Why do Firms Pollute (and Reduce) Toxic Emissions?

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ABSTRACT

There is a growing trend in both the U.S. and abroad for firms to reduce emission levels beyond the legally required mandate. One of the most publicized examples of this phenomenon in the U.S. is the release of toxic chemicals. These emissions have come under increasing scrutiny since passage of the "Right-to-Know" law mandating the public availability of toxic release inventory (TRI) information beginning in 1989. In response to this new information, some firms have dramatically reduced toxic chemical emissions. This paper explores the factors that both explain differences across firms in their initial toxic emission levels and in the reductions beyond any legally required levels subsequent to the availability of public information on TRI. The underlying theory is that firm-level pollution varies because of firm-specific factors that affect both the "ability" and "incentive" for firms to reduce pollution. In comparing emission levels between 1989 and 1992, we find that the largest firms are most likely to reduce emissions subsequent to this new information being made public. We also find that financial ability plays an important role in emission levels. On the other hand, we were unable to find any evidence that firms who advertise more heavily to consumers or had significant negative media attention concerning their emission levels reduced their emissions more than average after controlling for firm size.

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I. Introduction

Previous literature on why firms pollute has focused on whether or not firms comply with government regulatory standards. For example, optimal penalty theory assumes that the decision to comply depends on the probability of detection and the ultimate penalty if found to be out of compliance.[1] Subsequent empirical tests of this literature in the context of pollution control have shown that firms respond to marginal incentives such as higher penalties and more certain monitoring and enforcement.[2] On the basis of optimal penalty theory, firm compliance often appears to be irrational, as the "expected monetary penalty" from noncompliance may be less than the actual cost of compliance. One study of penalties for environmental crimes found that the monetary penalty seldom exceeded the harm caused by the offense.[3] This could only be "optimal"

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[1] The seminal article on optimal penalties is Gary Becker, "Crime and Punishment: An Economic Approach," 78 Journal of Political Economy 168 (1968). A summary of subsequent refinements to the Becker model, especially in the context of environmental enforcement can be found in Mark A. Cohen, "Environmental Crime and Punishment: Legal/Economic Theory and Empirical Evidence on Enforcement of Federal Environmental Statutes," 82 Journal of Criminal Law and Criminology 1054 (1992), and Mark A. Cohen. "Monitoring and Enforcement of Environmental Policy," International Yearbook of Environmental and Resource Economics, Volume III, edited by Tom Tietenberg and Henk Folmer; Edward Elgar publishers (1999).

[2] For example, Dennis Epple and Michael Visscher, "Environmental Pollution: Modeling Occurrence, Detection and Deterrence," 27 Journal of Law and Economics 29 (1984) develop and estimate a model of firm behavior in the face of government enforcement of oil spill regulation. This model was expanded to include the government's problem of optimally choosing an enforcement mechanism in Mark A. Cohen, "Optimal Enforcement Strategy to Prevent Oil Spills: An Application of a Principal-Agent Model with Moral Hazard," 30 Journal of Law and Economics 23 (1987). See also Wesley A. Magat and W. Kip Viscusi, "Effectiveness of the EPA's Regulatory Enforcement: The Case of Industrial Effluent Standards," 33 Journal of Law and Economics (1990).

if the probability of conviction was one, or if there were collateral sanctions that imposed other costs on the firm. Under such a scenario, possible explanations for firm compliance include the existence of more elaborate enforcement mechanisms that involve long-term relationships or more complex penalty schemes,[4] and non-governmental penalties such as the prospect of a private citizen lawsuit[5] or of damaging a firm's reputation.[6]

To those who wonder why firms comply, an even more intriguing question now appears to be of importance: why firms might reduce pollution even in the absence of (or beyond existing) regulatory standards. There is a growing trend in both the U.S. and abroad for firms to reduce emission levels beyond the legally required mandate. For example, over 1,200 firms participated in EPA's 33/50 program, agreeing to voluntarily reduce certain chemical emissions by 33% by

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[3] According to data reported in Cohen (1992), supra note 1 at 1081, the typical firm convicted of an environmental crime (where the harm could be estimated) could expect to pay total monetary sanctions just equal to that harm.

[4] For example, Clifford S. Russell, "Game Models for Structuring Monitoring and Enforcement Systems," 4 Natural Resource Modeling (1990), shows how an optimal enforcement strategy may involve a two-period enforcement game with a low probability of detection and small fines in the first period and near certain detection and very high penalties for second-time offenders.

[5] For example, see Wendy Naysnerski and Tom Tietenberg, "Private Enforcement," in Innovation in Environmental Policy: Economic and Legal Aspects of Recent Developments in Environmental Enforcement and Liability , Tom Tietenberg, ed. (Hants, England: Edward Elgar Publishing) 1992; and Michael S. Greve, "The Private Enforcement of Environmental Law," 65 Tulane Law Review 339 (1990).

[6]Jonathan M. Karpoff and John R. Lott, Jr., "The Reputational Penalty Firms Bear from Committing Criminal Fraud," 36 Journal of Law and Economics 757 (1993), argue firms may be penalized in the marketplace if their reputation is hurt. Karpoff and Lott examine frauds, not environmental offenses, and they conclude that "regulatory violations" such as currency reporting violations that do not hurt customers have virtually no effect on firm value. Whether or not environmental offenses have such an effect, however, is an empirical matter, and may depend on the nature of the industry and customers. According to Klassen and McLaughlin, "The Impact of Environmental Management on Firm Performance" Management Science (1996), there is evidence that bad environmental news (such as an oil spill) is accompanied by a significant decline in stock prices. We do not know if this is the result of the impending costs of cleanup and

1988 and 50% by 1995.[7] Other government sponsored programs and trade association initiatives also exist. Indeed, the Clinton administration has stressed new environmental programs that rely upon the "power of information" as opposed to more traditional forms of regulation.[8]

There are many potential reasons that firms would voluntarily go beyond compliance. Theoretically, in the absence of direct government regulation, we might imagine some form of Coasian bargain, whereby nearby residents negotiate with a polluting firm to reduce pollution to some acceptable level.[9]

Although high transactions costs might generally preclude most such negotiations from taking place, other forms of implicit bargaining might have similar results. For example, consumers might demand products that are less environmentally damaging or whose manufacturers are less polluting. To the extent consumers are willing to pay more for such products, firms will enter that segment of the market.[10] Community groups might pressure firms

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litigation, or if there is any residual "reputation effect."

[7]See Seema Arora and Timothy N. Cason, "An Experiment in Voluntary Environmental Regulation: Participation in EPA's 33/50 Program," 28 Journal of Environmental Economics and Management (1995).

[8] Among the highest priority items in the President's "Reinventing Environmental Regulation" initiative were the establishment of "public access programs" to make all EPA data and publications available through the Internet, and a new center for environmental information and statistics to ensure that data is available to the public. See Bill Clinton and Al Gore, "Reinventing Environmental Regulation," March 16, 1995.

[9] Ronald H. Coase, "The Problem of Social Cost," Journal of Law and Economics 1 (1960). Friedman (1992) provides a nice example of applying the Coase Theorem directly to the pollution control problem.

[10] Recent theoretical models have explored this possibility in a competitive market with consumer demand for "green products." See Peter W. Kennedy, Benoit Laplante and John Maxwell, "Pollution Policy: The Role for Publicly Provided Information," 26 Journal of Environmental Economics and Management 31-43 (1994); and Seema Arora and Shubhasis Gangopadhyay, "Toward a Theoretical Model of Voluntary Overcompliance," 28 Journal of Economic Behavior and Organization 289 (1995). Despite these theoretical models and public opinion polls

to reduce pollution by threatening implicit or explicit boycotts, zoning restrictions, and less favorable treatment elsewhere in community activities. Concerns over workplace safety and employee morale might make some form of pollution reduction in the firm's best interest. It is also possible that in large publicly traded companies, it is in the shareholder's interests to reduce pollution voluntarily.[11]

This paper provides new evidence on why some firms pollute more or less than their industry peers. We examine toxic chemical emissions that are entirely legal, but have come under increasing scrutiny as the public has gained ready access to them. In 1986, Congress passed the Emergency Planning and Community Right-to-Know Act, requiring manufacturing establishments to publicly disclose the quantity and type of toxic chemicals released into the environment.[12] The first reports were due to EPA no later than July 1, 1988 for toxic emissions in the calendar year 1987. Data from these reports have been referred to as the "toxic release inventory" (TRI). The first public disclosure of TRI data occurred on June 19, 1989. Hamilton (1995) showed that publicly traded firms whose TRI releases were first reported on that date experienced statistically significant negative abnormal stock returns.[13] The implication of this drop in stock price is that investors updated their expectation of future pollution-related

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indicating consumers are willing to pay slightly higher prices for environmentally sound products, actual behavioral evidence on the importance of green marketing is still scant.

[11] For example, Harford (1994) argues “that individual diversification of assets among firms dilutes each person’s financial gain from a firm’s pollution to such an extent that, in an ideal case, the average individual will have approximately the same trade-off between the benefits and costs of pollution as the economy as a whole.”

[12] See 42 U.S.C.A. 11023. The law applies only to companies with 10 or more employees in SIC codes 20 through 39 (with certain threshold sizes of chemical emissions).

[13] James T. Hamilton, "Pollution as News: Media and Stock Market Reactions to the Toxics Release Inventory Data," 28 Journal of Environmental Economics and Management 98, 1995.

expenditures or liabilities (e.g., expecting a higher probability of accidents, increased likelihood of exposure under other regulatory programs such as Superfund, or risk of future regulation), which would reduce future firm profitability.

In a follow-up study to determine the effect of the stock price reductions on firm behavior, Konar and Cohen (1997) found that firms that received a significant stock price reduction upon disclosing their TRI emissions subsequently reduced their emissions more than their industry peers - even if their industry peers had higher levels of emissions to begin with.[14] Although this implies that investor reaction to TRI may have helped spur on emission reductions, we do not know the reason for either this significant investor reaction or subsequent firm behavior. Moreover, stock price reductions cannot fully explain TRI reductions, since not all firms that reduced emissions were subject to significant stock price reductions on the day TRI emissions were released.

This paper explores the factors that both explain differences across firms in their initial TRI levels and in the reductions in TRI beyond any legally required levels subsequent to the "Right-to-Know" law passed in 1986. The underlying theory is that firm-level pollution varies because of both firm-specific factors that affect the "ability" of the firm to reduce pollution (such as age of assets and financial ability) and firm-level "incentives" (such as community pressures or effect on brand name reputation). Our key finding is that the largest firms are most likely to reduce emissions (both in an absolute sense and relative to their industry peers) subsequent to this new information being made public. We also find that financial ability plays an important role in emission levels, as firms with constrained cash flow positions were least likely to reduce

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[14] Shameek Konar and Mark A. Cohen, "Information as Regulation: The Effect of Community Right to Know Laws on Toxic Emissions," Journal of Environmental Economics and Management

emissions. On the other hand, we were unable to find any linkage between "closeness to consumer" (e.g., level of advertising expenditures or other forms of consumer marketing versus commodity-type products sold as intermediate goods) and firm-level emission reductions. Moreover, there is little evidence that firm-specific negative media attention had any impact on firm behavior after controlling for firm size.

The paper is organized as follows: Section II briefly reviews the theoretical foundations of our analysis by examining a simple model of profit maximizing behavior with "external pressures" to reduce pollution. Section III describes the data used in our study. Section IV presents the main results, where we examine the factors that influence both the initial decision to emit toxic chemicals as well as reductions in these legal emissions subsequent to a change in the external pressures firms faced. Several concluding remarks are contained in Section V.

II. Theoretical Framework: Why Do Firms 'Voluntarily' Overcomply with the Law?

In order to motivate the empirical analysis, we present a simple model of firm environmental performance under the assumption of expected profit maximization. Prior to any legal or extra-legal concern for environmental performance, the profit maximization problem could be represented by:

$$\text{Max}_y \qquad \pi(y) = p*y - c(w,y) \qquad (1)$$

$\pi(y)$ = profits at the output level y
p = price of output
$c(\bullet)$ = cost function
w = input costs

Profit maximization would occur at an output level where the marginal cost of production equals the price of the output. However, if we impose external costs to the firm that pollutes (such as

(1997).

legal constraints, community or consumer pressures), the profit function determining firm behavior is:

$$\pi(y) = p*y - c(w,y) - S[\ (1-a) * e(y), f\ ] - A\ [\ a * (e(y), t)\ ] \qquad (2)$$

a = degree of pollution abatement, $a \in (0,1)$
e(y) = emissions generated as a function of the output level y
S(•) = externally imposed incentives to reduce pollution. Depends on the level of pollution (1-a) ∗ e(y) and a vector of firm specific variables f.
f = vector of firm specific characteristics affecting the external incentives to reduce pollution (e.g., size of firm, closeness to consumers)
A(•)= pollution abatement costs to the firm as a function of the level of pollution abatement a∗e(y) and a vector of firm specific variables t.
t = vector of firm specific variables that account for the ability of the firm to reduce pollution (e.g., age of assets, financial ability)

Under this revised formulation, the firm now chooses both output (y) and abatement (a) in order to maximize profits. Given a level of output y*, the level of abatement, a*=a(e(y*), S*, A*), depends on the unabated level of pollution, external incentives to reduce to pollution, and abatement costs. The incentives to reduce will vary both across industries and across firms in the same industry, depending on factors such as the closeness of a firm's product to the final consumer or the geographic location of manufacturing facilities. The ability of a firm to reduce pollution will depend on factors such as technology, age of assets, and its financial ability to raise capital to purchase abatement or prevention technology.

Traditional models of firm behavior would have operationalized the external cost function (S), by equating it to the probability of detection multiplied by the expected fine if detected. We extend the analysis to include all forms of firm specific external costs (f), including the costs imposed by adverse investor behavior, consumer buying behavior, community or worker pressures, litigation, fines, etc. Thus, we also refer to these external "costs" as "incentives to reduce pollution." The first derivatives of both S and A with respect to their first arguments (pollution and abatement levels respectively) are positive:

$S'_1((1-a) * e(y), f) \geq 0;$ external costs increase with pollution levels

$A'_1(a*e(y), t) \geq 0;$ abatement costs increase as abatement increases

Assuming pollution levels increase with an increase in output y, i.e., $e'(y) > 0$, the first derivatives of the functions S and A with respect to "a" and "y" are:

$$S'_a = S'_1 * (-e(y)) = -e(y) * S' \leq 0, \qquad S'_y = S'_1 * (1-a) * e'(y) \geq 0$$
$$A'_a = A'_1 * e(y) \geq 0, \qquad A'_y = A'_1 * a * e'(y) \geq 0$$

The firm chooses output (y) and abatement (a) to maximize profit equation (2). The first order conditions can be solved for the profit maximizing levels a* and y* such that the firm will equate the marginal costs of pollution and abatement.[15] Thus, firm decisions to reduce emissions depend on the functions S(•) and A(•). If the firm faces large penalties, it is likely to reduce emissions (as it now has an "incentive to reduce pollution"). If pollution abatement is very expensive, it is less likely to reduce emissions. Thus, the firm optimally trades off expected penalties and abatement costs. Unlike previous models, however, we consider the fact that "expected penalties" may include external pressures brought by stakeholders to reduce pollution.

It is evident from this simple model of firm behavior that both the initial decision about emissions and subsequent changes depend on a number of factors that relate to the incentive and the ability of firms to reduce emissions:

$$\Delta \text{ Emissions} = f\text{ (incentive, ability)}$$

These factors are discussed below:

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15 Technically, one must ensure that second order conditions are met. For A(•), this implies that pollution abatement costs increase at an increasing rate, a standard assumption that is consistent with actual observations. For S(•), we also expect that as the firm pollutes more it receives more publicity and pressure to reduce its emissions. As a result we would expect S to be increasing at an increasing rate with an increase in the pollution levels. A more technical

Incentives to Reduce Emissions.

The incentive for firms to reduce emissions depends on pressure from various external stakeholders (e.g., consumers or community groups). Although government enforcement efforts would traditionally be another form of "incentive," recall that we are dealing with emissions that are entirely legal. Thus, EPA has no enforcement power over firm TRI emissions. These factors lead to the following general proposition:

> **To the extent that environmental reputation matters and stakeholder pressures are important, firms with the "most to lose" from a negative environmental reputation have a greater incentive to improve their environmental performance compared to others - regardless of any legal mandate to do so.**

Why would a firm care about the negative publicity associated with TRI announcements? One potential reason is that firms with significant reputation capital may be hurt from the release of new negative information concerning their environmental record. There are various possible sources for external pressure, such as: community or public interest groups that might bring about negative publicity, sue for tort damages caused by environmental hazards, or challenge the company on other issues (e.g. zoning board rulings); employees who might be concerned about their workplace environment; or consumers who might base some purchase decisions on a firm's environmental record. Another potential source of pressure is from investors who may use TRI emissions as a signal of the firm's productive efficiency. The following propositions operationalize these potential sources of pressure:

> ***Proposition 1:*** Larger firms have more reputation capital to lose in the event of bad environmental publicity. Thus, *ceteris paribus*, larger firms are more likely to reduce emissions subsequent to being required to release information to the public about their toxic emissions.

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derivation of the results presented here are contained in Chapter 3 of Konar (1996).

Although this proposition does not specify the mechanism by which firms will "lose" reputation capital, there are several ways in which larger firms are likely to be affected by TRI. By their very size and visibility, larger firms are more likely to be the subject of public scrutiny by community or public interest groups. They also have more at stake when considering the effect of negative publicity. For example, an expanding firm with multiple existing locations may find that their environmental reputation affects their ability to obtain favorable zoning and tax treatment when attempting to move into a new geographic area..

> ***Proposition 2***: Firms with the largest absolute emission levels will be most visible as "bad actors," and hence most subject to stakeholder pressures to reduce emissions. Thus, *ceteris paribus*, firms with larger absolute emission levels are more likely to reduce emissions subsequent to being required to release information to the public about their toxic emissions.

In addition to firm size, the absolute level of emissions may independently bring about external pressures on a firm to reduce those emissions. Once again, these pressures may come about from various sources. Community pressure to reduce emissions is likely to have an effect on any firm that has a significant stake in the community - regardless of size. Private parties (either individually or through an environmental group) may sue firms under various theories of tort actions or government-defined right of action.[16] "Green consumers" may decide to buy products of low polluting firms or otherwise look for alternatives to products sold by high polluters. Finally, the government may step up enforcement actions against high polluters. Even though TRI emissions are perfectly legal, the government might target these firms for inspections in other areas and the result might be increased penalties and/or the cost of new pollution abatement

[16] Konar and Cohen (forthcoming) find that the intangible asset value of firms is negatively related to the existence of environmental litigation and higher levels of TRI emissions.

equipment.[17]

Any or all of these external pressures may be placed on a firm forced to make new environmental disclosures and may result in costly expenditures to clean up pollution or to prevent future pollution. Although it is possible that pollution abatement or prevention will ultimately save some firms money (e.g., through lower raw material purchases) to offset the original capital expenditure, it is also possible that these activities will only result in a net drain on firm profits. Thus, firms high on the TRI list can be expected to spend resources to "catch up" with their competitors who are not polluting as much and to defend themselves in costly litigation.

Without information about a firm's environmental performance, there can be little pressure by stakeholders to reduce emissions. The publication of toxic release information beginning in 1989 was followed by full-page advertisements in the *New York Times* paid for by environmental groups identifying the nation's largest emitters of toxic chemicals. The announcement of annual TRI emissions is almost always accompanied by front page headlines in major newspapers with lists of the "largest polluters." Thus, we expect the increased availability of data on toxic emissions to have an impact on subsequent firm emissions, particularly those that have the largest emissions to begin with.

> ***Proposition 3:*** Firms with significant consumer brand name reputations have the most to lose. Thus, *ceteris paribus* firms with significant brand name loyalty should improve their environmental performance more than other firms when new negative information about their environmental performance is released to the public.

Firms with consumer brand name products and reputations are more likely to be sensitive to consumer demand for environmentally conscious products. Of course, this proposition is only valid to the extent that consumer purchase decisions are affected by firm environmental

[17] Indeed, EPA (1994: 1-3) recently implemented a strategy of targeting enforcement activities at

performance. There is growing evidence that a significant percentage of consumers care enough about environmental performance to make it one criterion in their purchase decisions. For example, the percentage of Americans classified as “true-blue greens” (the most environmentally active group) rose from 11% in 1990 to 20% in 1992 (Roper, 1992). Although consumers will generally not pay much more for "green products," many will consider negative information about a firm's environmental performance to be an important attribute to consider in product choices. For example, we have recently witnessed boycotts of products such as tuna and various brands of gasoline.[18] Another indication that firms care about their environmental performance is the growing interest on the part of large image-conscious companies to advertise their environmental performance.[19] Finally, Ottman (1993) reports that in 1991, 13.4% of all new product introductions involved “green marketing” aspects, and that green ads increased four-fold between 1989 and 1990.

> ***Proposition 4:*** Firms whose emissions have been subject to more negative attention from the media and public interest groups will improve their environmental performance relative to firms that have not received such negative publicity.

Negative publicity is similar to the "specific deterrent" effect we observe in criminal law enforcement. That is, an individual or firm who commits an offense and is punished for that behavior will be much less likely to repeat the violation than one who is not caught. In our context,

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"high risk" firms and industries based on TRI and other data.

[18]Although there is an obvious problem of collective action in sustaining such a boycott, several boycotts (such as the tuna/dolphin controversy) have affected firm behavior. As Makower [13:103-6] argues by way of examples, a relatively small number of individuals can generate a significant amount of media attention and bad publicity for a firm.

[19] For example, a study by Banerjee, Gulas and Iyer (1995) found that a majority of “green advertisements” attempted to project a corporate image instead of promote a specific product.

although the penalty might not be government imposed, the effect should be the same. For example, McDonald's dramatically changed their packaging and waste disposal practices in response to the significant negative publicity they received from an environmental group protesting their use of polystyrene packages for sandwiches (Makower, 1994: 187-92). Although some of their competitors have followed McDonald's lead, none appear to have taken the issue so seriously and adopted such stringent supplier restrictions and environmentally sound production and disposal practices.

> ***Proposition 5*****:** Firms with the largest emission levels per unit of production within their industry are the most inefficient (eg., waste significant amounts of raw materials). Once this is learned, there will be pressure from shareholders to become more efficient, save money and (as a byproduct) reduce emissions.

A firm that has higher emissions per dollar revenue than its competitors may be wasting resources that ultimately end up in the air or water. Thus, a disclosure of high TRI emissions may be seen by investors as an indicator of poor management practices and increased risk of spills or accidents. Proposition 5 suggests that “inefficient” firms will reduce TRI more than “efficient” firms in their industries.

> ***Proposition 6***: To the extent it is in the interest of shareholders to improve their environmental performance, publicly traded firms where top management and directors’ incentives are aligned with shareholders will improve their environmental performance more than other firms.

Proposition 6 follows from the corporate governance literature on the agency costs associated with separation of ownership and control of large publicly traded firms. One proxy for the degree to which incentives of owners and managers are aligned is to measure the percentage ownership of the company by managers and directors. In its simplest form, the theory states that firms whose managers and directors have a higher percentage ownership of the firm are more likely to be responsive to shareholder needs (see e.g., Jensen and Meckling, 1976). This "incentive" alignment effect will carry over to environmental performance if shareholders care about environmental improvements.

> **Proposition 7**: Firms with more frequent or more punitive environmental enforcement actions are more likely to reduce their legal emissions in subsequent time periods.

Previous studies have shown that firms respond to environmental enforcement activities. For example, Epple and Visscher (1984), and Cohen (1987) show that the volume of oil spilled from tanker transfer operations is negatively related to the level of Coast Guard enforcement activities, and Magat and Viscusi (1990) find that pulp and paper mill compliance records is also related to EPA inspections. These earlier studies, however, primarily focus on noncompliance or illegal discharges - not on the discharge of *legal* pollutants. Our model suggests that firms will also reduce allowable emissions. There are various reasons why a firm would reduce legal emissions following an enforcement action. For example, they might want to mitigate the negative publicity associated with a large fine or health hazard caused by an accidental release. They might also want to reduce the increased enforcement and/or public scrutiny that is likely to follow such actions.

Ability to Reduce Emissions.

In addition to the "incentive" to reduce pollution (captured in Propositions 1-7 above), the second factor that influences a firm's environmental performance is its "ability" to reduce emissions. The ability of the firm to improve its environmental record is dependent on: (1) the technical feasibility of emission reductions; and (2) the financial ability of the firm to afford the capital expenditures and operating costs associated with pollution abatement technology. The extent to which firms pollute and can reduce pollution will depend on the type of industry and production processes, age of firm assets, and ability of the firm to raise capital to cover the expenses associated with the installation of pollution control equipment. For our purposes, these factors are primarily control variables, as we are interested in the incentives to reduce emissions - not the technical feasibility of pollution abatement.

III. Data Description

The primary data on company-level toxic release inventory (TRI) emissions was provided by Investor Responsibility Research Center (IRRC). The IRRC data contains data on 1500 of the largest capitalization publicly traded firms including the S&P 500 and the Fortune 500 companies between 1988 and 1992. It also contains various other environmental performance measures (such as oil and chemical spills, government fines and environmental litigation), which are compiled from public sources such as EPA and 10-K filings.

Financial performance and other firm-specific data (e.g. number of employees, size and age of assets) were taken from Standard and Poor’s COMPUSTAT database. Stock market data was used to compute firm-specific abnormal returns, and were taken from the Center for Research in Security Prices (CRSP) data tapes.

In order to determine which firms received publicity in the media we searched LEXIS-NEXIS and the Wall Street Journal Index. In addition, we collected the names of companies criticized as being large toxic polluters in highly cited reports published by the Natural Resources Defense Council, "The Who’s Who of Toxic Polluters" (1989), and National Wildlife Federation, "The Toxic 500" (1989).

Data on the corporate governance structure (percent ownership by managers and directors) was taken from the annual proxy statement filings made to the SEC. To measure "closeness to the consumer" we obtained 1989 advertising expenditure data by firm from the Arbitron Company (1989), which contains advertising expenditures for firms that spend more than $3,000 annually in 9 major media outlets.

The initial sample size consists of the 1500 firms in the IRRC database. For the purpose of this study, firms in the SIC codes 20-39 are analyzed as they are required by law to report their toxic emissions to the EPA every year. After selecting the firms in the relevant SIC codes we had a sample of 915 firms.[20] Of these 915 firms we had valid environmental and financial data for about 650 firms. Other data limitations due to collection of key variables reduced our ultimate sample size to 520 firms - - the sample size for this study. Table 1 lists all variables used for this study, and gives brief descriptions as to how they were obtained. Table 2 reports the descriptive statistics for these variables.

IV. Empirical Results

This section presents our empirical findings. Although we are primarily interested in understanding why firms reduce emissions subsequent to TRI disclosure, we first examine the base level of toxic emissions in 1989. Next, we compare 1989 emissions to 1992 levels - a three year lag to allow for firm investment in pollution abatement programs. Table 3 displays the underlying hypotheses, expected signs of explanatory variables, and empirical results.

Base Level Toxic Emissions

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20 This resulted in the exclusion of sectors like the financial sector, retail stores, restaurants

Table 4 estimates the determinates of 1989 toxic emissions, where the dependent variable is the natural log of toxic emissions in 1989 (TRI89) and the independent variables are firm specific characteristics.[21] A tobit specification is used, since the dependent variable is truncated at zero. Industry effects are controlled for with dummy variables (based on two-digit SIC codes), not reported in the table. Based on our theoretical discussion, we did not expect many of the "incentive" variables to be significant. If TRI emissions were unknown to consumers and shareholders prior to 1989, then their levels should depend solely on technological/cost factors. Thus, we expect larger and older firms to have larger emissions. We also expect firms that are less financially sound to have larger emissions to the extent they cannot afford control technologies or are not productively employing their capital. Finally, since pollution problems tend to be correlated, we expect a positive correlation between TRI emissions and other measures of environmental performance (where the various environmental performance variables are measured so that a higher number means more pollution).

Table 4 confirms some (but not all) of our expectations. Larger firms (measured by firm revenues, REV), have significantly higher levels of toxic emissions. The parameter estimate for the square of the revenue (REVSQ) is negative, indicating that toxic emissions increase at a decreasing rate as revenue increases. Firms with more cash flows available as measured by the quick ratio (QCK), also had lower emission levels. Although this finding is consistent with the view that firms with better financial performance can afford to invest in better control technology and cleaner production, an alternative interpretation might be that these firms are more profitable

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and other inherently non polluting industries.

[21] Since TRI emissions are not normally distributed, and have a long right-hand tail, we transformed the variable by adding 1 and taking the natural log. (We add 1 to emission levels so that firms with 0 emissions will not drop out of our sample and will remain 0 under the

because they have lower emissions and hence less waste in their production process. Our findings do not address the direction of causality. Firms in highly concentrated industries (CONC2R) also had lower emissions ($p<.07$), which would be consistent with the above finding if firms in more concentrated industries tend to have more ability to invest in pollution control.

Some of our results are difficult to explain. Surprisingly, age of assets (AGE) was not significant. Since AGE has been computed such that larger values indicate newer assets, we expected this to be negatively correlated with emission levels, as older plants tend to have less innovative pollution control technologies. The higher percentage of the firm owned by managers and directors (OWN), the lower the initial level of toxic emissions. This was not expected a priori, since TRI emissions were not available to the investing public prior to 1989. One possible explanation is that managers anticipated that public disclosure under the Community Right-to-Know laws would bring about external pressures to reduces emissions and began reducing emissions prior to 1989. Another possible explanation for this result is suggested by Harford (1997), who argues that due to investor portfolio diversification, publicly traded firms will emit pollution levels that are closer to the socially optimal levels than privately held firms.[22]

We also included several other measures of firm environmental performance as control variables. Toxic release inventory chemicals were expected to be correlated with other forms of environmental problems, and were found to be positively correlated with Superfund sites (SF), RCRA corrective actions (CA), and oil or chemical spill volumes (SPII). However, firms with more environmental fines (FINN) and more chemical and oil spills (SPIN) had lower emissions.

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transformation.)

[22] It is also possible that OWN acts as a proxy for firm size, as larger firms tend to have smaller ownership shares. In that case, the coefficients for OWN and REV should be of opposite signs. Indeed, that is what we find. However, the correlation between OWN and REV is relatively small ($r=-.19$).

Reductions in Toxic Emissions

Next, we estimate the absolute TRI emission reductions between 1989 and 1992. Some firms in our sample had zero TRI emissions in both 1989 and 1992, even though they are in industries where competitors do emit toxic chemicals. A decision by a firm to essentially leave emissions unchanged (at some positive level) may be much different than a decision by another firm to remain at "zero" emissions. Thus, a simple OLS regression on TRICH may not be appropriate.

A more appropriate methodology is to consider a sample selection model, in which there is first a decision whether or not to emit toxics in 1989. If toxics are emitted, the second stage decision is whether or not to reduce emissions in 1992 (from their 1989 level). Thus, we estimate the change in TRI emissions using the Heckman (1976) selection bias model.[23] This model was estimated using both a probit and a logit for the first selection equation, and the logit specification had better predictability and was ultimately used to estimate the selection equation.[24]

Table 5 reports on the absolute change in toxic emissions between 1989 and 1992 (TRICH). Since TRICH is computed by subtracting 1992 from 1989 emissions, a positive number implies a reduction in emissions.[25] The second column reports on an OLS regression, where the

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[23] There are a few firms in the sample that were not emitting any toxic chemicals in 1989 but did start putting out toxic chemicals in 1992. These firms however constitute a very small part of the sample.

[24] We also estimated the basic model using ordinary least squares (OLS), correcting the standard errors for heteroskedasticity using White's heteroskedasticity consistent estimator. The results do not differ substantially from the sample selection model shown here.

[25] We considered using the percentage change in toxic emissions. However, absolute levels of toxic emissions were so small in some firms that a small change in emissions led to very high

dependent variable is the reduction in TRI emissions. Significance levels of each coefficient are reported in the third column. This is reported primarily for comparison purposes, since we believe a sample selection model is more appropriate.

Columns 4 and 5 of Table 5 report on the first stage of the sample selection model, where we estimate the probability that a firm in our sample will have positive TRI emissions in 1989. This logit model correctly predicts 85% of the 520 firms in the sample. Age of assets (AGE) is negative and significant at $p < .09$, indicating that firms with newer assets are less likely to emit toxics. Higher liquidity (QCK) is also associated with a lower probability of toxics. On the other hand, toxic emissions are positively correlated with the number of Superfund sites (SF) and the number of government imposed environmental fines (FINN).

Our main results appear in columns 6 and 7 of Table 5. This is the second stage of the selection bias model, which investigates the impact of firm specific factors on toxic emission reductions. Although not reported here, this model has also been controlled for fixed industry effects using industry dummy variables. The sample size for this stage is reduced to 414 firms, those with non-zero toxic emissions in 1989.[26] The main finding in Table 5 is that changes in the level of toxic emissions (TRICH) depend heavily on previous levels (TRI89). Firms that were large polluters significantly reduce their emissions over the time period being studied, although there are diminishing returns to TRI emission reductions (the coefficient on TRISQ is negative).

In addition, the larger the intra-industry rank (RANK), the larger the reduction in toxic emissions. RANK is measured such that a larger rank indicates lower base emissions (on a per

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percentages.

[26] There are a few extreme outliers in TRICH which may not be actual emission reductions, but instead could be other unrelated factors such as major corporate changes (divestiture of subsidiary or merger/takeover of another firm). In order to eliminate any potential bias, all equations have been re-estimated without the outliers and we find that the results remain the same.

dollar revenue basis) relative to other firms in the industry. This implies that those who reduced their emissions most from 1989-1992 were those who were relatively “clean” in their industry in 1989 to begin with (after controlling for base 1989 emissions). At first glance, this appears to contradict Proposition 5, in which we expected the worst ranked firms in each industry in 1989 to be among those who reduce their emissions most in hopes of gaining a better industry ranking. In particular, it does not appear to provide support for our hypothesis that highly polluting firms are inefficient producers and will be ‘forced’ by the market to become more efficient and waste less chemical inputs in their production processes. Note, however, that we have already controlled for "visibility" of firm emissions by including variables such as NRDC and NWF (whether or not the firm was mentioned by these two environmental groups as being among the worst emitters), and ABN (whether or not the firm’s stock price took a significant hit on the day of announcement of that firm's TRI emissions). Thus, the positive coefficient on RANK indicates that after controlling for the publicity/reputation effect of being among the worst emitters, firms that are high emitters relative to their industry peers do not reduce their TRI emissions as much as other firms. Moreover, to anticipate the results in Table 6b, we note that these firms are also most likely to improve in their relative rankings. That is, although the worst ranked firms in an industry are not the firms that reduce absolute emissions most, they do tend to improve relative to their industry peers.

Other than control variables such as firm size and other environmental performance measures, few of our ’incentive’ or ‘ability’ variables are significant. The fine amounts (FINA) and the numbers (FINN) provide an interesting result. These variables were included primarily as controls since it is not obvious what effect they will have on TRI levels. On the one hand, we expect TRI emissions to be positively correlated with other types of pollution and environmental noncompliance, either for technical reasons or due to firm-level incentives. On the other hand, TRI levels may be negatively correlated with other environmental performance measures that involve some form of government enforcement activity. For example, if firms receive penalties for noncompliance, they may reduce their pollution in subsequent periods. To the extent these emissions are correlated with TRI, we would expect a corresponding reduction in TRI emissions -- even though they are perfectly legal. In fact, we find that the more fines a firm had in 1989 (FINN), the less it reduced TRI emissions in the 1989-1992 time period. On the other hand, controlling for number of fines, the larger the monetary penalty (FINA) in 1989, the greater the reduction in toxic emissions between 1989 and 1992. Although the reasons for this finding are not clear, it is possible that large fines for violations of environmental laws have a deterrent effect on legal emissions. Large fines are more likely to be mentioned in the media and affect firm reputation. Thus, it is possible that there is some spillover into legal emissions, as firms who have paid high penalties seek to keep themselves away from further negative publicity on their environmental performance. We also find that firms with more Superfund sites (SF) reduced TRI emissions more than others. Since Superfund involves liability for pollution that often occurred many years ago, it may have nothing to do with current environmental performance. One possible explanation for this finding is that firms with significant Superfund liability are more concerned about other future liabilities. Since a high TRI increases the risk of citizen suits or other community pressures, these firms might have been more concerned about their future environmental performance than those without such existing liability.

The negative sign on NWF indicates that firms reported by the National Wildlife Federation as being among the largest toxic emitters reduced emissions less than their peers. This is somewhat surprising when considered in isolation. However, note that we have already controlled for base emissions themselves (TRI89), and for those firms that received a significant stock price hit (ABN) following the first TRI announcement. Thus, it appears that being singled out by the National Wildlife Federation had little effect on firm behavior by itself.

Change in Intra-Industry TRI Rank

Finally, we examine the change in intra-industry rank (RKCH) between 1989 and 1992. Since some industries are inherently "dirtier" than others, environmental performance might be better measured relative to industry peers. Even within the same industry, however, very large firms will inherently have higher emissions - even if they are the most environmentally conscious. Thus, in order to arrive at firm rankings, we divide all emissions by revenue, and compare each firm's emissions per thousand dollars revenue to other firms in the same four digit SIC code.

Prior to 1989, the public did not have information about a firm's TRI rank. Thus, we expect some adjustment in firm rankings following announcement of TRI in 1989. According to Proposition 2, we would expect firms known to be among the worst polluters in their respective industries to have the most incentive to improve their performance relative to their industry peers. For example, although the paper industry is traditionally known to be a high polluting industry, a firm in the paper industry would rather be the cleanest firm in a dirty industry than the dirtiest paper company.

To operationalize this scenario, we constructed a dummy variable by comparing the industry ranks for each firm in both 1989 and 1992. The dummy takes a value of '0' if the firm has gone up in the company rankings, i.e. it has worsened its environmental performance with respect to its industry peers.[27] A value of '1' indicates that the company has remained at the same rank

[27] A rank of 1 indicates that the firm is the highest polluter in its industry classification in terms of

over the period being studied, while a value of '2' indicates that the company has moved down in the rankings and hence actually improved its environmental performance with respect to its industry peers.

Based on the above, a multinomial logit model is estimated, where each firm can be in one of three states: (1) improves its performance relative to others in its industry, (2) remains the same in industry rankings, or (3) worsens its environmental performance relative to other firms in the industry. The results of the multinomial logit model are presented in Table 6a. The third state, i.e. the firm worsens its environmental performance, is normalized for the purposes of the estimation and the coefficients for the other two states are presented in the table. This specification correctly specifies 53% of the data. Since the coefficients from the multinomial logit model are difficult to interpret, the marginal effects of these variables on the probabilities of the firms staying in the same state or moving are calculated and reported in Table 6b.

The first column of coefficients in Table 6b shows the effect of the independent variables on the probability of the firm worsening its intra-industry ranking (RKCH = 0). The second set of coefficients report the marginal effects on the probability of the firm staying the same in terms of rankings (RKCH=1). The third column reports the marginal effects on the probability of the firm going down in the industry rankings (RKCH = 2), i.e. improving its environmental performance compared to its industry peers.

Although Table 6b confirms many of the results of Table 5, it also provides a few additional insights into the reason behind emission reductions. The most important result in Table 6b is that the marginal impact of intra-industry rank (RANK) is statistically significant for all three possibilities. Consistent with Proposition 5, poorly ranked firms are likely to move up in the

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TRI emissions per thousand dollars in revenue.

rankings as they attempt to get over the 'stigma' associated with being among the dirtiest in their industry. However, unlike the finding in Table 5, being a relatively "clean" firm (i.e., a high numerical ranking) increases the likelihood that the firm will subsequently get worse in its relative ranking; and decreases the likelihood that it will improve. Thus, firms with a high normalized rank (i.e. relatively clean firms) will not improve their rankings but will have a tendency to either stay the same or get worse.

Larger firms as measured by revenue (REV) are less likely to worsen their environmental performance relative to industry peers, and are more likely to improve. This finding is consistent with that shown earlier in Table 5 and with Proposition 1. Firms with higher levels of toxic emissions in 1989 (TRI89) are more likely to stay the same in industry rankings, and are less likely to improve relative to their industry peers. This result appears inconsistent with that found in Table 5, where firms with larger emissions in 1989 had larger reductions in emissions in the subsequent time period. However, note that Table 5 compares absolute emission reductions, while Table 6b compares changes in firm rankings within each industry. Thus, it appears that although firms with high emissions subsequently reduced them most, this did not tend to improve their rankings within their respective industries.

Although firm cash flow (as proxied by the quick ratio, QCK) was not a significant factor in the absolute emission reductions estimated in Table 5, it has a significant impact on intra-industry rankings. In Table 6b, firms with a higher quick ratio in 1989 tend to have a lower probability of worsening their rankings and a higher probability of staying the same. Put differently, it appears that a tight financial situation might be one reason that firm environmental performance worsens relative to their industry peers.[28]

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[28] This finding is consistent with Alexander and Cohen (1996), who find that poor financial

V. Concluding Remarks

Over the past few years, firms in the U.S. have dramatically reduced many of the toxic chemicals released into the air, water and soil despite the fact that there are no laws or regulations requiring these reductions. Assuming this fact cannot be explained solely on the basis of altruistic behavior, firms must be acting in profit maximizing ways when determining it is in their own self interest to reduce pollution beyond any legally mandated level. There are many possible sources of benefits to a firm wishing to voluntarily reduce emissions beyond compliance, including: better public and community relations, reduced costs and higher productivity due to better utilization of chemical resources and other production inputs, better employee morale, improved firm reputation with consumers, and reduced threat of citizen lawsuit.

This paper empirically examines the factors that explain why firms reduce legal emissions of toxic chemicals. In particular, we are interested in understanding why some firms significantly reduced their toxic emissions following an increase in the amount of information available to the public in 1989. As one corporate official was quoted in a 1993 Business Week article, “We knew the numbers were high, and we knew the public wasn’t going to like it.” Another industry spokesman explained why toxic emissions were cut drastically following the new law: “Companies just want to get off the lists of top polluters” (Regan, 1993). Based on a simple profit maximization model, we hypothesized that environmental performance would be affected by both the "incentive" to reduce emissions and the "ability" of firms to reduce emissions. In particular, firms that were most visible to the public and that received the most negative publicity following disclosure would have the most incentive to reduce their emissions in subsequent periods. We also

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performance helps explain the existence of environmental crimes.

expected the results to be most dramatic relative to industry peers, since some industries are inherently dirtier than others.

The results from the study indicate that following the release of new information on toxic emissions, large firms (as measured by revenue) reduced emissions most and were more likely to improve their position relative to their industry peers. Thus, it appears that the most "visible" corporations in the U.S. felt the most external pressure to reduce toxic emissions.

Controlling for firm size, the larger the initial level of toxic emissions in 1989, the larger the emission reductions. Despite this fact, firms that are large emitters in 1989 are not likely to reduce their emissions so much more than their industry competitors that they thereby improve on their industry rankings.

Financial ability appears to play an important role in environmental performance. Firms in more concentrated industries and with higher cash flows tend to be lower baseline emitters of toxic chemicals. Further, firms with more constrained cash flow positions are more likely to increase their TRI emissions (or reduce less) relative to their industry peers over time.

Despite the commonly held belief that consumer pressure would have a significant effect on environmental performance, we were unable to find any such effect. Although this might be partly due to our inability to obtain better data, it may also be that consumers are not in general as informed and/or interested in a firm's environmental performance as they are in the firm's product quality and price. Thus, to the extent there is external pressure, it is more likely to come from environmental or community groups or shareholders interested in the financial/legal risks associated with high levels of toxic emissions than from consumer pressure.

This paper has set forth a positive analysis of firm behavior; hence normative implications for government policy do not necessarily follow. The fact that requiring firms to disclose their legal emissions provides an incentive for them to reduce emissions does not necessarily imply that this reduction is worth the cost to society. Further investigation of the type of pollutants and costs of pollution control would be required to analyze this important policy question.

Table 1
Variable Definitions

Variable Name	Description	Units
REV	Revenue in 1989	thousand dollars
REVSQ	Square of the Revenue in 1989	thousand dollars
OWN	Percentage owned by the management and the directors of the firm	percentage
AGE	Proxy for the age of assets of the firm. Measured as: (Net Asset Value/Gross Asset Value)	ratio
KL	Capital labor ratio: Value of capital/employment	dollars/person
ARET	Market adjusted returns for the firm in 1989	percentage points
QCK	Quick ratio: Liquid assets/Total assets	ratio
ADINT	Advertising expenditures in 1989/Revenue	ratio
CONC2R	Four firm concentration ratio at the 2 digit SIC code calculated using value of shipments	ratio
TRICH	Reduction in TRI emissions in the 1989-1992 period	million pounds
TRI89	Level of TRI emissions in 1989	million pounds
TRISQ	Square of TRI 89	
RANK	Normalized intra-industry rank in 1989:(Industry rank based on TRI/000 $ revenues) /(# of firms inn the industry)	ratio
SF	Number of Superfund sites	
CA	Number or RCRA corrective actions	
FINA	Dollar amount of fines levied on the firm for environmental offenses	million dollars
FINN	Number of fines levied on the firm	
SPII	Spill Index: Weighted average of the number and the amount of spills in 1989	
SPIN	Number of oil and chemical spills in 1989	
NRDC	Listed by Natural Resources Defense Council (1989) as one of the 40 largest emitters (among publicly traded companies) of carcinogenic chemics from the TRI list.	0-1 dummy (1=yes)
NWF	Listed by the National Wildlife Federtation (1989) as one of the 40 largest TRI emitters (among publicly traded companies) in the U.S.	0-1 dummy (1=yes)
ABN	Firms that took the largest hits in the stock markets the day their toxic releases were mentioned in the media in 1989 (n=40). The analysis and the selection of firms is described in Konar and Cohen (1997).	0-1 dummy (1=yes)
RKCH	Dummy variable for the directional changes in the intra-industry rank in the 1989-92 period	RKCH=0; increase RKCH=1; no change RKCH=2; decrease

Table 2
Descriptive Statistics

Variable	Mean	Std. Deviation	Cases
REV	2680.4	7718.8	647
REVSQ	6.67E+07	6.73E+08	647
OWN	11.132	14.272	654
AGE	0.56409	0.12326	654
KL	-0.23572	10.837	653
ARET	-8.12E-03	0.33388	657
QCK	0.5019	0.82643	629
ADINT	0.477	1.5923	655
CONC2R	18.355	12.421	557
TRI89	4.5932	20.8	658
TRISQ	453.09	5909.9	658
RANK	0.59935	0.33595	658
SF	5.7112	10.193	658
CA	0.67021	2.6222	658
FINA	31341	1.74E+05	658
FINN	1.3161	3.8948	658
SPII	1.8141	8.3875	647
SPIN	0.79787	3.9329	658

Table 3
Summary of the Hypothesis and Results

Propositions (Factors in 1989 expected to affect 1992 emissions)	**Variable**	**Expected Sign for TRI89**	**Results (Table 4)**	**Expected Sign for TRICH**	**Results (Table 5)**
1: Firm Size	REV REVSQ	+ ?	+ -	+ ?	- +
2: High Absolute Emissions	TRI89 TRISQ	n.a. n.a.	n.a. n.a.	+ ?	+ -
3: Brand name and Reputation	ADINT	-	n.s.	+	n.s.
4: Negative Media Attention	NWF NRDC ABN	n.a. n.a. n.a.	n.a. n.a. n.a.	+ + +	- n.s. n.s.
5: High Emissions relative to Industry	RANK	n.a.	n.a.	-	+
6: High Percent Ownership by Managers and Directors	OWN	?	-	+	n.s.
7: Increased Enforcement and Penalties	FINN FINA	+ +	- n.s.	+ +	- +
ABILITY:	QCK ARET CONC2R	- - -	- n.s. -	+ + +	n.s. n.s. n.s.
TECHNOLOGY:	AGE KL	- ?	n.s. n.s.	? ?	n.s. n.s.

Note: The abbreviations used in this table are described below:

n.a.: not applicable

n.s.: not statistically significant

'?' : hypothesized effect unclear a-priori

The positive and negative signs just indicate the direction of the relationship between the independent and dependent variables. The signs have only been reported for variables that were statistically significant.

Table 4
Cross-Section Analysis of base levels of Toxic Emissions, 1989
(Model: Tobit)

Variable	Coefficient	p-value
Constant	0.39732	0.07144
REV	1.30E-04	0***
REVSQ	-2.46E-09	0***
OWN	-5.22E-03	0.04281**
AGE	6.16E-03	0.98394
KL	6.88E-03	0.68564
ARET	1.69E-02	0.88424
QCK	-0.15556	0.00146***
CONC2R	-6.99E-03	0.07112*
ADINT	-1.23E-02	0.55329
SF	4.45E-02	0***
CA	9.22E-02	0.00048***
FINA	1.02E-07	0.64396
FINN	-2.96E-02	0.02671**
SPIN	-5.05E-02	0.00002***
SPII	4.40E-02	0***

Note: The dependent variable in this estimation is the natural log level of Toxic emissions in 1989 (Ln(TRI89+1)). All the independent variables are for the year 1989. Industry dummies in SIC codes 20-39 have been used as control variables.

* p < .10 ** p < .05 *** p < .01

Table 5
Cross-Section Analysis of Toxic Emission Reductions by Firms, 1989-92

	OLS		Selection Model: First Stage (Logit)		Selection Model: Second Stage (OLS)	
	Coefficient	p-value	Coefficient	p-value	Coefficient	p-value
Constant	-2.0832	0.071*	0.78534	0.370	-2.2296	0.191
REV	-2.48E-04	0.088*	0.00024	0.394	-0.00026	0.10*
REVSQ	9.29E-09	0.01**	-0.012577	0.087*	0.010273	0.004***
OWN	-1.33E-02	0.117	-0.00141	0.888	-0.01743	0.379
AGE	0.79796	0.474	-2.1342	0.080*	0.80848	0.729
KL	4.63E-03	0.095*	-2.0309	0.067*	-1.0602	0.604
ARET	0.33471	0.394	0.051662	0.903	0.55445	0.544
QCK	2.32E-02	0.823	-0.35645	0.036**	0.20948	0.651
ADINT	5.09E-02	0.521	0.005132	0.955	0.0386	0.8
CONC2R	2.33E-02	0.084*	0.052172	0.032**	0.02061	0.452
TRI89	0.53826	0***			0.54144	0***
TRISQ	-3.21E-04	0.375			-0.00032	0.007***
RANK	1.4709	0.032**			2.926	0.005***
SF	0.20077	0.035**	0.64903	0.0***	0.19272	0.0***
CA	-0.31274	0.334	0.13585	0.866	-0.31052	0.122
FINA	7.45E-06	0.008***	3.2253	0.865	7.4934	0***
FINN	-0.77857	0.012**	2.2587	0.064*	-0.7999	0***
SPII	1.91E-02	0.813	-0.07533	0.504	0.041606	0.533
SPIN	-0.24313	0.07627*	1.7799	0.53	-0.25204	0.004***
ABN	0.65576	0.554			0.58655	0.534
NWF	-2.9912	0.06*			-2.8059	0.02**
NRDC	0.34286	0.811			0.43341	0.683
Lambda					-0.4226	0.722
Number of Observations	520		520		414	
Adj. R^2	.81		85%		0.809	

Note: The dependent variable in the regression is the change in firm toxic emissions over the 1989-92 time period. A positive number indicates a reduction in the level of toxic emissions. The units for the dependent variable are pounds of toxic chemicals released in millions. Independent variables are 1989 figures. The industry effects are controlled for in this equation using industry dummies at the two digit SIC code.

* $p < .10$ ** $p < .05$ *** $p < .01$

Table 6a
Cross-Sectional Analysis of the Directional Changes in Firm Intra-Industry Ranking
(Model: Multinomial Logit)

	RKCH=1		RKCH=2	
	Coefficient	**p-value**	**Coefficient**	**p-value**
Constant	-0.71988	0.28758	0.96101	0.15178
REV	2.24E-04	0.03151**	2.84E-04	0.01285**
REVSQ	-6.83E-09	0.01142**	-1.36E-08	0.01272**
OWN	-1.42E-02	0.0927*	-8.16E-03	0.34725
AGE	0.1406	0.89508	0.24629	0.81581
KL	-4.93E-02	0.95542	0.77206	0.34239
ARET	-0.54677	0.19178	3.79E-03	0.99297
QCK	0.52099	0.00481***	0.14191	0.50642
ADINT	2.27E-02	0.7565	3.62E-02	0.59386
CONC2R	9.61E-04	0.9303	-2.14E-03	0.83979
TRI89	4.52E-02	0.08791*	-4.54E-02	0.1237
TRISQ	4.00E-05	0.68462	1.85E-04	0.11388
RANK	0.74934	0.07304*	-2.3618	0***
SF	-1.24E-02	0.6283	2.47E-02	0.2518
CA	-0.11235	0.441	-5.49E-02	0.62986
FINN	-0.3111	0.00541***	-0.18381	0.01425**
FINA	2.41E-06	0.18779	1.83E-06	0.10212*
SPIN	2.33E-02	0.68055	1.55E-02	0.75397
SPII	-1.62E-02	0.75661	5.22E-02	0.17447
ABN	-1.1628	0.11236	3.43E-02	0.94136
NWF	-8.18E-02	0.91669	-1.1103	0.08577*
NRDC	-0.46607	0.52857	0.35395	0.52627
Number of Observations	493			
% Correctly Predicted	53%			

Note: The dependent variable RKCH is coded in the following manner:

RKCH = 0; Firms moving up in the ranking (worse environmental performance)
RKCH = 1; Firms staying the same
RKCH = 2; Firms moving down in the ranking (improving environmental performance)

The model normalizes the coefficients for RKCH=0 and only the results for RKCH=1 and RKCH=2 are reported. The independent variables are the 1989 values.

* p < .10 ** p < .05 *** p < .01

Table 6b
Estimated Marginal Benefits Explaining Changes in Intra-Industry Rank Between 1989 and 1992

	RKCH=0		RKCH=1		RKCH=2	
	Coefficient	p-value	Coefficient	p-value	Coefficient	p-value
Constant	-4.06E-02	0.768	-0.25271	0.047**	0.29327	0.041**
REV	-5.83E-05	0.009**	1.74E-05	0.418	4.09E-05	0.058*
REVSQ	2.38E-09	0.002***	-1.00E-11	0.992	-2.37E-09	0.002***
OWN	2.50E-03	0.161	-2.15E-03	0.204	-3.54E-04	0.827
AGE	-4.49E-02	0.836	3.82E-03	0.984	4.11E-02	0.841
KL	-8.87E-02	0.617	-9.14E-02	0.548	0.1801	0.284
ARET	5.75E-02	0.500	-0.11575	0.155	5.82E-02	0.478
QCK	-7.25E-02	0.034**	9.50E-02	0.011**	-2.25E-02	0.571
ADINT	-6.80E-03	0.632	9.89E-04	0.935	5.81E-03	0.679
CONC2R	1.58E-04	0.943	4.27E-04	0.832	-5.85E-04	0.778
TRI89	7.24E-04	0.898	1.43E-02	0.016**	-1.50E-02	0.007***
TRISQ	-2.67E-05	0.172	-1.09E-05	0.609	3.76E-05	0.092*
RANK	0.20784	0.017**	0.40591	0***	-0.61375	0***
SF	-1.69E-03	0.748	-5.21E-03	0.213	6.90E-03	0.143
CA	1.86E-02	0.546	-1.79E-02	0.436	-6.41E-04	0.979
FINN	5.53E-02	0.025**	-4.63E-02	0.003***	-9.00E-03	0.616
FINA	-4.78E-07	0.217	3.17E-07	0.183	1.61E-07	0.582
SPIN	-4.36E-03	0.716	3.28E-03	0.740	1.08E-03	0.914
SPII	-4.64E-03	0.663	-8.90E-03	0.230	1.35E-02	0.149
ABN	0.11913	0.450	-0.24892	0.015**	0.12979	0.269
NWF	0.14373	0.383	9.92E-02	0.445	-0.24298	0.09*
NRDC	6.37E-03	0.96	-0.13547	0.218	0.1291	0.314

Note: The independent variables are the 1989 values.
$* p < .10$ $** p < .05$ $*** p < .01$

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