Information As Regulation: The Effect of Community Right to Know Laws on Toxic Emissions

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ABSTRACT

There is growing academic and policy-level interest in the use of information as a quasi-regulatory mechanism. Examples of recently enacted information remedies include mandatory disclosure of toxic chemical emissions, securities regulations requiring disclosure of certain environmental liabilities, and European government sponsored "green labels." Mandatory disclosure requirements might be viewed as a form of "market-based incentive" for firms to change their behavior. However, little evidence to date has been gathered on the effect of these disclosure requirements on firm behavior. This paper provides some initial answers by examining firm behavior in response to disclosures that they were among the largest emitters of toxic chemicals in the U.S. We first examine those firms that experienced the largest decline in stock price immediately following the release of this information to the public. We find that firms that received the largest stock price decline subsequently reduced their emissions more than their industry peers. This is consistent with the view that financial markets provide a strong incentive for firms to change their environmental behavior.

I. Introduction

Information remedies have recently been touted as powerful supplements or alternatives to direct command-and-control regulation. When President Clinton and Vice President Gore recently issued their "Reinventing Environmental Regulation" report [4], they continually stressed the "power of information" in bringing about significant change in environmental quality. Among their highest priority "action items" were the establishment of a "public access program" 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. This recent interest in the use of information as a quasi-regulatory mechanism follows several recent government programs that provide information to interested members of the public in an attempt to affect firm behavior indirectly through consumer, public or community pressure. Examples of recently enacted information remedies include mandatory disclosure of toxic chemical emissions (which is the subject of the current paper), securities regulations requiring disclosure of certain environmental liabilities,[1] and European government sponsored "green labels."[2] Concurrently, several authors have developed models of firm or consumer behavior when information is used as a quasi-regulatory mechanism (see e.g., Arora and Gangopadhyay [2] and Kennedy, Laplante and Maxwell [12])

Is information an effective regulatory mechanism for controlling environmental hazards? If consumers, community groups or investors care about a firm's emissions,

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[1] See for example, "Accounting and Disclosures Relating to Loss Contingencies, Staff Accounting Bulletin No. 92," 58 Fed. Reg. 32,843 (June 8, 1993), and Wallace [18].

[2] See e.g., OECD [16].

providing more firm-specific environmental information may cause consumers to adjust their purchase decisions, community groups to pressure firms to reduce pollution beyond that required by federal laws, or investors to change their portfolios. Thus, mandatory disclosure requirements might be viewed as a form of "market-based incentive" for firms to change their behavior. In theory, each firm will independently weigh the costs of public disclosure of "bad" information against the costs of taking actions that will put the firm in a more favorable light. Firms will voluntarily go beyond any legally mandated regulatory standard if it is in their interest to do so. This will only work, however, if the "public" cares enough about the information being released to "punish" firms that are bad actors.

Before information remedies are used more frequently as regulatory mechanisms, we need to understand how they work and what effect they have on firm behavior. This paper provides some initial answers to these questions by examining firm behavior in response to disclosures that they were among the "worst polluters" in the U.S. In 1986, Congress passed the Emergency Planning and Community Right-to-Know Act, requiring manufacturing establishments with 10 or more employees in SIC codes 20 through 39 (with certain threshold sizes of chemical emissions) to publicly disclose the quantity and type of toxic chemicals released into the environment. The first reports were due to EPA no later than July 1, 1988 for toxic emissions in the calendar year 1987.[3] Data from these reports have been referred to as the "toxic release inventory" (TRI). According to a recent paper by Cohen, Fenn and Naimon [7], firms with lower TRI emissions outperformed their industry competitors in the stock market between 1987 and 1989. The first public disclosure of TRI data occurred on June 19,

[3] See 42 U.S.C.A. 11023.

1989. According to Hamilton [11], publicly traded firms whose TRI releases were first reported on that date experienced statistically significant negative abnormal market returns. The implication of this drop in stock price is that investors updated their expectation of future pollution-related expenditures or liabilities (e.g., probability of accidents, likelihood of exposure under other regulatory programs such as Superfund), which would reduce the future firm profitability. We test this hypothesis by examining how firms responded to this negative stock price information. In particular, we ask whether or not significant stock price reductions translate into significant reductions in toxic emissions.

The paper is organized as follows: Section II briefly reviews the theoretical foundations for our analysis. In particular, it reviews why new information might act as a regulatory mechanism and how this interacts with the stock market. Section III describes the data and empirical methods, while Section IV presents the main results. Section V presents some confirmatory evidence that firms responded to this initial stock market reaction by significantly reducing their toxic emissions. Several concluding remarks are contained in Section VI.

II. Theoretical Framework: Why Should Information be an Effective Regulatory Instrument?

The key issue being addressed in this paper is the extent to which publicly provided environmental information acts as an alternative tool in the place of direct environmental regulation. In order to be a successful policy alternative the provision of information to the public must create an incentive structure that pressures firms to improve their environmental

performance. If the provision of this information negatively impacts the financial performance of the firm, it will provide a strong incentive to the firm to a become better environmental actor. We hypothesize that the change (or the lack thereof), in the financial performance of the firm as a result of the provision of this new information will provide incentives that will affect the attitude of the firm towards environmental performance.

Financial performance of firms may be measured in a number of ways, the two basic classes of measures of financial performance are accounting-based measures and stock market-based measures. This study uses stock market rather than accounting measures to estimate financial performance. The stock market-based approach has a number of attractive aspects. First, this approach has strong theoretical and empirical foundations in the financial markets literature. The efficient markets hypothesis (see e.g., Fama [8],[9]) predicts that in a well- functioning capital market, security prices provide the best available unbiased estimates of the value of a company's assets. That is, the company's stock price fully reflects the present discounted value of all future cash flows due to all of the tangible and intangible assets of the firm.[4]

Providing new environmental performance information to the public may have significant implications for the expected future cash flows of the firm. These implications will be discussed in detail later in the section. As a result of this new information investors re-evaluate the firm's expected future cash flows and ultimately trade the firm's securities in the stock market, thus affecting both stock prices and market returns. This information is

[4] The finance literature provides ample support for the efficient markets hypothesis. A review paper by Fama [9] provides an excellent background to the theoretical and empirical evidence available and concludes that markets in general adjust to publicly available information.

incorporated into the security prices through the creation of new arbitrage opportunities. If the new information that has been released indicates an increase in the expected future cash flows then the firms stock is currently under valued in the market. Traders and investors aware of these arbitrage opportunities will take advantage and buy this stock which in turn increases the demand for the security and drives its price up. Thus, this new information will affect financial performance as reflected by security prices.

Stock market-based measures of financial performance are forward looking because they incorporate future performance of the firm. Future performance is important in this case because most of the impacts resulting from the current environmental performance of a firm are felt in the future. For example, increases in expected future liability and future investments in pollution abatement capital stock may be required in order to reduce pollution. On the other hand, accounting data generally reflect historical performance and are more susceptible to managerial manipulation.

Under the efficient markets hypothesis, we expect any abnormal movement in stock prices to be the result of new information that changes the expectations of the investing public about the future prospects of a firm. Understanding prior expectations versus public announcements is important in the case of TRI emissions, since the public knew that TRI emissions were going to become public well before they were actually released in 1989. Indeed, the law requiring disclosure was passed in 1986, and required that firms report their 1987 emissions to EPA. It was not until June 1989 that the first disclosure of these 1987 emission levels actually took place. Thus, by the time the first announcement was made in 1989, the market may have already anticipated some of these future announcements, and TRI emissions may have been incorporated into existing stock prices. As a result, we would

expect the market to react more in cases when the market did not anticipate a firm to be a high polluter and thus did not anticipate a significant reduction in firm value following the TRI announcement.[5]

Why would TRI announcements reduce firm value? One possibility is that investors use TRI emissions as a signal of the firm's productive efficiency. 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. Another possibility is that there is some form of pressure from an interested "stakeholder." Community pressure to reduce emissions is likely to have an effect on any firm that has a significant stake in the community. Private parties (either individually or through an environmental group) may sue firms under various theories of tort actions or government-defined right of action. "Green consumers" may decide to boycott products of high polluting firms or otherwise look for alternatives.[6] 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

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[5] A related question is whether or not firms anticipated the importance of TRI disclosure as soon as Congress passed the law (or while it was being debated), and reduced their emissions prior to 1987, the first year of disclosure. Unfortunately, no data exist to test this hypothesis.

[6]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. In addition, market research has provided some evidence of a green consumer market segment, see Roper [17].

penalties and/or the cost of new pollution abatement equipment.[7]

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 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. Investors who learn that a firm is high on the TRI list may rationally react to this information by bidding down that firm's stock price. Following this logic, the flip side of the coin is also true. If a firm's stock price is bid down because it is a high polluter, management has a strong incentive to reduce pollution and strengthen firm value in subsequent years.[8]

Increased pressure due to new information about environmental hazards may be focused either on an entire industry or within specific firms in an industry. In some cases,

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[7] Indeed, EPA recently implemented a strategy of targeting enforcement activities at "high risk" firms and industries based on TRI and other data [19:1-3].

[8] Although at first glance the stock price hit might be considered a "sunk cost," there are many reasons why management would view it otherwise. The stock price hit might be thought of as an indicator of serious problems in the firm that will require expensive changes in production processes, impose future liability, or are simply an indicator of bad management. Reduced firm value might also increase the future cost of capital or cause the firm to become a potential takeover target. Finally, the fact that the market reacted in this manner to TRI disclosure tells management that this is now an important criteria to investors, and thus managers might take this as new information for them to use in deciding the relative tradeoff between pollution and profits. Regardless of the direction of causation, we expect to observe firms that took a significant stock price hit to reduce their TRI emissions in subsequent periods.

consumers may look at alternative product lines that are less polluting or otherwise change their aggregate consumption habits to reduce the demand for an entire product category. In this case, the negative impact following environmental disclosures is industry-wide. Corresponding to this effect, however, might be a positive impact on other industries whose products now look relatively more favorable. The extent to which this new information is likely to affect industry-wide valuation will depend on the availability of close substitutes, the price elasticity of demand for that product, as well as other "elasticity" factors related to the demand for green products. Similarly, new information on environmental hazards may have firm-specific effects as some firms within an industry now look more or less favorable than others in that same industry. Even if aggregate demand for a product line is not affected (or even positively affected) by this new disclosure, differential emission rates across firms may create new winners and losers in that industry.

III. Empirical Method

Since we are interested in the effect of new information on subsequent firm behavior, we identified the first public announcement of TRI data, June 19, 1989. On that date, the EPA released TRI data for the calendar year 1987. Subsequent information has shown that 1987 data are particularly unreliable, and most studies of actual TRI emissions start with 1988 as the base year. However, since we are primarily interested in the effect of stock price movements on subsequent firm behavior, we begin with the June 19, 1989 announcement date - even though the data released on that date was subsequently found to be unreliable. What matters most is the fact that on June 19, 1989, the data was thought to be reasonably accurate, and it was relied upon by various stakeholders.

Because of the time lag between actual emissions and public availability of TRI data, we begin with 1989 emissions as the base year for our analysis. Since we are interested in what firms did following the TRI reports made in 1989 (for 1987 emissions), we take actual 1989 emissions as the base year. That is the starting point from which firms had to begin to reduce TRI emissions subsequent to the first disclosure. We compare 1989 emission to 1992 levels - a three year lag to allow for firm investment in pollution abatement programs. In addition, in order to smooth out any one-year aberrations (and potential TRI reporting errors), we also compare the average TRI emissions for two time periods: 1988-1990 and 1991-1992.

Although the initial release of data included all U.S. facilities, the EPA did not provide this information in a format conducive to firm-level comparisons. Instead, several environmental groups compiled this information to arrive at the "worst" corporate polluters. In other cases, the public was informed of a particular company's emissions when a newspaper reporter identified a particular facility or company as being a high polluter. Some of these announcements took place subsequent to the initial TRI publication date of June 19. In order to determine which firms received publicity in the media as a result of the announcement of the TRI, we searched both the Wall Street Journal Index and the LEXIS-NEXIS database for all mentions of toxic chemicals or TRI in 1989.

This search yielded 363 facilities and companies that were mentioned in the print media as being emitters of toxic substances in 1989. A majority of these media reports were around the dates of release of two reports. The first report was dated June 19, 1989 (the same day on which the EPA made the TRI database available to the public), and compiled by the Natural Resources Defense Council [14] ("NRDC"). This publication reported the release of

carcinogenic chemicals (a subset of the TRI chemicals), and was often the impetus for media reports implicating various firms as emitters of carcinogens. The second publication was issued by the National Wildlife Federation [15] ("NWF") on August 10,1989. Unlike the NRDC report, which looked at carcinogens, the NWF report dealt with aggregate releases of all toxic substances as listed under section 313 of the EPCRA. Thus, companies receiving media attention around this time were the largest toxic chemical polluters.

Of the firms and facilities receiving media coverage in 1989, 53% were mentioned after the NRDC report between June 19 and June 21, 1989; 29% followed the NWF report on August 10 and August 11, 1989; and the remaining 18% were first mentioned in the media on other dates that year. Approximately 59% of the facilities or plants referred to by the media were operated by publicly traded firms, the rest were owned either by private corporations or were single facilities. After accounting for multiple mentions to the same parent company, 192 publicly traded firms were found in the sample.[9] Stock price data for 130 of these firms were available from the Center for Research in Security Prices (CRSP) data tapes and formed the core of our study.[10]

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[9] Hamilton [11, Table 3] reports on the determinants of media coverage. He finds a higher likelihood of media coverage among firms with larger emissions, more TRI reports, and more employees. Firms with many facilities spread out over the country were less likely to be reported on than those with larger concentrated facilities. Finally, firms in the chemical and primary metals industry were less likely to be reported on even though they had large emissions, presumably because they were already expected to have high TRI emissions, whereas firms in the pulp and paper industry (whose emissions were higher than expected) were more likely to be reported on.

[10]These 130 firms represent all NYSE and AMEX companies with complete stock price data available on CRSP out of the 192 publicly traded firms with TRI-related media reports in 1989. We did not include the NASDAQ companies in our data set since many of them are not as frequently traded and are less suitable for a study of daily stock price returns.

Many firm-specific events like this are best studied by evaluating their effect on the firm's security prices. This technique is known as an event study and uses market model prediction errors to test hypotheses (see Fama [10] and Brown and Warner [3]). The basic approach is to control for the systematic or market risk in the security returns by estimating the market model. This gives us the individual risk coefficients (betas) which are then used to calculate the prediction errors on the event day. These prediction errors, also known as "abnormal returns" (μ_{it}), are firm specific returns that remain after controlling for the movement of the market on the event day and have an expected value of zero under the market model:

$$R_{it} = a_i + b_i R_{mt} + \mu_{it}, \qquad \mu_{it} \sim N(0, s^2).$$

Whether an event has a significant effect on a firm or not may be analyzed by examining the statistical significance of the abnormal returns. In this case the provision of new information to the public about the environmental performance of the firm may impact the future financial performance of the firm which would be reflected in the firm specific abnormal returns accruing to the firm on the day of the event .

The abnormal returns were then calculated for these firms using event study methodology. The firm betas were estimated using the market model:

$$E(R_{it}) = a_i + b_i R_{mt}$$

Where R_{it} is the individual firm return for that time period, a_i is the constant term, b_i is the beta for firm ‘i’ and R_{mt} is the market return at time 't'. Daily returns for a 240 day period, beginning with 250 trading days before the event and ending 10 days prior to the event, were used to estimate the betas. These betas were then used in the market model to calculate the abnormal returns for the event period. We calculated the abnormal returns for a 20-day

window around the event day. The event day has been defined as the day the firm was first mentioned in the print media.[11] As shown in Table 1, firms that were mentioned in the media as being a toxic chemical emitter received significant stock price reductions on the day of the announcement. The first column is taken directly from Hamilton [11], which indicates that all publicly-traded firms with TRI emissions received a significant stock price reduction on the day of announcement (-0.284%), although there was no price effect on the day prior to announcement. This suggests a lack of information leakage prior to the initial press reports on June 19, 1989. The second column repeats this analysis for the 130 firms in our sample that had some firm-specific media coverage (-0.299%). Once again, we find no significant information leakage on the day prior to announcement.

The third column of Table 1 examines the 40 firms in our sample of 130 that received the largest negative abnormal returns, an average of -1.324% on the event day.[12] These firms represent about one-third of all firms with media reports in 1989, and their average abnormal returns is four times the mean (-1.3% versus about -0.3% for the entire sample).[13] The

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[11] Note that this date is not necessarily the same for each firm, as media stories appeared at various times throughout the year. Instead, these dates represent the first time a media story appeared about that company's toxic emissions. Thus, day 0 is designated as the day the company was mentioned in the media and all firms are aligned using their event day.

[12] We dropped two other firms from our sample that had higher abnormal returns, both of which also had "confounding events" on the day of the TRI announcement. Time-Warner was involved in significant takeover activity during this time period. LTV Corp. was involved in a $2 billion dispute over unfunded pension liabilities following their 1986 bankruptcy. The Supreme Court agreed to hear the case on the day of the TRI announcement. Thus, these two firms were dropped from the sample to ensure we did not incorrectly attribute abnormal returns to TRI announcements.

[13] The smallest abnormal returns chosen had a significance level at about 25%, indicating there was only a 25% chance that the abnormal returns were drawn from a sample with zero mean. The mean of -1.34% has a z-statistic of 9.23 which has a negligible

smallest abnormal return in the "top 40" sample is -0.6%, twice the average for the full sample of 130 firms. Abnormal returns are normally reported in percentage terms to control for firm size (Brown and Warner [3]). A few million dollars means virtually nothing to IBM, but plenty to a company whose market value is only $50 million. Nevertheless, these percentage losses translate into quite significant absolute dollars, with a mean loss of -$87 million, median loss of -$29 million, and a range of -$3.6 to -$841 million for our TOP 40 sample. We use this TOP 40 sample throughout the remainder of the paper to examine the impact of significant negative stock price reactions on firm behavior. The sample selection process balances our need for a sample of companies that had very significant stock price reductions (and hence are likely to react by reducing emissions) and for a reasonably large sample size.[14]

Although we refer to these firms as the TOP 40 for ease of exposition, this label refers to the stock price hit they took, not necessarily to the level of TRI emissions. In fact, of the TOP 40 firms with negative abnormal returns, only 11 were also among the top 40 largest TRI emitters (hereinafter referred to as LARGEST EMITTERS) in terms of absolute levels of pollutants. This is consistent with our earlier conjecture that many of the largest TRI emitters would not receive significant stock price reductions upon disclosure of their emissions, since the market was already expecting these firms to be among the largest emitters. That is, the

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probability of happening if the true mean were 0.

[14] This paper is primarily concerned with whether or not a negative stock price effect induces firms to reduce emissions. Note that there are various pressures exerted upon firms to reduce emissions (e.g., community pressure, consumers, cost savings), and most firms have reduced their TRI emissions over time. Thus, in this study, we focus only on those firms that received a statistically significant stock price "hit" and compare them to a matched sample control group of firms. A broader study of why firms reduce TRI emissions would require a different methodology and data. Instead, we focus on one of the reasons for TRI emission reductions - the financial markets.

negative stock price reaction had already been capitalized in the market value of the largest emitters by the time actual emissions were announced in June 1989.[15]

Since we want to examine the effect of significant stock price reductions on subsequent firm behavior, we compare TRI emissions among the TOP 40 to that of their industry peers. Given the discussion above concerning inter- versus intra-industry effects, and the fact that the TOP 40 companies are primarily from traditionally polluting industries, a comparison sample of firms from cleaner industries would not allow us to draw legitimate inferences on the behavior of firms in the TOP 40. Thus, instead of comparing the TOP 40 to all publicly traded companies, we adopt an "industry-weighted" approach. To construct this sample, we first determined the Standard & Poors' industry classification for each of the TOP 40 companies above. We obtained a list of 1500 publicly traded firms from IRRC (which also contained TRI and related environmental information),[16] of which 942 were in industries where at least one firm reported TRI emissions. Of these 942 companies, 512 were in the same industry category as one of our TOP 40. After excluding a few companies with missing data and the TOP 40, a total of 455 companies remained in our comparison group. Finally, each firm in the sample of 455 companies was given a weight so that we could replicate the

[15] Additional evidence with regard to the validity of this hypothesis emitters is discussed in Section V.

[16] IRRC selects this list of 1500 publicly traded firms to include both the Standard and Poors' 500 and the Fortune 500 companies, as well as the largest capitalization stocks. Thus, the firms in our population are among the largest and most visible publicly traded companies in the U.S. Since we are interested in the effect of stock price declines on subsequent firm behavior, this is an appropriate population for our study. Moreover, we are interested in comparing similarly situated companies. Thus, it is important to compare a firm who took a significant stock price hit with one who could potentially have received the same hit in the market. It also allows us to ignore different underlying incentives and governance structures of privately-held organizations.

industry classifications of the TOP 40. For example, since the TOP 40 abnormal returns sample included two steel companies, firms in the steel industry were given a weight of 1/20 for purposes of constructing the industry-weighted sample.[17]

Since firms vary dramatically by size and opportunities to pollute, any measurement of environmental performance must somehow adjust emission levels so that firms can be compared on an equal footing. Unless we explicitly control for firm size, any results would be extremely misleading. For example, a multi-billion dollar firm with massive emissions could reduce emissions by a small percentage and become the firm with the largest absolute emission reductions while still being one of the most inefficient polluters. Thus, we adopt two measures of performance: (1) the absolute level of emissions per thousand dollars revenue, and (2) firm rank within its industry category (normalized by the number of firms in the industry), where ranks are determined by the level of emissions per dollar revenue.[18]

In addition to TRI data, we also obtained two other measures of environmental performance from the IRRC dataset: oil and chemical spills and government-imposed fines for environmental violations. We collected this information to examine the extent to which

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[17] Note that although we report the "industry-weighted" sample of 455 firms throughout the paper, we also compared the TOP 40 to the unweighted full sample of 873 firms with TRI data, as well as to a smaller "matched sample" of 80 firms. The results reported in Tables 3 and 4 remain essentially unchanged regardless of the comparison group.

[18] An alternative approach is to examine the percentage reduction in emissions. The problem with this measure of performance is that empirically, percentage changes of TRI vary dramatically - and often for reasons that have little to do with firm reaction to the market. For example, a firm might expand by acquiring or building a new plant or merging with an existing firm. In such a case, TRI emissions might double or triple. Alternatively, a firm that closes a plant might cut its emissions by half. But that firm is also producing less output. Given the huge variation in percentages, we opted for our measure of emissions per dollar revenue.

there is any positive spillover between TRI emission reductions and other areas of environmental performance. If firms reduce their TRI emissions as a result of receiving negative abnormal returns, do they also take actions to reduce the probability of other bad environmental news? Even though spills are primarily accidents, firms can take actions ex ante to reduce their likelihood and severity (see e.g., Cohen [6]). Thus, a reduction in the number and the amount of spills may indicate better environmental management techniques and that the firm is attempting to improve its environmental performance. The other trend variable is the dollar value of fines per 1000 dollars revenue. Although government imposed penalties are certainly an indication of environmental performance, they are also partly based on discretionary and/or random enforcement. Both variables are measured as the average of two different time periods, 1988-1990 and 1991-1993.

The next section examines TRI emissions and the ranking of firms within their industry category, both before and after public announcement of TRI data.

IV. Results

Table 2 lists the TOP 40 firms that received the largest negative abnormal returns in 1989 as a result of TRI announcements. Among these TOP 40 firms, Owens-Corning Fiberglass Corp. received the largest negative abnormal returns (-2.7%), while McDonnell Douglas Corp. received the smallest stock price hit (-0.6%). Next, firms are ranked <u>within</u> their industry category on the basis of pounds of TRI emissions per thousand dollars revenue. For example, in 1989 Owens-Corning Fiberglass Corp. was the 7th largest TRI emitter in the Building Materials industry on a per dollar basis out of the 19 firms in the Building Materials industry, while in 1992 it was the 2nd largest emitter per dollar revenue. These rankings are

not based on absolute TRI emissions because larger firms would tend to have higher emissions and hence bias the rankings. The number of firms in each industry is taken from the list of 1500 publicly traded firms in the IRRC dataset. As shown in Table 2, the mean "rank" for TOP 40 companies was 7.04 in 1989. The mean "normalized" rank (company rank divided by industry size) was 0.339, indicating that firms in the TOP 40 were in the top 1/3 of their industry in terms of TRI emissions per dollar revenue.[19] The average rank in 1992 was 7.65, while the normalized rank was 0.396, indicating that these firms became relatively "lower" TRI emitters following the public announcement of TRI data, both in absolute and relative terms within their industries.[20]

The sixth column of Table 2 reports the change in industry rank between 1989 and 1992. A positive number indicates that the firm lowered its rank in terms of TRI/$, and is now a relatively "cleaner" firm than before. Of the 40 firms shown, 21 lowered their rankings, 7 firms remained unchanged, and 12 increased their relative TRI emissions. The last column shows the absolute change in TRI emissions per dollar of revenue, with a negative number indicating a reduction. Of the 40 firms, 32 reduced their TRI/$ revenue, while only 8 firms

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[19] Although these firms were among the largest TRI/$ emitters in their industry categories, they were not necessarily the largest emitters. Only 11 of the TOP 40 firms that received significant negative abnormal returns were also among the 40 LARGEST EMITTERS in terms of absolute pollution volume.

[20] The change in absolute ranking is not significant ($p < .31$). This is not really an appropriate measure of comparison, however, since the size of industries range from four to 53 firms. Thus, a two unit change in ranking, for example, might indicate an important shift in relative performance in an industry with four firms, but only a minor change in an industry with 53 firms. Thus, a more appropriate measure (and the one used in subsequent empirical analyses) is the normalized ranking, rank divided by number of firms in the industry. As shown later in Table 5, the improvement in normalized firm ranking is not statistically significant at normal levels of significance ($p < .15$).

increased emissions. The average firm reduced emissions by 1.84 pounds per thousand dollars revenue.

It is clear from Table 2 that the 40 firms who received the most significant negative stock price reactions following announcement of TRI emissions significantly lowered both their TRI/$ emissions and their TRI/$ ranking within their industry. As further evidence, and to help rule out the possibility of other unknown factors causing the TRI reductions, Table 3 compares industry rankings and TRI/$ reductions of the TOP 40 firms to our industry-weighted sample of 455 companies. TRI/$ revenue for the TOP 40 firms was nearly twice that of the industry-weighted sample in 1989 ($p<.05$). However, by 1992, the TOP 40 firms had reduced their TRI/$ revenue nearly in half, so that the difference between those firms and the industry-weighted sample was no longer statistically significant. While the TOP 40 firms reduced TRI/$ revenue by 1.84 pounds per thousand dollars revenue,[21] the industry-weighted sample had only reduced their TRI/$ revenue by 0.17 pounds per thousand.

Since the analysis above only compared two years of data (1989 and 1992), we also compared average TRI/$ revenue over two different time periods in order to smooth out any errors in reporting or annual fluctuations. Table 4 reports on the average TRI/$ revenue during the time periods 1988-90 and 1991-2.[22] The results are equally striking, with average TRI/$ revenue decreasing from 4.48 to 3.23 in the TOP 40 group ($p < .01$), compared to a reduction from 2.43 to 2.14 ($p < .21$) for the industry-weighted sample.

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[21] As noted in Table 3, this reduction (from 4.38 to 2.54 pounds per thousand dollar revenue) is statistically significant at $p < .10$.

[22] Although the results shown in Table 4 are based in current dollars, there is virtually no difference once they are converted to constant dollars.

Table 4 also reports on two other measures of environmental performance: oil and chemical spills, and government-imposed fines.[23] While the average volume of spills per dollar sales decreased in the TOP 40 group (from 4.00 to 3.14, $p < .10$), it actually increased slightly in the industry-weighted sample (from 2.04 to 2.15, $p < .56$).

Trends in government-imposed fines are a little more complicated to assess, since they not only serve as a measure of firm environmental performance, but also reflect changes in government enforcement programs. Both the TOP 40 firms and the industry sample increase their fines/$ revenue over time, with average fines being higher for the TOP 40 firms. However, only

the increase in industry-weighted fines is statistically significant ($p < .01$).[24] The fact that fine levels increase for both samples may be an indication of changes in EPA penalty and/or enforcement trends.[25]

V. Confirmatory Evidence on the Role of Information

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[23] Unlike the TRI trend data which compare 1988-90 and 1991-92, these data compare 1988-90 and 1991-93. Since there is a longer lag in reporting TRI data, it is not as current as spill data and enforcement data.

[24] Note that there are more than twice as many firms with increased fines/$ than decreased fines/$ among the industry-matched sample. This ratio is about 1.5 for the TOP 40. Using a Wilcoxon sign test, we find that the industry-matched sample has a significant number of increases at $p < .01$, whereas the TOP 40 sample does not have a statistically significant number of increases ($p < .26$). Thus, even if enforcement trends and fine levels are increasing for the TOP 40 group, they are increasing at a much lower rate than their industry peers.

[25]Cohen [5] and U.S. Environmental Protection Agency [19] provide evidence of increasing monetary penalties and enforcement trends during this time period

We have argued that the reason for a significant reduction in stock market valuation following release of TRI data is the fact that this is new information and was unanticipated. Thus, if a firm was expected to be the highest polluter and was subsequently found to be so, we are likely to see little or no change in stock market valuation on the actual date of TRI announcements. Market valuation would already reflect market expectations.

Table 5 compares the TOP 40 group to the 40 LARGEST EMITTERS. As noted earlier, we found that only 11 of our TOP 40 were also among the 40 LARGEST EMITTERS. The 40 LARGEST EMITTERS were also larger emitters in terms of TRI/$. Whereas the TOP 40 sample had average emissions of 4.38 pounds per thousand dollars revenue in 1989, the 40 LARGEST EMITTERS averaged 12.95 pounds per thousand dollars revenue. Moreover, while the TOP 40 significantly reduced their TRI/$ (from 4.38 to 2.54, $p < .10$), the LARGEST EMITTERS did not reduce TRI/$ at a statistically significant level (from 12.95 to 10.05, $p < .23$). This same result carries over to the industry TRI/$ rankings, where the normalized rank (in terms of TRI/$) of the 40 LARGEST EMITTERS remained virtually unchanged (.216 to .214), while the ranking for the TOP 40 sample improved from .34 to .40 ($p < .15$). These findings are consistent with the view that media attention and resultant stock price effects have more of an effect on subsequent firm behavior than simply being known as the largest emitters in the U.S.

These results are consistent with our hypothesis that the market reacted more to unexpected TRI disclosures than to those that were already expected to be very large. Further evidence is presented by Hamilton [11], in an analysis the dollar value of abnormal returns on the day of TRI disclosure. After controlling for size of firm, he found a positive correlation between the number of existing Superfund sites (already known to the public) and abnormal

returns, which is consistent with the market already anticipating that these firms would be major polluters. He also found little correlation between industry dummies for the five most polluting industries (in terms of aggregate toxic emissions) and abnormal returns, suggesting that investors also expected these industries to be highly polluting.[26]

Finally, although most of the 130 publicly traded companies with media announcements of TRI emissions in 1989 had negative (or essentially zero) abnormal returns on their respective event days, some actually had positive abnormal returns. Twenty-two firms had positive abnormal returns with a t-statistic at the 25% level or below (the same criteria used in generating the TOP 40 sample of companies with negative abnormal returns). Of these 22, we had to eliminate three that did not have subsequent environmental data to compare. Thus, we constructed a sample of 19 firms with the largest positive abnormal returns (hereinafter labeled POSITIVE 19) - comparable to our TOP 40 negative returns. Although the sample size is small and we have not controlled for industry characteristics, we can make a few tentative comparisons. Whereas the TOP 40 firms had an average normalized industry rank of .339 in 1989, the POSITIVE 19 firms were ranked .385. Thus, the POSITIVE 19 were relatively low emitters in their industry groups compared to the TOP 40 in 1989, although the difference is only significant at $p < .28$. By 1992, the TOP 40 group caught up with the POSITIVE 19, with the normalized rank being .396 for the TOP 40 and .383 for the POSITIVE 19. This is consistent with our hypothesis that the market reacted to new information - some of which positively affected firms that looked more favorable than their

[26]The only significant industry dummy was primary metals, which actually had a positive coefficient. Thus, the market may have been surprised that this industry was not as large a polluter as expected.

industry peers and more favorable than investor's expectations.

VI. Concluding Remarks

This paper has examined firm behavior in response to a significant stock market reaction to new information on toxic chemical emissions. We identified all firms with significant negative abnormal returns upon the public announcement of their TRI emissions in 1989. Firms with the largest negative stock price effects following announcement of their TRI emissions were found: (1) to be among the top 1/3 of polluting firms (per dollar revenue) in their industries; (2) not to be the largest absolute TRI emitters; (3) to subsequently reduce their TRI emissions more than other firms in their industry (including those firms with the largest TRI/$ revenue prior to the disclosure of TRI levels); (4) to also make other significant attempts at improving their environmental performance by reducing the number and severity of oil and chemical spills, and (5) to have a lower chance of receiving higher fines from the government in subsequent years.

We have provided a partial answer to the fundamental question concerning the role of information in reducing the emission of environmental contaminants. New information concerning a firm's toxic emissions that has a significant effect on market valuation is likely to induce that firm to significantly reduce subsequent emissions and to otherwise improve its environmental performance. Thus, in some instances, providing information to the public may be an effective remedy to reduce environmental externalities beyond a regulatory standard. Nevertheless, several important questions are left unanswered. Are these reduced emissions the "worst" pollutants for these firms? Are these emissions the most cost-effective

ones to reduce or alternatively, are they simply those that are most subject to public scrutiny?[27] Do the stock price and subsequent emissions reductions represent responses to public pressure/environmental concerns or to previously inefficient production processes? What other factors cause firms to reduce emissions beyond the regulatory standard? Are manager's expectations that decreasing TRI emissions following a significant stock price hit realized; in other words, does it "pay " these firms to reduce TRI? Finally, do the social benefits of this form of regulation exceed its costs, and does it dominate direct regulation or other forms of market-based incentives? Answers to these questions must await further research.

[27]One of the "risks" associated with using information as a regulatory tool is that providing one piece of information might stifle the flow of another type. For example, by focusing on the absolute level of TRI emissions instead of the harmfulness of emissions, some have argued that firms who appear to be the worst polluters are actually not.

Table 1
Abnormal Returns Following Disclosure of TRI Emissions

Window (days)	*All Firms in TRI Database*	*Firms Mentioned in the Media*	*Top 40 Firms in terms of Event Day Returns*
-1	0.00000767	-0.00019	-0.000331
	(-0.249)	(-0.158)	(-0.1623)
0	-0.00284***	-0.00299***	-0.01324***
	(-3.8411)	(-2.7787)	(-14.52)
0-5	-0.0120***	-0.00743***	-0.01129***
	(-6.029)	(-2.99)	(-2.436)
Number Of Observations	436	128	40

Note: First column taken directly from Hamilton (1995).

Z statistics are reported in parenthesis.

***Statistically significant at $p < .01$.

Table 2: Change in TRI Industry Rank for Top 40 Companies w/TRI related Abnormal Returns

Company	Rank by Abn. Ret.	Industry	Industry Rank 1989	Industry Rank 1992	Change in Rank 1989-92*	Change in TRI/$ 1989-92**
Owens-Corning Fiberglass Corp.	1	Building Material	7/19	2/19	-5	0.61
Quanex Corp.	2	Steel	16/22	15/22	-1	-1.31
Cooper Industries Inc.	3	Machinery	14/49	18/49	+4	-0.6
Crown Cork & Seal Co. Inc.	4	Containers (Metal)	1/12	3/12	+2	-3.14
Armco Inc.	5	Steel	5/22	4/22	-1	-1
Eastman Kodak Co.	6	Photographic	2/4	1/4	-1	-0.74
Thomas Industries Inc.	7	Electrical Equip.	9/53	4/53	-5	0.45
Hewlett-Packard Co.	8	Electronics Instr.	6/21	9/21	+3	-0.3
Rhone-Poulenc Rorer	9	Drugs	1/18	4/18	+3	-16.15
Coastal Corp.	10	Natural Gas	1/40	1/40	0	-0.67
General Motors Corp.	11	Auto	1/5	1/5	0	-0.61
Phelps Dodge Corp.	12	Metals	1/18	4/18	+3	-14.22
Springs Industries Inc.	13	Textiles	6/24	9/24	+3	-0.25
Scott Paper Co.	14	Household Prod.	3/9	2/9	-1	0.88
James River Corp. of Virginia	15	Paper	9/27	15/27	+6	-1.16
Illinois Tool Works Inc.	16	Manufacturing	17/37	9/37	-8	0.28
Inland Steel Industries Inc.	17	Steel	2/22	3/22	+1	-4.68
Eaton Corp.	18	Heavy Duty Truck	2/6	6/6	+4	-1.03
International Business Machines	19	Computers	9/44	5/44	-4	-0.05
Bethlehem Steel Corp.	20	Steel	15/22	12/22	-3	-1.47
Maytag Corp.	21	Household Furn.	5/6	5/6	0	-0.24
Whirlpool Corp.	22	Household Furn.	3/6	4/6	+1	-0.95
Unocal Corp.	23	Oil	3/32	7/32	+4	-1.29
Parker Hannifin Corp.	24	Manufacturing	14/37	14/37	0	-0.46
Olin Corp.	25	Chemicals	0	15/22	+7	-4.68
Chrysler Corp.	26	Auto	2/5	4/5	+2	-0.43
General Electric Co.	27	Electrical Equip.	12/53	21/53	+9	-0.49
Allied-Signal Inc.	28	Manufacturing	3/37	3/37	0	-3.46
Raytheon Co.	29	Aerospace	10/19	14/19	+4	-0.31
Lockheed Corp.	30	Aerospace	16/19	18/19	+2	0.04
Boeing Co.	31	Aerospace	8/19	15/19	+7	-0.5
Upjohn Co.	32	Drugs	2/18	2/18	0	-7.11
Ferro Corp.	33	Specialty Chem.	7/31	8/31	+1	-2.97
Atlantic Richfield Co.	34	Oil	20/32	11/32	-9	0.35
Westvaco Corp.	35	Paper	1/27	2/27	+1	-3.09
Mobil Corp.	36	Oil	19/32	8/32	-9	0.59
Armstrong World Industries Inc.	37	Household Furn.	2/6	2/6	0	-0.33
Union Camp Corp.	38	Paper	3/27	8/27	+5	-3.92
Federal Paper Board Co. Inc.	39	Paper	11/27	9/27	-2	1.07
McDonnell Douglas Corp.	40	Aerospace	12/19	16/19	+4	-0.26
Mean Values			**7.04**	**7.65**	**0.68**	**-1.84**
Normalized Industry Rank (Company Rank/Industry Size)			**0.339**	**0.396**		

* Positive number indicates improvement relative to industry; rank=1 for worst polluter.
** Negative number indicates improvement through reduced emissions.

Table 3
Comparison of TRI/$ and Industry Rank for "Top 40" Firms and Industry Peers

	Top 40 Firms Ranked by Event Day Abnormal Returns	Industry Weighted Sample of Firms	T-Test Values Comparing the Top 40 Firm Means with Industry Peers
Sample Size	40	455	
TRI/$ Revenue in 1989	4.382	2.318	-1.87**
TRI/$ Revenue in 1992	2.543	2.017	-0.53
Change in TRI/$ Revenue 1989-1992	-1.84	0.17	
T-test Values Comparing 1989 to 1992 within each category	-1.49*	-0.35	

Note: t-statistics are reported based on one-tailed tests.
* Significant at $p < .10$
** Significant at $p < .05$

Table 4
Comparison of Environmental Performance Trends

	Average for period 1988-90	Average for period 1991-93 (1992 for TRI)	Paired T-test values comparing two time periods
TRI/$ Revenue - TOP 40	4.48	3.23	3.93***
- Industry weighted sample (n=455)	2.43	2.14	1.25
Spills/$ Revenue - TOP 40	4.00	3.14	1.61
- Industry weighted sample (n=455)	2.04	2.45	-0.58
Fines/$ Revenue - TOP 40	22.4	134.8	-1.44
- Industry weighted sample (n=455)	15.9	96.7	-2.85***

Note: t-statistics are reported based on two-tailed tests.
* significant at $p < .10$
** significant at $p < .05$
*** significant at $p < .01$

Table 5
Comparison of TRI/$ and Industry Rank for "Top 40" Abnormal Returns & "Top 40" Emitters

	Top 40 Firms Ranked by Event Day Abnormal Returns	Top 40 Firms Ranked by Absolute TRI Levels
TRI/$ Revenue in 1989	4.38	12.95
TRI/$ Revenue in 1992	2.54	10.05
Change in TRI/$ Revenue 1989-1992 (t-statistic in parenthesis)	-1.84 (-1.49)*	-2.90 (0.77)
Normalized Industry Rank in 1989 (Company Rank / Industry Size)	0.339	0.216
Normalized Industry Rank in 1992 (Company Rank / Industry Size)	0.396	0.214
Decline in Normalized Industry Rank 1989-1992 (t-statistic in parenthesis)	0.05 (1.03)	-0.002 (-0.17)

Note: The top 40 firms ranked by absolute TRI emissions have higher TRI/$ and higher TRI/$ normalized industry rankings than the top 40 ranked firms ranked by abnormal returns, in both 1989 and 1992 ($p<.01$).

t-statistics are reported based on one-tailed tests.
* Significant at $p < .10$

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