Toxic Release Inventory, Stockholder Reaction, and Restructuring of the Electric Utility Industry

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Abstract

Community-right-to-know programs such as the EPA's Toxic Release Inventory use mandatory information disclosure to "shame" dirty firms into reducing emissions. The idea is that the public–armed with previously unavailable emissions information–will pressure firms with higher-than-expected emissions to "clean-up." We use the electricity industry to study the impact of price-and-entry deregulation on the effectiveness of the TRI. We ask whether stockholder reaction differs according to whether announced emissions occurred in price-and-entry regulated or deregulated states. We use event studies to calculate changes in firm value, finding that, on average, utilities experience losses in firm value immediately following TRI announcements. We regress the changes in firm value on a panel with announced emissions disaggregated by whether the emissions occurred in regulated or deregulated states. We find that each additional pound of toxic emissions released in regulated states decreases firm value by $1.04. Also, we find that each additional pound of toxic emissions released in deregulated states increases firm value by $1.55. We also test for state characteristics that may lead to this difference in stockholder reaction. I.e., is the probability of future liabilities higher in regulated states? Are firms able to pass on abatement costs more easily when they are deregulated? We find that deregulated states are more likely to have higher environmental quality as well as utilities with greater political power. Regulated states have a higher probability of TRI-related legislation. We also estimate the impact of changes in stockholder value on subsequent emissions, finding that subsequent emissions of cancerous toxins, sulfuric acid, and hydrofluoric acid are reduced with losses in firm value for emissions in regulated states, but not in deregulated states.

1 Introduction

Community-right-to-know programs and efforts to restructure the electricity industry share a similar goal: to transfer power from centralized regulators to the public. Community-right-to-know programs such as the EPA's Toxic Release Inventory (TRI) use mandatory information disclosure to shame "dirty" firms into reducing emissions. The idea is that the public—consumers, community groups, local governments, and investors—punish firms for "bad news" about emissions. I.e., firms with higher-than-expected emissions face public pressure–bad publicity, boycotts, lawsuits, and/or local regulation–to "clean-up." Thus, with news of higher-than-expected emissions, stockholders immediately update their expectations of future pollution-related expenditures or liabilities, which reduces profitability and hence market value.

Restructuring (deregulation) is a movement to make the electric utility industry–historically a set of price- and entry-regulated natural monopolies–more competitive. A popular debate raises the question: if market forces instead of state commissions set prices, then will the public's desire for cheaper and hence dirtier power outweigh the desire for a clean environment? If so, the TRI should be less effective in price-and-entry deregulated states.

We examine stockholder reaction to TRI emissions announcements, partitioning emissions according to whether they were emitted in regulated or in deregulated states. We use event studies to estimate changes in market capitalization (firm value) corresponding to the EPA's annual publication of the TRI. We employ panel techniques to estimate the effect of deregulation on the relationship between emissions announcements and changes in firm value. We then use a logit model to test for state characteristics that may lead to observed differences in stockholder reaction. I.e., is the probability of future liabilities higher in regulated states? Are firms able to pass on abatement costs more easily when they are deregulated? Finally, we estimate the impact of changes in stockholder value on subsequent emissions, and again ask whether this relationship differs according to state type.

We find that announcements of higher-than-expected emissions decrease firm value, which is consistent with previous studies about other industries. Firm value decreases by $1.04 per pound of emissions released in regulated states and increases (firm loss is reduced) by $1.55 per pound released in deregulated states. Regulated states are more likely to have fines and liabilities corresponding to higher-than-expected emissions. Deregulated states have utilities with greater political power and thus greater ability to pass on compliance costs to consumers.

Further, we find losses in firm value reduce subsequent emissions of cancerous toxins, sulfuric acid and hydrofluoric acid in regulated states, but not in deregulated states. However, when we account for federally-regulated sulfur dioxide, we are unable to discern whether the aforementioned reduction is a result of shaming, a by-product of federal cap-and-trade legislation, or a combination of both types of regulation.

2 Background and Literature Review

2.1 Mandatory Data Disclosure

The Toxic Release Inventory (TRI) requires all manufacturing firms with SIC codes 20-39 with 10 or more employees to submit reports of their on-site releases and off-site transfers of each of more than 300 toxic chemicals. It takes approximately two years for the EPA to compile and release TRI data to the public (e.g. 1987 pollution figures, the first year of data, were released in 1989). The electric utility industry was first required to report data in 1998, which was released by the EPA in 2000.

A growing literature studies stockholder reaction to TRI releases. Hamilton (1993) uses event studies to calculate stockholder reaction to 1989 TRI announcements concerning 436 firms in the manufacturing sector. He finds that firms reporting any TRI emissions experienced negative abnormal returns: as 1989 was the program's first year, on average, any firm-level TRI data was "bad news" to stockholders. Firm losses increase with greater media coverage and more Superfund sites.

Konar and Cohen (1997) ask whether losses in firm value lead to subsequent reductions in emissions. Using 1989-1992 release data, they calculate TRI-induced abnormal returns for 138 manufacturing firms. The 40 firms in their sample with the largest abnormal returns had the largest subsequent reductions in emissions when compared to other firms in the TRI. Konar and Cohen (1997) conclude that the more negative the abnormal return, the higher are the incentives to reduce emissions.

Khanna et. al. (1998) use a sample of 91 firms in the chemical industry and find statistically significant negative abnormal returns corresponding to TRI disclosure in the years 1990-1994. Khanna et. al. (1998) find that losses in firm value have a negative impact on subsequent on-site toxic releases and a significant positive impact on wastes transferred off site.

Hamilton, Konar and Cohen, and Khanna et. al. find statistically significant abnormal returns, ranging from -.16% to -1.3%. Using data from 2000-2006, we find average abnormal returns of -.21% for a set of 44 firms in the electricity industry. We too find that subsequent emissions of certain pollutants appear to decline with negative abnormal returns.

A more recent study, Bui (2005), does not find statistically significant abnormal returns in the petroleum industry from 1989-1999. As for subsequent emissions, the author speculates that while the TRI may have led to some decline in emissions, most of the decline is due to more traditional command-and-control regulations. She finds a strong correlation between levels of toxic air emissions and levels of criteria air pollution.[1] With an increase in abatement expenditure for non-toxic air pollutants, she notes declines in both toxic and non-toxic air emissions.[2] Our results show some evidence in favor of Bui's argument; we find a subsequent reduction of 1,461 pounds of sulfuric acid (chemically very close to SO_2) per $1 million loss in

[1] Criteria pollutants include pollutants such as sulfur dioxide and nitrogen dioxide, both regulated under the Clean Air Act of 1990.

[2] For example, the EPA's Acid Rain Program (stemming from CAA 1990) requires a two-phased tightening of restrictions on fossil fuel-fired power plants, resulting in a permanent cap on sulfur dioxide of 8.95 million tons nationwide, half the amount emitted in 1980.

firm value. When we account for SO_2, we no longer see a statistically significant relationship between reductions in sulfuric acid and losses in firm value.

Delmas et. al. (2006) tackle the relationship between mandatory information disclosures and environmental performance in the electricity industry. Instead of the TRI, the authors use state-level regulation that requires utilities to publish fuel-mix compositions and emissions levels. According to Delmas et. al., this data is easier-to-read and more accessible than TRI data, which requires "environmental database expertise to interpret the information." The authors' sample includes data from 145 investor-owned firms from 1995 to 2003. They find 23 of the 25 states that adopted disclosure rules are deregulated. Customers may change suppliers in deregulation; as a consequence, customers react to unfavorable disclosures by shifting toward cleaner fuels and providers. Delmas et. al. find that mandatory disclosure programs decrease the average ratio of fossil to renewable fuels used in electricity generation; however, these findings are sensitive to both customer composition and pre-existing fuel mix levels. We expand upon Delmas' study as we consider the effect of TRI disclosures on the electricity industry. We also consider public reaction to the TRI in regulated versus deregulated states.

3 Theoretical Framework

Both Hamilton and Konar postulate that losses in market value could be a signal of firm inefficiency, pending lawsuits, community pressure and/or future regulation. Investors may be using the TRI to gauge firms' productive efficiency–higher emissions means more inputs wasted and thus lower efficiency. Or, the TRI could be a catalyst for community pressure to reduce emissions through lawsuits or product boycotts. In addition, local governments could react to higher-than-expected emissions by increasing enforcement actions against polluters.

These ideas are instrumental in modeling the mechanism through which emissions announcements change firm value. Since there is a two-year span between emissions and announcements, we estimate changes in market capitalization as a function of lagged emissions. For simplicity, a 1-year lag time is assumed (emissions at $t-1$ are announced in period t).

We use the Lucas (1978) Asset Pricing Model. In this particular version of the Lucas model, firms own capital and households own the firms. To shareholders (consumers) firm value at time t is the return on investment multiplied by the marginal utility derived from that return. Shareholder value at time 0 is a summation of these returns over time. The variable q_t denotes the discounted marginal utility of consumption ($q_t = \beta^t u'(c_t)$), or the price at time 0 of a unit of consumption in period t. The firm is assumed to take q_t (determined in equilibrium) as given. Without loss of generality, $C_t = C_{t+1.}$ is assumed. If V denotes shareholder value and d_t dividends, then discounted shareholder value is:

$$V_0 = \sum_{t=0}^{\infty} \beta^t d_t \tag{1}$$

According to the Modigliani-Miller theorem, the market value of a firm is determined by its earning power and the risk of its underlying assets; market value is independent of how a firm chooses to finance its investments or distribute dividends. Thus, we have firm value as a function of dividends d_t, assuming without loss of generality that no bonds or retained earnings exist.

Consistent with Bartz and Kelly (2006), emissions are proportional to a dirty input E_t. Production is a constant returns to scale Cobb-Douglas function of capital K_t and dirty input E_t. We define A_t as a total factor productivity factor. If P_t is the retail price of electricity, then total revenue for a firm is given by:

$$P_t A_t K_t^{\theta} E_t^{1-\theta} \tag{2}$$

For regulated firms, P_t is the retail price of electricity, set by public utility commissions (PUCs). For deregulated firms, P_t is determined by the demand for electricity. Common in the electricity literature is the assumption that a deregulated electricity industry resembles a Cournot oligopoly. We therefore assume firm i produces Q_{it} and there are n identical firms competing in a market. Then, demand for electricity is given by:

$$Q_t = \sum_{we=1}^{n} Q_{it} = Q_{it}n = Q_t(P_t) \tag{3}$$

Dividend d_t equal revenues less capital investment, payments for factors of production (dirty input), and compliance costs. Investment expense is $k_{t+1} - (1-\delta)k_t$, or the investment decision net of depreciation. The cost of the dirty good is $P_{ct}E_t\ + f_t E_{t-1}$,where P_{ct} is the price of the dirty good and f_t is the firm's liability on emissions released in $t-1$. We assume "liability" represents fines levied by state and local governments, legal costs, clean-up costs (e.g. Superfund), and/or costs associated with community pressure.

The liability f_t is a sunk cost; it is assessed on past emissions. Since emissions are not known by regulators and stockholders until they are announced, firms are assessed fines/pay cleanup costs in period t for emissions emitted in $t-1$.

Firms determine dividends (profits) from the following:

$$d_t = P_t A_t K_t^{\theta} E_t{}^{1-\theta} - (k_{t+1} - (1-\delta)k_t) - P_c E_t - f_t E_{t-1} \tag{4}$$

Hence, the firm problem is to maximize:

$$V_0 = \max_{k_{t+1}, E_t} \sum_{t=0}^{\infty} q_t d_t, \tag{5}$$

subject to a given K_0 and (4) for a regulated firm and subject to (3) and (4) for a deregulated firm. The following first order conditions determine optimal investment and emissions:

$$\beta^{t+1}\left[P_{t+1}\theta A_{t+1} K_{t+1}^{\theta-1} E_{t+1}^{1-\theta} + (1-\delta)\right] = \beta^t \tag{6}$$

$$P_tE_t + \beta f_{t+1}E_t = P_t(1-\theta)A_tK_t^{\theta}E_{t+1}^{-\theta} \tag{7}$$

To solve for the value of a regulated firm V_0^R, we combine (6) and (7), and obtain firm value at time 0 as a function of d_0 and discounted streams of capital and emissions:

$$V_0^R = d_0 + \sum_{t=0}^{\infty}\beta^tK_{t+1} - \sum_{t=1}^{\infty}\beta^tK_t + \sum_{t=1}^{\infty}\beta^{t+1}f_{t+1}E_t - \sum_{t=0}^{\infty}\beta^{t+1}f_{t+1}E_t \tag{8}$$

This equation simplifies nicely to $d_0+k_1+\beta f_1E_0$. If we solve for d_0 using (6) and (7) at time 0, then we obtain:

$$V_0^R = \theta P_0A_0K_0E_0^{1-\theta} + (1-\delta)K_0 - f_0E_{-1} \tag{9}$$

Or, if $\theta P_0A_0K_0E_0^{1-\theta} + (1-\delta)K_0$ is set equal to $(1+r_0)K_0$, where $1+r_0$ is the gross rate of return at time 0, then:

$$V_0^R = (1+r_0)K_0 - f_0E_{-1} \tag{10}$$

For both V_0^R and V_0^{DR} (initial values of regulated and deregulated firms, respectively), a stockholder has full knowledge of interest rate r_0 and initial capital K_0. For regulated firms, changes in stockholder value in response to announcements of toxins emitted in the prior period are thus determined by the stockholders' prior expectations of emissions levels and corresponding fines/clean-up costs f_0. I.e., if investors form expectations of announced emissions $\mathbb{E}(E_{-1})$, then the change in regulated firm value with the announcement of E_{-1} is:

$$\Delta V_0^R = -f_0(E_{-1} - \mathbb{E}(E_{-1})) \tag{11}$$

For deregulated firms, we obtain similar results but with the addition of a "markup." A consequence of price-setting power in deregulation, this value is equal to the sum of discounted stream firm revenues divided by the absolute value of the price elasticity of demand $|\epsilon|$; i.e.,

$M_t = \sum_{t=1}^{\infty} \beta^t \frac{Q_{it} P_t}{|\epsilon|}$. This markup is reduced by a higher price elasticity for electricity. A deregulated firm's initial market value is thus:

$$V_0^{DR} = (1 + r_0)K_0 - f_0 E_{-1} + \sum_{t=0}^{\infty} \beta^t \frac{Q_{it} P_t}{|\epsilon|} \quad (12)$$

We consider four possible reasons why the change in firm value may differ for regulated versus deregulated emissions. The first is that environmental stringency differs. The second is that revealing emissions allows investors to update other expectations. The third is that deregulated firms have the ability to pass on clean-up costs to customers. The fourth is the possibility that consumers, who are assumed to have choice under deregulation, react to higher-than-expected emissions by increasing their demand for green (cleaner) power.

For the first possibility, for regulated and deregulated firms, the change in firm value with emissions, announced between time 0 and time 1, is equal to:

$$\Delta V_0^R = -f_0^R (E_{-1} - \mathbb{E}(E_{-1}) \lesseqgtr \Delta V_0^{DR} = -f_0^{DR}(E_{-1} - \mathbb{E}(E_{-1})) \quad (13)$$

Here, the change in firm value is negative if emissions are higher than expected. If environmental stringency is greater for regulated firms, all else equal, then $f_0^R > f_0^{DR}$. I.e., ΔV for a regulated firm is comparably more negative. If environmental stringency is greater in deregulated states, all else equal, then $f_0^R < f_0^{DR}$.

The markup on firm value in deregulated states also serves to impact changes in firm value. Investors may not observe total factory productivity A_{t-1} without knowing E_{t-1}. Investors use A_{t-1} to form their expectations of A_t. I.e., when emissions E_{-1} are announced, investors will adjust their expectations of A_0:

$$\Delta V_0^{DR} = -f_0^{DR}(E_{-1} - \mathbb{E}(E_{-1})) + \mathbb{E}\left[\frac{1}{|\epsilon|} P(Q_0(A_0)) * Q_0(A_0) \frac{1}{|\epsilon|} P(Q_0(A_0)) * Q_0(A_0)\right] |E_{-1} - \mathbb{E}\left[\frac{1}{|\epsilon|} P(Q_0(A_0)) * Q_0(A_0)\right] \quad (14)$$

Thus, higher-than-expected emissions leads to a lower-than-expected A_{-1} and hence A_0.[3] A change in expectations of A_{t-1} effects the markup through demand elasticity ϵ and firm revenue PQ:

$$\frac{\partial M}{\partial A} = \left[-2P'(Q)Q - P''(Q)Q^2\right] \tag{15}$$

When E_{t-1} is announced, investors update their expectations of firm value and hence M_0:

$$\frac{\partial M}{\partial A} \gtreqless 0 \; if \; 2P'(Q) \gtreqless P''(Q)Q \tag{16}$$

If we assume linear demand (3), then $\frac{\delta M}{\delta A}$ will be positive.[4] Therefore, the markup and firm value will decrease with higher-than-expected emissions. Investors adjust expectations and hence market value to reflect a lower-than-expected efficiency of the firm. For demand that is of the form $P = \frac{1}{Q^\alpha}$, $\frac{\delta M}{\delta A}$ will be negative for values of $\alpha > 1$. For isoelastic demand ($\alpha = 1$), $\frac{\delta M}{\delta A} = 0$.Thus, the impact of an update in expected A_0 depends on the elasticity and functional form of demand.

The green power story is that when E_{t-1} is revealed, consumers react by demanding power from cleaner sources. The deregulated firm faces separate demand curves for green and brown (dirty) power. An increase in the demand for green power increases its price, markup, and thus firm value. Demand for brown power declines, decreasing its markup and firm value. Green power consumers are generally less price sensitive. Therefore, the net effect is that firm value rises. Evidence for this story can be seen in Delmas, et. al. (2006). However, our model does not yet explicitly account for green power.

Since f_0 is a fixed cost, we don't see any evidence of deregulated firms being able to pass on costs to consumers. Our model shows that a firm's production decision is independent of f_0; prices are determined in equilibrium and are hence a function of A_0, K_0, E_0. While E_0 is

[3] Q_{t-1} is known prior to the emissions announcement. If emissions are higher than expected, it must follow that A_{t-1} is lower than expected.

[4] P"(Q) is equal to zero

correlated with E_{-1}, firms have full knowledge of both.

We could model the idea that captured[5] public utility commissions allow regulated utilities to recover compliance costs through surcharges. However, our empirical results do not show evidence of surcharges being a factor. As for capturing, we find states with more powerful utilities are more likely to be deregulated, not regulated. We have not yet explored modeling retail price of power P for regulated firms as a function of E_{-1}; i.e., public utility commissions raise or lower regulated retail price P depending on public reaction to E_{-1}.

In conclusion, we model how emission announcements possibly change firm value ΔV. Since past emissions are known to firms, their production decision is independent of $E_{-1.}$ Instead, announcements affect firm value through incorrect expectations and corresponding costs of abatement and/or fines, as well as through the deregulated firm's markup. Specifically, differences in fines (environmental stringency) in regulated versus deregulated states leads to differences in how shareholders react to higher-than-expected emissions. Through the markup, a deregulated firm may have a favorable or unfavorable reaction if emissions are higher-than-expected. Similar to both Hamilton and Konar's assumptions, in our model, higher-than-expected emissions indicate lower productivity. Also, higher-than-expected emissions in deregulated states may lead consumers to increase demand for green power, which leads to an increase in firm value.

4 Data

For our study we need: (1) TRI announcement dates; (2) firm value changes ΔV corresponding to emissions announcements; (3) pounds of emissions in regulated and deregulated states (from TRI announcements); (4) firm-specific financial characteristics that may impact (2); (5) firm

[5] Capturing is a theory that states that government regulatory agencies are "captured" by the leading organized interest (a company or business association) in the industry over which particular agencies operate(Stigler (1971)). This view rests on the understanding that the political actors most interested in the regulation of a particular industry are the companies in that very industry.

characteristics that may impact (3); and state characteristics that may impact the interaction of (3) and (2).

The TRI announcement dates are identified through LexisNexis and the WSJ Online. Consequential change in firm value is determined from Center for Research in Security Prices (CRSP). Standard & Poor's Compustat database provides firm-specific financial data. Emissions data are from the EPA's TRI and the OMB Watch's[6] Right-to-Know Network (RTK Net) databases. State and firm characteristics involving energy statistics (fuel data, etc.) are from the Dept. of Energy. Overall, our sample includes 54 electric utility firms with full data for years 2000-2005.

4.1 Abnormal Returns and Firm Valuation Data

It takes approximately two years for the EPA to collect and publish TRI data. Thus, data collected in 1998 is published in 2000, and so forth. To estimate the cost of public reaction to each annual TRI announcement, we use an event studies methodology. Event studies measure the impact of an unanticipated event on the market capitalization of a firm; i.e., if the market is efficient, then the effects on shareholder value will be reflected immediately in security prices. In comparison, direct productivity-related measures may require months to years of observation (MacKinlay 1997). Also, according to McWilliams and Siegel (1997), event studies are a less biased way of measuring the monetary impact of an announcement than accounting methods, which may be manipulated by managers.

Event studies utilize abnormal returns to estimate investors' reaction to new information– here, the TRI emissions. An abnormal return is the actual ex-post return of a security minus the normal return; the normal return is the return if an event did not occur. To estimate the normal return, we use the market model, common in this literature and, according to (Brown and Warner 1985), well-specified and powerful. In the market model, the rate of return on the

[6] OMB Watch is a nonprofit government watchdog organization that attempts to "promote open government, accountability and citizen participation."

share price of firm i on day t is expressed as:

$$R_{it} = \alpha_i + \beta_{it} R_{mt} + \epsilon_{it} \tag{17}$$

Here R_{it} is the rate of return on the share price of firm i on day t, R_{mt} is the return on a market portfolio of stocks, α_i is the intercept term, β_{it} represents the systematic risk of stock i, and ϵ_{it} is the error term with $\mathbb{E}(\epsilon_{it}) = 0$. We use ordinary least squares (OLS) to estimate α_i and β_i from a subset of returns known as an estimation window. Our estimation window is from 10-to-100 days prior to the announcement, similar to Khanna, et. al. (1998). For R_{mt}, we use the value-weighted index from CRSP as a market proxy. Thus, the estimated error term e_{it} is a representation of the abnormal return AR_{it} for firm i at time t :

$$e_{it} = AR_{it} = R_{it} - (a_i + b_i R_{mt}) \tag{18}$$

In (18) a_i and b_i are OLS parameter estimates.

Using standard event-study methodology, statistically significant cumulative average abnormal returns (CAAR) are the sum of abnormal returns for each stock over an event window, a pre-specified period of time surrounding an announcement date. A positive CAAR indicates a favorable response to an event, while a negative value indicates an unfavorable response.

Three assumptions are made for event studies to produce valid results (McWilliams and Siegel 1997). The first is that markets are efficient; the second is the events are unanticipated; and the third is that there are no confounding events. We searched LexisNexis for both leakages and confounding events. To the best of our knowledge, the TRI data was not leaked to the press prior to the event date and there were no confounding events on the release dates. To also control for confounding events, we limit our event window to one day. Like Khanna, et. al., we choose the day following the announcement, assuming that if an announcement comes in the afternoon it takes time to disseminate the information. In most cases, we noticed the following sequence of events: the EPA announces the TRI emissions on day 0, the wire services (AP, UPI, etc.) post wire stories on day 0, and on day 1 and 2, dailies such as the Wall Street Journal, Washington Post, New York Times, Denver Post, etc. run TRI-related copy. A wire story is not well-dissemilated until it is picked up by other news sources; i.e., the public does not have direct access to the AP or UPI. The data takes time to translate; for example, the data are facility-level and need to aggregated by parent company, another argument for using Day 1.

We calculate abnormal returns and then convert them to changes in market capitalization ΔV.[7] All results are available in the appendix. Our sample size is 54 firms over six years for a total of 324 observations. For all years combined, we find a statistically significant negative abnormal return of .31%, corresponding to a $17.1 million loss in firm value. I.e., firms in our sample experienced a $17.1 average loss in value on the day after the information was released. For years 2000 and 2005, we find statistically significant returns of -1.46% and -0.45%, respectively. Year 2000 has the largest abnormal return; this is probably because 2000 is the first release year of TRI data for utilities. We therefore conclude that the data release has some statistically significant impact on stock prices. We utilize ΔV below in our regression estimating the relationship between change in firm value and announced emissions released in regulated versus deregulated states.

4.2 Emissions Data

We use the following five categories of TRI toxins: all TRI toxins reported, sulfuric acid aerosols (H_2SO_4), hydrofluoric acid aerosols (HFL), hydrochloric acid aerosols (HCL), mercury (HG), and an aggregate measure of carcinogens[8]. HFL, HCL and H_2SO_4 are the top three chemicals

[7] Market capitalization is equal to the number of shares outstanding multiplied by the stock price. It is a measure of firm value.

[8] We compile a list of chemicals emitted by the utilities which are known carcinogens (classified as such by UC Berkeley). Pollutants include: metals such as nickel, cobalt, and copper, acid aersosols such as HCL, etc. For a full listing and the amount generated by our sample, please send the Appendix.

released by electric utilities, accounting for 98 percent of TRI air emissions and 73 percent of overall releases. According to Natan, et. al. (2000), these acid aerosols are corrosive and can cause acute respiratory problems. Also, these emissions contribute to secondary particulate pollution. HG is of interest as it is known to cause cognitive development problems in children.

We also use the TRI's measures of on-site releases and stack emissions. Total on-site releases include air emissions, surface water discharges, underground injections, and releases to land. An off-site transfer occurs whenever toxic wastes are sent to a facility that is geographically or physically separate from the facility reporting under TRI. A toxic waste is transferred off-site generally for disposal, recycling, combustion for energy recovery, or treatment. Stack emissions are the total amount of a chemical emitted from smoke stacks into the air. We include stack emissions since HFL, HCL and H_2SO_4 are primarily emitted as aerosols. The TRI provides emissions data by facility, not by parent company; thus, we rely on the RTK Net and extensive Google searches to match facilities with parent companies. The RTK Net simplifies TRI searches: for example, in the RTK Net, one can search by industry; in the TRI one cannot. Since parent company data is often incomplete in both databases, we use Google searches to pin down exact ownership at the time of the release.

4.3 State Regulatory Status Data

Regulation data is from the Dept. of Energy (2003). We create a deregulation dummy for each year, denoting whether each state is deregulated (approximately 19 states; list available in the appendix) and interact it with plant-level emissions data. If a facility is located in a deregulated state, then its emissions are counted as deregulated. A firm may have both regulated and deregulated emissions if it has plants in both regulated and deregulated states. For example, in 2000, 45 percent of Allegheny Power's emissions were emitted in deregulated states. For a breakdown by parent company, please see the appendix. The data show that off-site releases (56%) are slightly higher in deregulated states. Waste transferred off site instead of released on site indicate a higher likelihood of recycling. Overall on-site releases and stack releases are higher in regulated states (65%).

5 Empirical Estimation and Results

5.1 Effect of Emissions Announcements and Restructuring on Changes in Market Capitalization

Using event studies, we estimated an overall loss in firm value (-$17.1 million) for our sample of 54 firms over 6 years. Overall, there are 194 negative and 129 positive changes in market capitalization. Firms with negative abnormal returns emit on average 35% of their emissions in regulated states; firms with positive abnormal returns emit 48% of their emissions in deregulated states.

Now we attempt to estimate the effect of announced emissions and regulatory status on the *change* in market capitalization. We denote ΔV_{it} as the change in firm value calculated from the event studies in the previous section. $E^R_{i,t-2}$ and $E^D_{i,t-2}$ are TRI emissions in regulated and deregulated states, respectively. These variables are created by interacting emissions with deregulation dummies. E.g., if D_{t-2} denotes a deregulation dummy, then $E^D_{i,t-2} = E_{t-2} * D_{t-2}$. Emissions are lagged two time periods as it takes the EPA two years to release emissions information. $I_{i,t-2}$ (emissions per plant) is a variable controlling for emissions intensity and number of plants. Like Khanna, et. al., we include $\mathbf{X}_{it}$, a vector of firm-specific financial characteristics to control for firm differences. $\mathbf{X}_{it}$ consists of firm sales and debt-equity ratios. Firm sales is a proxy for firm size. The debt-equity ratio controls for a firm's financial condition: a utility with a high level of debt may find it more costly to respond to regulatory and community pressure. a_i is a scalar representing the effects of omitted variables that are specific to the firm i and constant over T years. γ_t represents the effects of omitted variables that vary over time but are constant across firms. Then, our econometric model is:

$$\Delta V_{it} = a_i + \gamma_t + \beta_1 E^R_{i,t-2} + \beta_2 E^D_{i,t-2} + \beta_3 I_{i,t-2} + \beta_4 \mathbf{X}_{it} + u_{it},$$
$$i = 1, ...I;\ t = 1, ..T \quad (19)$$

We consider pooled OLS (constant a_i), fixed effects, and random effects estimators. Results of the Breusch-Pagan Lagrange Multiplier test rules out pooled OLS (i.e., standard errors are not homoscedastic). The Hausman (1978) test indicates that individual effects (a_i) are not correlated with the regressors. We thus use random effects estimation as it better allows us to pick up of the effects of our deregulation dummy. I.e., fixed effects estimation may make it hard for slowly changing independent variables to survive over time, as they are highly collinear with a_i. While there is some slight variation in regulation status over time, for the most part it is fixed. We also include firm-specific variables ($\mathbf{X}_{it}$) to control for some firm-specific effects that may bias our results.

We estimate our model for six pollutant categories: All TRI toxins, H_2SO_4, HCL, HFL, HG, and Cancerous Toxins. The results are located in the appendix. Overall, we find statistically significant results for the relationship between announcements of TRI emissions and ΔV. Across all pollutant groups, additional emissions decrease firm value in regulated states. For the overall TRI category, each announced additional pound emitted in a regulated state decreases the change in market capitalization by \$1.04. For deregulated states, for an additional pound of emissions, ΔV is increased by a \$1.55. For releases in regulated states, we find statistically significant losses in firm value ranging from \$6.24/lb. (for cancerous toxins) to \$21.22/lb. (for HFL). For emissions in deregulated states, we find statistically significant increases in ΔV (i.e., decreases in the loss in firm value) for overall releases and for cancerous toxins (\$1.55 and \$4.67, respectively). Other increases in ΔV were not statistically significant for deregulated emissions. Mercury (HG) appears to decrease ΔV for announcements of both deregulated and regulated emissions; however, this result does not hold with any degree of statistical significance. A possible reason for larger error terms for HG is that the sample size for mercury is smaller; the EPA did not include mercury releases in the TRI until 2002.

According to our theoretical framework, the above results suggests that regulated-state emissions are (1) higher than expected and (2) subject to f_t, whether it be fines, compliance costs, or community-pressure related expenditures. Conversely, reduced losses in firm value for announced emissions in deregulated states suggest that these emissions are subject to relatively lower fines/compliance costs. In addition, reduced losses in firm value with higher-than-expected emissions in deregulated states is evidence that in addition to relatively lower compliance costs, markups increase for these firms. In our theoretical framework, the increase is through decreased expectations for total factor productivity. Also, not explicitly modeled in our theoretical framework is the idea that higher-than-expected emissions create higher demand for green power and hence higher markups. As firm value is reduced for regulated-state emissions, we don't find evidence of captured PUCs allowing utilities to recoup clean-up costs.

5.2 Differences in Regulated Versus Deregulated States

The regression in the previous section suggests that there may be relatively lower compliance costs in deregulated states. In our theoretical framework, lower clean-up costs/fines (unlike the markup) are not a consequence of deregulation. Yet, lower values of f_t are somehow correlated with states that happen to be deregulated. Thus, the purpose of this section is to test for state characteristics that lead to increased liabilities with higher-than-expected emissions. We also look for characteristics such as utility political power that make it easier for utility firms to pass on clean-up costs. To avoid endogeneity issues with the TRI releases, we estimate the effect of certain state characteristics on the *probability* of restructuring. We thus use state data from 1998, prior to the decision to deregulate and prior to the inclusion of power companies into the TRI.

We include GSP_i, gross state product, and USI_i, the utilities' percentage share of GSP. The greater this percentage, the larger the impact of utilities on a state's economy. P_i denotes revenue per kwh (kilowatt hour). Anecdotal evidence suggests that states with higher retail prices are more likely to deregulate (with the hope that more competition will lower said prices). Higher retail prices may also indicate a more lenient utility commission with a history of passing on costs to consumers. We include NRC_i as the percentage of nonresidential customers in a state. This percentage is an indication of customer power; we would expect less of a likelihood of passing on costs if larger consumers wield more power.

We also employ a variety of environmental indicators to test for state differences that may lead relatively higher fines and liabilities with higher-than-expected emissions. These indicators include political leanings, prior TRI-inspired state legislation, as well as emissions and environmental-quality rankings. More liberal states may have higher environmental quality; thus, we include BS_i as a dummy for blue (democratic) states, proxied by whether Clinton won the state's electoral votes in 1992 and 1996. SOR_i is a state's SO_2 emissions ranking (highest emitter has a rank of 1). GIR_{we} is a environmental quality rank.[9] $TLEG_i$ is a dummy for whether the state used in TRI data in the formation of legislation or regulation prior to 1997.[10] $COAL_i$ is a dummy for whether coal is the primary fuel used by utilities.

We denote D_i^* as the unobserved probability that a state will deregulate. If the probability is high enough, the state will deregulate; if not, then D_i (our independent deregulation status

[9] This rank is based on a set of 256 indicators of each state's environmental health including state policy initiatives, green policies, water pollution, air pollution, community and workplace health, etc. The indicator is compiled by Bob Hall and Mary Lee Carr in *Green Index 1991-1992 Green Index: A State by State Guide to a Nation's Environmental Health*, Institute for Southern Studies: 1991.

[10] U.S. Environmental Protection Agency, "Economic Analysis of the Final Rule to Add Certain Industry Groups to EPCRA Section 313", p. 6-29, April 1997

dummy) will be equal to zero. Thus our logit model is:

$$D_i^* = \beta_0 + \beta_1 GSP_i + \beta_2 USI_i + \beta_3 P_i + \beta_4 NRC_i + \\ + \beta_5 BS_i + \beta_6 SOR_i + \beta_7 GIR_i + \beta_7 TLEG_i + \beta_8 COAL_i + \varepsilon_i \tag{20}$$

$$where\ D_i = \left\{ \begin{matrix} 1 \text{ if } D_i^* \geq 0 \\ 0 \text{ if } D_i^* < 0 \end{matrix} \right\}$$

We estimate the model using maximum likelihood estimation (MLE) and obtain an overall statistically significant model. Results are available in the appendix. While a change in GSP will not change the odds of deregulation, the share of GSP earned by utilities will: for a one percentage increase in utility share, the deregulation-to-regulation odds ratio increases by a factor of 15.08. For an increase in revenue per kwh, states are 2.5 times more likely to deregulate. For each increase in a state's SO_2 emissions ranking (less polluting), the state is 1.6 times more likely to deregulate. The odds of a state with coal-burning utilities being deregulated is 79 times the odds of a state without coal-users being deregulated. The odds of a state with TRI-related legislature restructuring are .009 times the odds of a state without TRI-related legislature restructuring. For our measure of political leaning, we find that the odds of a blue state being deregulated are 530 times the odds of a red state being deregulated.

We conclude that deregulation is more likely to occur in states where utilities generate a higher percentage of GSP, where the retail prices are higher, where environmental quality is higher, where there are coal-burning utilities, and where the state is more democratic. A state with prior TRI-related legislation is less likely to deregulate. A state's percentage of nonresidential customers will not effect the odds ratio with any degree of statistical significance. These findings buttress our results from the theoretical framework and from the panel estimation.

Since states likely to deregulate have relatively lower sulfur dioxide emissions, higher environmental quality rankings, and lean to the left politically, we conclude that deregulated states have an initially cleaner environment, despite having predominately coal-burning utilities. Indeed, in our sample, TRI emissions are lower in deregulated states (291,083 lbs. per state versus 333,868. lbs. per regulated state). These results, especially political leanings, are in favor of the notion that increased demand for green power is a consequence of higher-than-expected emissions in deregulated states.

Our finding that states with prior TRI-related legislation are less likely to deregulate suggests there is a higher probability of fines for higher-than-expected emissions in regulated states.

Our results also show that capturing is more likely in deregulated–not regulated–states. States likely to deregulate have higher retail prices. Higher retail prices suggest that public utility commissions are more lenient on passing costs on to consumers. Also, utilities in deregulated states have a larger percentage share of GSP, indicating greater political strength of these utilities. More utility political power translates into a higher ability to pass on compliance costs to customers.

5.3 Effect of Firm Changes in Value on Subsequent Emissions

In the previous sections, we estimated the effect of TRI announcements on firm value. Now, we turn to assessment of the effectiveness of the TRI as a regulatory instrument. Thus, we test for correlations between changes in market capitalization and subsequent emission releases. I.e., the effectiveness of the TRI can be shown in how abnormal returns in period 1 affect emissions in period 2. We use 2000 abnormal returns and 2004 emissions announcements, as 2004 TRI announcements contain 2002 emissions data. I.e., we regress 2002-2003 emissions E_{it} (information released in 2004 and 2005, respectively) on 2000-2001 changes in market capitalization $\Delta V_{i,t-2}$. We control for variables such as sales ($Sales_{it}$), costs of goods sold (COG_{it}), and number of plants ($Plants_{it}$) that may influence emissions decisions. We have two years of data for 54 firms. Using a fixed effects panel structure to control for unobservable variables, we estimate the following:

$$E_{it} = a_i + \gamma_t + \beta_1 \Delta V_{i,t-2} + \beta_2 Sales_{it} + \beta_3 COG_{it} + \beta_4 Plants_{it} + u_{it},$$
$$i = 1, ...I; t = 1, ..T \tag{21}$$

A consensus in the TRI literature is that negative abnormal returns lead firms to reduce emissions. Thus, we restrict our sample to test the impact of negative abnormal returns on subsequent emissions. For regulated states, we find significant results for overall on-site releases, H_2SO_4, HCL, HFL, and cancerous toxins. I.e., for H_2SO_4, our results show that a loss of $1 million in firm value in 2000-2001 translates into a subsequent reduction of 1,461 lbs. of H_2SO_4 released in 2002-2003. However, for overall on-site releases and HCL, we find that a $1 million dollar loss in firm value actually increases subsequent emissions of both by 20,042 lbs. and 23,827 lbs., respectively. More than 40 percent of overall releases are HCL emissions.

Finally, we regress year 2000 ΔV on *change* in emissions from 2000 to 2004. Again, we find a statistically significant relationship for H_2SO_4 emitted in regulated states. A $1 million loss in firm value leads to a 1528.80 lb. decline in H_2SO_4 emissions from 2000 to 2004. Also, we find a 1,610 lb. decline in HFL per $1 million loss in firm value. For deregulated emissions, losses in market capitalization lead to increases in subsequent emissions for all emissions groups. However, none of the deregulated-state values are statistically significant.

We also test whether reductions in H_2SO_4 and HFL are really a consequence of the TRI. To do so, we include ΔSO_2 in the above regression of change in subsequent of emissions on change in market capitalization. Sulfur dioxide, which is federally regulated, is chemically closely related to H_2SO_4. Also, it is a stack emission, as are H_2SO_4, HFL, and HCL. The question here is: are reductions in H_2SO_4 and HFL are really just a by-product of federal regulation of non-TRI emissions? I.e., if firms install scrubbers or switch to cleaner fuel due to federal regulation, are TRI chemicals affected? With the inclusion of ΔSO_2, our previous results lose significance. However, we are unable to discern whether this is because: (1) Reductions of H_2SO_4 and HFL are not related to the TRI program; (2) Reductions in H_2SO_4 and HFL are a consequence of *both* federal regulation of SO_2 and the TRI; (3) ΔSO_2 is not a good instrument for federal regulation; or (4) We are asking to much of our data; we have a very limited number of observations (please see the appendix for results and sample sizes).

6 Concluding Remarks

This research examined the impact of restructuring on stockholder reaction to announcements of TRI emissions. We calculated abnormal returns and corresponding changes in market capitalization for announcements of the EPA's Toxic Release Inventory. Most utilities in our sample experienced losses in firm value. We also regressed change in firm value on regulated-state and deregulated-state emissions. For regulated states, higher-than-expected emissions decreased firm value; for deregulated states, higher-than-expected emissions increased firm value. These results support findings from our theoretical model, which shows the TRI affects regulated utilities strictly through fines and liabilities from higher-than-expected emissions.

Lower fines from higher-than-expected emissions in deregulated states explain why the loss in firm value is smaller for deregulated emissions. The deregulated utility's markup, however, explains why higher-than-expected emissions lead to *increases* in firm value. When TRI emissions are revealed, investors update their expectations on unobserved total factor productivity (decrease for an increase in emissions). The change in the markup with a decrease in total factor productivity is positive for certain demand curves. When a deregulated firm can offer green power and faces separate demand curves for green and brown power, the demand and hence the markup for green power increases with higher-than-expected emissions, while demand and the markup for brown power decreases. The increase in the green power markup dominates, therefore the change in market capitalization is positive.

This paper contributes to the literature on how restructuring affects the environment through restructuring's impact on the effectiveness of the Toxic Release Inventory. We have evidence that the TRI is more effective in price- and- entry regulated states, as it leads to subsequent reductions for certain TRI chemicals (H_2SO_4,HFL, and cancerous toxins). However, as Bui (2005) notes, the reduction of H_2SO_4 is positively correlated with the reduction of sulfur dioxide, required by the Clean Air Act (1990). Indeed, our results lose significance when we include ΔSO_2 as a covariate. However, limited data could be inhibiting our ability to separate federal regulation effects and TRI effects on subsequent emissions. Our results are limited by years and number of firms; our study would benefit from additions of both. The interaction of shaming and federal regulation warrants further study. **?**

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1 Appendix

Summary Statistics ΔV
Event Studies Results

Year	Mean Abn. Return (%)	Patell Z	Positive: Negative	Mean ΔV($M)	Total ΔV($M)
2000	-1.47	-5.12***	7:47	-63.5	-3,430
2001	.37	1.24	31:23	10.3	556
2002	.26	.141	24:30	-2.5	-135
2003	-.36	-.761	21:33	-34.4	-1,830
2004	-.16	-.585	29:25	9.6	519
2005	-.52	-2.913**	19:35	-22.6	-1,220
ALL	-.31	-3.080**	129:192	-17.1	-5,530

Table 1: Summary statistics of abnormal returns corresponding to releases of TRI data. Specific dates are May 12, 2000, April 12, 2001, May 24, 2002, July 1, 2003, June 23, 2004, and May 12, 2005. Significance is tested using a 2-tailed Patell (1976) Z-test. Statistical significance at the .10, .05, .01 level is denoted by *,**,*** respectively. "Positive:Negative" is the ratio of positive-to-negative abnormal returns for a particular year.

Abnormal Returns Comparison for Different Studies

Study	Abn. Returns (%)	ΔV ($M)	Industry	Years	Obs.
This Study	-.31	17.1	Electricity	2000-05	324
Hamilton	-.284 to -.373	4.1 to 6.2	Manufacturing	1989	436
Konar	-.299 to -1.387	3.6 to 84	Chemical	1989-92	40
Khanna	-.16 to -.46	83.4	Chemical	1990-94	91

Table 2: Comparison of abnormal returns and changes in market capitalization for different studies. Our values fall within the range of other studies' values.

Deregulation: Limited- to Full-Access for Retail Customers

State	Years
Arizona	2001-2005
Arkansas	2003-2005
California	1998-2001
Connecticut	2000-2005
Delaware	2000-2005
Illinois	2002-2005
Maine	2000-2005
Maryland	2000-2005
Massachusetts	1998-2005
Michigan	2002-2005
Montana	2004-2005
Nevada	2002-2005
New Hampshire	2001-2005
New Jersey	2000-2005
New York	2001-2005
Ohio	2001-2005
Pennsylvania	2000-2005
Rhode Island	2000-2005
Texas	2001-2005
Virginia	2002-2005

Limited Access to Commercial and Industrial Consumers: Nevada and Oregon
Delayed: New Mexico (2007) and Ist Virginia
Suspended: California, Oklahoma
Source: DOE: Status of State Electric Industry Restructuring Activity (Feb. 2003)

Table 3: Deregulated States and Corresponding Years of Deregulation. Traditional electricity markets involve investor-owned utilities that are vertically-integrated natural monopolies: a single utility transmits, distributes and sells the electricity it generates. State public service commissions regulate the monopolies with respect to price and entry. These regulators traditionally determine how much revenue a utility may earn and a corresponding price structure; i.e., retail prices and how they among differ among residential, commercial and industrial customers. Deregulation separates the vertically integrated natural monopolies. Competition is encouraged in generation, marketing, and retail sales, while transmission and distribution are both centralized and regulated. The ultimate goal is to allow consumers to "shop around" for generation services: increased competition would ultimately lower retail prices for consumers of all types. In the mid 1990s, deregulation efforts were fueled by high retail prices, an anti-regulatory atmosphere, and orders by the Federal Energy Regulatory Commission to promote open access of transmission lines. In 2000, 24 states and the District Columbia either enacted legislation or issued a regulatory order to implement retail access. Today, due to factors such as the California electricity crisis of 2000-2001, the Enron scandal, volatile wholesale market prices, and rising retail prices in some states, only 17 states still allow retail competition to all consumers. Two states allow retail competition to only large customers. Other states have reversed, delayed or suspended the deregulation process.

Cancerous Toxins Emitted by Electric Utilities

	ON-SITE RELEASES (lbs.)	STACK EMISSIONS (lbs.)	OFF-SITE TRANSFERS (lbs.)
1,2,4-TRIMETHYLBENZENE	2726.12	25	402.2
AMMONIA	1.15E+07	9217734	1875146
ANTIMONY COMPOUNDS	1443495	14789	90191
ARSENIC	2.63E+07	590592.8	4648927
BARIUM COMPOUNDS	6.13E+08	6853152	1.60E+08
BENZENE	8516.66	7265.66	0
BERYLLIUM COMPOUNDS	2295357	27933.4	398022
CADMIUM COMPOUNDS	0	0	0
CHROMIUM	4.85E+07	1107094	1.53E+07
COBALT COMPOUNDS	1.58E+07	190785	2138474
COPPER COMPOUNDS	6.31E+07	803997.5	1.73E+07
ETHYLENE GLYCOL	98606	15	130745
FORMIC ACID	421242	292871	0
HEXACHLOROBENZENE	252.42	252.42	0
HYDRAZINE	801.81	0	0
HYDROCHLORIC ACID (ACID AEROSOLS)	3.13E+09	3.13E+09	0
LEAD COMPOUNDS	2.98E+07	768671.5	6681703
MANGANESE COMPOUNDS	1.30E+08	1478443	3.27E+07
MERCURY COMPOUNDS	456034	323935.4	65652.16
METHYL TERT-BUTYL ETHER	59	44	0
MOLYBDENUM TRIOXIDE	367838	57189	338994
NAPHTHALENE	5496.18	3320.6	2281.473
N-HEXANE	137226.5	132854.6	885.8
NICKEL COMPOUNDS	4.86E+07	2785139	2.49E+07
NITRIC ACID	13000	0	0
PENTACHLOROBENZENE	344.2	344.2	0
SELENIUM COMPOUNDS	6312682	2844448	647534
SILVER COMPOUNDS	125315.8	4435.8	0
STYRENE	8888	88	0
THALLIUM COMPOUNDS	4069335	37668	86351
TOLUENE	12232.82	2804.51	2803
TRICHLOROFLUOROMETHANE	0	0	0
VANADIUM	9.07E+07	4734661	5.52E+07
XYLENE	14971.2	718.44	3770
ZINC COMPOUNDS	8.31E+07	2978966	2.36E+07
TOTAL	4.31E+09	3.17E+09	3.46E+08

Table 4: Chemicals classified as cancerous toxins by UC Berkeley and the State of California.

Summary Statistics: TRI Toxins and Regulatory Status

Toxic Release by Category and Type	Mean (lbs.)	Maximum (lbs.)	Reg. States Percentage	Dereg. States Percentage
All TRI Releases On Site	15,200,000	1.38E+08	65%	35%
All TRI Releases Stack	11,900,000	1.12E+08	65%	35%
All TRI Releases Off Site	994,217	1.26E+07	44%	56%
H_2SO_4 On Site	1,550,618	1.19E+07	60%	40%
H_2SO_4 Stack	1,548,394	1.19E+07	60%	40%
H_2SO_4 Off Site	182	50,000	0%	100%
HCL On Site	9,351,383	9.54E+07	66%	34%
HCL Stack	9,349,979	9.54E+07	66%	34%
HCL Off Site	0	0	0%	0%
HFL On Site	898,315	7,818,867	63%	37%
HFL Stack	895,986	7,818,867	63%	37%
HFL Off Site	23	4673	100%	0%
HG On Site	1882.24	14,580	48%	52%
HG Stack	1331.43	9,445.9	51%	49%
HG Off Site	277.79	3,021	54%	46%
Cancerous Toxins On Site	1.28E+07	1.21E+08	66%	34%
Cancerous Toxins Stack	9449953	9.57E+07	65%	35%
Cancerous Toxins Off Site	993324.3	1.26E+07	44%	56%

Table 5: Summary statistics for TRI emissions by pollutant and release type.

Parent Company	Change in Mkt. Cap.($)	Total TRI (lbs.)	Percent Dereg.
AES Corp.	50,100,000	6,521,346	49%
Allegheny power	-35,800,000	26,200,000	45%
Allette	-13,100,000	2,132,828	0%
Ameren	-2,920,389	25,200,000	35%
American Electric power	-43,300,000	98,600,000	25%
Baltimore Gas & Electric	-15,300,000	14,500,000	99%
Black Hills power and Light	-7,906,585	1,448,441	0%
Cinergy	-19,800,000	37,600,000	32%
Cleco Corp.	428,200	3,495,308	0%
CMS Energy	-1,656,963	14,400,000	64%
Consolidated Edison	9,102,940	224,711	4%
Dayton power & Light	-16,700,000	19,900,000	81%
Detroit Edison	-26,000,000	20,900,000	64%
Dominion Resources	-63,400,000	22,400,000	50%
Duke Energy	-231,000,000	46,100,000	0%
Dynegy	-23,600,000	10,300,000	46%
Edison International	-27,600,000	12,100,000	79%
Empire District	-2,830,810	917,640	0%
Entergy	39,200,000	3,886,826	23%
FirstEnergy	21,000,000	21,300,000	79%
Florida power & Light	-49,700,000	3,709,018	1%
Kansas City power & Light	-566,110	4,033,615	0%
Northeast Utilities	39,681	3,560,582	81%
Northern Indiana Public Service	-206,196	5,084,391	0%
Northern States power	-24,900,000	11,800,000	6%
Oklahoma Gas & Electric	-4,376,291	710,663	0%
Pacific Gas & Electric	29,600,000	2,657,541	84%
Pennsylvania power & Light	-45,600,000	12,200,000	100%
Pinnacle Ist	-7,110,828	2,671,422	63%
Potomac Electric	604,666	6,293,746	86%
Progress Energy	-57,800,000	51,000,000	0%
PSEG	-19,400,000	6,002,806	100%
Public Service Co. New Mexico	4,192,222	305,552	47%
Puget Sound	-4,650,388	65,691	0%
Reliant	76,100,000	34,200,000	96%
Sierra Pacific Resources	1,138,850	1,056,652	88%
South Carolina Electric & Gas	-6,608,802	8,351,961	0%
Southern Company	-164,000,000	110,000,000	3%
Tampa Electric	-18,200,000	11,500,000	0%
TXU	-38,200,000	15,600,000	85%
Westar	-13,800,000	3,785,188	0%
Wisconsin Energy	-2,142,899	5,780,048	16%
Wisconsin power & Light	-4,046,949	2,267,980	0%
Wisconsin Public Service	7,457,381	2,537,518	65%

Table 6: Summary statistics for year 2000 firm emissions, change in market capitalization, and percentage of releases emitted in deregulated states.

Change in Market Capitalization & TRI Releases

Dependent Variable: Change in Market Capitalization (ΔV)

Emissions Category:	All On-Site	On-Site+Off-Site	Stack (Air)	Cancerous Toxins
Reg. Emissions (lbs.)	-1.04	-1.01	-5.98	-6.24
	(0.33)***	(0.32)***	(1.91)***	(1.83)***
Dereg. Emissions (lbs.)	1.55	1.39	-1.21	4.67
	(0.90)*	(0.83)*	(2.54)	(2.628)*
Firm Sales (M$)	-1170.98	-1203.56	320.02	-1477.21
	(771.30)	(775.74)	(485.29)	(764.69)*
Debt-Equity Ratio	-1.23E+05	-1.55E+05	-1.22E+05	-4.31E+05
	(6.33E+05)	(6.34E+05)	(1.03E+05)	(6.45E+05)
Emissions per Plant (lbs.)	-8.84	-8.61	-2.78	-8.77
	(4.38)**	(4.26)**	(1.72)*	(3.86)**
Constant	1.20E+07	1.32E+07	5.20E+06	3.06E+07
Obs.	322	322	322	322
BP chi2(1)	12.02 {.0005}	12.00 {.0005}	10.1 {.0015}	7.06 {.0079}
Hausman chi2(2)	3.89 {.14}	3.99 {.14}	4.7 {.10}	3.65 {.16}
% Total On-Site			28%	40%

Table 7: Change in market capitalization and TRI releases. Statistical significance at the .10, .05, .01 level is denoted by *,**,*** respectively. Standard errors are the values in parenthesis. Breusch-Pagan (1980) and Hausman statistics are reported with p values in brackets. Random effects were used for Hausman values with probabilities greater than .05.

Change in Market Capitalization & On-Site Releases

Dependent Variable: Change in Market Capitalization (ΔV)

Emissions Category:	H_2SO_4	HCL	HFL	HG
Reg. Emissions (lbs.)	-9.22	-1.54	-21.22	-6358.62
	(3.70)**	(0.47)***	(5.90)***	(4651.66)
Dereg. Emissions (lbs.)	8.71	2.07	21.30	-2076.11
	(5.89)	(1.44)	(14.28)	(4921.69)
Firm Sales (M$)	-1341.23	-986.49	-1062.65	-2038.68
	(769.32)*	(769.19)	(760.62)	(1534.62)
Debt-Equity Ratio	-1.90E+04	-7.09E+03	-1.90E+05	-1.67E+06
	(6.41E+05)	(6.34E+05)	(6.34E+05)	(6.78E+05)**
Emissions per Plant	-9.64	-8.14	-7.71	-1.82
	(3.97)**	(4.42)*	(4.17)*	(4.40)
Constant	1.12E+07	5.86E+06	1.42E+07	6.76E+07
Obs.	324	324	324	209
BP chi2(1)	9.44 {.002}	11.41 {.0001}	9.95{.002}	10.52{.001}
Hausman chi2(2)	5.28{.07}	3.55(.17}	2.9{.23}	8.8{.07}
% Total On-Site	14%	28%	10%	.02%

Table 8: Change in market capitalization and TRI releases. Here, on-site releases are broken down by emissions categories. Statistical significance at the .10, .05, .01 level is denoted by *,**,*** respectively. Standard errors are the values in parenthesis. Breusch-Pagan (1980) and Hausman statistics are reported with p values in brackets. Random effects were used for Hausman values with probabilities greater than .05.

Logit: State Characteristics

Probability of Deregulation	Odds Ratio
GSP	1.000
	(1.71E-5)**
Utility Output Share of GSP (%)	15.078
	(17.72)**
Revenue per kwh	2.485
	(0.952)**
Fraction of Nonresidential customers (%)	0.654
	(0.276)
Coal Input	79.348
	(192.817)
Voted for Democratic President 1992& 1996	529.850
	(1398.106)**
SO_2 Emissions Rank	1.632
	(.320)**
Environmental Quality Index Rank	1.110
	(0.064)*
TRI used in State Legislature as of 1997	.0094
	(.024)*

Obs. 50
LR chi2(8) 44.41
(Prob > chi2 0.000)
Pseudo R^2 .64

Table 9: Likelihood of Deregulation. Dependent Variable: Dummy for Deregulation Status. Statistical significance at the .10, .05, .01 level is denoted by *,**,*** respectively. Standard errors are the values in parenthesis.

Change in Market Capitalization & Subsequent Emissions in Reg. States

Dependent Variable (lbs.):	All TRI	Stack	Cancerous	H_2SO_4	HCL	HFL
ΔV($M)	-20412.22	1615.40	4520.40	1461.90	-23827.70	425.10
	(7373.70)	(513.00)**	(1037.00)***	(488.20)**	(7811.60)**	(150.58)**
Sales ($M)	4339.87	467.67	128.034	298.287	3619.96	142.56
	(4340.09)	(194.65)**	(585.36)	(161.34)*	(4439.77)	(79.87)*
Cogs ($M)	-2971.07	-570.20	-850.38	-392.84	-1579.066	-180.86
	(4456.86)	(203.47)**	(567.47)	(167.77)**	(4535.05)	(75.46)**
Plants	1.05E+05	8.78E+04	-3.30E+04	1.09E+05	7.09E+04	-2.29E+04
	(1.47E+06)	(1.61E+05)	(1.72E+05)	(1.57E+05)	(1.48E+06)	(4.16E+04)
Constant	1.44E+06	1.45E+06	6.78E+06	5.96E+05	-6.45E+06	1.05E+06
R^2(within)	.65	.81	.72	.81	.70	.59
Obs	45	45	45	42	45	44

Table 10: Effect of change in firm value on subsequent emissions by pollution type in regulated states. Dependent Variable: Subsequent Emissions. This table shows the results of the regression of subsequent toxic releases on negative changes in market capitalization. Statistical significance at the .10, .05, .01 level is denoted by *,**,*** respectively. Standard errors are the values in parenthesis. Fixed effects with robust standard errors were used.

Change in Market Capitalization & Change in Subsequent Emissions in Reg. States

Dependent Variable (lbs.):	ΔOn-Site	ΔTotal	ΔStack	ΔCancerous	ΔH_2S0_4	ΔHCL	ΔHFL
ΔV($M)	-37587.30	-37994.12	2993.19	12955.80	1528.80	-39538.20	1610.30
	(9689.60)***	(8873.65)***	(1141.95)**	(6703.10)*	(794.90)*	(11432.40)***	(540.40)***
ΔSales ($M)	-1481.77	-1346.46	-184.61	5.389	-156.11	-1146.60	-26.70
	(346.76)***	(357.54)***	(40.867)***	(268.26)	(28.47)***	(409.13)***	(19.34)
ΔPlants	-1.9E+06	-1.25E+06	1.016E+05	1.05E+06	-2.5E+04	-2.47E+06	1.18E+05
	(1.50E+06)	(1543057)	(176372)	(1.16E+06)	(1.23E+05)	(1.77E+06)	(8.35E+04)*
Constant	-14.4E+06	-1.36E+07	-1.43E+06	2.20E+05	-1.25E+06	-1.21E+07	-2.05E+05
Obs.	59	59	57	45	54	57	57
R^2(within)	0.85	0.84	0.93	0.53	0.46	0.65	0.83

Table 11: Effect of change in firm value on subsequent emissions by pollution type in regulated states. Dependent Variable: Change in Subsequent Emissions. This table shows the results of the regression of change in subsequent toxic releases on negative changes in market capitalization. Statistical significance at the .10, .05, .01 level is denoted by *,**,*** respectively. Standard errors are the values in parenthesis. Fixed effects with robust standard errors were used.

Change in Market Capitalization & Change in Subsequent Emissions in Deregulated States

Dependent Variable (lbs.):	ΔAll TRI	ΔTotal	ΔStack	ΔCancerous	ΔH_2S0_4	ΔHCL	ΔHFL
ΔV($M)	-10535.90	-9313.10	-5181.00	-530.30	-5564.90	-4491.50	-434.70
	(18174.00)	(17095.00)	(4648.40)	(4196.10)	(3679.60)	(17434.60)	(541.30)
ΔSales ($M)	422.38	472.22	38.55	248.25	13.13	139.98	25.45
	(145.45)***	(136.82)	(35.12)	(31.70)***	(28.93)	(131.73)	(4.09)***
ΔPlants	1.27E+06	1.26E+06	5.17E+05	1.17E+04	4.50E+05	7.31E+05	5.36E+04
	(4.83E+05)**	(4.54E+05)**	(1.17E+05)***	(1.06E+05)	(9.66E+04)	(4.38E+05)	(1.36E+04)***
Constant	2.76E+05	7.37E+05	-1.55E+06	2.25E+06	-1.70E+06	2.69E+05	1.82E+05
Obs.	47	47	40	45	39	40	40
R^2(within)	0.87	0.89	0.91	0.96	0.89	0.72	0.97

Table 12: Effect of change in firm value on subsequent emissions by pollution type in deregulated states. Dependent Variable: Change in Subsequent Emissions. This table shows the results of the regression of change in subsequent toxic releases on negative changes in market capitalization. Statistical significance at the .10, .05, .01 level is denoted by *,**,*** respectively. Standard errors are the values in parenthesis. Fixed effects with robust standard errors were used.

Change in Market Capitalization & Change in Subsequent Emissions in Regulated States with Sulfur Dioxide (SO_2)

Dependent Variable (lbs.):	ΔOn-Site	ΔTotal	ΔStack	ΔCancerous	ΔH_2S0_4	ΔHCL	ΔHFL
ΔV($M)	-32217.60	-31795.30	157.30	-1661.40	-263.20	-25387.30	356.30
	(12024.00)**	(12324.90)**	(485.10)	(3830.0)	(473.30)	(12810.90)*	(325.00)
ΔSales ($M)	-1829.45	-1747.84	-.988	1072.64	-40.01	-2062.86	54.50
	(569.87)**	(584.13)***	(22.99)	(208.95)***	(22.47)*	(607.16)***	(15.40)***
ΔPlants	-1.72E+06	-1.02E+06	-3.68E+03	9.29E+05	-9.08E+04	-1.94E+06	7.16E+04
	(1.52E+06)	(1.58E+06)	(6.21E+04)	(5.27E+05)	(6.05E+04)	(1.64E+06)	(4.16E+04)*
ΔSO_2(lbs.)	-26.53	-30.62	14.00	73.36	8.84	-69.90	6.19
	(34.20)	(35.06)	(1.38)***	(11.67)***	(1.35)***	(36.44)*	(0.92)***
Constant	-16.10E+06	-1.55E+07	-4.92E+05	5.30E+06	-6.55E+05	-1.68E+07	2.1E+05
Obs.	59	59	57	45	54	57	57
R^2(within)	0.85	0.85	.99	0.91	0.98	0.72	0.96

Table 13: Effect of Change in Firm Value on Subsequent Emissions by Release and Pollution Type in Regulated States. Dependent Variable: Change in Subsequent Emissions. This table shows the results of the regression of change in subsequent toxic releases on negative changes in market capitalization when sulfur dioxide is included as a covariate. Statistical significance at the .10, .05, .01 level is denoted by *,**,*** respectively. Standard errors are the values in parenthesis. Fixed effects with robust standard errors were used.