998) and to shape future mandatory standards by voluntarily over-complying (Lutz, Lyon and Maxwell, 2000). Maxwell, Lyon and Hackett (2000) study the incentives and welfare implications of self-regulation by firms to preempt consumer groups from lobbying for more stringent abatement regulations. Arora and Gangopadhya (1995) demonstrate conditions under which consumer willingness to pay premiums for environmentally friendly products leads firms to overcomply with environmental standards. This paper analyzes the extent to which firm behavior actually reveals that firms perceive these benefits from being environmentally friendly and respond by improving their environmental management.

Much of the existing empirical literature has focused on explaining the decision by firms to participate in voluntary programs established by the USEPA such as the 33/50 program (Arora and Cason, 1995,1996; Khanna and Damon, 1999), Green Lights, WasteWise (Videras and Alberini, 2000) and the Climate Challenge Program in the U.S (Karamanos, 2000) that provide visible benefits to participants through public recognition and technical assistance. Henriques and Sadorsky (1996) is one of the few studies examining the motivations for environmentally friendly organizational changes within firms where direct benefits are not as evident as through participation in voluntary programs. They analyze the adoption of a single practice, an environmental plan, by firms using perceived pressures, from consumers and regulations, ranked in importance by firms, as explanatory variables.

From an environmental policy perspective, it is also important to explain the observed diversity in the scope of the EMSs adopted by firms and to examine the types of firms that are more likely to feel various regulatory and market based pressures and demonstrate environmental stewardship in response to public policy and stakeholder concerns. This would enable the design and targeting of policy initiatives towards firms less likely to be self-motivated towards environmental management. This paper uses a broad range of observed characteristics of firms to examine the relative strengths of various incentives for different types of firms to be proactive to varying levels. Section 2 provides the conceptual framework that underlies the empirical analysis. This framework allows for several sources of incentives for a profit-maximizing firm to adopt an EMS and generates empirically testable hypothesis about a broad set of explanatory variables. The validity of these hypotheses and the assumptions that generate them are tested using the empirical method and data described in Sections 3 and 4 respectively. Section 5 presents the discussion of results of the empirical analysis and is followed by the conclusions.

2. Conceptual Framework

Consider a firm that uses a pollution generating input x (such as chemicals) and capital equipment k to produce output y. The effectiveness with which input x is used during the production process is represented by ϕ. Output y produced by the firm is a function of the amount of input used effectively in production (ϕx) and of the stock of capital k:

$$y=f(\phi x, k);\ f_x>0,\ f_k>0,\ f_{xx}<0,\ f_{kk}<0 \qquad (1)$$

where ϕ is assumed to be a function of the technological knowledge t of the firm and a scalar measure q of the quality of environmental management and is represented by:

$$\phi=\phi\ (q\ ,t);\ \phi_q>0,\ \phi_t>0,\ \phi_{qq}<0,\ \phi_{tt}<0 \qquad (2)$$

As ϕ increases, the input is utilized more effectively during production and therefore input-waste and the amount of pollution associated with given levels of input-use decreases. For simplicity, pollution (waste) generated, z, is represented as an inverse function of ϕ and a direct function of x as follows: $z= x/\phi$ (3)

Using (3) to substitute for x in (1), output levels can be expressed as follows with z being now considered as a factor of production: $y = f\,(\phi^2 z\ ,k\,)$ (4)

We assume that the firm is operating in a monopolistically competitive industry with $n=1\ldots N$ firms that are producing a product that is homogeneous in all other respects but differs in the environmental friendliness of the process used for its production. The firm faces an inverse demand curve that is a function of the aggregate output of the industry and the environmental practices adopted by the firm and is represented by *P(Y, q)* where $Y=\sum_{n=1}^{N} y_n$. This implies that a firm can shift the demand curve it faces to the right by adopting environmentally friendly management practices, thus $P_q>0$. The magnitude of P_q, however, could vary across firms. Firms that are producing final goods and dealing directly with consumers may perceive larger benefits from "green consumerism" than those producing intermediate goods. The relevant issue here is not whether consumers are indeed able to differentiate products based on the environmental practices followed by firms but whether firms perceive that to be the case and therefore seek to build an environmentally friendly reputation.

The firm is assumed to be a price-taker in the input market. The per unit cost of the variable input is *w*. The annualized cost of capital is *r(q)* and is assumed to be a decreasing function of a firm's quality of environmental management. A number of studies have shown that investors react negatively to disclosures about poor environmental performance by firms and that this leads to a significant negative impact on the stock market returns of the firms which is likely to raise their cost of raising capital in the market (Hamilton, 1995; Konar and Cohen, 1997; Khanna, et al., 1998). This observed negative reaction is possibly because investors view firms that are not environmentally friendly as being more risky since they are more likely to face penalties due to enforcement actions and greater pressure from the USEPA to implement strategies for reducing their waste generation in the future and a greater risk of environmental liabilities and lawsuits (GAO, 1994). Such firms are likely to have a higher cost of raising capital in the market. We therefore assume that firms with poor environmental management practices have to pay a higher price for borrowing capital, therefore $r_q<0$.

Proactive environmental management imposes costs of training employees in reducing waste, improving monitoring and supervision and conducting audits to track input flows and waste generation. These costs are likely to increase at an increasing rate as the quality of environmental management improves. These costs are represented by $V=V(q);\ V_q>0,\ V_{qq}>0.$

The regulatory benefits from adopting an EMS, such as the potential to reduce the threat of liabilities and costs of compliance with existing or anticipated regulations are likely only if firms go beyond adoption of EMS and demonstrate superior environmental performance. These costs are assumed to be a function of the volume of pollution generated and are represented by, $C=C(z)$, with $C_z>0$, $C_{zz}>0$. Uncertainty about the imposition of regulations or liabilities is denoted by ρ which represents the probability of a firm being regulated or held liable. The expected cost of mandatory regulation is then $\rho C(z)$.

The price elasticity of demand is defined as $\eta=-\frac{dY}{dP}\frac{P}{Y}>0$. The elasticity of output with respect to pollution is defined as $\varepsilon_{yz}=\frac{dy}{dz}\frac{z}{y}>0$. The elasticity of ϕ with respect to q is defined by $\varepsilon_{\phi q} = \frac{d\phi}{dq}\frac{q}{\phi} > 0$. It measures the responsiveness of input productivity to an improvement in the quality of environmental management. The share of the *nth* firm's output in total industry output is represented by $s = y_n/Y$.

We assume that the firm has Cournot conjectures about the impact of its production on the aggregate production of the industry. It chooses the optimal level of managerial quality and pollution level to maximize its profits, assuming a fixed level of capital stock *k* and technical knowledge *t* in the short run. The firm's decision-making problem is represented as follows:

$$\begin{aligned} &Max \quad \Pi = P(Y,q)f(\phi^2 z,k) - w\phi z - r(q)k - V(q) - \rho C(z) \\ &\text{where} \quad \phi = \phi(q,t) \end{aligned} \tag{5}$$

The first order necessary conditions for maximization are as follows, after rearranging terms and substituting in the elasticities defined above:

$$\frac{\partial \Pi}{\partial q} = 0 \;\Rightarrow\; \frac{2P(1-s/\eta)y\varepsilon_{yz}}{q} + \frac{P_q y}{\varepsilon_{\phi q}} = \frac{V_q}{\varepsilon_{\phi q}} + \frac{wx}{q} + \frac{r_q k}{\varepsilon_{\phi q}} \tag{6}$$

$$\frac{\partial \Pi}{\partial z} = 0 \Rightarrow P(1-s/\eta)y\varepsilon_{yz} = [w\phi + \rho C_z]z \tag{7}$$

Equations (6) and (7) show that the firm chooses the level of *q* and *z* that equates the marginal benefits of each with its marginal costs. The marginal benefits from *q* arise indirectly from it contribution to the marginal revenue product of *z* and directly because it could allow the firm to charge a higher price for its product and also reduce the cost of capital and the effective cost of the polluting input *x* by increasing the efficiency of its use. The marginal cost of increasing *q* is represented by V_q, which is expected to increase as *q* increases. Equation (7) shows that the firm chooses *z* to equate its marginal revenue product to its marginal cost, which depends on the marginal cost of compliance and liabilities. We solve for *w* from (6) and substitute in (7) to obtain the following expression that shows the determinants of the level of *q* chosen by a firm:

$$q = \frac{[\rho C_Z z/y + P(1-s/\eta)\varepsilon_{yz}]\varepsilon_{\phi q}}{(V_q/y) + (r_q k/y) - P_q} \tag{8}$$

This expression leads to the following testable hypotheses regarding the determinants of the quality of the EMS of a firm.

Hypothesis I: The greater the threat of environmental liabilities and the higher the costs of compliance with mandatory regulations faced by a firm, the higher the quality of its environmental management.

As shown in equation (8), as the cost of environmental liabilities and the cost of compliance with mandatory regulations increases so do the incentives to increase q and reduce waste generation. The expected marginal costs of liabilities increase either because of increased likelihood of being held liable or larger fines. The costs of complying with mandatory regulations are expected to be higher when these regulations specify inflexible performance standards or technology standards, when the likelihood of the implementation of such regulations is high and the penalties for non-compliance are high.

Hypothesis II: The greater the benefits perceived in the form of higher output price and a lower cost of capital, the higher the quality of the firm's environmental management system.

The greater the marginal effect of poor environmental management on lowering output price ($P_q > 0$), the greater are the incentives for improving q. Firms that expect output price to be responsive to their EMS are more likely to adopt a higher quality EMS. The impact of the cost of capital on incentives to raise q is measured by the term $r_q k/y$ in the denominator (8). Assuming that investors react negatively towards firms that are not using environmentally friendly practices and thus the sign of r_q is negative, we would expect that firms where capital is less productive, or that are using a larger amount of capital per unit of output and therefore incurring a high cost of capital per unit output have greater incentives to increase q.

Hypothesis III: The impact of industry concentration on incentives for higher quality environmental management is ambiguous.

Equations (6) and (8) show that on the one hand, firms in industries that are less concentrated (have a smaller s) have a greater incentive to raise q. The marginal benefit of increasing the productivity of z by adopting an EMS, is lower in a concentrated industry relative to a competitive industry. This is because as the monopoly power of a firm increases the marginal revenue product of z decreases relative to its value of marginal product in a competitive industry. On the other hand, the marginal benefit of increasing the productivity of z is higher for a firm that is producing a larger output, as shown by the first term on the left hand side of (6) and by (8). A monopolist can be expected to produce a larger output than an individual firm in a competitive industry, with all per unit costs of production being the same, and thus the monopolist is expected to gain more at the margin from raising q. The net impact of industry concentration on incentives for increasing q is, therefore, ambiguous.

The literature analyzing the effects of market structure on innovation has also yielded ambigous predictions (see survey by Cohen and Levin, 1989). Arrow (1962) demonstrates that a firm's gain from a cost-reducing innovation at the margin are larger in an industry that is competitive than under monopoly conditions. This is because with a downward sloping demand curve the marginal benefit from a cost reducing innovation that lowers the marginal cost and increases output is less than the average benefit and while a competitive firm facing a fixed price receives the average benefits a monoplist receives the marginal benefit. On the other hand, Denicolo and Delbono (1999) show that the benefits of a small cost-reducing innovation are proportional to the output of the innovator which is likely to be larger for a monopolist than for an individual firm in a competitive industry.

Hypothesis IV: Firms that have a lower marginal cost of environmental management, larger pollution-output ratios and a higher responsiveness of ϕ to q are more likely to have a higher quality of environmental management.

From equation (8) we see that the benefits of improving q are larger for firms that have a higher z/y ratio. Firms with poor environmental performance are, therefore, more likely to undertake environmental management. Firms facing a lower marginal cost of improving q, V_q, are also more likely to have a higher q. Finally, firms that have a high level of technical knowledge that allow changes in management practices to be accompanied by larger increases in the effectiveness of input-use, resulting in a high $\varepsilon_{\phi q}$, are more likely to benefit by adopting a higher quality of environmental management.

3. Empirical Methodology

We now develop an empirical method to examine the determinants of the dependent variable, the unobserved quality of the environmental management system of the firm. We proxy this unobserved quality by the observed number of environmental practices adopted by a firm, which is an indicator of the comprehensiveness of its environmental management system. The discrete non-negative nature of the observed variable generates non-linearities that make the usual linear regression models inappropriate, because some of the basic assumptions such as the normality and homoskedasticity of the residuals or the linear adjustment of the data are no longer fulfilled. The use of linear regression methods with a discrete non-negative dependent variable would result in inefficient, inconsistent and biased estimates (Cameron and Trivedi, 1998). Two alternative approaches are applied here to deal with the discrete nature of the dependent variable. In the first approach, the count of practices adopted by a firm is used as a cardinal measure of quality of management. In the second approach, the count of practices adopted is used to obtain an ordinal measure of the quality of management.

The Poisson regression model is one way to deal with a cardinal measure (based on the count of practices adopted) of the quality of environmental management. The scalar dependent variable is the observed number of occurrences (practices adopted) by the *nth* firm, $w_n = 0,1,2..J$,. The Poisson model stipulates that each w_n is drawn from a Poisson distribution with parameter λ_n which is linearly related to a vector of regressors, v_n, such that $\lambda_n = \beta' v_n$ and the

$$\text{Probability}(w_n) = \frac{e^{-\lambda_n} \lambda_n^{w_n}}{w_n!}, \quad w_n = 0,1,2....13 \tag{9}$$

The Poisson regression model, however, is restrictive in that it assumes that the conditional variance of the distribution is equal to the conditional mean (Greene, 1993). The Negative Binomial is less restrictive than the Poisson distribution in that it allows for over-dispersion. Cameron and Trivedi (1990) have proposed a test for over-dispersion in the Poisson model that involves testing

$$H_o: var[w_n]=\lambda_n \text{ against } H_1: var[w_n]=\lambda_n+\gamma g(\lambda_n). \qquad (10)$$

If the over-dispersion parameter γ is significantly different from zero it implies the validity of the negative binomial model. The marginal effect of the Poisson model measures the change in the conditional mean λ_n if the *mth* regressor changes by one unit, and is given by $\hat{\beta}_m \hat{\lambda}_n$.

Unlike the Poisson model that treats the count of practices adopted as being the result of discrete choices, the ordered probit (OP) model considers the count of practices adopted as being generated by a continuous process of improvement in an unobserved latent variable (environmental management quality) that on crossing a threshold leads to a new practice being adopted (Greene, 1993). The OP introduces a latent (unobserved) random variable, ϖ_n*, that represents the quality of the environmental management system of the *nth* firm, as a function of a vector of independent variables, v_n.

$$\varpi_n^* = \beta' v_n + \xi_n \text{ where } \xi_n \text{ is } N[0,1]. \qquad (11)$$

The observed discrete variable w_n is generated from the unobserved ϖ_n* in the following way:

$$\begin{aligned} w_n &= 0 \quad \text{if } \varpi_n^* \leq 0 \\ &= 1 \quad \text{if } 0 < \varpi_n^* \leq \alpha_1 \\ &= 2 \quad \text{if } \alpha_1 < \varpi_n^* \leq \alpha_2 \\ &\vdots \\ &= J \quad \text{if } \alpha_{J-1} \leq \varpi_n^* \end{aligned} \qquad (12)$$

where *J* now represents the categories into which firms can be grouped based on the number of practices adopted. The α*'s* are threshold variables or cut-off points that generate the categorical variables, with α_0 normalized to zero. The OP estimates the probability that the quality of a firm's environmental management system lies within one of the *J* categories:

$$Pr[\alpha_j < \varpi_n^* \leq \alpha_{j+1}] = \Phi(\alpha_{j+1} - \beta' v_n) - \Phi(\alpha_j - \beta' v_n) \qquad (13)$$

where Φ is the standard normal cumulative density function. The parameters $\alpha_1,..\alpha_{J-1}$ and the vector β are estimated using maximum likelihood. The marginal effect of a change in the *mth* regressor on the probability of belonging to the *jth* category is: $[f(\alpha_{j-1}-\beta' v_n)-f(\alpha_j-\beta' v_n)]\beta_m$ where $f(.)$ is the standard normal density.

4. Description of Data

Primary data on management practices used in this study are obtained from the Corporate Environmental Profile Directories 1994 and 1995, compiled from a survey of S&P 500 firms conducted by the Investor Research Responsibility Center (IRRC). The survey inquires about the adoption decision of firms for a variety of environmental management practices, such as, number of environmental staff, environmental auditing and reporting procedures, described below. Environmental performance data are primarily obtained from the Toxics Release Inventory (TRI) database that contains facility-level information on on-site releases and off-site transfers of chemical-specific toxic pollutants. The TRI, first released in 1989, is mandated by the Emergency Planning and Community-Right-to-know Act of 1986 and requires production facilities to report annual quantities of on-site toxic emissions to air, water and land and underground injection and the quantities of off-site transfers on a chemical-specific basis. Financial information about firms is obtained from the publicly available Standard & Poor (S&P) 500 and Super Compustat databases which provide company specific information on all publicly traded firms that file 10-K forms with the Securities and Exchange Commission.

Of the 500 firms included in the IRRC survey, only firms that responded to the survey in 1994 and 1995 and reported to the TRI and for which financial data are available are included in this study. This results in a sample of 176 firms for 1995 and 159 firms for 1994. All time dependent explanatory variables are measured with a five-year lag to avoid endogenous regressors since adoption of some practices may have occurred prior to 1994 or 1995.

Variable Construction

The dependent variable in this study is the adoption of an EMS, defined as a system of 13 practices that indicate multifaceted efforts that are proactive and anticipative in orientation and targeted towards improving environmental performance. The practices are listed in Table 1 and include having an environmental policy, training and rewarding workers to find opportunities to prevent pollution, setting corporation-wide internal standards that are maintained even by facilities in other countries with lower environmental standards, undertaking internal environmental audits to identify opportunities for preventing pollution and ensuring that manufacturing operations are in compliance with regulatory requirements. Some firms also adopted the philosophy of TQM, which seeks to minimize quality defects while making continuous efforts at improving performance across the firm's activities, to improving environmental management. Firms may also choose to set aside funds to reduce their risks of future environmental liability costs and buy insurance to cover liability or remediation costs of environmental incidents. The adoption decision of each practice is represented by a dummy variable as described in Table 1.

As shown in Table 1, 92% of the firms have a formal environmental policy while 70% apply TQM principles to environmental management. Other practices, however, are adopted less frequently, with less than 40% of firms having a uniform corporate-wide environmental standard and regularly releasing environmental reports to the public. Of the firms included in the two-year sample, 156 firms had observations for both years. Over the two-year period, 62 of these firms increased the number of practices they adopted, while 12 firms decreased the number of practices adopted. Of the 335 observations over the two-year period, 17% indicated an adoption of less than 3 practices, while 38% indicated adoption of 4 to 7 practices. The mode of the distribution is 9 practices and less than 2% of firms adopted all 13 practices.

We find that the adoption decisions for these practices were positively correlated with each other indicating that these practices are complementary to each other rather than substitutes for each other. For example, firms adopting TQM were more likely to have an environmental policy, corporate standards, provide environmental performance related compensation to employees and conduct environmental audits. We, therefore, use a summated scale, by summing the dummy variables indicating adoption of the various practices to obtain a total score for each firm, which is used as an indicator of the quality or comprehensiveness of a firm's environmental management system. The explanatory variables are categorized into those proxying regulatory pressures, market based pressures and firm-specific characteristics. These variables are described below and their descriptive statistics are provided in Table 2.

Regulatory Pressures

We proxy the impact of existing and anticipated mandatory environmental regulations using several explanatory variables. The potential threat of liability is expected to be higher for firms with a larger accumulated NUMBER OF SUPERFUND SITES for which a firm is named as a potentially responsible party under the provisions of the Comprehensive Environmental Response, Compensation and Liability Act (as in Khanna and Damon, 1999; Videras and Alberini, 2000). These data are obtained from the Site Enforcement Tracking System (USEPA, 1996). Facility-specific data are aggregated to the parent company level by obtaining the list of subsidiaries and divisions of each parent company from various Corporate Directories.[6]

The impact of existing mandatory regulations on incentives for proactive environmental management are captured by the civil penalties and inspections received by firms to enforce compliance. Several major environmental statutes, such as the Clean Air Act, the Clean Water Act, and RCRA have provisions for severe penalties in cases of violations of regulations, releases of hazardous pollutants and record keeping violations. Firms are also subject to periodic inspections to enforce compliance with mandatory regulations. Firms that have received civil penalties for not complying with mandatory regulations are presumably the ones that have high costs of compliance; hence they prefer to risk being penalized rather than be in compliance with regulations. Such firms may also consider themselves as having a higher likelihood of receiving penalties in the future if they do not make efforts to improve their environmental performance. Data on the civil penalties received by a firm under 10 different environmental statutes were obtained from the IRRC directory. The variable CIVIL PENALTY is a dummy variable equal to 1 if the firm received at least one civil penalty for violation with any of the environmental statutes. The variable INSPECTIONS represents the number of inspections made on firms to investigate compliance with various environmental statutes such as the Clean Air Act, Clean Water Act, and the Toxic Substances Control Act. Information on inspections is obtained from U.S. EPA's publicly available database IDEA, Integrated Data for Enforcement Analysis[7], which is a comprehensive source of information on compliance records and penalties imposed on all regulated facilities in the US.

To capture the stringency of the existing regulatory environment for a firm we use the ratio of Pollution Abatement Costs and Expenditures for the industry to total industry shipments (PACE/INDUSTRY SALES) at the two-digit SIC level as an explanatory variable. Pollution capital expenditures include expenses associated with the purchase and expansion of plant and equipment used to control air and water pollutants and solid waste. Abatement costs consist of all costs and expenses necessary to operate and maintain pollution abatement equipment. The value of total industry shipments is defined as the receipts for all primary and secondary products manufactured and shipped, services rendered and resale of products bought and resold without further processing. Firms that belong to industries that are heavily regulated as indicated their PACE to industry output ratio are likely to have high costs of compliance and greater incentives to improve their environmental management. These data are obtained from the Annual Survey of Pollution Abatement Costs and Expenditures compiled by the Bureau of Census (1989,1990).

In order to proxy the incentives to seek strategic advantages over competitors by reducing emissions of hazardous air pollutants ahead of time through improved environmental management, we construct the ratio of hazardous air pollutants to on-site toxic releases (HAP/ON-SITE RELEASES) as in Khanna and Damon (1999). Title III of the 1990 CAA Amendments has listed 189 toxic chemicals that will be regulated under the National Emission Standards for Hazardous Air Pollutants (NESHAP). Firms have been aware since 1990 that air emissions of these chemicals will be subject to Maximum Available Control Technology (MACT) standards that would be based on emissions levels already achieved by the best-performing similar facilities (USEPA, 2000). Reducing these pollutants ahead of time using flexible methods is expected to lower the future costs of compliance and may also give the firm a strategic advantage relative to its competitors if its performance influences the standards that are set for other firms. We would, therefore, expect that firms with a larger ratio of HAP to on-site toxic discharges are more likely to adopt a comprehensive EMS. The data on HAP emissions by firms were obtained from the TRI after aggregating across all chemicals categorized as HAP and across all facilities belonging to a parent company.

Market Pressures

Market pressures emanate from consumers, investors and competing firms. Firms that produce final goods and are in closer contact with consumers are likely to feel greater pressure or benefit more from improving their environmental friendliness. Thus, strategic considerations to improve market share or charge premium prices from green consumers may motivate corporate environmental management among some firms.[8] We use the 4-digit secondary SIC code of the sample firms to classify them into final goods and intermediate goods. Firms are represented by a dummy variable FINAL GOOD equal to 1 if that firm is primarily selling final products such as pharmaceutical preparations, cosmetics, and food products consumed directly by consumers. It also includes retail stores, restaurants and banks that provide direct services to consumers.

Firms with a higher capital stock per unit output are more likely to be concerned about negative investor reactions about their environmental practices and performance. We proxy this impact by the SALES-ASSET ratio for the firm and expect that firms with a higher value of this ratio will have lower incentives to adopt a more comprehensive environmental management system. The impact of market structure of the industry on incentives for environmental management is measured by the Herfindahl-Hirschman index (HHI), which equals the sum of the squared percentages of market shares of each firm in the industry (as in Arora and Cason, 1995). A high value of HHI implies that the industry is more concentrated and less competitive than one with low HHI. The impact of exposure to global competition and greater pressure to differentiate its products on a firm's incentives for adopting an EMS is captured by the ratio of its facilities that are in foreign countries to its total facilities (MULTINATIONAL STATUS). A count of the number of U.S. and non-U.S. facilities for each parent company is obtained from various Corporate Directories.

Firm-specific Characteristics

As suggested by the theoretical analysis, firm-specific characteristics, such as its pollution-output ratio, technical knowledge and the cost of improving environmental management are also expected to influence the quality of environmental management.

Data on all the various types of pollution generated by firms were not publicly available. The only information available at a facility and chemical-specific level is on the volume of toxic releases emitted and reported to the TRI. Each facility is identified by its name, its primary SIC code, its parent company name and a Dun and Bradstreet (D&B) number assigned to each parent company. We used this information to group facilities by their parent company and aggregate toxic releases to air, land, water and underground injections of all TRI chemicals by each facility of a parent company to obtain on-site toxic releases at the parent company level. We aggregated all off-site transfers for energy recovery, recycling, treatment and disposal to obtain off-site transfers. We distinguish between on-site discharges and off-site transfers because on-site discharges represent emissions into the environment, while off-site transfers represent end-of-pipe abatement and disposal of waste. To allow for their differential impact on incentives for environmental management, while controlling for firm size, we use ON-SITE RELEASES/SALES and OFF-SITE TRANSFERS/SALES as explanatory variables.

The technology of the firm and its cost of improving environmental management are proxied by two variables, technical knowledge and age of assets. Firms that are more innovative are more likely to have the knowledge to implement changes in process and product design to accompany their adoption of innovative management practices and achieve the benefits of input cost savings and reduced waste. Technical knowledge of firms is measured by their annual R&D expenditures (as in Khanna and Damon, 1999; Videras and Alberini, 2000). We also use the age of assets as a proxy for the cost of replacement of equipment that may be required to improve the process and product design to realize the benefits of environmental management. Firms with older assets are expected to face lower costs of replacement than firms with newer assets and may thus be more willing to take a proactive approach towards the environment. The variable AGE OF ASSETS is measured by dividing the total assets of a firm by its gross assets (Khanna and Damon, 1999). Total assets are defined as current assets plus net property plant and equipment plus other non-current assets. Gross assets are defined as total assets plus accumulated depreciation on property, plant, and equipment. Age of assets takes a value between 0 and 1, with higher values indicating newer plant and equipment with more current assets and smaller accumulated depreciation.

5. Results

We estimate two alternative specifications to analyze the factors motivating corporate environmental management with both the Poisson model and the OP model (Table 3). Model I examines the effects of existing regulations on incentives for environmental management [columns (1) and (2)], while Model II also examines the effects of anticipated regulations on HAP [columns (3) and (4)]. The estimate of γ in (10) is statistically insignificant at the 1% level in both the count data models estimated indicating that the data fail to reject the null hypothesis regarding the validity of the Poisson model. The validity of the Poisson model relative to the Negative Binomial distribution for this model is also confirmed by the log-likelihood ratio test statistic that is insignificant at the 1% level. A Lagrange-multiplier test rejects the presence of heteroskedasticity in all the OP specifications. Likelihood ratio tests reject the null hypothesis that all slope coefficients in any of the regressions estimated here are jointly equal zero. All test statistics are reported in Table 3. The marginal effects using parameters estimated with Model II using the Poisson specification and the OP model are presented in Table 4. The threshold coefficients or α*'s* for the OP specifications should exhibit the following relationship, $\alpha_1 \leq \alpha_2 \leq \ldots \alpha_{J-1}$, and they must be positive. Failure to exhibit any of these conditions would imply specification error of the model. We find all threshold coefficients to be positive and statistically significant at the 1% level in each of the three models. They are not reported here for brevity.

All of the regression models estimated here are consistent in showing that firms facing a stronger threat of liabilities and of high costs of compliance with anticipated HAP regulations were significantly more likely to adopt a more comprehensive EMS. The threat of liabilities, proxied by the number of Superfund sites for which firms are potentially liable, and the ratio of HAP to on-site toxic releases, have a positive impact but at a diminishing rate on the quality of EMS adopted by firms. We also find that firms in industries that were more highly regulated as reflected in higher pollution abatement cost expenditures per unit sales were significantly more likely to seek innovative ways to improve their environmental management. These results are consistent with other studies such as Videras and Alberini (2000) and Khanna and Damon (1999) that find that the threat of liabilities, proxied by the number of Superfund sites for which firms are potentially liable, motivated participation in the 33/50 and WasteWise programs. Firms emitting a larger ratio of HAP to 33/50 Releases were also more likely to participate in the 33/50 program (Khanna and Damon, 1999). Henriques and Sadorsky (1996) find that perceived regulatory pressures by firms were important in motivating them to develop an environmental plan. However, we also find that not all types of regulatory pressures lead firms to adopt an EMS. The threat of penalties for non-compliance with existing environmental statutes or inspections to ensure compliance with them was not a significant motivator of EMS adoption. This indicates that the incentives for the adoption of an EMS were not stemming from the need to improve compliance with existing regulations but to reduce the threat of liabilities and stringency of anticipated regulations in the future.

Among market pressures, we find that firms that are selling final goods and thus in closer contact with consumers are more likely to have a more comprehensive/higher quality environmental management than firms in intermediate good industries. This indicates that expectation of gains from differentiating their products or establishing an environmentally friendly reputation did motivate EMS adoption by firms producing final goods. Furthermore, firms that have a high capital-output ratio, or a low sales-asset ratio, and thus are likely to be more affected by high costs of capital due to potentially negative investor reactions to poor environmental performance, are also more likely to adopt a more comprehensive EMS. Although we find that the effect of competitiveness of the industry on pressures to adopt an EMS is insignificant, firms with a stronger multinational presence are more likely to adopt a comprehensive EMS. This indicates the incentives provided by competition and need for product differentiation at the global level for adopting an EMS.

Among the firm-specific attributes, we find that firms with larger on-site releases per unit sales but smaller off-site transfers per unit sales were more likely to have a comprehensive EMS. Firms with low off-site transfers per unit sales could be either those that generate waste that is unsuitable for end-of-pipe abatement or disposal or find that the costs of doing so are relatively high. Our results suggest that these firms are more likely to be seeking other innovative strategies for reducing waste generation. Firms with larger on-site releases per unit sales were more likely to adopt a comprehensive EMS either to offset adverse public reactions generated by public disclosure of TRI or to preempt or shape any future regulations on toxic releases. The result that firms with poor environmental performance are more likely to adopt proactive strategies to reduce pollution is consistent with other studies. This was a characteristic of firms that participated in the 33/50 program (Khanna and Damon, 1999; Arora and Cason, 1995, 1996), and the Climate Challenge program (Karamanos, 2000). We also find that firms that are more innovative as indicated by their R&D expenditures and likely to have the knowledge and capability to find innovative solutions to their environmental problems were more likely to adopt a comprehensive EMS. Additionally, firms with older equipment were more likely to undertake environmental management possibly because it was less costly for them to replace old equipment with newer less pollution intensive equipment.

Table 4 shows the effect of a one standard deviation change in each of the continuous explanatory variables at the mean values of those variables on the expected number of practices adopted. The marginal effects of the dummy variables are measured for a change from 0 to 1 in those variables. These effects are estimated using the coefficients estimated with Model II assuming a Poisson model. They show that a one standard deviation increase in the number of Superfund sites and the ratio of industry PACE-Sales, proxies for regulatory pressure, increases the expected number of practices adopted by 0.5 and 0.4 respectively. A one-standard deviation increase in the ratio of HAP to on-site releases increases the expected number of practices adopted by 0.4. A firm producing final goods is likely on average to adopt 1.8 practices more than other firms and an increase in the ratio of facilities in foreign countries increases the expected number of practices adopted by 0.5.

The estimated coefficients and threshold levels from the OP model are used to estimate the impact of a one standard deviation change in the explanatory variables from their sample mean level on the probability that an average firm would adopt more than 7 (the average number) practices. For dummy variables, the percentage change in probability is estimated for a change in the variable from a value of 0 to 1 (as in Greene, 1993). The parameter estimates obtained here indicate that an increase in the number of Superfund sites increases the probability of an average firm adopting at least 7 practices by 10%, while an increase in the ratio of PACE/industry sales increases that probability by 8%. A 10% increase in R&D expenditures would increase the likelihood of this firm adopting more than 7 practices by 10%. An increase in the ratio of HAP to on-site releases increases the probability of adopting 7 or more practices by a small amount of 1.3%. This effect is larger at lower values of the ratio because the incremental effect of the variable is decreasing. An average firm producing final goods has a 24% probability of adopting more than 7 practices. A one standard deviation decrease in the sales-asset ratio would increase the probability of adopting more than 7 practices by 5.5%.

Policy Implications

These findings suggest that both the threat of regulations and liabilities as well as the opportunities for winning customer and investor goodwill and increasing market share globally through product differentiation are driving corporate environmental management. To identify the relative extent to which various factors were influential in motivating corporate environmental management, we predict the number of practices adopted and the probability of adopting more than 7 practices using low and high range values of the explanatory variables shown in Table 5 The low and high values chosen here represent minimum and maximum values of the explanatory variables for the sample of firms considered in this study.

We find that the number of practices adopted by a firm that faced low regulatory and market pressure, low costs of off-site transfers and did not generate on-site toxic releases is likely to be less than 1 and its probability of adopting more than 7 practices is close to zero. The expected number of practices a firm facing strong regulatory pressures proxied by a high number of Superfund sites, high PACE/sales ratio and high HAP-On-site releases ratio would adopt is 1 and the probability of adopting more than 7 practices is less than 1%. This indicates that while regulatory pressures created positive incentives to undertake corporate environmental management, the effect on the number of practices adopted and on the probability of adopting a comprehensive EMS was fairly weak. The incentives created by contact with final consumers and strong multinational presence, although stronger than those due to regulatory pressures, would still lead to the expected number of practices adopted being less than 2 and the probability of adoption of more than 7 practices being less than 1%. In contrast, firms with high capital assets per unit sales (that is, low sales-asset ratio) that are more exposed to adverse impacts from shareholder reactions to their environmental image faced stronger incentives to undertake environmental management. The most important motivators for corporate environmental management, however, are high levels of on-site releases per unit sales and low levels of off-site transfers per unit sales. This indicates that the potential for adverse public pressure in response to information about poor environmental performance and the high costs or other barriers to waste treatment and disposal at the end-of-the-pipe are motivating firms to be more innovative about managing their environmental impacts.

This analysis has several implications for public policy that seeks to encourage business-led environmental management as a supplement to existing mandatory regulations. Several theoretical studies have suggested that the threat of mandatory regulations or the potential to shape future regulations is motivating self-regulation by firms (Segerson and Miceli, 1998; Lutz, Lyon and Maxwell, 2000). The analysis here shows that while the potentially high costs of compliance with existing and anticipated regulations as well as the threat of liabilities are inducing firms to be more proactive about managing their environmental impacts, these pressures are not as strong as the non-regulatory pressures, from consumers, investors and communities. Among these, it is dependence on capital markets, concerns about public reputation and the adverse effects on it of information about environmental performance and high costs of disposing of waste off-site that provide stronger incentives to adopt a broad-based EMS than consumer pressure and pressure from global competition. This indicates that public policy can influence adoption of comprehensive EMSs by firms by providing information about the environmental performance of firms to the public, public recognition to firms with EMSs, and educating the public about the adverse effects of various pollutants, while maintaining stringency of the regulatory framework that imposes high costs of pollution on firms.

6. Conclusions

There is growing evidence of a transformation in the corporate response to concerns for environmental protection away from an adversarial approach based on a view of environmental costs as non-productive towards one of corporate environmentalism. Firms are crafting environmental management systems to anticipate and address environmental problems. There is, however, considerable diversity in the comprehensiveness or scope of these systems across firms. This paper develops a behavioral model of firm decision-making to obtain econometrically testable hypothesis about the factors influencing the quality of a firm's environmental management system. The theoretical analysis here suggests that firms facing higher costs of compliance with mandatory regulations, higher potential liabilities and green preferences from consumers and investors are more likely to have a higher quality of environmental management. Moreover, firms that have larger levels of pollution per unit output and are more innovative are also more likely to adopt a higher quality environmental management system.

The empirical analysis supports several of the hypotheses generated by the behavioral model. It demonstrates that the adoption decision of firms was motivated by rational economic self-interest. In particular, it shows that concerns about environmental liabilities and the threat of high costs of compliance with anticipated and existing mandatory regulations have a statistically significant influence on the incentives for corporate environmental management. Anticipated HAP regulations appear to provide strategic incentives for firms with a large portion of HAP to other toxic releases to adopt environmental management practices ahead of time and possibly influence the MACT standards to be set. This analysis suggests that the incentives for adoption of an innovative environmental management system do depend on the existence of a regulatory framework that would penalize poor environmental performance. However, the adoption of an EMS appears to be geared more towards dealing with anticipated environmental issues rather than as a reaction to improve compliance with existing regulations. A credible threat of stringent regulations in the future for many currently unregulated pollutants can play an important role in making firms proactive in their environmental management to avoid those costs of compliance.

However, the analysis here also shows that the incentives created by the threat of liabilities and mandatory regulations are not as strong as those created by market pressures. Firms that rely more strongly on the capital market, produce final goods and face greater global competition are more likely to adopt a comprehensive EMS. The most important motivators of EMSs appear to be high costs of off-site transfers of toxic releases and public pressures on firms with high on-site toxic emissions per unit output.

[1] The TRI is a database of emissions of over 300 toxic chemicals generated by each manufacturing facility in the US, mandated by the Emergency Planning and Community Right to Know Act of 1986.

[2] Further information can be found at http://www.mswg.org. Other participants at the summit included institutions such as the Brookings Institution, the National Academy of Public Administration and the Council of State Governments. The USEPA has also sponsored the creation of a National Database on EMS that will include information on various aspects of EMS implementation by 100 volunteer facilities in the U.S. to understand their costs and benefits to firms and society (http://www.eli.org/isopilots.htm).

[3] Internal memos from Amoco cite several reasons for adopting proactive environmental management practices: "Environmental concerns are gaining increasing support from the public and political institutions. This support is evidenced in many ways, including several resolutions from Amoco shareholders, recent public opinion polls, and comments by both Republican and Democratic pollsters, and more recently by the efforts of the Coalition for Environmentally Responsible Economies to enlist investors who control more than $100 billion to support only those companies that subscribe to a list of principles of environmental protection. Fundamentally this means that instead of the use of government command and control types of influence, we can expect people to act more directly on Amoco by way of shareholders and customers" (Hoffman, 1997).

[4] To offset the expected negative publicity likely to be generated by release of its TRI emissions, Monsanto's Chairman announced the "Monsanto Pledge" the day before the TRI was to be publicly released for the first time in 1986. The company pledged to reduce its worldwide air emissions of toxic chemicals by 90% by the end of 1992 and then continue to work towards the ultimate goal of zero emissions (Cairncross, 1995).

[5] For example, environmental audits by themselves are only a means to examine performance and unless accompanied by adoption of other practices, such as a broad-based commitment from the management to provide the resources and incentives to employees to prevent pollution, are likely to be ineffective in improving environmental performance. Hence a decision to conduct environmental audits is likely to be accompanied by the adoption of other related practices as well.

[6] These include Ward's Business Directory and the Directory of Corporate Affiliations.

[7] http://www.epa.gov/oeca/idea

[8] For example, the chemical industry has attempted to develop green markets by instituting the Responsible Care trademark. This trademark is of greater value to firms that have frequent consumer contact and produce final goods as compared to those that produce intermediate products.

Table 1. Description and Adoption of Environmental Management Practices

Variable	Mean Values	Description of the Variable (1=yes; 0=no)
Staff	0.47 (0.50)	Firm has an environmental staff of more than 50
Directors	0.46 (0.50)	Firm has more than 3 environmental directors
Policy	0.92 (0.28)	Firm has a formal written policy and codes of conduct on environmental issues
Corp. Stds.	0.39 (0.49)	Firm applies uniform standards to environmental practices worldwide
TQM	0.70 (0.46)	Firm applies total quality management philosophy to environmental management
Payments	0.61 (0.49)	Firm provides incentive compensation to employees whose efforts lead to achievement of specific environmental goals
Audits	0.90 (0.29)	Firm conducts audits to assess compliance with environmental regulations
Suppliers	0.52 (0.50)	Firm evaluates its environmental risks when selecting its suppliers
Partners	0.39 (0.49)	Firm evaluates its environmental risks when selecting its partners
Clients	0.11 (0.31)	Firm evaluates its environmental risks when selecting its clients
Report	0.37 (0.48)	Firm regularly releases reports about its environmental performance and activities
Reserves	0.47 (0.50)	Firm sets aside funds to cover the costs of penalties for environmental violation or remediation activities
Insurance	0.44 (0.50)	Firm purchases insurance to meet unexpected environmental liabilities

Standard Deviations are in parenthesis.

Table 2. Descriptive Statistics of Variables

Variable[a]	Mean	Description of the Variable
Environmental Management	6.75 (3.25)	Count of environmental management practices adopted
Civil Penalty	0.69 (0.46)	Firm has received a civil penalty for non-compliance for one of 10 environmental statutes (1=yes; 0=no)
Inspections	33.73 (52.2)	Number of inspections to investigate compliance with existing regulations
No. of Superfund Sites	13.35 (17.45)	Accumulated number of Superfund sites for which the firm is listed as a potentially responsible party
HAP-On-Site Releases	0.39 (0.31)	Ratio of hazardous air pollutants targeted by NESHAP to on-site releases emitted by the firm
On-site Toxic Releases-Sales ('000lbs/$Million)	1.36 (3.59)	Ratio of on-site toxic releases to net sales
Off-site Transfers-Sales ('000lbs/$Million)	0.24 (0.55)	Ratio of off-site transfers to net sales
Final good	0.60 (0.49)	Firm sells a final good or service (1=yes; 0=no)
HHI	826.16 (720.1)	Herfindahl-Hirschman index of the 4-digit primary SIC code
Multinational Status	0.44 (0.28)	Ratio of facilities in foreign countries to all facilities of a firm
Age of assets	0.77 (0.10)	Ratio of total assets of a firm to its gross assets
R&D ($ Billion)	0.29 (0.69)	Annual expenditures on research and development by firm
PACE-Sales	0.81 (0.78)	Ratio of Pollution abatement and control expenditures to Sales, both at the 2-digit SIC level
Sales-Asset	1.11 (0.49)	Ratio of sales to total assets owned by the firm

Data on number of practices adopted are for 1994-1995. All explanatory variables are for 1989-1990.

Table 3. Determinants of Corporate Environmental Management

	Model I		Model II	
Indep. Variables	**Poisson**	**OP**	**Poisson**	**OP**
Intercept	2.04 (0.21)***	2.41 (0.69)***	1.97 (0.21)***	2.29 (0.70)***
A. Existing or Anticipated Regulatory Pressure				
Civil Penalty	0.42E-01 (0.54E-01)	0.48E-01 (0.14)	0.33E-01 (0.54-01)	-0.29E-01 (0.15)
Inspections	0.19E-03 (0.53E-03)$^{+}$	0.16E-02 (0.17E-02)	0.27E-04 (0.54E-03)	0.12E-02 (0.17E-02)
Industry PACE-Sales	0.093 (0.032)***	0.28 (0.10)***	0.080 (0.033)**	0.26 (0.10)**
No. of Superfund sites	0.63E-02 (0.29E-02)**	0.20E-01 (0.10E-01)**	0.54E-02 (0.30E-02)*	0.18E-01 (0.41E-02)*
No. of Superfund sites squared	-0.61E-04 (0.35E-04)*	-0.16E-03 (0.13E-03)	-0.51E-04 (0.35E-04)$^{+}$	-0.14E-03 (0.13E-03)
HAP-On-Site Releases	-	-	0.57 (0.28)**	1.28 (0.80)*
HAP-On-Site Releases squared	-	-	-0.62 (0.29)**	-1.50 (0.91)*
B. Market Pressure				
Final goods	0.27 (0.50E-01)***	0.59 (0.14)***	0.27 (0.50E-01)***	0.61 (0.14)***
HHI	0.53E-04 (0.32E-04)*	0.83E-04 (0.98E-04)	0.5E-04 (0.32E-04)$^{+}$	0.82E-04 (0.96E-04)
Multinational status	0.28 (0.85E-01)***	0.61 (0.24)***	0.28 (0.86E-01)***	0.60 (0.24)**
Sales-Asset	-0.17 (0.53E-01)***	-0.29 (0.14)**	-0.17 (0.53E-01)***	-0.28 (0.14)**
C. Firm Attributes				
On-site Toxic Releases-Output Ratio	0.11E-01 (0.59E-02)**	0.29E-01 (0.17E-01)*	0.15E-01 (0.62E-02)**	0.37E-01 (0.18E-01)**
Off-site Toxic Releases-Output Ratio	-0.15 (0.50E-01)***	-0.37E-01 (0.14E-01)**	-0.16 (0.50E-01)***	-0.39E-01 (0.15E-01)***
Age of assets	-0.61 (0.23)***	-1.50 (0.67)**	-0.60 (0.23)**	-1.38 (0.70)**
R&D expenditures	0.84E-01 (0.33E-01)***	0.39 (0.12)***	0.84-01 (0.34E-01)**	0.36E-03 (0.13E-03)***
γ	0.8E-02(0.01)		0.5E-02(0.01)	
Log likelihood values	-825.46	-766.32	-823.16	-764.18
χ^2[d.f] {p-value}	182.7[13]{0}	157.7[13]{0}	187.29[15]{0}	161.99[15]{0}
χ^2[1] {p-value}	0.23 {0.63}		0.12 {0.73}	
χ^2[d.f] {p-value}		3.24[3]{.50}		3.36[3]{.50}

Standard errors are in parentheses. Degrees of freedom (d.f.) are in square brackets. χ^2 is a test for all slope coefficients jointly equal to zero. P-value is in curly brackets. ***Statistically significant at the 1% level. **Statistically significant at the 5% level; *Statistically significant at the 10% level. $^{+}$Statistically significant at the 20% level. χ^2[1] is a test for the null hypothesis that the Poisson model is appropriate. χ^2[10] is a test for all slope coefficients jointly equal to zero. χ^2[d.f] {p-value} is a test for heteroskedasticity in the ordered probit model.

Table 4. Marginal Effects on Count and Probability of Adoption of Environmental Management Practices

	Poisson Model	Ordered Probit
Independent Variables	Marginal Effect on Expected Number of Practices Adopted	% increase in Probability of Adopting 7 or more practices
A. Regulatory Pressure		
Civil Penalty	0.23 (0.36)	1.46
Inspections	0.009(0.004)	2.46
No. of Superfund sites	0.48 (0.26)*	9.92
HAP-On-Site Releases	0.42 (0.25)*	1.17
Industry PACE-Sales	0.42(0.17)**	7.98
B. Market Pressure		
Final goods	1.84 (0.34)***	23.65
HHI	0.28(0.18)	2.64
Multinational status	0.51 (0.16)***	6.45
Sales-Asset	-0.56 (0.18)***	-5.45
C. Firm Attributes		
On-site Toxic Releases-Output	0.35 (0.15)**	5.16
Off-site Toxic Releases-Output	-0.58 (0.19)***	-8.36
Age of assets	-0.42 (0.16)**	-5.58
R&D expenditures	0.39 (0.16)**	9.55

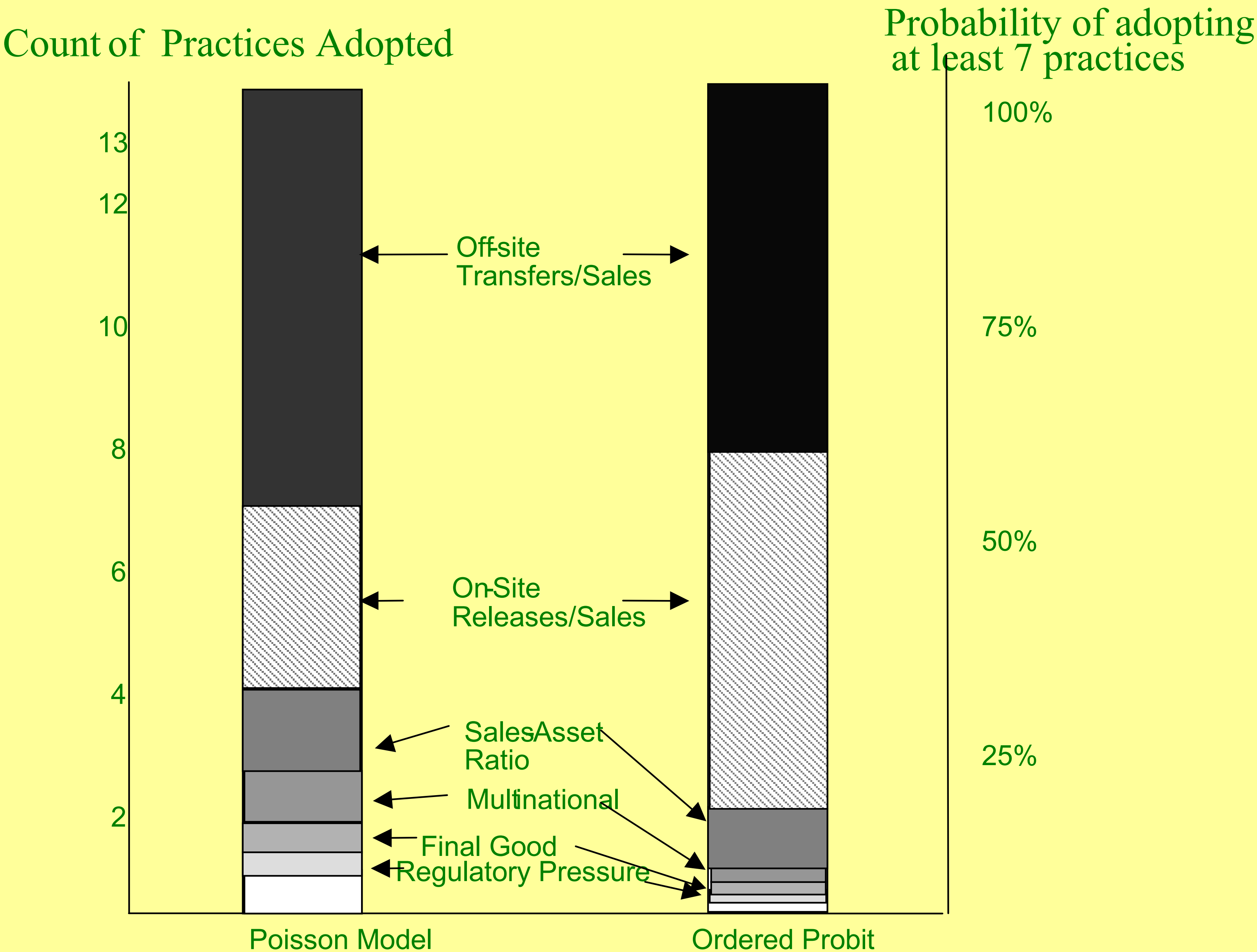
Marginal effects of a change in each explanatory variable on the expected number of practices adopted are estimated using the parameters estimated using the Poisson model II. These effects are estimated at the average number of practices adopted, 6.75 and for a one standard deviation change in the continuous variables and for a change from 0 to 1 for the dummy variables. Standard errors are in parentheses. ***Statistically significant at the 1% level. **Statistically significant at the 5% level; *Statistically significant at the 10% level. Marginal effects of a change in each explanatory variable on the probability of adoption of 7 or more practices are estimated using the parameters estimated using the Ordered Probit model II. These effects are estimated for a one standard deviation change in the continuous variables from their mean values and for a change from 0 to 1 for the dummy variables.

Table 5. Simulation Values for Exogenous Determinants of Corporate Environmental Management

	Superfund Sites	HAP-On-site	PACE -Sales	Final Good	Multinational Status	Sales-Asset	On-Site Releases-Sales	Off-Site Transfers - Sales
Low	0	0	0	0	0	4.46	0	4.77
High	120	1	2.1	1	1	0.29	36.37	0

Other variables held constant: Age of Assets=0.99; R&D=0.29;HHI=826, Civil Penalty=1; Inspections=33.73

Determinants of Comprehensiveness of Environmental Management



REFERENCES

Arora S. and S. Gangopadhyay, "Towards a Theoretical Model of Voluntary Overcompliance," *Journal of Economic Behavior Organization* 28 (1995), 289-309.

Arora, S. and T.N. Cason, "Why Do Firms Volunteer to Exceed Environmental Regulations? Understanding Participation in EPA's 33/50 Program," *Land Economics* 72 (1996), 413-432.

____________, "An Experiment in Voluntary Environmental Regulation: Participation in EPA's 33/50 Program," *Journal of Environmental Economics and Management* 28 (1995), 271-286.

Arrow, K., "Economic welfare and the allocation of resources for invention." In R. Nelson (ed.) *The Rate and Direction of Innovative Activity*. Princeton: Princeton University Press (1962).

Batie, S.S., "Environmental issues, policy and the food industry." In B. Schroder and T.L. Wallace (eds.), *Food Industry and Government Linkages*, Boston: Kluwer Academic Publishers (1997).

Cairncross, F., *Green Inc.: A Guide to Business and the Environment*, Island Press, Washington DC., (1995).

Cameron, A. C. and P. K. Trivedi, "Regression-based Tests for Overdispersion in the Poisson Model," *Journal of Econometrics* 46 (1990), 347-364.

____________, *Regression Analysis of Count Data*, (Cambridge, U.K.: Cambridge University Press, 1998).

Cohen, W. M. and R. C. Levin, "Empirical Studies of Innovation and Market Structure." In R. Schmalensee and R. D. Willig (Eds.), *Handbook of Industrial Organization, Volume II*, Elviser Science Publishers (1989).

Denicolo, V. and F. Delbono, Monopoly, competition, and the speed of R & D. *RISEC* 46 (1), 1999: 35-43.

Esty, D.C. and M.R. Chertow, "Thinking ecologically: an introduction." In M.R. Chertow and D.C. Esty (eds.), *Thinking Ecologically: The Next Generation of Environmental Policy*, New Haven: Yale University Press (1997).

Florida, R. and D. Davison, "Why Do Firms Adopt Advanced Environmental Practices (And Do They Make a Difference)?" In C. Coglianese and J. Nash (eds.), *Going Private: Environmental Management Systems and the New Policy Agenda*, Washington, DC: Resources for the Future, forthcoming 2001.

GAO (United States General Accounting Office), "Toxic Substances: Status of EPA's Efforts to Reduce Toxic Releases," Report to the Chairman, Environment, Energy and Natural Resources Sub-committee, Committee on Government Operations, GAO/RCED-94-207 (Sept. 1994).

Greene, H., *Econometric Analysis*, Second Ed., New York: Macmillan Publishing Co., 1993.

Gutfield, R., "Shades of green: eight of 10 Americans are environmentalists, or at least say so," *Wall Street Journal*, August 2 (1991).

Hamilton, J. T., "Pollution as News: Media and Stock Market Reactions to the Toxics Release Inventory Data," *Journal of Environmental Economics and Management* 28 (1995), 98-113.

Henriques, I. and P. Sadorsky, "The Determinants of an Environmentally Responsive firm: An Empirical Approach," *Journal of Environmental Economics and Management* 30 (1996), 381-395.

Hoffman, A. J., *From Heresy to Dogma: An Institutional History of Corporate Environmentalism*, San Francisco: The New Lexington Press (1997).

Karamanos, P., "Voluntary Environmental Agreements for the Reduction of Greenhouse Gas Emissions: Incentives and Characteristics of Electricity Utility Participants in the Climate Challenge Program." Working Paper, Sanford Institute of Public Policy, Duke University (2000).

Khanna, M., "Non-Mandatory Approaches to Environmental Protection: A Survey," *Journal of Economic Surveys*, forthcoming.
Khanna, M. and L. Damon, "EPA's Voluntary 33/50 Program: Impact on Toxic Releases and Economic Performance of Firms," *Journal of Environmental Economics and Management* 37:1 (1999), 1-25.
Khanna, M., W.R.H. Quimio and D. Bojilova, "Toxics Release Information: A Policy Tool for Environmental Protection," *Journal of Environmental Economics and Management* 36:3 (1998), 243-266.
Konar, S. and M.A. Cohen, "Information as Regulation: The Effect of Community-Right-to-Know Laws on Toxic Emissions," *Journal of Environmental Economics and Management* 32 (1997), 109-124.
Kuhre, W. Lee, *ISO 14001 Certification: Environmental Management Systems*, Upper Saddle River, NJ: Prentice Hall, 1995.
Lutz, S., Lyon, T. P., and Maxwell, J. W. (2000) Quality leadership when regulation standards are forthcoming. *Journal of Industrial Economics* XLVIII (3), 331-348.
Lyon, T. P. and J. W. Maxwell, "Voluntary" Approaches to Environmental Regulation: A Survey," in M. Franzini and A. Nicita (eds.), *Environmental Economics: Past, Present and Future*, Aldershot, Hampshire: Ashgate Publishing Ltd. (1999).
Maxwell, J. W., Lyon, T. P., and Hackett, S. C. (2000) Self-regulation and social welfare: the political economy of corporate environmentalism. *Journal of Law & Economics*, XLIII (2), 583-618.
Multi-State Working Group (MSWG), Environmental Management Systems: National Research Summit, November 2-3, Washington D.C. 1999.
National Center for Environmental Economics, "The United States Experience with Economic Incentives for Protecting the Environment," Washington, DC, Office of Policy, Economics, and Innovation, U.S. Environmental Protection Agency (2001).
Schmidheiny, S. (ed.), *Changing Course: A Global Business Perspective on Development and the Environment*, Cambridge, M.A.: MIT Press (1992).
Segerson, K. and T. J. Miceli, "Voluntary Environmental Agreements: Good or Bad News for Environmental Protection," *Journal of Environmental Economics and Management* 36:2 (1998), 109-130.
U.S. Bureau of the Census, Current Industrial Reports: Pollution Abatement Costs and Expenditures: 1989,1990, MA200(89)-1; U.S. Government Printing Office, Washington, D.C.
USEPA (United States Environmental Protection Agency) "Taking Toxics Out of the Air." Washington, D.C. (2000).
_______, "Aiming for Excellence: Actions to Encourage Stewardship and Accelerate Environmental Programs. Washington DC: Office of the Administrator (1801), EPA 100-R-99-006, 1999a.
_______, Draft EMS Action Plan. Washington D.C.: Innovation Task Force, Office of Reinvention, 1999b.
_______, Office of Science and Technology (Producer). National Technical Information Service, "*Site Enforcement Tracking System (National) (for microcomputers)*," Springfield, VA (1996).
_______, Office of Air and Radiation, *The Clean Air Act Amendments of 1990 Summary Materials*, Washington D.C. (1990).
Videras, J. and A. Alberini, "The Appeal of Voluntary Environmental Programs: Which Firms Participate and Why?" *Contemporary Economic Policy* 18(4) 2000: 449-461.

The Economics of Tailored Regulation and The Implications for Project XL

Summary Report

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Project term: January 1, 1998 - December 31, 2000
EPA Agreement Number: R826154-01

Introduction

Launched with considerable fanfare in March 1995, Project XL (which stands for eXcellence and Leadership) is the flagship of the Environmental Protection Agency's regulatory reinvention initiative. It is a voluntary program in which individual facilities negotiate agreements that allow them to replace or modify specific regulatory requirements on the condition that these changes improve their environmental performance. A common XL project waives a facility's Clean Air Act Title V obligations to obtain new permits every time the production process is modified in exchange for the facility's commitment to a plant-wide emissions cap set below the baseline level of aggregate emissions (for example, the Intel and Merck agreements). A second common project waives the designation of a facility's wastes as "hazardous" in exchange for investments in specified pollution control or pollution prevention technologies (for example, the Molex and Hadco agreements).

By all accounts, Project XL has had a troubled history. It has repeatedly fallen short of self-imposed performance benchmarks. EPA's initial goal was to have 50 XL projects approved by the end of 1996. However, by December 1999, four years after this deadline, only 15 projects had been approved, 16 were in an intermediate stage of project development, and 15 more had been accepted for initial review. Key reasons for this halting progress have been an inability to attract proposals and delays in the project approval process. Fewer than 12 proposals per year were received in the first four years of the program, and fewer than five proposals per year were approved in each of the first five years of the program. Since December 1999, project approval has accelerated.

Given the problems that Project XL has encountered, some analysts have predicted that it will not survive. Even if it does not, we believe Project XL deserves serious study because it is likely to be a prototype for future programs. Certainly this is how the project has been billed. When unveiled by President Clinton in a 1995, Project XL was touted as a "regulatory blueprint for the future" (Phillips, 1995), a characterization that was reflected in press reports. For example, according to the New York Times, Project XL is "…widely seen as a prototype for a much broader—and still largely unexplored—change in how the nation regulates industry" (Cushman, 1996).

While there is some hyperbole involved in such characterizations, there is also considerable validity. A compelling argument can be made for the *general* approach to regulation exemplified by Project XL. This approach has five defining characteristics. It is:

- facility-specific
- voluntary
- replaces command-and-control standards with performance standards that guarantee "superior environmental performance"
- requires a stakeholder process that involves community representatives in negotiating the regulatory agreement
- emphasizes diffusing regulatory innovations among non-participating firms

We refer to this approach as "tailored regulation" (TR). TR is viewed by many as a means of mitigating several well-recognized drawbacks of command-and-control regulation. Command-and-control regulation often dampens incentives for innovation in pollution control, dictates the means by which facilities should control pollution without due consideration to firm-specific attributes, and dictates how much pollution facilities should control, again, without due consideration to heterogeneity across firms.

Economists have long recognized these problems with command-and-control regulation. The solution they often propose is to replace command-and-control with economic incentive instruments like emissions fees and tradable permit systems. But for a variety of technical, enforcement-related and political reasons, widespread application of these regulatory instruments is impractical in the short term. TR amounts to a more limited reform. Although it generally fails to eliminate the problem of the regulator dictating how much heterogeneous facilities should abate, it does create incentives for innovation in pollution control and it does eliminate one-size-fits-all regulation regarding the means by which facilities control pollution.

There is quite a bit of support for TR. Evidence includes recommendations in a number of influential policy reports (for example, Enterprise for Environment, 1998 and National Academy of Public Administration Report, 1997), state-level initiatives such as New Jersey's "Gold Track" program, and proposed federal legislation to provide the underpinnings for a broad-based TR program (often referred to as the "second generation" initiative).

Even though there are good reasons to support TR, there are also a number of potential problems. How should the regulator set appropriate performance standards for individual facilities? What is the appropriate legislative foundation for TR? Are the transaction costs associated with TR prohibitive? On the face of it, the prospect of regulatory agencies negotiating environmental regulations with thousands of individual facilities would seem very costly, perhaps prohibitively so. Finally, what effect will TR have on intra-industry competition? Allowing facilities participating in TR to operate under a different set of guidelines than non-participants begs the question of whether there might be adverse competitive impacts.

The first two issues—how to set and monitor TR standards, and how to provide a legislative foundation—have already received considerable attention (see for example Steinzor, 1998; Hausker, 1999; Caballero, 1998; and Mank, 1998). However, the second two issues have attracted virtually none. These issues have been the focus of our research. Our findings are detailed in two papers. Blackman and Mazurek (2000) is an empirical investigation of the transaction costs associated with TR, and Blackman and Boyd (2000) is a theoretical analysis of TR's competitive implications. In the remainder of this report we briefly summarize the key findings from these papers. Please see the papers themselves for details.

Empirical research on transaction costs

The broad question this research addresses is, What can we learn from Project XL about transaction costs associated with TR? More specifically, we have attempted to answer the following questions:

- What is the magnitude of the transaction costs associated with project development?

- What stages of the project development process are perceived as being the most costly?
- What issues associated with that process are perceived as being the most costly?
- Why are transaction costs higher for some facilities?

Defining transaction costs

By "transaction costs" we simply mean the costs of developing XL projects. We include legal fees and the monetized value of person-hours spent on developing a project proposal, stakeholder negotiations, interacting with local regulators, interacting with the EPA regional office, and obtain final approval. We do not include capital investments associated with XL agreements. Furthermore, we include only costs incurred by the facility and EPA regional office. We do not include costs incurred by EPA headquarters, local regulators or other stakeholders (simply because collecting this data would be too costly). Therefore, our estimates of transaction costs represent a lower bound on the true value of these costs.

Data

The data for this study comes from a fall 1998 telephone survey administered to one representative from each of the 11 sample facilities, and one representative of the EPA region involved in negotiating the XL agreement. In addition, we use some publicly available data on the sample facilities.

The projects in our sample are: Berry, Hadco, Intel, Lucent, Merck, Molex, OSI-Witco, Weyerhaeuser, Imation, 3M and IBM. We selected only private facilities because they are the principal focus of Project XL. Also, we chose only facilities that submitted proposals to the EPA in the first six months of the program. We did this because, to the extent possible, we wanted to analyze facilities that had completed the project development process (so we could capture all the costs involved), and because at the time we conducted our survey, there were very few completed (or nearly completed) projects to choose from.

The fact that our sample only includes the very first cohort of program applicants has both advantages and disadvantages. On one hand, it allows us to control for subsequent changes in project development rules and guidelines. On the other hand, it begs the question of whether our findings are still relevant. Some of the problems the facilities in our sample encountered may have been mitigated by subsequent changes in program procedures. For example, over the years there have been several clarifications of the guidelines governing superior environmental performance and stakeholder involvement. Nevertheless, for reasons discussed below, we believe our findings are still very relevant.

What is the magnitude of the transaction costs associated with project development?

The average transaction costs for our sample facilities were $350,000. Average transaction costs for the EPA regional offices were $110,000. Thus, total average per project transaction costs were $460,000.

We use the cost data to divide our sample into two groups—high-cost projects and low-cost projects—based on whether the transaction costs associated with each project were above or below the sample median ($540,000). We did this to try to determine why certain projects were more costly than others. The high-cost projects are Imation, Intel, Lucent, Merck, Weyerhaeuser, and 3M. The low-cost projects are Berry, Hadco, IBM, Molex, and Osi-Witco.

What stages of the project development process are perceived as being the most costly?

To address this question we divided the project development process into six stages and asked each of our survey respondents to tell us what percentage of the transaction costs arose in each of these stages. Table 3 gives the results (the numbering of the Tables is that which appears in Blackman and Mazurek 2000).

Table 3. Average percentages of firms' costs associated with each project development stage

Stage	All firms (n = 11)	High-cost firms (n = 6)	Low-cost firms (n = 5)	t-statistic
Preliminary proposal	18.6	5.0	35.0	(-4.187)**
Stakeholder negotiations	20.2	16.2	25.0	(-1.291)
Interact w/ local regulators	13.4	17.0	9.0	(2.619)*
Interact w/ EPA region	22.5	24.5	20.0	(0.904)
Final approval	24.4	37.5	8.6	(6.714)**
Other	1.1	0.0	2.4	(-3.537)**

*Difference between high- and low-cost firms significant at 5 percent level.
**Difference between high- and low-cost firms significant at 1 percent level

(Source: RFF survey 1998)

The key finding is that for the entire sample, about half of transaction costs arose from interacting with EPA regions and from obtaining final approval from EPA headquarters, while only about a fifth of transaction costs arose from stakeholder negotiations. By looking at the differences between the responses of the high-cost and low-cost firms, one can see clearly that the high-cost firms spent more time obtaining final approval than the low-cost firms. Thus, the bottleneck for high-cost firms appears to have been obtaining final approval. This finding jibes with the conventional wisdom that interacting with EPA—and in particular obtaining final approval—has been the principal source of transaction costs. But it also runs counter to the conventional wisdom that stakeholder negotiations are a major source of transaction costs. (See Blackman and Mazurek 2000 for results from the survey of EPA regional offices)

What issues associated with the project development process are perceived as being the most costly?

In order to address this question, we compiled a list of the issues most frequently mentioned in the literature as sources of transaction costs and asked our survey respondents to choose one of these issues as most important and one as second most important. Table 5 gives the results.

Table 5. Importance to firms and EPA regions of 10 sources of project development costs

Source of costs	*No. times selected 1st or 2nd most important by…*	
	Firms	*EPA regions[a]*
A. "Superior environmental performance" requirement unclear	5	4
B. Design stakeholder negotiating process flawed	1	0
C. EPA lacks statutory authority to implement FPAs	2	4
D. Lack of coordination among EPA offices	6	5
E. Lack of coordination between state and local regulators	0	1
F. Lack of coordination between EPA and other regulators	3	2
G. Lack of coordination with other EPA regulatory reform initiatives	0	0
H. Industry competitors blocked FPA approval	0	1
I. National environmental advocates blocked FPA approval	1	2
J. Other program design issues	4	5

[a] Two EPA regional offices were involved in Hadco process

(Source: RFF survey, 1998)

The issues most often selected by facilities were A (requirement of superior environmental performance unclear) and D (lack of coordination among EPA offices)

The issues most often selected by EPA regions were A, D (the same two items selected by facilities), and C (EPA lacks statutory authority to implement the FPA). Thus, EPA management problems were identified by our respondents as being the most important sources of costs

Why are transaction costs higher for some facilities?

To address this question, we collected publicly-available data on 23 characteristics of our sample facilities and their proposals—four characteristics of the FPA, six characteristics of the firm, nine characteristics of the facility, and four characteristics of the negotiating process—and then we tried to see if there was a correlation between these characteristics and the costliness of their proposals. Ideally we would like to have used multivariate regression analysis to see which of these characteristics drove costs. However, our sample simply was not big enough: we have twice as many explanatory variables as observations. Our second-best methodology is to look for simple correlations between these characteristics and our two cost categories and to rely on intuition to sort out the results.

As explained in detail in Blackman and Mazurek (2000), having gone through this process we came to the conclusion that difference in the complexity of proposals—*not* the characteristics of the facility, firm, or negotiating process—drove differences in transaction costs across firms. Table 6 presents the relevant results.

Table 6. Proposal characteristics by cost category

Firm	*Principal flexibility requested*	*Multiple facilities?*	*Principal media affected by flexibility*	*Legal lever*
High-cost				
Imation	caps 4 C.A.P.s + other A.P.s; permit preapproval	no	air	under development
Intel	caps 5 C.A.P.s + H.A.P.s; permit preapproval	no	air	alternative permits
Lucent	permit preapproval	yes	air, water, s. & h. wastes	site-specific rule
Merck	aggregate cap 5 C.A.P.s; caps 3 C.A.P.s; permit preapproval	no	air	site-specific rule; permit variance
Weyerhaeuser	cap on H.A.P.s & water effluents; consolidated reporting; waiver review	no	air, water	existing waiver mechanism
3M	caps on 5 C.A.P.s + H.A.P.s; permit preapproval	yes	air	wanted site-specific rule
Low-cost				
Berry	consolidated permitting	no	air, water, s. & h. waste	generally applied int. statements
Hadco	delist wastewater sludge	yes	water, s. waste	existing waiver mechanism
IBM	alternative wastewater treatment	no	water	determination of equivalent treatment
Molex	delist wastewater sludge	no	water, s. waste	existing waiver mechanism
Osi-Witco	deferral of new technology standards for h. waste	no	air, water	existing waiver mechanism

Abbreviations: C.A.P. = criteria air pollutant; H.A.P. = hazardous air pollutant; s. & h. = solid and hazardous.

(Sources: see Blackman and Mazurek 2000)

The results are striking. Every one of the facilities in the high-cost category requested either a waiver of the requirement to get new air permits every time the production process changes in exchange for an aggregate cap on air emissions, or an agreement covering more than one facility. By contrast, none of the facilities in the low-cost category requested such a waiver, and only one submitted a proposal involving more than one facility. It is important to note that the projects involving aggregate caps on air emissions were quite complex. They entailed difficult questions about how to set the caps, whether there could be trading among different pollutants, and how often to require repermitting, and monitoring. The other projects did not have to deal with these questions.

Are our findings still relevant?

As discussed above, the XL project approval process has been modified considerably since its inception. If we were to conduct our analysis on a more recent cohort of participants, would results be the same?

The only way to know for sure is to do a follow-up survey. But our intuition is that while the magnitude of the costs would likely be lower, the sources of costs that we have identified would likely stay the same. In particular, two of our key findings would likely persist: (i) interaction with EPA, not the stakeholder process, is the project development activity that gives rise to the lion's share of transaction costs, and (ii) the complexity of project proposals drives differences in transaction costs.

The reason is that—notwithstanding EPA's attempts to clarify guidelines and to "reengineer" the approval process—the key problems that underlie these findings have not yet been resolved. With regard to final approval problems, the experience of recent project participants clearly illustrates that the EPA has not eliminated this bottleneck. Of the 16 projects waiting for final approval in December 1999, two had been waiting more than four years, three had been waiting more than three years, and five had been waiting more than a year. Lack of a legislative foundation for Project XL and a lack of buy-in among EPA staff have been widely blamed for raising the costs of obtaining final EPA approval. Both problems persist (Inside EPA, 1999; The Reinvention Report, 1999).

Key problems that have raised project development costs for firms submitting complex proposals also remain unsolved. For example, the EPA's attempt to establish clear guidelines regarding "superior environmental performance" have fallen short of their goal since they have waffled on the key issue of how baseline environmental performance should be measured (Cabellero, 1998, 406). Also, difficult issues that inevitably arise in evaluating proposals for plant-wide caps on air emissions—how to set the caps, whether to allow cross-pollutant trading, how often to require repermitting, and how to monitor compliance—remain difficult to address except on a case-by-case basis.

Policy implications

What do our findings imply about the viability of Project XL and, more broadly, the viability of TR? They constitute 'good news' in some respects and 'bad news' in others. The good news is that, although we found that the costs of project development have been significant, our survey results indicate that the one part of the process that many critics have identified as a potentially most costly and most difficult to manage efficiently—stakeholder negotiations—has not been a major component of costs. Rather, a considerable percentage of costs have been due to problems with EPA's management of the initiative.

But our results constitute bad news as well. We found that the complexity of the project proposal may well have been the key determinant of project development costs. To the extent that complexity is correlated with innovation—and judging from our sample there does appear to be a strong correlation—this implies that innovative proposals are likely to be the most costly. This does not bode well for EPA's prospects of remedying one of the often-cited weakness of

Project XL: its inability to attract proposals that, if transferred, could have a significant impact on the efficiency of the regulatory system as a whole.

A second troubling implication of our findings is that, given that participating in Project XL has been costly and that pushing through the most beneficial type of project agreements has been especially costly, one would expect the initiative to be biased in favor of large firms. Such firms have financial and human resources and economies of scale and scope that lower the costs and increase the benefits of participation relative to smaller firms. The fact that virtually all of the firms in our sample are relatively large (see Table 7 in Blackman and Mazurek 2000) confirms this hypothesis.

It is important to note that in certain respects this 'anti-competitive bias' may be inevitable if not beneficial. According to the EPA, the goal of the program is to transfer regulatory innovations that are tested in Project XL. For example, efforts are now underway to make air emissions caps broadly available (Inside EPA, 1998). Presumably, small firms will eventually be able to take advantage of the efforts of larger firms to spur regulatory reform. Hence, the competitive advantage that large firms get from participation in Project XL could in theory be temporary and best thought of as a return on their investment in regulatory reform, analogous to the return that inventors get from patents.

The policy prescriptions that flow from these conclusions are straightforward. In order to achieve either the ambitious goal of making Project XL a viable 'regulatory blueprint' for site-specific regulation, or the less ambitious objective of ensuring that it serves as an effective test-bed for policy innovations, EPA must clearly demonstrate that the cost of project development can be reduced. Despite EPA's many reforms, there is as yet no extensive record to indicate that the process will be less costly for future participants. The challenge for EPA will be to change the negative perceptions of both sets of stakeholders by ushering a second group of XL participants through the project development process in short order and at relatively low cost. Just as important, EPA must demonstrate that costs can be reduced for innovative proposals as well as prosaic ones, that small firms can participate, and that the benefits of regulatory innovations can be transferred.

Our study also suggests, that given the need to find ways of reducing the costs associated with developing XL projects, EPA would benefit immensely from developing a reliable mechanism to track costs—both those incurred by firms and by the EPA. As yet, there is little public information available, and very little analysis of the costs incurred by EPA headquarters.

Theoretical research on competitive issues associated with TR

Unlike the very concrete issue addressed in our study of transaction costs, the question addressed in this research is more hypothetical since it explores the implications of a large-scale application of TR. Consider a program akin to that advocated by the supporters of the "Second Generation" initiative: a permanent nationwide program with the five characteristics of TR discussed in the introduction (facility-specific, voluntary, sets performance standards that guarantee superior environmental performance, entails a fixed transaction cost due to the stakeholder process, and promotes diffusion of regulatory innovations). Our question is, would such a program necessarily improve social welfare?

There are several reasons to believe it would. First, by allowing firms to substitute performance standards for inefficient command-and-control regulations, TR can generate significant cost savings for industry. In addition, the superior environmental performance rule assures that environmental quality will not deteriorate.

Notwithstanding these benefits, one troubling feature of TR is that it enables participating firms to operate under a different set of guidelines than their competitors. Therefore, intuition suggests TR could have detrimental welfare impacts by providing cost savings—and hence a competitive advantage—to selected firms.

The main finding (from our stylized model) is that TR can reduce welfare because it can have adverse competitive impacts. The principal means by which this may occur is the diffusion of regulatory innovations to non-participants.

Model framework

For readers who are technically inclined, we very briefly provide a flavor of the modeling framework used to derive our results (see Blackman and Boyd, 2000 for details). We use a Cournot duopoly model. Firms maximize profit by choosing how much output to produce, and whether to participate in a command-and-control regulatory regime, or a TR regime. Their choices are constrained by three exogenous factors. First, the TR agreement must ensure superior environmental performance. Second, the regulator sets some rule regarding whether and how the regulatory flexibility offered in the TR agreement is diffused to competing firms. And finally, firms must pay a fixed transaction cost to participate in TR. This modeling framework generates three key results.

Result #1. Transaction costs constrain welfare improvements

The higher are transaction costs, the harder it is for the regulator to generate participation in TR and environmental benefits. The logic behind this result is simple: Given fixed transaction costs, to get firms to participate, regulators must offer TR agreements that lower production costs. Moreover, the higher are fixed transaction costs, the larger must be the production cost reductions. But when the regulator is forced to offer relatively large production cost reductions, she has less leeway to set high environmental performance standards.

Result #2. TR can reduce welfare via market stealing

Our second key result is that it is theoretically possible in our stylized model for a TR agreement to *reduce* welfare by reducing total industry profits. This can happen because of a phenomenon known as "market stealing."

To understand this phenomenon, which is well known in the industrial organization literature, imagine a sector comprised of just two firms with identical market shares. One of them gets a TR agreement and one does not. The market share and the profit of the firm that gets the TR agreement goes up and the market share and profit of the firm that does no goes down. The firm that gets the TR agreement is the "winner" and its rival is the "loser." TR's impact on total industry profits will be negative when the winner's gain is smaller than the loser's loss. This happens when the winner is "less efficient" (has a lower profit margin) than the loser. So essentially, one can get a welfare loss when TR agreements are given to inefficient firms who profit at the expense of efficient ones.

That may seem like a far-fetched story, especially since most firms that participate in Project XL—our TR prototype—are large market leaders who are not likely to be inefficient (see Blackman and Mazurek, 2000). But the possibility of TR leading to welfare losses via market stealing is far less remote when one takes into account the diffusion of TR agreements.

Result #3. Diffusion of TR agreements may entail significant costs as well as benefits

We model the diffusion of TR agreements as the ability of firms which do not formally participate in TR to get the same TR agreements that participants get without paying the fixed participation cost. In such situations, diffusion has two important disadvantages. First, it can reduce industry profits via "market stealing" even if only efficient firms participate formally. The reason is that the regulator is essentially giving a competitive advantage to relatively inefficient firms.

Second, diffusion dampens incentives for firms to formally participate. Clearly, if firms can get the benefits of TR via diffusion, they have less incentive to participate. There is a strong analogy to firms' incentives to invest in developing new products. Such incentives are dampened when firms know that their rivals can appropriate the fruits of their investments (this is the basic argument for patents).

Policy implications

Our findings suggest that regulators can ensure that TR attracts participants and enhances welfare by carefully choosing which firms can participate, the cost savings offered to each firm, and the extent to which TR agreements are allowed to diffuse to non-participating firms. With regard to the selection of firms and the terms of the agreement, the regulator can avoid welfare losses by ensuring that relatively inefficient firms are not singled out for participation or particularly advantageous agreements. Even if this strategy can be successfully implemented, it has an important drawback: it implies that regulators should provide cost-breaks to market leaders, a policy that smacks of inequity and would likely run into stiff political opposition. Moreover, such a policy could result in the exit of smaller firms and increased market concentration. We have focused on demonstrating how TR can have adverse welfare impacts even abstracting from exit. Nevertheless, intuition suggests that while TR administrators should ensure that inefficient firms are not the principal beneficiaries of the TR regime, they should also ensure that efficient firms are not helped to such an extent that their competitors are forced to exit the market.

Happily, in practice, even if regulators do not actively select relatively efficient firms to participate, political-economic considerations are likely to favor their participation. With in-house environmental management and lobbying capabilities and relatively easy access to investment capital, large market leaders (which are presumably relatively efficient) can more easily pay the fixed cost of participation in TR. The Project XL experience thus far would appear to confirm this hypothesis. Blackman and Mazurek (2000) found that of the first eight firms to implement XL agreements, six were among the top three firms in their industries in terms of market share. Does this mean that regulators can ignore the threat of welfare losses due to market stealing? Probably not. TR's emphasis on the diffusion of TR agreements among non-participants implies that inefficient firms need not formally participate in TR in order to steal market share from their competitors—market stealing that results from diffusion may lead to welfare losses.

Hence, from the point of view of social welfare, the regulator's diffusion policy is critical. Diffusion has a number of potential costs. We found that it can lead to welfare losses from market stealing, and can also dampen firms' incentives to participate. In some situations, when diffusion is costless, it may not be possible to induce participation no matter how attractive the terms of the TR agreement. Therefore, the regulator may want to limit diffusion in order to both prevent market stealing and to generate formal participation. Widespread formal participation has clear advantages. It always has a positive impact on consumers' surplus and—assuming that performance standards under TR are more stringent than under command-and-control—on the environment.

But diffusion of TR agreements clearly has economic benefits as well. It reduces firms' marginal costs and therefore inevitably enhances consumers' surplus. This benefit *may* be sufficient to offset any potential loss in producers' surplus. Hence, in setting a diffusion policy, the regulator must balance potential welfare benefits against costs. This calculation is likely to vary across industries.

Finally, our findings highlight the desirability of minimizing the fixed costs of participating in TR. Given that TR agreements must reduce operating costs in order to induce participation, there is clearly a trade-off between the amount of cost-reducing regulatory flexibility an agreement entails, and the amount of environmental benefit it requires. But we have seen that lower participation costs imply that regulators can induce participation with less attractive offers. Therefore, one means of allowing for more of each type of benefit is to find ways of reducing the fixed costs associated with participation. Although we have modeled fixed participation costs as exogenous, in practice, regulators should have some control over them. For example, in the case of Project XL, empirical research has indicated that management problems at EPA as well as uncertainty about the statutory foundation of the initiative are key contributors to participation costs, so it seems reasonable to assume that regulators have some ability to reduce these costs.

REFERENCES

RFF research summarized in this report:

A. Blackman and J. Mazurek. 2000. "The Cost of Developing Site-Specific Environmental Regulations: Evidence from EPA's Project XL." *Environmental Management.* Vol. 27, No. 1, 109-121. This paper is also available electronically on RFF's website as *Resources for the Future Discussion Paper 99-35* at http://www.rff.org/disc_papers/PDF_files/9935rev.pdf

A. Blackman and J. Boyd. 2000. "Tailored Regulation: Will Site-Specific Environmental Regulation Improve Welfare?" Under review at the *Journal of Public Economics.* This paper is available electronically on RFF's website as *Resources for the Future Discussion Paper 00-03* at http://www.rff.org/disc_papers/PDF_files/0003rev.pdf. Finally, the paper is also available as *Fondazione Eni Enrico Mattei (FEEM) Working Paper 76.2000* at http://www.feem.it/web/activ/wp/abs00/76-00.pdf

Other references:

Caballero, T. 1998. Project XL: making it legal, making it work. *Stanford Environmental Law Journal* 17: 399-471.

Cushman, J. 1996. US seeking options of pollution rules. *New York Times* May 27, A11.

Enterprise for the Environment. 1998. *The Environmental Protection System in Transition, Toward a More Desirable Future.* Center for Strategic and International Studies Press: Washington, DC.

Hausker, K. 1999. Reinventing environmental regulation: the only path to a sustainable future. *Environmental Law Reporter* 29: 10148-57.

Inside EPA Weekly Report. 1998. EPA will cut paperwork in new plan for 'emission cap' air permits. October 30: 11.

Inside EPA Weekly Report. 1999. EPA headquarters set to 'reinvent' environmental enforcement. August 25: 3.

Mank, B. 1998. The environmental protection agency's Project XL and other regulatory reform initiatives: the need for legislative authorization. *Ecology Law Quarterly* 25: 1-88.

National Academy of Public Administration (NAPA). 1997. *Resolving the paradox of environmental protection, an agenda for Congress, EPA and the states.* NAPA, Washington, DC.

Phillips, A. 1995. Clinton, Gore say Project XL pilots are blueprint for regulatory reform, *Daily Environmental Reporter*, November 7: AA-1.

The Reinvention Report. 1999. Lack of regional support threatens EPA goals for Project XL. February 10, 5.

Steinzor, R. 1996. Regulatory reinvention and Project XL: does the emperor have any clothes? *Environmental Law Reporter* 26: 10527-37.

Discussion of Session I Papers
by Daniel J. Fiorino, US EPA Office of Policy, Economics and Innovation

We may distinguish between an old and a new approach to environmental regulation. The old version is based on a fairly simple model of behavior. It relies almost entirely on the specification of government rules backed by sanctions, to which firms must respond or face penalties. The goal in this old version of regulation was compliance rather than broader definitions of environmental performance. The regulated industry is seen as a "black box" in which everyone is officially the same, regardless of their past performance or their capacities for future performance.

The research that we are discussing today reflects a much more sophisticated version of regulation. It recognizes that firms vary considerably in their intentions and capabilities; many not only consistently comply but do better than compliance in many ways. This new version of regulation recognizes that positive as well as negative incentives may be effective in influencing the behavior of firms in the desired directions. In addition, there is an awareness that factors other than regulation — such as community attitudes, public image and reputation, customer and investor pressures, the efficiency of clean production practices — also influence environmental behavior.

The papers under discussion today share common themes. They demonstrate a concern with environmental performance broadly rather than only compliance. They also accept that there is substantial variation in the motivations and capacities of different firms. The objective of these papers, and of much of the research that they represent, is to identify and measure differences in performance as well as to explain the causes of those differences. The more understanding we have on this question, the better we can design regulatory and other policies to achieve our goals.

In the three papers presented in this session, we may see the effort to understand what factors other than standard government regulation drive behavioral change in industry. These papers address three sets of issues: those regarding tailored regulation (in Project XL); what I call collective self-regulation (represented in Responsible Care); and management systems and practices (the EMS paper).

The Responsible Care paper uses data from the Toxics Release Inventory to evaluate the effects of that program, which is led by the American Chemistry Council for its membership. Industry codes of conduct, of which Responsible Care is the leading example, are a potentially promising trend in private sector environmental management. They bring the resources of a trade association together in a collective effort to improve environmental performance in that sector. This study finds that, at least as reflected in trends in releases of TRI chemicals, Responsible Care facilities do not appear to be improving any more than those that have not adopted Responsible Care.

This is an important area of research, and this paper suggests ways to improve these codes of conduct. There are questions, however, about the conclusions drawn from the research. TRI performance over the short term is a narrow measure of performance. Many of the changes it introduces in the practices of firms — product stewardship or reduced likelihood of accidents — are not reflected in the TRI. If Responsible Care has been less effective than it perhaps should have been so far, at least as measured by the TRI, this may be a product of where different firms started or how their levels of production have changed. This is important research, but we should be careful about what conclusions are drawn from it.

The paper does make many important points about the strengths and limitations of these codes. I agree that external validation is necessary to reinforce the effects of these codes and to provide credibility with the public and regulatory agencies. Better and more consistent information on actual environmental performance under Responsible Care is also important.

The paper on Project XL provides an excellent characterization of one class of innovation programs, appropriately called "tailored regulation." It also addresses a core issue in regulatory design: How do we balance consistency and predictability in regulation with flexibility? Environmental regulation often is criticized for its inflexibility, as when general rules do not make sense when they are applied to specific circumstances. Project XL was designed to allow EPA to make exceptions when a facility could demonstrate that flexibility would lead to a better environmental result.

The focus of this paper is on the transaction costs of tailored regulation. Because it involves case-by-case determinations, tailored regulation does involve substantial transaction costs for industry and government, as well as other stakeholders. The key finding is that the larger source of costs was not external stakeholders, as is commonly assumed, but the internal EPA costs for coordination and issue resolution. These costs, as one would have expected, were higher for the more complex issues. In fact, the more complex the issues, the higher were the transaction costs.

This suggests that many of the costs of tailored regulation lie within an agency's control. This study also reinforces the importance of agencies having statutory authority for tailored regulation, because it is difficult to resolve issues when the legal authority is unclear or not agreed upon. Clearer authority could reduce much of the uncertainty that drives up the transaction costs.

The paper on environmental management systems presents a great deal of empirical information. It offers findings relevant to practical policy design and confirms the working assumption of the research that is represented here (and the new thinking about environmental regulation that I referred to above): that factors other than regulation matter, such as consumers, investors, communities. An especially interesting finding is the importance that capital markets, performance information, and high disposal costs have on business decisions regarding environmental improvement.

The research reported in this paper also confirms that government regulation is important in placing pressure on firms, by increasing the costs of environmental mismanagement, and that the threat of future, more stringent regulation is a powerful motivation for improvement. It confirms my own thinking that government must continue to maintain pressure on firms for continuous improvement in performance, but should allow more flexibility in determining how to achieve it.

This research also suggests that public policy may influence the adoption of EMS by providing performance information and public recognition of firms that are using an EMS. It is relevant to the design of EPA's Performance Track, whose objectives are to promote EMS adoption, performance measurement (and commitments), and information to communities, as well as to require compliance with existing regulatory requirements.

Based on these papers, I would suggest three areas for additional research and discussion:

1. How do different policy strategies affect firms' behavior? This would help in determining the best mix of regulation, recognition, flexibility, and accountability to influence behavior toward continuous improvement in environmental performance.

2. What is the long-term role for voluntary programs? These programs have emerged in response to specific issues (e.g., the need to reduce greenhouse gas emissions without regulatory authority), but do not fit into an overall plan or as part of a larger EPA strategy. This research can help to inform efforts to decide on the long-term role of voluntary programs.

3. How should we measure performance when we evaluate the effects of these programs? Moving from a compliance-based system to one that is performance-based is an explicit or implied goal of most of this research. EPA and others still are at an early stage of measuring performance reliably and consistently.

Discussion of Session I Papers

by Peter May, University of Washington

- These papers can be read from a variety of perspectives: (1) as a "report card" on programs to induce voluntary compliance; (2) as a better understanding of motivations of firms to participate in such programs; and (3) at a more fundamental level, as a sparking of questions about what constitutes beyond compliance? I will comment briefly on each of these perspectives.

- **Report Card on Existing Programs**
  - As these authors point out, there have been a variety of studies of voluntary regulatory programs. These add to the store of knowledge in important ways.
  - Those under study here — Responsible Care of the Chemical Manufacturers Association and EPA's Project XL, along with the more general topic of firm adoption of environmental management systems — have been the "poster programs" of voluntary regulation. They have received a lot of publicity, attention, and high expectations. What is the reality?
  - Reality is sobering, as too often is the case!
    - Professor King provides what I read as a decidedly mixed assessment of Responsible Care, especially compared to positive image the program has obtained — good (B to B+) on attendance and citizenship of larger chemical firms, but weaker (C or below?) in achievement.
      - Those firms who join Responsible Care are those who would want to – larger firms, "dirtier" firms.
      - But, empirical findings raise questions about how much progress relative to other firms Responsible Care firms have made in reducing emissions.
    - The RFF group provides an overview of their work that points to their own and past studies of the weak performance of Project XL — poor on attendance (C or worse) given the expected draw, and at least from a transaction cost perspective, a high cost group to bring along (suggesting a need for Project XL tuition subsidies if want more participants).
    - Professors Khanna and Anton do not study a specific program, but their data suggests among Fortune 500 corporations a less than stellar adoption of all but the easier aspects of environmental management systems — perhaps a grade of incomplete at best!

- **Understanding of Motivations**
  - The bigger question, of course, is whether future voluntary programs can be designed to bring about better environmental outcomes? What constitutes "smart regulation"? — to use the term of Australian regulatory scholars Neil Gunningham and Peter Grabosky. There is not a simple answer to this question but starting by thinking about the motivations of firms to participate/adopt relevant practices is essential.

- I have come to think about three basic sets of motivations for compliance, which I think also apply to voluntary programs in some fashion. Individuals and firms comply because they fear detection of violations and fines (in the case of voluntary programs — they fear more costly regulation), feel a civic duty to comply (public image), or feel social pressure to comply (customers, investors, peers). These can be labeled calculated, normative, and social motivations. Yet also relevant are the awareness of rules (in this case awareness of opportunities) and ability to comply. I think these papers speak to aspects of each of these.
  - Each of the papers, in some way, addresses motivations. Khanna and Anton suggest that existing regulatory pressures — the fear of violations and penalties — appear to be weak motivations for participation in voluntary programs. Looming larger, but harder to measure, are the calculations of the impacts of threats of stronger regulation — which presumably are now lessened in many environmental areas given the political and policy context of today. These show up in Professor King's work as well.
  - Professor King points to the importance of civic duty and social pressure among larger chemical firms for the Responsible Care Program.
  - The RFF group speaks most directly to the ability to comply — financial ability to absorb transaction costs.
  - Less attention is given in these papers to awareness of opportunities.

- **Questions About Beyond Compliance and Voluntary Regulation**
  - We are, of course, only beginning to understand how all of this adds up and what happens when we project these natural experiments to more intensive, nationwide voluntary regulatory programs — a few hints emerge, especially from the RFF work — let's save these for discussion.
  - Yet, as we shift from traditional regulatory programs to voluntary, tailored, or more likely, mixed programs of some kind, to me three fundamental questions arise:
    - What constitutes "compliance" for voluntary programs? Studies tend to emphasize either participation as a binary activity (part of Responsible Care or not?) or the extent to which various compliance-like behaviors have been undertaken. If there are no standards, is there anything other than procedural measures like these?
    - What are the relevant expectations in terms of emissions reduction or other outcomes? Improvements of any kind? Improvements relative to those firms who did not participate — recognizing that the problem of selection biases looms greatly here? Comparisons to hypothetical mandatory regulations?
    - What constitutes "regulatory capture" for voluntary programs? — what Professor King refers to as opportunism and what the RFF group refers to in their calculations of social welfare. How would we recognize such capture and avoid it?

Question and Answer Period for Session I

Moderator Derry Allen offered the speakers the chance to respond to the remarks of the discussants.

Andrew King began by addressing the issue of measurement that Dan Fiorino had raised. King said that he aimed to present the simplest interpretation of the results. The issue of performance measurement is vexing, and King's study presents what the investigators believe is the best interpretation of the data that they can give.

However, other interpretations of the data are possible. For example, because the study uses employees as a measure of facility size, if Responsible Care firms are more efficient, they will have fewer employees and so will appear relatively smaller. As a result, they will also appear dirtier, relative to less efficient firms. So the initial analysis of performance could be biased against Responsible Care.

If this is true, the initial participants might have been relatively better performers at the start. That would explain their slower rate of improvement, because the participants would have been in a lower, flatter part of the learning curve. That logic works if there are differences in efficiency of use of labor between the two groups, and efficiency of labor is not reflected in the ability to reduce pollution.

Allen Blackman noted that measurement is part of the debate over what is "superior environmental performance" under Project XL. If an applicant proposes to improve its present performance, is that enough to qualify as superior environmental performance? What if the applicant is already doing well relative to other firms? Can it take credit for improvements that it has already made? The exact meaning of superior environmental performance is an issue that Project XL has had to sort out.

Blackman also touched on Fiorino's second question, regarding the long-term value of programs like XL, noting that one of the values is working through and clarifying issues like the one above.

Madhu Khanna commented on what constitutes compliance and noncompliance. Any reduction in emissions reported under the TRI goes beyond compliance, because the TRI itself sets no emission limits. She also noted that toxic releases are a narrow measure of a firm's performance. Programs of environmental management usually aim to improve performance in a much broader sense, including such factors as worker safety and community relations.

From the audience, Bruce Clemens of James Madison University remarked that the study of XL looked at costs. However, a rational firm will also be looking at the expected benefits of participation. It would be fascinating to look at the benefits that firms get from having a different regulatory approach.

Allen Blackman agreed. He noted that EPA has three or four reports on its web site documenting the benefits of participation. He also said that he asked the firms in his study whether they would participate again in XL, and 40% said no. But his study looked only at the first cohort of firms, and the transaction costs for those firms were high.

Peter May noted no mention of predictability as a benefit. To what extent do these programs offer firms a better sense of control?

Blackman responded that one of the most popular XL proposals is to eliminate the necessity to report on process changes. That helps firms get a better handle on costs.

Bruce Clemens then brought up a second issue, the conundrum of how to measure what we are really doing. He noted that in the financial field, if you ask firms how well they are doing, the subjective responses correlate well with objective outside measures of financial performance. Why not ask firms how well they are doing environmentally? Clemens ventured that the subjective sense of the managers might turn out to give a more accurate measure than the TRI, which is influenced by many complex factors besides the quality of environmental performance.

Adrian Demayo of the World Bank noted that the essence of performance is how we affect the environment, and that meeting standards is only a surrogate for that real concern.

Demayo then asked the panel if they saw voluntary programs as a replacement for or as a complement to compulsory standards. He noted that some people advocated voluntary action as a replacement for compulsory standards, and he asked if such replacement was possible.

Dan Fiorino replied that few would argue that we could replace external regulation with voluntary standards. Each complements the other. He noted that the relative roles may be different in different industrial sectors. In some industries, voluntary programs backed up by regulation can be effective. In others, a stronger command and control presence may be necessary.

Peter May urged the audience to take time into consideration. These are dynamic programs, and the relative roles of voluntary and compulsory standards will evolve over time. Also, programs like XL are small now, and their roles will change if they expand. How they will change is hard to predict.

Bette Hileman of Chemical and Engineering News asked whether the regulatory innovations of XL projects can readily diffuse to other companies under the present program.

Allen Blackman replied that EPA characterizes XL projects as testbeds and intends to apply the lessons learned elsewhere.

Hileman asked if that would still be “tailored regulation.”

Blackman explained that individual firms would participate in developing innovations, and then these innovations would have to be applied on a case-by-case basis to other firms. EPA would still have to tailor innovation to fit each participant.

Fiorino added that EPA is learning from the XL experiments, and some of the innovations may turn out to be suitable for more general application, to whole categories of firms.

Derry Allen said that EPA is looking at that very subject — how to apply lessons learned from XL to more of the regulated community, hopefully to achieve more environmental benefit.

Jay Benforado, Deputy Associate Administrator of EPA's Office of Policy, Economics, and Innovation, said there is some ambiguity about the future of XL. Some see XL as a source of innovative concepts like emission caps that can apply more broadly within the regulated community. Some see XL as a proving ground for the process, eventually making it easier for facilities to get individually tailored regulation.

Benforado also noted that many of the benefits of XL projects have been ancillary to the pollution control approach being tested. For example, at Intel, the way the facility worked with the community was innovative and could be copied.

Suzanne Giannini-Spohn, EPA Office of International Activities, asked if anyone had looked at self-policing by industry groups and whether groups were expelling non-complying members from voluntary programs.

Andrew King replied that his group was hoping to evaluate whether differences in sanctions affect performance. Some research in progress suggests that having graduated sanctions, with a history of use, is critical. However, there are few programs to evaluate and most have short histories. It is hard to get statistically significant results.

Joseph Sarkis of Clark University wondered what businesses would conclude from this research — perhaps that that they should not do too much or try to take the lead on new things? In the King study, the less you did, the better off you seemed to be. In the Blackman study, the less you did, the less cost you incurred. And in the Khanna study, those who took only a few steps to improve compliance did as well as some who took many steps. Why do extra things if you won't perform better?

King said that evidence suggests that second movers in many circumstances do better. However, going first may have advantages in some cases. Maybe you can secure the benefits while discouraging others from following. Maybe you can set the way things will work in the future. You can create a template that fits you well but your competitors less well.

Sarkis then observed that first movers are usually a small percentage of the community. How do the organizers of a voluntary program motivate the others to follow?

Peter May replied that this issue comes up often, and not only in the environmental area. That is why you need a two-tiered regulatory structure. Incentives alone are never enough. You need a regulatory floor.

Madhu Khanna said her study's results were consistent with the view that the optimal choices for firms may vary. It is rational to see different firms opting to participate in different ways. She cautioned about drawing conclusions based on the inverted-U shape of the graph in her study. One should not conclude that adopting more environmental management practices causes a firm to perform worse.

Wayne Gray of Clark University raised a follow-up point about drawing conclusions based on the number of practices a firm chooses to adopt. We lack a good and complete measure of the difficulty that firms face in solving their environmental problems. Unless you control for this degree of difficulty, which is influenced by outside factors such as the attitude of regulators, can you fairly compare firms based on how many practices they choose to adopt?

Khanna agreed that both the decision to adopt environmental management practices and the effect of those practices were influenced by outside factors. Her study tried to account for the problem by taking a two-step approach. In the first step, the study looked at the impact of outside pressures on firms to adopt environmental practices. It showed that the intensity of these pressures led some firms to adopt more practices than others. From that, she and her co-author developed predictions of how many practices a firm could be expected to adopt, based on the firm's characteristics.

In the second step, they took these predictions and looked at their impact on on-site and off-site toxic releases while controlling for other factors that could affect the releases. The results show that firms that adopt more environmental practices have lower toxic releases but that the added benefit from each new practice becomes rapidly insignificant. Since the environmental management practices are affected by outside factors, she hesitated to directly draw the conclusion that adoption of more practices by a firm would reduce its toxic releases. Instead, she concluded that regulatory and market based pressures (such as those considered in her study) can reduce toxic releases by inducing the adoption of environmental management practices.

Michele Sullivan of the American Chemistry Council noted that the TRI does not capture the full depth of environmental protection efforts. Her group was looking at broader ways to track environmental health and safety performance and sustainable development. She expressed her group's wish to cooperate with other researchers in this effort and in the collection of data about transaction and control costs.

Clinton Andrews of Rutgers University questioned why researchers were looking at compliance at the firm or facility level rather than examining motivations at lower levels, within the organizations.

Andrew King answered that gathering data within organizations is hard. He had done that in earlier studies of the printed circuit board industry, and he got some detailed close-up portraits of behavior. They were useful, but panoramic pictures are also useful, even if they miss fine details. Ideally, we should have views from many levels.

Allen Blackman added that if you have the resources, looking inside the organization can yield valuable insights. He did some field research in Mexico on environmental requirements of brick-making plants. He found that variations in the education levels of the plant managers helped explain variations in plant performance.

Homer Erekson of Miami University (Ohio) urged the researchers to draw policy distinctions about motivations that go beyond economic distinctions. Responsible Care was not an effort to increase profits directly. It was aimed at addressing reputation. The fundamental motivation was not so much to increase individual profits as to avoid disaster for the industry. In the coming years, economics can give us insights about individual firm behavior in participating in these programs. But although King's study is otherwise praiseworthy, its results are flawed in concept when the study tries to address the question of motivation.

King replied that reputation has a dollar value. It affects stock price. And it is shared to some extent — for example, an accident like Bhopal affects stock prices throughout the chemical industry. Rational economic motivations lie behind these industry-wide environmental improvement programs. Some of the larger, better-performing, more visible firms are participating in these programs hoping to improve industry reputation and head off more stringent government regulation. Some industry associations are beginning to move towards more stringent self-policing, recognizing the potential economic benefits.

Blackman agreed that it is possible to include reputation in economic models. Also, some existing studies have analyzed the effect of a background threat of stronger legislation. He did not wish to diminish the importance of good intentions and goodwill, but heading off future regulation can also be a strong incentive for better performance.

Allen observed that firms take many approaches to environmental improvement. Some simply add pollution control devices to their existing operation. Some practice pollution prevention, redesigning their operations so there is less pollution to control. A few look beyond their own operations, to the whole flow of materials before and after it reaches their firms, and ask themselves how they can reduce the environmental harms. Has anyone looked at what motivates firms to take the broader, next-generation approaches to pollution control?

Blackman said that it depends on what is more profitable for the firm. Many firms recognize the potential benefits of emissions trading systems, pollution prevention planning, and so forth. But the firms weigh the expected benefits against expected costs.

King said his group struggled with how to measure supply chain performance. They tried to use the emergency response and notification system database to determine the accident record of supply chain firms, but that database often does not identify the responsible party clearly. They would like to find a better way to evaluate supply chains.

A related issue is the diffusion of environmental improvement down supply chains: can clean firms influence their suppliers to get cleaner? King had looked at the issue under Responsible Care and also looked at diffusion of standards under ISO 9000. Depending on the structure of the industry, diffusion to suppliers and contractors may happen more or less quickly. It would help if firms had a reliable standard that would let them quickly and accurately verify the environmental performance of potential suppliers.

John Moskal, who works on XL implementation in EPA Region I, said he thought the single biggest motivation of many early participants was to get a seat at the table with EPA — to influence the future direction of the program. He wondered how things would change as the program grew and offered individual participants less attention and influence. He also observed that the cost of participating in XL probably varied depending on the attitudes of the EPA program offices.

Fiorino said that he had talked with about 230 firms participating in EPA's National Environmental Performance Track Program. One reason that firms often gave for joining was that they did not want to be just a "face in the crowd." They wanted positive contact with EPA. As the program grows, this special recognition incentive will get weaker.

Sandra Schneider of NSF raised the possibility of looking at other performance indicators, suggesting that other indicators might lead investigators to consider other motivations for better performance. She offered self-reporting as an example. Perhaps internal motivational factors are responsible for the variance in self-reporting rates among firms. She urged the panel to consider how to go beyond economics in their analyses.

Khanna agreed that other motivational factors may be worthy of study, but observed that they were difficult to quantify.