Does Being a "Top 10" Worst Polluter Affect Environmental Releases? Evidence from the U.S. Toxic Release Inventory

Wolfram Schlenker♣ and Jason Scorse♠

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Abstract

We use the 1998 expansion of the Toxic Release Inventory (TRI) that required newly regulated industry sectors to report facility releases to obtain exogenous changes in a facility's relative ranking within a state to test whether being labeled a "Top 10" worst polluter affects a facility's action. After the expansion of the program some facilities were dropped from the "Top 10" because newly regulated facilities surpassed their emissions. Facilities that dropped out of the "Top 10" in 1998 did not significantly alter their emissions in 1999 or 2000, but had 50% higher emissions in 2001 than they would have had if they had stayed on the "Top 10" list. This timeline is consistent with the fact that EPA does not release emissions until a year and a half after the reporting year, i.e., rankings for 1998 were not released until the middle of 2000. Facilities responded to rankings that are based on onsite-emissions used by Scorecard, but less so to total releases published by TRI, which also include offsite releases, suggesting that Scorecard's aggregation was indeed he relevant information at the time. We find no evidence for a counterbalancing decrease in offsite transfers for further waste management.

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♣Columbia Unieversity and NBER. Email: wolfram.schlenker@columbia.edu

♠Monterey Institute of International Studies. Email: jason.scorse@miis.edu

> The day it became clear that disclosure was a powerful regulatory tool was June 30, 1988, when Richard J. Mahoney, then head of Monsanto (one of the biggest chemical manufacturers in the U.S.), made a dramatic claim. Mahoney said bluntly that he had been astounded by the magnitude of Monsanto's annual release of 374 million pounds of toxins. He vowed to cut the release of air emissions 90% worldwide by the end of 1992.[1]
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> Atlantic Monthly, April 2000

In 1986, on the heels of the 1984 Union Carbide chemical disaster in Bhopal, India, and the subsequent chemical plant accident in West Virginia, the U.S. Congress passed the Emergency Planning and Community Right-to-Know Act (EPCRA), which required all manufacturing facilities employing more than 10 people and using more than 10,000 pounds of any of 377 listed toxic chemicals to report their emissions and transfers to the U.S. government annually for dissemination to the public.[2] This information is organized under the heading of the Toxic Release Inventory (TRI), which represented the first nationally mandated public Right-to-Know program in U.S. history. Over the years, there has been a push to use more of such Right-to-Know Acts both in the United States and abroad. These laws no longer directly tell firms how much to emit, but instead simply requires them to report the emissions they are releasing. The underlying idea is consistent with financial filings of publicly traded companies. Various stakeholders, e.g., customers, investors, or residents living close to a facility can use this information to put pressure on firms. Whether they can be seen as a substitute to environmental regulation that directly limit emissions has been subject to an intense debate.

Since its first year of operation in 1987, the TRI has been expanded to include almost 650 chemicals as well as several additional industries that were initially exempt. These include all federal agencies as well as power and mining companies. From 1988 to 1997 total environmental releases reported under the TRI fell around 60% and from 1998 to 2001 they fell an additional 20%. It is not possible to compare aggregate emissions reductions across the entire time period due to the expansion of the program in 1998. The key question for both policy-makers and academics is whether the publication of the TRI is at least partially responsible for this dramatic decrease in emissions.[3]

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[1] Between 1988 and 1992 TRI reported environmental releases from Monsanto facilities dropped almost 94%.

[2] Transfers refer to waste that is produced on site and then moved to another site.

[3] One possibility is that firms switched to chemicals that were not covered by the TRI, and therefore, the decline in TRI releases does not correspond to actual reductions in aggregate levels of emissions, but is due to the substituting of some chemicals for others. While this may account for part of the reported TRI

"Top 10" worst polluter lists became popular in the television, print, and internet media, as well as with environmental groups, since they focused attention on a small subset of the TRI facilities that emitted the overwhelming share of toxic chemicals.[4] EPA's TRI Explorer website allowed users to rank facilities and provides state reports that highlight the "Top 10" emitters each year.[5] Also, the internet's most popular environmental website at the time, Scorecard, which received over 100,000 visits per month, displayed a rotating set of "Top 10" worst polluter lists on its homepage.[6] Firms that find themselves in the spotlight will most likely face significant public pressure to decrease their emissions. An added benefit of examining only those facilities with the highest environmental releases is that this largely avoids the problem presented by the reporting thresholds for individual chemicals. Almost all of the "Top 10" facilities within states report environmental releases for most chemicals that are much greater than the 10,000 pound limits.

This paper attempts to isolate the extent to which the distinction of being on a "Top 10" worst polluter list within a given state affects a firm's environmental releases. It fits in the broader context off how firms respond to public pressure by constituents, which has become more powerful in the age of social media. Examining the historic "Top 10" lists at the state level is chosen for two reasons; one policy oriented and one econometric. From a policy standpoint, it is easier to make changes in state versus national environmental regulations; therefore, it is reasonable to assume that firms will be more responsive to how they are perceived by politicians, environmental groups, and citizens at the state level. In addition, public pressure due to environmental concerns is often localized since the people who live in the vicinity of highly polluting firms have a direct and immediate incentive to curb firm emissions. Finally, firms that fall within the "Top 10" list within a given state may not rank high nationally, and therefore the national rankings will not include many facilities that likely face significant pressure to reduce their emissions at the state level.[7]

From an econometric standpoint, the major change in the TRI rules that occurred in 1998, when seven new highly polluting industries were added to the TRI database, provides

declines it is important to note that 286 chemicals were added to the TRI list in 1994 and total releases continued their decline thereafter.

[4]Another common worst polluter list reported in the media was the "Dirty Dozen"; the top 12 worst polluters.

[5]The reporting practice since changed, as did the web interface, but "Top 10" lists were common around 1998.

[6]The website was subsequently sold by the original creator (Environmental Defense Fund), and has since shut down.

[7]Facilities that rank high nationally will by definition also rank high at the state level and therefore examining the behavior of worst polluters at the state level will includes these facilities.

a quasi-natural experiment that helps identify causality between changes in facility pollution rankings within states and subsequent facility emissions. Existing TRI facilities in states that had many new entrants experienced large drops in their pollution rankings, often leading to their removal from the "Top 10" polluter lists, while facilities in states without many of the new industries saw little to no change in their rankings. If state pollution rankings do matter then facilities in the former group had less incentive to reduce emissions after the rule change, and as a result, likely reduced emissions less than they would have had they not experienced the unexpected drop in their rankings.

The econometric results confirm that being on a "Top 10" worst polluter list within states did affect facility emissions in the direction predicted; overall, facilities that had already been covered under the TRI before 1998, and had been ranked as one of the "Top 10," had 50% higher releases compared to a case where they remained on the "Top 10" list. Moreover, the timing of when new releases and ranking are released to the public, suggests that firms did not simply change reported releases, but implemented actual changes. EPA made new releases and rankings public in the middle of 2000. Firms therefore had the possibility to change reported releases in 2000, while changes in production technology would likely not be effective until later that year. We find no significant change in either 1999 or 2000 releases.

This finding is important for two reasons. First, it demonstrates that pollution rankings, and hence the information provided by the TRI does influence facility releases, thereby bolstering the general case for Right-to-Know programs. Organizations such as the World Bank are investigating whether Right-to-Know programs may be a cost-effective environmental regulatory tool for developing countries given the (perceived) success of the TRI and its relatively low cost. The European Union began a program similar to the TRI.[8] Moreover, many groups in the U.S. would like to expand the TRI. Second, the econometric results show how changes to a Right-to-Know program can have unintended consequences; in this case the expansion of the TRI (with the intent of putting pressure on an additional set of extremely polluting facilities) decreased the incentives for firms already covered by the program to reduce their emissions.

The remainder of the paper is organized as follows: Section 1 surveys the TRI literature as well as work regarding other types of Right-to-Know programs. Section 2 provides an overview of the TRI data and problems regarding its accuracy. Section 3 presents our

[8]For a description of the new EU program see, "EU Launches Emissions List" in *Chemical and Engineering News*, March 1, 2004, Vol. 82(9). The first reporting year for the EU program was 2003 and the second dataset will be available in 2006 since the program provides audits every three years, unlike the annual reports provided by the TRI.

empirical strategy, while Section 4 presents empirical results whether facility releases were affected by the removal from the "Top 10" lists within states. The policy implications of the results are discussed in Section 5.

1 Background

Most researchers who have studied the TRI have concluded that at least part of the decline in TRI-reported chemicals is tied directly to the provision of the information mandated by the TRI legislation. (Cohen 1997, Fung & O'Rourke 2000, Graham 2000, Jobe 1999, Stephan 2002, Restrepo 1999, Abel, Kraft & Stephan 2005, Hamilton 2005). Hamilton (2005, p. 254) summarizes the finding as:

> *Information provision can work.* The TRI changed the property rights to information about toxics, forced firms to estimate toxic figures, and combined the resulting information into a database made increasingly easy for the public to use. The provision of TRI data clearly changed behavior. Case studies abound about managers who learned about pollution figures for the first time, communities that placed pressures on facilities for reductions, and regulators that used the data to focus on particular chemicals or facilities. Overall, the TRI become a standard by which actors in the private and public sectors measured companies' environmental performance. Environmentalists used the data to develop reports and lists that often focused attention on firms or plants that ranked the highest on some aspect of the TRI data.

There are a number of channels through which stakeholders can exert pressure on firms to reduce their emissions.[9] The first is political pressure: At the behest of environmental organizations or concerned citizens, politicians may try to enact legislation to curb firm emissions, and the threat alone may be sufficient to influence firm behavior.[10] Residents

[9] We do not attempt to quantify the extent to which these different channels may influence firm behavior; we are only presenting a summary why rational profit-seeking firms may be influenced by the public disclosure of toxic release information. Apart from public pressure, firms may in fact benefit from the environmental audits required by the TRI in that it forces them to scrutinize elements of their production processes that they may have largely neglected. This information, in turn, may help them to become more environmentally efficient (this is discussed further in the literature review). In addition, if members of the firm include employees with a strong environmental ethic such an internal review may also create pressure from within the firm to improve environmental performance even in the absence of outside pressure (Gunningham, Kaga & Thornton 2003).

[10] Bui (2005) provides evidence that suggests that the use of the TRI information by local and state politicians, which used it to craft additional legislation and focus pressure on worst polluters, was most

have been shown to "vote with their feet" and relocate away from plants with toxic emissions (Banzhaf & Walsh 2008). Second, green preferences by consumers, firms, and government and non-governmental agencies can exert pressure on companies by purchasing less products from highly polluting firms or by rewarding less polluting firms with increased business. Third, the data exposes potential future liabilities. Once pollution data is part of the public domain this creates a record for any future liabilities firms may face regarding environmental or human health claims. Fourth, the data can have effect on future expansion plans of firms. Firms that want to expand their business, especially in new locations, will find it more difficult to do so if their current operations are known to be highly polluting.

Since all of the environmental release data reported under the TRI fall within legally defined limits set by the U.S. Environmental Protection Agency (EPA), any changes in facility releases that can be traced to the dissemination of the TRI data suggest that the TRI has provided a public benefit.[11]

Although prior to the establishment of any environmental Right-to-Know program existing firms had the opportunity to highlight their *positive* environmental performance (as a means to attract business or promote a positive image), there is evidence that the costs to firms of poor environmental performance are much greater than the relative benefits of good performance (O'Rourke 2005). This may be explained by the theory of loss aversion (Tversky & Kahneman 1991), which states that people tend to value losses much more than commensurate gains. Behavioral economists have conducted numerous laboratory experiments in which they have uncovered evidence of loss aversion, and they point to many aspects of contemporary U.S. law that explicitly recognize it (Kahneman, Knetsch & Thaler 1991). For example, in court rulings losses are often treated more much seriously than foregone gains when assessing damages. This heightened sensitivity to losses translates over into the environmental domain (Shogren 2002); people often expend much greater effort chastising firms that are highly polluting rather than rewarding firms that are working to improve the environment. For this reason, "Top 10" polluter lists have significant potential to stimulate

responsible for changes in firm behavior brought about by the TRI in the petroleum industry.

[11]In order to determine whether, in fact, the public benefits of any emissions reductions brought about by the TRI are greater than the costs would require a detailed cost-benefit analysis and such an analysis has not yet been undertaken by the Environmental Protection Agency. However, if the TRI is causing firms to reduce emissions we can be almost certain that members of the public and government at least perceive that the emissions are sufficiently harmful and should be reduced, and the costs to firms of doing so are less than the costs imposed on them if they maintain the status quo. This needn't imply that the chemical reductions are necessarily optimal from a social benefits standpoint, but that the TRI is providing the public with information that it finds useful. For a more thorough discussion of the overall benefit of the TRI see Hamilton (2005).

activism since they highlight firms with the worst environmental performance (in absolute and relative terms), which from a concerned citizen's standpoint translates into a loss of environmental quality.

Fung & O'Rourke (2000) refer to the common practice of using the TRI to create "worst polluter" rankings as a type of "Maxi-Min" policy instrument, in which *maximum* attention is focused on the facilities with the *minimal* environmental performance (highest levels of pollution). From a regulatory perspective, these lists offer the potential for continual pressure on firms to decrease pollution since the lists are generated based on emissions relative to other firms, and hence there are always worst polluters in every period.

A number of researchers have been able to demonstrate a link between TRI reporting and stock performance. Hamilton (1995) found that the TRI provided "new" information to investors and that the stock performance of publicly traded companies was significantly and negatively correlated with toxic releases on the day after the TRI report was released in 1989, often translating into decreases in stock valuation of millions of dollars per firm. Khanna, Quimio & Bojilova (1998) examined the stock returns for major firms in the chemical industry between 1989-1994 on the day after the TRI data was released and found that from 1990-1994 firms whose emissions were worse compared to their own past emissions, or relative to industry trends, suffered significant and negative stock valuations. Konar & Cohen (2001) found that toxic releases were negatively correlated with stock performance for a sample of S&P500 manufacturing firms in 1989.

Regarding the composition of emission reductions, Hamilton (1999) found that firms which emitted more carcinogenic chemicals were more likely to reduce emissions between 1988 and 1991.[12] Arora & Cason (1996) and Khanna & Damon (1999) used the TRI data to explore why firms may have decided to participate in the EPA's voluntary pollution reduction program, "33/50." They found that firms with high public visibility were more likely to enter the program, and that potential environmental liabilities were also a deciding factor in their decision to participate.[13]

The TRI data has also been used extensively to study issues related to Environmental Justice, such as whether firms site toxic waste facilities disproportionately in poor and minority communities, and whether toxic emissions are influenced by community demographics (Rhodes 2005, Arora & Cason 1999). Although there is a strong correlation between toxic

[12]This is the only study which attempts to specifically assess the health risk of different TRI chemicals and determine whether these were targeted for greater reductions than others.

[13]The 33/50 program ended in 1995 so it does not affect my results, which makes use of data from 1995 onwards.

releases and concentrations of poor and/or minority populations throughout much of the U.S., all else equal, the main determinant influencing facility emissions tends to be the level of political participation people exercise in their respective communities.

In addition to external forms of pressure to reduce emissions, before the advent of the TRI many facilities had never before performed environmental audits, and the detailed analyses of their own emissions mandated by the TRI may have actually helped some of them uncover inefficient aspects of their own production processes (Office of Environmental Information, U.S. Environmental Protection Agency 2003).[14]

Within a developing country context, Afsah, Blackman & Ratunanda (2000) found that an environmental Right-to-Know program in Indonesia led firms to reduce their emissions, while also improving facility efficiency by requiring internal environmental audits. The authors describe the process how Indonesian firms were shamed into reducing emissions after being highlighted as serious polluters. In Canada, where the government enacted a program very similar to the TRI, Antweiler & Harrison (2003) found evidence that green consumerism linked to pollution reporting had a significant effect on toxic emissions reductions.

Jin & Leslie (2003) analyzed the effects of a unique Right-to-Know program in Los Angeles, CA, which mandated that all restaurants clearly post the results of their health inspection scores based on a simple letter grade A to F. They found that not only is consumer demand sensitive to the restaurant health scores (lower health scores resulting in lower demand), but that after the introduction of the program, the incidence of food-borne illnesses decreased in the surrounding area, both due to the increased demand for cleaner restaurants, as well as health improvements (made in response to the Right-to-Know program) in formerly poorly rated restaurants.

In summary, the TRI has been demonstrated to influence the stock valuation of U.S. firms, and similar Right-to-Know programs in other countries have influenced firm emissions. In addition, U.S. firms emitting highly carcinogenic chemicals have been sensitive to the TRI reporting and decreased these types of emissions more than firms whose emissions are less toxic. Right-to-Know programs are not limited to environmental data, and a program based on health inspections has also influenced the behavior of both consumers and restaurant owners in L.A., resulting in less illness.

The following study adds to the research on Right-to-Know programs by examining whether the TRI has had effects on the emissions of facilities in the U.S. through "Top

[14]This can be thought of as a manifestation of the "Porter Hypothesis." Regulation may actually help firms discover new methods for improving environmental efficiency that they may not have in the absence of the regulation (Porter & van der Linde 1995).

10" pollution rankings within states. "Top 10" lists are an efficient way of both presenting emissions data to the public and for targeting regulatory action, and examining whether firms respond to this identification is a logical step in the large and growing TRI literature.

2 Data

The Environmental Protection Agency (EPA) administers the Toxic Release Inventory. EPA compiles all facility reports and jointly releases them on one day in late spring / early summer a year and half after the reporting year ended. For example, facility level releases for reporting year 1998 are made public in the middle of 2000. The timeline is shown in Figure 1. Reports include releases for each of 650 chemicals, separated by medium: air, surface water, land, and underground injection, which all constitute onsite releases. The report also includes offsite releases as well as offsite transfers for further waste management, where the latter category is *not* included in TRI's definition of total releases.

While all data sets originally come from EPA, we obtained two distinct data sets: Scorecard provided us total onsite environmental releases, sometimes simply called total releases. Scorecard is the website that at the time listed "Top 10" polluters (see discussion above). Scorecard only added onsite releases, which are shown in Figure 2 in the appendix for the years 1998-2001, the years for which they provided us the data. If firms react to public pressure, Scorecard's ranking at the time the data were made public identifies who received the pressure of being labeled a "Top 10" polluter.

We subsequently extracted all facility releases from TRINET[15] for the years 1988-2010. These data report releases by medium: onsite (air, surface water, land, and underground injection), offsite releases, as well as offsite transfers for further waste management. TRINET includes onsite releases in their measure of total releases, and hence we constructed rankings using the sum of onsite and offsite releases, which is different from Scorecards definition that only included onsite releases. When we matched the data to the release data we obtained from Scorecard, total releases were generally comparable but not always identical, even if we excluded offsite releases. A possible reason is that TRI data is noisy and needs to be cleaned. EPA revises past estimates and cleans them, as did Scorecard, and they might use different algorithm. Our baseline estimates use the releases of Scorecard and the rankings obtained from Scorecard's releases. In sensitivity check, we also use total releases from TRINET, as well as ranking based on these emissions.

[15]Accessed in June 2010 on http://www.epa.gov/tri/tridotnet/index.html

The facility level data sets included other descriptive information such as the facility name, address, zip code, 4-digit SIC code / 6-didigit NAICS code, production ratio (the ratio of total output in one year to the next) and parent company name. In 2001, roughly 20,000 facilities reported emissions. Figure A1 shows the national distribution of TRI facilities in 2001. The majority of facilities are concentrated east of the Mississippi River, with the majority of these 30+ states containing hundreds of facilities. There are relatively few TRI facilities scattered throughout the West except for the coastal states, which also contain significant concentrations of facilities, particularly in California. On the other hand, the figure shows color-coded total releases in the TRINET data, and some of the largest overall emitters are found in the Western United States.

Figure 2 shows total reported environmental releases in TRINET from 1988 to 2010 as black lines.[16] Total releases drop by more than 60 percent between 1988 and 1998 (from a high of more than seven billion pounds in 1988 to around 2.5 billion pounds in 1997), and show a general downward trend. Total releases in the scorecard data, which only included onsite releases in shown in grey. The data we obtained from Scorecard ended in 2001. Figure 3 further disaggregates total releases in TRINET. The top four panels break total releases in Panel A1 into onsite and offsite releases in Panel A2 and A3. The bottom row splits total onsite releases into the air, surface water, land, and underground injection, respectively. Most of the reduction in onsite releases stems from reduction in air emissions, followed by reductions in underground injections.

The one exception to the general downward trend are offsite transfers for further waste treatment, as shown in top right panel of Figure 3. Especially in the early 1990s, there is a significant increase in total transfers, and the absolute size of these transfers is big. Transfers have since stabilized and most recently declined. It should be noted that offsite waste transfers are not included in total releases either in the Scorecard or TRINET data set. Note that one way to reduce releases is to increase the share of offsite transfers, which we address below.

Total releases are extremely concentrated within a relatively small number of facilities. Figure 4 uses pollution rankings to highlight how the "Top 10" polluters across states accounted for a widely disproportionate share of total U.S. environmental releases. The y-axis shows the percentage share of total U.S. environmental releases (averaged across the years 1988-1997) and the x-axis groups facilities according to their total environmental release

[16] Although the TRI officially began in 1987 the quality of the data in the first year is considered unreliable and therefore is omitted.

rankings within their respective states. The sum of the environmental releases from facilities that comprised the "Top 10" biggest emitters across the 50 states accounted for, on average, approximately 58 percent of total U.S. environmental releases each year (with a minimum of 52% and a maximum of 62% in any given year). Put another way, the approximately 500 facilities that comprised the "Top 10" worst polluter lists in their respective states (50 times 10)[17] were responsible for more than half of the total environmental releases emitted by the more than 20,000 TRI facilities in the entire U.S.; *approximately 1/40 of the TRI facilities released more than 1/2 of the total reported toxic chemicals.* This high concentration of total environmental releases dips dramatically as the next 10 biggest emitters (ranked 11-20) accounted for on average only 11 percent of total environmental releases, less than one-fifth of the releases of the facilities ranked 1-10. By the time we move beyond facilities ranked 30 or more, each ranking group accounts for at most only a few percentage points of total U.S. environmental releases.

As Fung & O'Rourke (2000) point out, worst polluter lists help to focus attention on a manageable subset of facilities that are responsible for the greatest environmental pollution, and hence may be an efficient way means of prioritizing environmental activism. As Figure 4 shows, in the case of the TRI, "Top 10" worst polluter lists within states target the facilities that are responsible for the majority of environmental releases. It is important to note, however, that total environmental releases may be a poor proxy for actual levels of toxicity and environmental damage because of the heterogeneity of toxicity of the hundreds of TRI chemicals. For example, some TRI chemicals are several orders of magnitude more toxic than others, and there are instances where a facility that ranks high on total environmental releases may rank low based on some form of "toxic scoring" (and vice versa).[18] Despite this complication, this study focuses on total environmental releases because this has been the category most cited by media sources, used by the EPA in its own rankings reports, and is the default used on the Scorecard website. There are literally dozens of toxicity categories and weighting schemes to choose from and for the purposes of this analysis, which focuses on overall media exposure, total environmental releases is a reasonable choice.[19] In a sensitivity check, we use toxicity-weighted releases given in TRINET.

All of the TRI data are self-reported by firms and firms are not required to specifically

[17]In some years, not all states had 10 facilities on the TRI list.

[18]Such as Scorecard's cancer risk score which weights all of the TRI chemicals according to their benzene equivalent.

[19]In addition to total environmental releases, Scorecard allows users to rank facilities based on 39 different categories ranging from reproductive toxins to kidney toxins to ozone-depleting substances. As one Scorecard employee noted: "We made it so that every facility would be top ranked on at least one dimension."

monitor all of their TRI chemical releases, but at minimum, must present reasonable release estimates. The EPA does not employ a comprehensive system for auditing TRI reports and firms do not face regulatory penalties for inaccurate release estimates. In addition, the text of the EPCRA (the law which established the TRI) makes explicit that states are not required to expend significant effort in order to ensure accurate TRI reports. However, regional EPA offices look for large deviations in reported releases from one year to the next and routinely audit facilities that report the 10 greatest changes in environmental releases (both positive and negative) by SIC code, and request that they verify the accuracy of their data.[20] In addition, the EPA keeps a close watch on industry trends regarding the environmental releases of different chemicals in order to establish benchmarks with which to judge the accuracy of changes in releases in individual facilities.

The EPCRA permits levying fines of up to $25,000 per violation of TRI reporting requirements, i.e., not filing the necessary TRI reports. Between 1990 and 1999 the EPA brought 2,309 administrative actions against facilities under EPCRA (Office of Enforcement and Compliance Assurance, U.S. Environmental Protection Agency 2000). These fines (both in relative and absolute terms) are much lower than the fines for violations of the Clean Air Act; for example, in 2001 total penalties levied for TRI violations approached $4 million while fines levied for violations of the Clean Air Act were more than $84 million.

Unsurprisingly, one of the major shortcomings of studies that seek to uncover evidence that the TRI has caused firms to reduce their environmental releases is that reductions in releases may be due to non-truthful or inaccurate reporting by facilities. Firms that face significant pressure to reduce their toxic emissions may have incentives to misreport their releases in order to demonstrate reductions that aren't actually occurring, even if the reputational costs and any increased regulatory scrutiny may be great if they are caught. A few studies have uncovered significant evidence of inaccuracy within the TRI data, but the extent to which this is driven by purposefully dishonest reporting versus measurement error in estimating releases is unknown.

A recent report by the Environmental Integrity Project (2004) analyzed TRI emissions data in 2001 in Texas and found underreporting in the range of 15%, with greater disparities for some highly carcinogenic chemicals. The study attributes this less to purposeful cheating on the part of firms, than on the outdated estimation techniques used for TRI reporting. It has also been observed that in some years the rate of non-compliance with the TRI has been quite large, up to 1/3 of all covered facilities. However, Brehm & Hamilton (1996) show

[20] Personal communication of Jason Scorse with EPA employees in Region 9.

that the majority of non-complying facilities were very small, comprised a small percentage of total environmental releases, and often their non-compliance was the result of ignorance of the law rather than evasion.[21]

In a recent study by DeMarchi & Hamilton (2006) the authors assessed the accuracy of the TRI data in two ways: by cross-checking the TRI data with a source outside the control of firms, and analyzing the TRI chemical reports for peculiar statistical patterns. First, they compared reported releases of five TRI chemicals with the results of EPA regional emissions monitoring. They found that the releases of two of the five chemicals closely matched the monitoring results, two suggest overestimates of the reductions reported under the TRI (lead and benzene, which are highly toxic; benzene is a known carcinogen), and one which actually decreased more in the emissions monitoring than was reported under the TRI (ethylbenzene, which is also highly toxic). They also make use of Benford's Law to assess whether the reported releases for a larger subset of TRI chemicals are distributed in a manner that suggests accurate reporting.[22] They found that for lead and nitric acid (two highly regulated chemicals) the reported releases did not adhere to the expected distribution. The authors posit that (in addition to the incentives to misreport) the inaccurate release estimates may be due to the fact that in absolute terms the releases per facility of these chemicals are relatively low, and therefore, significant effort is not invested to ensure precise release figures, and often guesses are made that may skew the aggregate distributions.

In summary, the while the TRI data represents the most extensive toxic release database in the U.S., there exists both the incentive to misreport releases and a relatively weak legal structure to monitor and punish such deviations (including mistakes in the reported figures). It is worth emphasizing that if firms that are labeled "Top 10" worst polluters incur significant costs because of this stigma there exist significant incentives to misreport emissions to the extent that the costs of breaking the law and the risks associated with it are lower than the costs of being a "Top 10" polluter in the first place. Below, we can utilize the timing of the release of information to indirectly test whether firms simply misreporting releases in response to changes in rankings. EPA publishes releases a year and half after the

[21]The facilities who are not complying do not comprise "Top 10" worst polluter lists.

[22]Benford's Law states that the first digits of self-reported data should follow a monotonically decreasing distribution; i.e. 1s should appear more frequently than 2s, which should appear more frequently than 3s, etc. This pattern has been verified in numerous types of datasets and is used by accountants as a way to detect discrepancies in balance sheets and tax forms. With respect to the TRI, Benford's Law suggests that the first digits of the self-reported pollution figures should follow the same monotonically declining pattern. For the first digits of the TRI reported emissions data, 1s should appear more frequently than 2s, which should appear more frequently than 3s, etc.

reporting year is over, e.g., releases for 1998 are made public in May 2000. If a firm where to simply change its numbers, it could do so for the reporting year 2000, but any change in the production process would likely only show up in 2001.

3 Model

The ideal way to test for the effects of pollution rankings on facility releases would be to randomly create and disclose rankings in different states and then observe the changes in releases between the control and treatment groups, utilizing a difference in difference approach. In the absence of such an experiment, the most credible way to identify the effects of state rankings on releases is within the context of a quasi-natural experiment in which there is an exogenous shock to facility rankings that is different across different states, thereby creating a quasi-control and treatment group. Such a shock occurred in 1998 when Congress changed the TRI rules and required seven additional industries to disclose their emissions data.[23] This rule change instantly added approximately 2,000 facilities to the TRI, spread out across all 50 states. These new industries were (and are) some of the countries largest polluters, and therefore, their addition lowered the rankings for the facilities that were already under the jurisdiction of the TRI. This expansion of the TRI program had been fought and stalled in Congress for many years and its passage could not have been easily anticipated by firms.[24]

Our analysis focuses on facilities that make the "Top 10" list of polluters, and specifically firms that were dropped from the list in 1998 because newly covered facilities had higher emissions.[25] The addition of the seven new industries in 1998 only had the effect of potentially lowering the rankings of existing facilities. New entrants that released more toxic chemicals than an existing facility resulted in a lower ranking for the existing facility, while those that emitted less were ranked below them on the list and did not change the ranking of an existing

[23]These seven new industries are: (i) metal mining (SIC 1021, 1031, 1041, 1044, 1061, and 1099); (ii) coal mining (SIC 1221 and 1222); (iii) electrical utilities that combust coal / oil (SIC 4911, 4931, and 4939); (iv) Resource Conservation and Recovery Act Subtitle C hazardous waste treatment and disposal facility (SIC 4953); (v) chemicals and allied products wholesale distributions (SIC 5169); (vi) petroleum bulk plants and terminals (SIC 5171); (vii) solvent recovery services (SIC 7389).

[24]Some people have suggested that in fact many of the existing firms lobbied for the inclusion of these additional firms, and therefore, that the rule change was not completely exogenous. If this were true it would only strengthen the case presented here since it would demonstrate that these firms cared about their rankings and that they wanted other larger firms to enter the jurisdiction of the TRI to make their releases appear relatively less polluting.

[25]Sanders (2011) examines the effect of changes in releases due to the 1998 expansion on housing prices.

facility. For example, if an existing facility emitted 100,000 pounds and was ranked number 2 and one of the new facilities in their respective state emitted 101,000 pounds (a quantity greater than the number 2 facility) than the existing facility's rank improved to number 3. However, if the new facility emitted 99,000 pounds (a quantity less than the number 2 facility) then the existing facility remained ranked number 2 with one more facility added below them in the rankings. The number of newly covered facilities that made the "Top 10" list in each state is shown in Figure 5. While there is no strong apparent spatial pattern, one might be concerned that the number of newly covered facilities that made the "Top 10" list are correlated with other factors that determine releases, e.g., the demographic or industrial composition of a state. Table 1 presents regressions where the number of newly covered facilities that ended up in the "Top 10" in each state is linked to various Census characteristics, one at a time. The two sectors that show a statistically significant link are manufacturing and health care. To incorporate possible baseline changes, we hence include facility-level time trends to account for the fact that facility releases have been trending. The effect of a change in ranking should be seen on top of the preexisting trends.

We use the following instrumental variable approach:

$$\begin{aligned} y_{i,t+\tau} &= \alpha_i + \beta_i t + \gamma_t + \delta I_{\Delta(top10),1998} + r_{i,1998} + \epsilon_{it} \\ I_{\Delta(top10),1998} &= a_i + b_i t + c_t + dN_{s,1998} + r_{i,1998} + \mu_{it} \end{aligned}$$

where $y_{i,t+\tau}$ are the log of total environmental releases for facility i at time $t+\tau$. They are modeled as a function of an indicator variable $I_{\Delta(top10),1998}$ that captures whether a facility drops out of the "Top 10" list in 1998, i.e., the variable is one if the facility drops out of the "Top 10" in $t = 1998$, and 0 otherwise. The regression also included facility fixed effects α_i, facility-specific time trends β_i to adjust for overall release patterns, year fixed effects γ_t, and the initial facility rank $r_{i,1998}$ in 1998 *without* counting newly regulated facilities. It is important to adjust for the initial rank as facility with a lower rank (higher releases) are less likely to be dropped from the "Top 10" list. Since changes in the "Top 10" list $I_{\Delta(top10),1998}$ are endogenous, we instrument with the number of new entrants in the top 10 list from *newly regulated sectors* $N_{s,1998}$. The variable $N_{s,1998}$ is displayed in Figure 5 for 1998, the year the program expansion occurred. It is zero for all other years. Since our source of variation comes at the state level, all regression cluster the errors at the state level.

One specific feature of this analysis is the timing of the data as shown in Figure 1. Releases for reporting year 1998 had to be transmitted to the Environmental Protection

Agency, who releases data for *all* facilities in the late spring / early summer two years later, i.e., 2000. Back then the data vas disseminated via CD-ROMs and not immediately accessible on EPA's website. It took Scorecard some extra time to clean and release the data on their website. The new state rankings where hence made public in the middle of 2000. If firms wanted to implement measures to reduce their emissions and relative ranking, the first full year to do so would be in 2001, or three years later. The baseline model hence uses $\tau = 3$.

By the same token, examining the effect for $\tau = 2$ gives us an indirect test whether facilities shirk on their reports. Since the new rankings were only made public in the middle of 2000, it would have been difficult to implement changes to the production process in the same year. On the other hand, simply adjusting the reported numbers would easily be feasible. Finding an effect for $\tau = 3$, but not $\tau = 2$ hence makes it less likely that the effect is only driven by fake changes in the reported numbers in response to changes in rankings, as they would have been available in $\tau = 2$.

4 Empirical Analysis

Our baseline results are graphically motivated in Figure 6, which splits "Top 10" facilities into two subgroup: the ones that stay in the top 10 in 1998 after the program is expanded to cover additional facilities (black line), and those that drop out of the top 10 because enough newly covered facilities entered above them (red line). It plot total emissions relative to 1998, summing over all facilities within a group. We remove facility-level trends that are estimated using data before 1998. The graph uses data from TRINET as Scorecard data stops in 2001. Both groups of facilities have very similar pre-trends and continue to track each other until 2000, but suddenly diverge starting in 2001, the first full year when adjustments to the production process were possible.

The baseline regression results are shown in Table 2. It presents a facility-level regression, while Figure 6 aggregates emissions from all facilities in each group. Panel A shows the results when we aggregate emissions as reported by Scorecard at the time. Panel B uses onsite emissions as reported by TRINET in 2010.[26] The first four columns (1a)-(1d) show the results for a regression that includes facilities in the 50 states. The last four columns (2a)-(2d) replicate the analysis but also include facilities from US territories (American

[26] Since Scorecard data is only available until 2001, we cannot estimate the model in columns (d) in Panel A.

Samoa, District of Columbia, Puerto Rico, and the Virgin Islands). In each of the two sets of regressions, columns (a)-(d) vary the time lag between the 1998 expansion and when emissions are measured, i.e., in 1999, 2000, 2001, and 2002, respectively. They examine the timing of the publication of facility rankings in more detail. Recall Figure 1, which outlined when facility releases and rankings are made public. EPA collects releases from firms for calendar year t and publishes them jointly for all facilities in late spring a year and a half later. For example, the 1998 releases were published in late spring of 2000. Firms that are simply gaming the system and misrepresenting their releases hence had ample time to simply report lower numbers at the end of 2000. On the other hand, implementing production changes in response to changes in the ranking will likely have limited effect in 2000 and only show up in 2001. All regression account for facility fixed effects, facility-specific time trends, and year fixed effects. There is tremendous variation in emissions over time, both on average (picked up by the facility fixed effect), but also across time. Some facilities are expanding, while others are contracting, which is picked up by the facility-level time trends. Since we are estimating a log model of releases, these are firm-specific growth rates in emissions. Errors are clustered at the state level, since the variation (number of newly regulated facilities in the "Top 10") varies at the state level. Given that we include facility fixed effects as well as facility-specific time trends, we need to include at least three years of releases for each facility. Our baseline regressions include data for the years 1995-1998. Recall that releases ar recorded with a time lag of $\tau = 3$ in the baseline regression, i.e., the change in "Top 10" status in 1998 is paired with emissions in 2001. Observations in 1995-1998 are paired with release data from 1998-2001.

Columns (a) and (b) generally give insignificant results. This is not surprising as the data on 1998 emissions is submitted to EPA in 1999 and published in 2000. The news about which company dropped out of the top 10 list of polluting facilities was hence not publicly available until mid 2000, when the data CDs were released. Scorecard highlighted the top 10 polluters all through Earth Day in 2001. This is the year when results become significant in columns (c). We find it reassuring that large and significant positive effect are found for $\tau = 3$, but not $\tau = 1$ or $\tau = 2$. It not only provides a falsification test for $\tau = 1$ (before new rankings are released), but also suggests to us that changes in releases were not only on the books, as firms had time to change the reported releases in $\tau = 2$, the year new rankings are reported. Moreover, if our instrument was highly correlated with other statewide trends, these confounding results should also show up in $\tau = 1$ and $\tau = 2$.

Firms that were dropped from the "Top 10" list after the expansion of the program on average have a staggering 50% higher emissions in column (1c) of Panel A, although this effect is relative to the trend. The top panel of Figure A2 shows the distribution of the facility-specific time trends corresponding to the regression results of Panel A, column (1c) in Table 2. The average is -0.16, i.e., on average facility decrease emissions by 16% per year. The average rank fixed effect for facilities in the "Top 10" in 1998 is -0.37.[27] The sum of the average time trend and average 1998 rank fixed effect is -0.53, which is roughly equivalent to the estimated treatment effect. In other words, if the effect is not measured relative to expected declines, but relative to the *total* emissions in 1998, facilities that drop out of the "Top 10" have small reduction in releases, while releases of facilities that remain on the "Top 10" decrease significantly.

F-statistics of the first-stage instrument are given in the footer of the table. The first-stage results are shown in Appendix Tables A1-A2 for Panel A and B, respectively. Not surprisingly, the number of new facilities that enter in the "Top 10" is highly significant in predicting the probability of a facility dropping out of the top 10. All regressions adjust for the initial rank of a facility *without* counting newly regulated firms. This is crucial as a facility ranked 10th is more likely to drop out of the top 10 than one that is ranked first, and relative reductions might differ by initial releases.

Table 3 contrasts various data sources: we use data as reported by Scorecard or TRINET in two ways: first to calculate total releases over time and second to derive the 1998 state rankings. It includes all possible combinations. Column (1a) uses data from Scorecard, while columns (2a)-(3b) include data from TRINET for emissions over time. They are different for several reasons: Scorecard provided us with their ranking of releases as they were published at the time TRI became available each year. They only include onsite releases, and since the website is now defunct, it is no longer possible to change their aggregation. Onsite releases are different for some facilities in TRINET versus Scorecard, likely reflecting different cleaning algorithms by the time the TRINET data was downloaded in 2010. Moreover, TRINET can be disaggregate by medium and can also include offsite releases. Columns (a) include total onsite releases while columns (b) include the sum of onsite and offsite releases. Since Scorecard did not include offsite releases, there is no column (1b). Columns (1a)-(2b) include all chemicals that were reported each year. Since the list of chemicals that need to be reported changed over time, we also include columns (3a)-(3b) that limit the chemicals to a consistent set of chemicals that get reported in each year to ensure there are no compositional changes.

[27]Note that the fixed effects for firms ranked 9 and 10 is largest in magnitude, i.e., these are the facilities just below the threshold, and they reduce releases the most.

Panels A-C change what data source is used to rankings facilities within a state: Panel A uses data from Scorecard. Panel B uses onsite releases from TRINET and Panel C uses the sum of onsite and offsite releases. Panel A and B generally show significant results, Panel C does not. Firms seem to have respondent to total onsite releases that Scorecard used identify top polluters and not another aggregate measure, e.g., total releases that include offsite releases.

4.1 Sensitivity Checks

We conduct several sensitivity analysis. Table 4 varies the temporal controls and interaction of the instrument by rank. Columns (1a)-(1e) consecutively include more temporal controls. Column (1a) include no temporal fixed effects. Our baseline regression (now shown in column 1b) includes year fixed effects. Columns (1c)-(1e) include industry-by year fixed effects at the first through third digit SIC code, respectively. None of the temporal controls has a strong effect on the observed results.

Column (2) in Table 4 includes again year fixed effects like our baseline regression, but interacts the instrument with the rank of the facility. Recall that we always include rank fixed effects, but now we allow the treatment effect of how many facilities enter the "top 10" to vary by original rank. We have 10 instead of one instrument. The results remain significant to interacting the instrument with the original rank, although the magnitude decreases. However, it is not significantly different from column (1b).

Table 5 replicates the analysis for releases into air, surface water, land, and underground injections in columns (1a)-(1d), all of which are considered onsite releases. Recall that we only obtained the desegregated data by medium from TRINET as Scorecard only kept the aggregate data. Results by medium appear noisier, and only air and water emissions are significant at the 5% level although the magnitude of the coefficients is large for all of the four onsite releases. Some of the coefficients should be taken with caution, as the number of facilities reporting realeases can be very small. For example, there are only 48 facilities out of the 500 "Top 10" facilities that report underground injection.

Column (2) of Table 5 considers offsite transfers for further waste management to rule out that facilities simply shift the problem by transferring waste. These tranfers are not included in the total onsite releases. There is no evidence that firms reduced releases by decreasing offsite transfers for further waste management, although the error terms are again wide, but the point estimates are of the opposite sign as expected.

Column (3) of Table 5 provides a toxicity-weighted estimate of facility releases that are available in TRINET. Facility rankings are still determined by summing the pounds emitted of all chemicals as this is what was reported in the media at the time, but the dependent variable are toxicity-weighted emissions. One worry is that firms respond by cutting emissions, but cut the less harmful ones (Auffhammer & Kellogg 2011). Our regression results do not support this hypothesis. The toxicity weighted results find a comparable decline in emissions to the simple sum.

Table 6 conducts a Placebo test where we pretend the newly covered facilities in 1998 had their emissions recorded in 1997 instead, i.e., one year prior. We redo the comparable analysis now using data from 1994-1997 instead of 1995-1998. None of the coefficients for a time lag of $\tau = 1, 2, 3$ years is significant. This suggests to us that we are not simply picking up trends in states that had more newly covered facilities enter.

Finally, Appendix Table A3 shows that results are robust to how many years are used to derive the facility level time trends if we use at least four years. Recall that we need at least three years as we include facility fixed effects and facility-level time trends. A model with three years has only one degree of freedom per facility.

5 Conclusions

We conduct a study of how firms respond to negative news about their pollution. Our results provide evidence that the TRI database did influence facility emissions through a list of "Top 10" polluters as compiled by Scorecard. Facilities that experienced exogenous drops in their pollution rankings, which resulted in their removal from "Top 10" polluter lists within their states, subsequently had higher emissions. The results suggest that overall the more than 160 facilities within the industries originally covered by the TRI who were removed from "Top 10" worst polluter lists released a staggering 50% more toxins into the atmosphere than they otherwise would have if they were not dropped from the list. These results are relative to a downward trend: facilities that remain on the "Top 10" list continue to reduce emissions, while the ones that drop off do not.

Our results have significant policy implications. Although changes to the TRI reporting rules led to less emissions reductions among already existing firms, the finding that firms do respond to pollution rankings should bolster the overall case for Right-to-Know programs. The TRI appears to be providing members of the public and policy makers with information that they act upon, which in turn, creates pressure on the most polluting firms to change their behavior. The costs (real or perceived) are significant enough that firms respond. Since environmental releases are heavily concentrated amongst the worst polluters, influencing their behavior is a very efficient way to reduce overall emissions, especially since pollution rankings are relative and every year there are always top polluters.

Given that the maintenance costs of the TRI for the U.S. government have remained extremely low, at approximately $25 million a year, and the cost to industry of providing the information has dropped from approximately $550 million in the first year to $300 million a year since (Fung & O'Rourke 2000), the TRI may be a potentially cost-effective means of better enabling the public to express its environmental preferences.[28]

These results also highlight the potential unintended consequences of bringing new entrants under the jurisdiction of the TRI. While the inclusion of new industries in 1998 shifted the focus to facilities that polluted significantly more than already existing facilities, at the same time, this expansion decreased incentives for the latter group of facilities to reduce their emissions. Depending on the relative susceptibility of the new and existing firms to public pressure as well as their abatement costs, it is open question whether the change in the TRI rules will lead to long-term increases or decreases in total environmental releases across the United States.[29]

Despite the likelihood that the facility-level data provided by the TRI is not entirely precise, the results of the current study are still of interest and policy-relevant because they indicate that at minimum firms are *concerned with the public perception* of their emissions. The evidence in this study suggests that once firms experience improvements in their pollution rankings they actually report *lower* emissions reductions, which is the opposite direction expected from untruthful reporting. This indicates that firms are thinking strategically about their pollution rankings. If anything, untruthful reporting is more likely to occur in instances where firms report *greater* emissions reductions (i.e., relatively lower emissions). Moreover, the timing of the changes in facility releases makes it less likely that is simply due to changes in reported emissions, as firms could have reacted and changed their emissions a year earlier.

Given that the TRI currently covers only a small fraction of the toxic chemicals emitted in the U.S. (approximately 5%) there is significant room to expand the scope of the program, but as this paper has demonstrated, there may be unintended consequences that should be taken into account.

[28]This does not include the actual costs of emissions reductions, but simply the cost of providing the information to the government that the TRI legislation requires. The estimated cost of all U.S. environmental regulation is in the hundreds of billions per year.

[29]In addition, if the chemicals emitted by the original set of TRI facilities are significantly more toxic than the new entrants then changes in the composition of the TRI may have shifted attention to facilities that actually pose less of a health and environmental risk.

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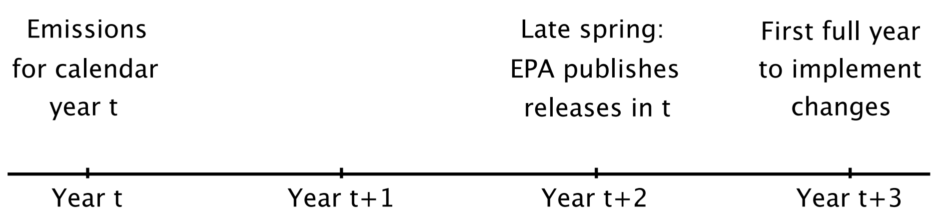
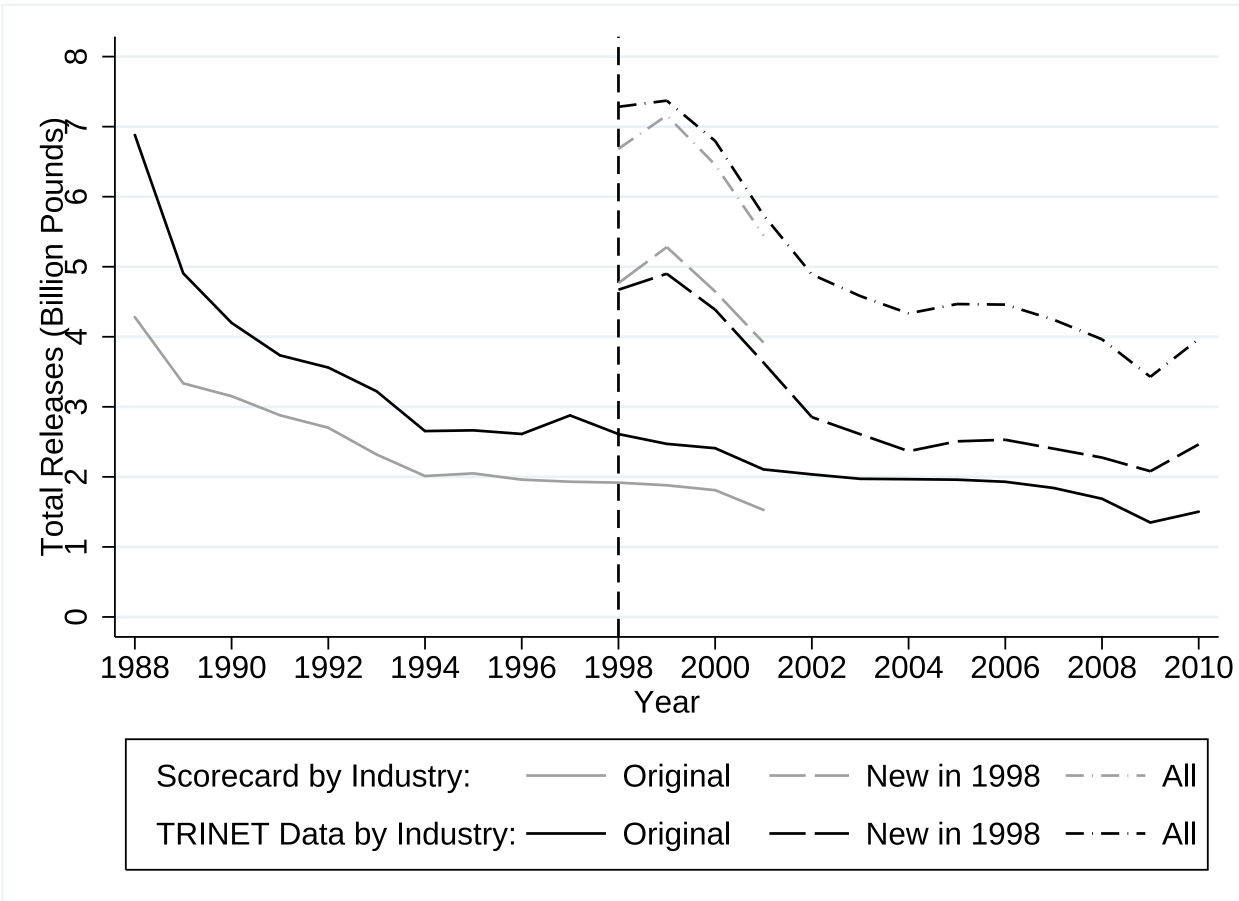
Figure 1: Timeline of Publication of Facility Releases and Rankings



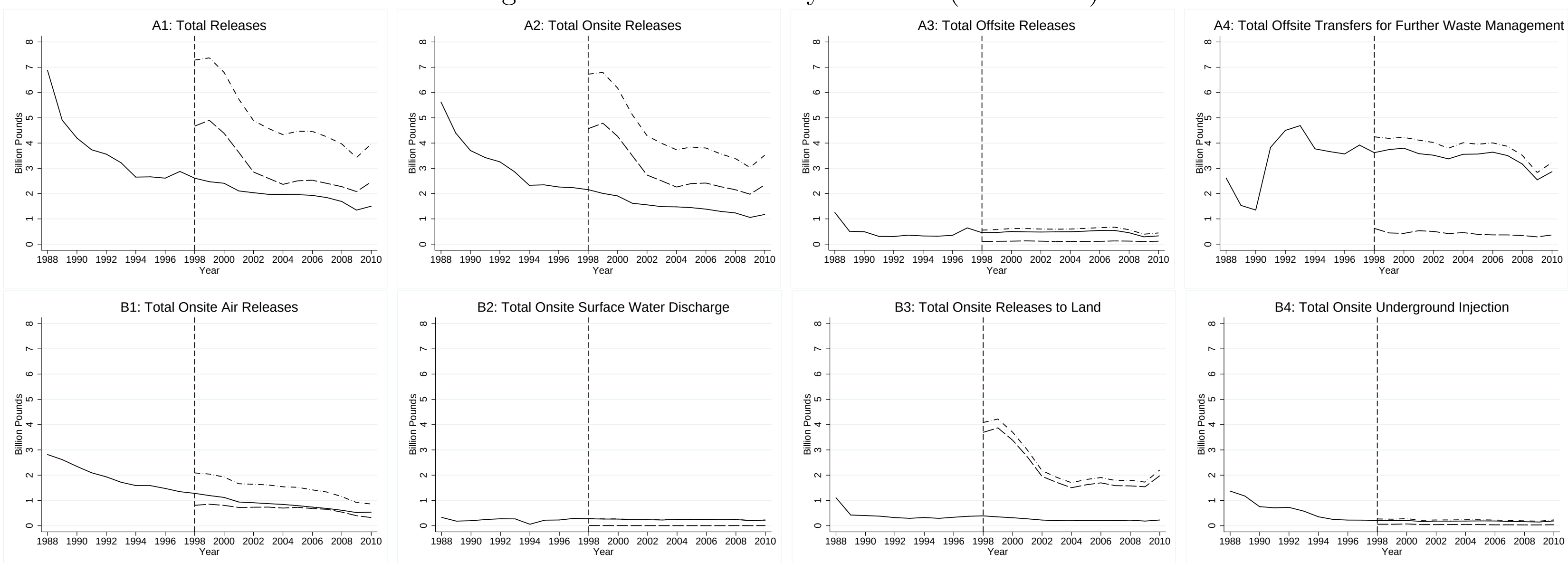
Notes: Figures illustrates the time line when information about the toxic releases is made public and when firms can respond.

Figure 2: Total TRI Releases 1988-2010



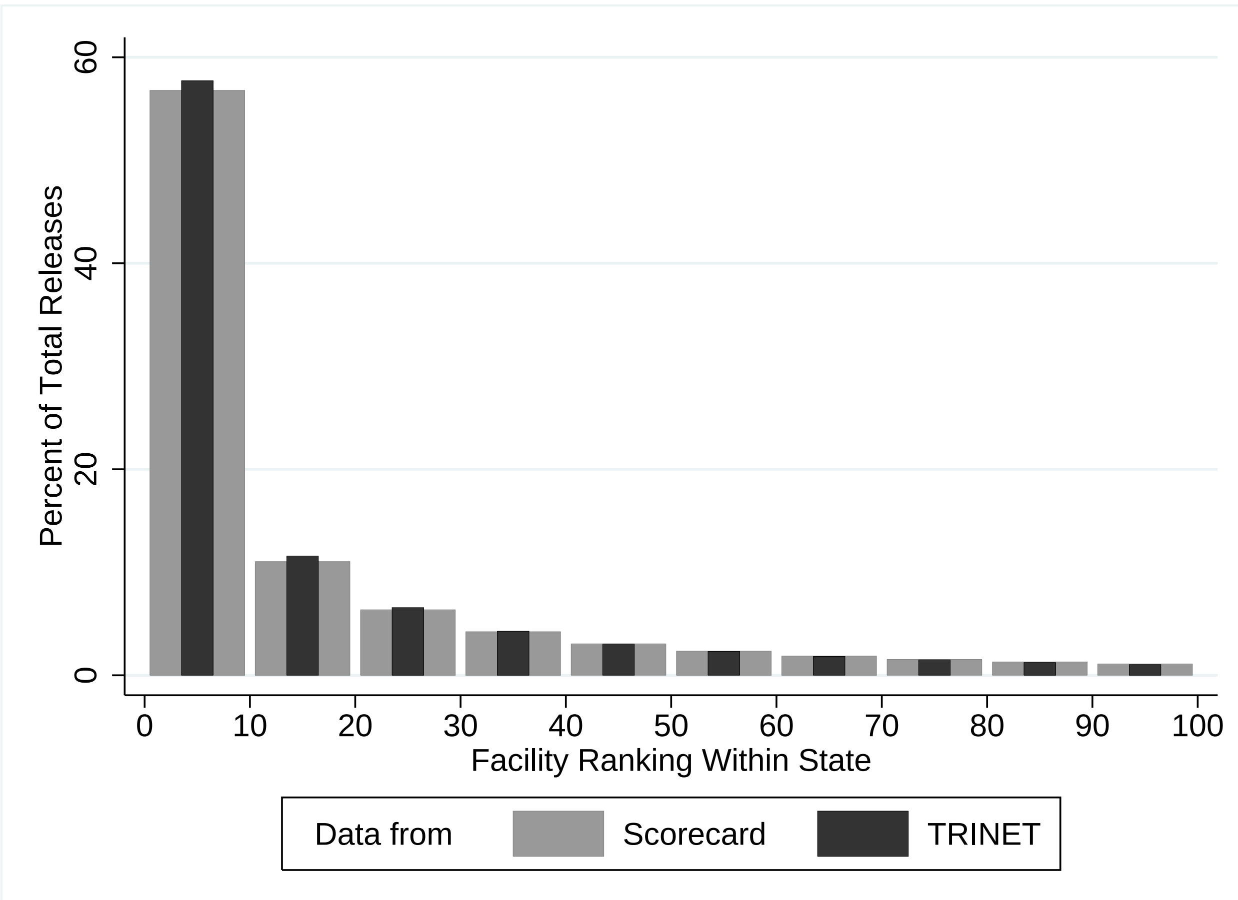
Notes: Figures displays total releases of all facilities by year. Industries who had to report releases in the TRI expanded in 1998. We plot both releases reported in Scorecard (data available until 2001) or in TRINET.

Figure 3: TRI Releases By Medium (1988-2010)



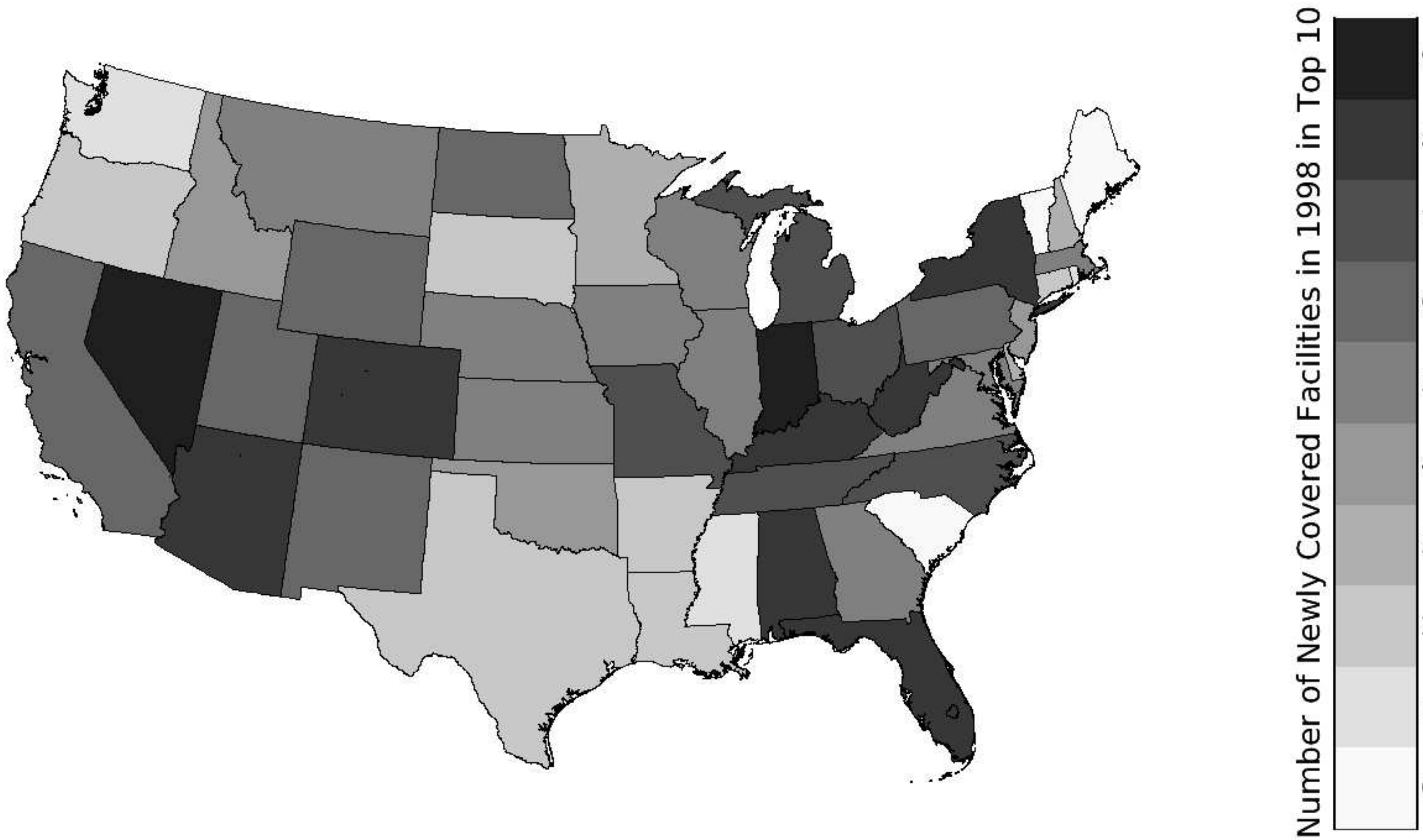
Notes: Figures displays releases of all facilities by year and medium. Total releases as reported by TRINET in Figure 2 are shown again in panel A1 (top left). The next two columns (Panels A2 and A3) split the total releases into onsite and offsite releases. The top right panel A3 shows total offsite transfers for further waste management, which are *not* included in total releases. The bottom row further separates onsite releases into air, water, land, and underground injections in panles B1-B4. The legend is the same as in Figure 2. Source: TRINET.

Figure 4: Share of Releases



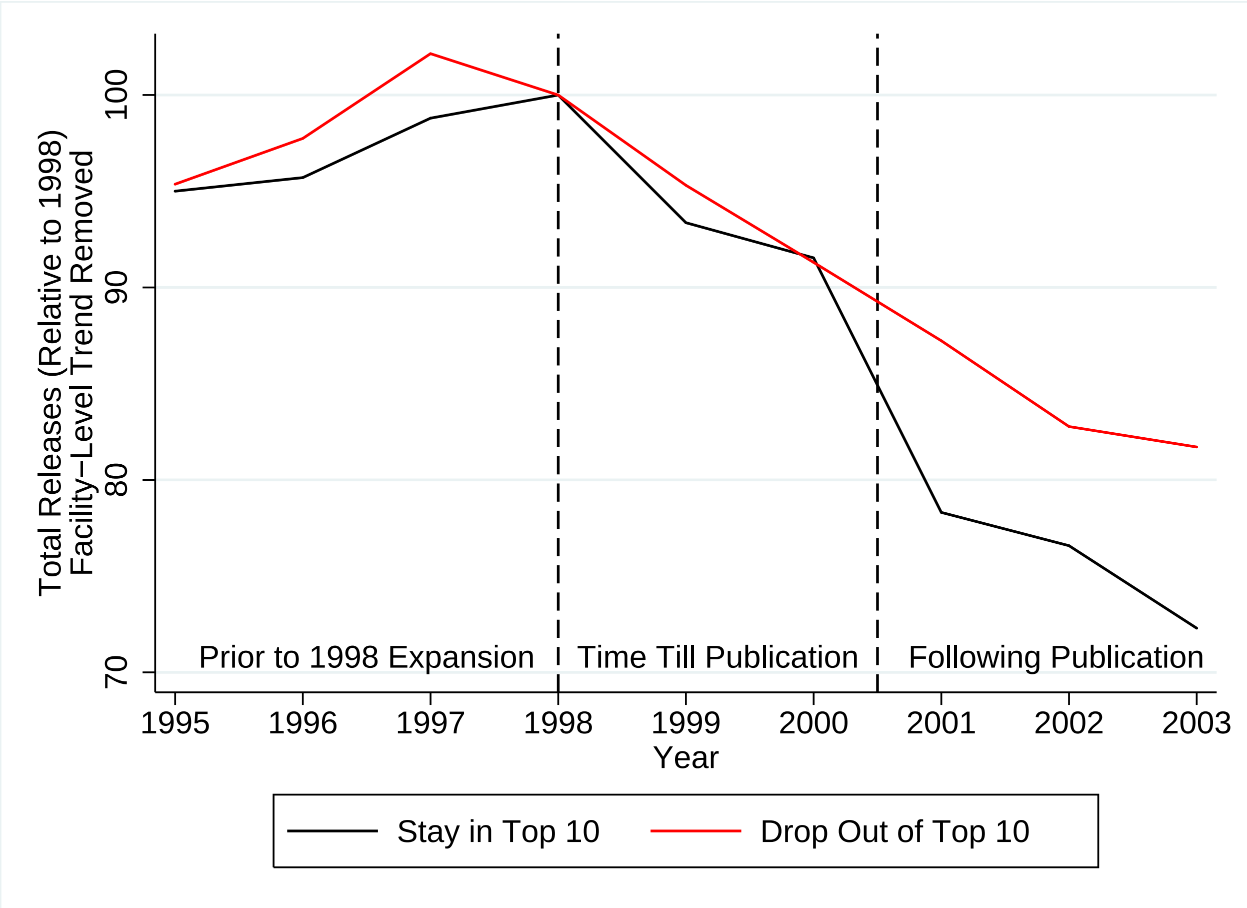
Notes: Figures shows the average percentage of releases of the "Top 10" polluters for the years 1988-1997. Source: TRINET and Scorecard.

Figure 5: Number of Newly Covered Facilities in 1998 in the Top 10 of Each State



Notes: Figure displays the number of facilities that were forced to report for the first time after the program expanded in 1998 and were among the "Top 10" polluters in a state. The corresponding numbers for the states / territories not displayed are: Alaska (5), DC (1), Hawaii (6), American Samoa (0), Puerto Rico (5), and Virgin Islands (3). Source: Scorecard.

Figure 6: Effect of Being Label a Top-10 Polluter



Notes: Figure displays total releases of top-10 facilities in 1998 in the originally covered manufacturing sector over time. The data is aggregated into two groups: facilities that drop out of the top 10 since more polluting facilities from newly covered sectors enter in the 1998 expansion (red line) and those that remain in the top 10 (black line). Total emission are shown relative to 1998. Graphs remove facility-specific trends in onsite releases estimated during the pre-period 1995-1998. *Source*: TRINET.

Table 1: Explaining Number of Newly Regulated Facilities in "Top 10"

	Coefficient	(Standard Error)
Variables in 2000 Census of Population		
Fraction of population that is White	-1.34	(2.81)
Fraction of population that is Black / African American	-1.70	(3.80)
Fraction of population that is Hispanic	5.52	(4.01)
Fraction of population that is below 5 years old	51.47	(57.08)
Fraction of population that is 65 or older	0.03	(19.13)
Housing units per capita	-12.84	(13.14)
Vacant housing units per capita	33.77	(22.50)
Median Age	-0.07	(0.19)
Variables in 2002 Economic Census		
Utilities: Establishments per 1000 People	-8.77	(6.65)
Utilities: Employees per 1000 People	0.20	(0.46)
Mining: Establishments per 1000 People	0.83	(1.51)
Mining: Employees per 1000 People	0.04	(0.06)
Construction: Establishments per 1000 People	-0.68	(0.45)
Construction: Employees per 1000 People	0.07	(0.06)
Manufacturing: Establishments per 1000 People	-3.58**	(1.66)
Manufacturing: Employees per 1000 People	-0.04	(0.04)
Finance: Establishments per 1000 People	-0.25	(1.18)
Finance: Employees per 1000 People	-0.02	(0.04)
Health Care and Services: Establishments per 1000 People	-2.39**	(1.09)
Health Care: Employees per 1000 People	-0.07*	(0.04)

Notes: Table presents regresson results. Each row is a separate regression, where we regress the number of newly regulated facilities in 1998 in each of the 50 states that were among the "Top 10" polluters on characteristics from the Census. The regressions have 50 observations (one fore each state). Significance levels are indicated by *** 1%, ** 5%, * 10%.

Table 2: The Effect of Being a "Top 10" Facility

Variable	(1a)	(1b)	(1c)	(1d)	(2a)	(2b)	(2c)	(2d)
				A: Data From Scorecard				
Out of Top 10	-0.029	-0.002	0.534**		-0.031	-0.014	0.422*	
	(0.157)	(0.107)	(0.216)		(0.156)	(0.107)	(0.245)	
F-stat (1st stage)	488.48	247.96	239.10		484.65	248.67	236.98	
Observations	1863	1863	1874		1899	1905	1922	
Facilities	468	469	473		477	480	486	
				B: Data From TRINET - Onsite Releases				
Out of Top 10	-0.269*	0.028	0.774***	0.067	-0.124	-0.198	0.720**	0.239
	(0.157)	(0.139)	(0.292)	(0.173)	(0.220)	(0.253)	(0.301)	(0.242)
F-stat (1st stage)	753.71	230.42	202.46	223.36	663.64	221.57	193.33	208.89
Observations	1927	1925	1930	1918	1983	1981	1986	1974
Facilities	483	483	484	482	497	497	498	496
Include Territories	No	No	No	No	Yes	Yes	Yes	Yes
Time Diff τ	1	2	3	4	1	2	3	4

Notes: Table regresses log releases on whether the facility dropped out of the "Top 10" list, which is instrumented by the number of newly covered facilities in the top 10 after the 1998 program expansion. All regression use data from 1995-1998 and include facility fixed effects, facility-specific time trends, and year fixed effects. The first four columns (1a)-(1d) use facilities in the United States, while the last four columns (2a)-(2d) also include facilities from US territories. Columns (a)-(d) vary the time lag between the 1998 expansion and when emissions are measured, i.e., in 1999, 2000, 2001, and 2002, respectively. Panel A uses data from Scorecard on onsite releases, while panel B uses data from TRI.NET. Appendix Table A1 reports first stage results for Panel A, while Table A2 reports it for Panel B. Facility releases as well as state rankings are taken from Scorecard. Errors are clustered at the state level. Significance levels are indicated by *** 1%, ** 5%, * 10%.

Table 3: Results by Data Source (Scorecard versus TRINET)

Variable	(1a)	(2a)	(2b)	(3a)	(3b)
	A: Facility Ranking - Scorecard				
Out of Top 10	0.534**	0.557***	0.545**	0.438**	0.423**
	(0.216)	(0.211)	(0.212)	(0.171)	(0.172)
F-stat (1st stage)	239.10	238.89	238.89	238.89	238.89
Observations	1874	1881	1881	1881	1881
Facilities	473	474	474	474	474
	B: Facility Ranking - TRINET Onsite Releases				
Out of Top 10	0.616**	0.774***	0.739**	0.554***	0.516***
	(0.274)	(0.292)	(0.291)	(0.192)	(0.188)
F-stat (1st stage)	210.78	202.46	199.37	202.46	199.37
Observations	1873	1930	1934	1930	1934
Facilities	473	484	485	484	485
	C: Facility Ranking - TRINET Total Releases				
Out of Top 10	0.226	0.740**	0.706**	0.337	0.300
	(0.297)	(0.333)	(0.333)	(0.210)	(0.207)
F-stat (1st stage)	289.29	186.43	187.30	271.13	271.63
Observations	1857	1918	1918	1917	1917
Facilities	469	481	481	481	481
Releases	Onsite	Onsite	Total	Onsite	Total
Release Estimates	Scorecard	TRINET	TRINET	TRINET	TRINET
Chemicals	All	All	All	1995-2001	1995-2001

Notes: Table replicates the specification of column (1c) in Table 2. Panels vary what data source and variable are used to rank facilities in a state: panel A uses onsite releases from Scorecard, panel B uses onsite releases from TRI.NET, while panel C uses total releases from TRI.NET, which are the sum of onsite and offsite releases. Columns vary the emissions variable that are allowed to be impacted by a facilities' rank. Columns (a) look at onsite releases, while columns (b) look at total (onsite+offsite) releases. Columns (1a) uses data from Scorecard, while columns (2a)-(3b) use data from TRINET. Columns (3a)-(3b) are comparable to (2a)-(2b) except that they only include chemicals that are reported in each year between 1995 and 2001 in TRI.NET thereby ensuring there is no compositional change. Errors are clustered at the state level. Significance levels are indicated by *** 1%, ** 5%, * 10%.

Table 4: The Effect of Being a "Top 10" Facility - Sensitivity Checks

Variable	(1a)	(1b)	(1c)	(1d)	(1e)	(2)
	A: Data From Scorecard					
Out of Top 10	0.535**	0.534**	0.579***	0.588**	0.590**	0.359**
	(0.216)	(0.216)	(0.224)	(0.233)	(0.253)	(0.144)
F-stat (1st stage)	239.25	239.10	219.56	217.45	211.74	49.94
Observations	1874	1874	1874	1874	1874	1874
Facilities	473	473	473	473	473	473
	B: Data From TRINET - Onsite Releases					
Out of Top 10	0.774***	0.774***	0.842***	0.875***	0.910**	0.480***
	(0.292)	(0.292)	(0.304)	(0.336)	(0.377)	(0.170)
F-stat (1st stage)	202.60	202.46	179.60	164.93	175.61	59.83
Observations	1930	1930	1930	1930	1930	1930
Facilities	484	484	484	484	484	484
Year FE	No	Yes	No	No	No	Yes
Industry-Year FE	No	No	SIC1	SIC2	SIC3	No
Instrument by 1998 Rank	No	No	No	No	No	Yes

Notes: Table replicates the specification of column (1c) in Table 2, which is now shown in column (1b), but varies temporal controls. Column (a) has no temporal control, column (b) adds year fixed effects, while columns (c)-(d) add industry-by-year fixed effects at the 1-digit, 2-digit, and 3-digit SIC level, respectively. Finally, column (2) interacts the instrument (newly covered facilities in top 10 after program expansion in 1998) with the state rank of a facility in 1998 not counting newly covered facilities. Panel A uses data from Scorecard, while panel B uses data from TRI.NET. All regression use data from 1995-1998 and include facility fixed effects, facility-specific time trends. Errors are clustered at the state level. Significance levels are indicated by *** 1%, ** 5%, * 10%.

Table 5: Results by Medium

Variable	Air (1a)	Water (1b)	Land (1c)	Under-ground (1d)	Waste Transfer (2)	Hazard Weight (3)
	A: Instrument: Newly Covered Top 10 Facilities					
Out of Top 10	0.511*	1.537**	2.014	2.162	-0.182	0.885***
	(0.278)	(0.720)	(1.633)	(1.444)	(0.815)	(0.270)
F-stat (1st stage)	180.71	11.95	10.49	1.70	13.68	202.48
Observations	1925	1593	1251	195	1739	1926
Facilities	483	403	320	50	440	483

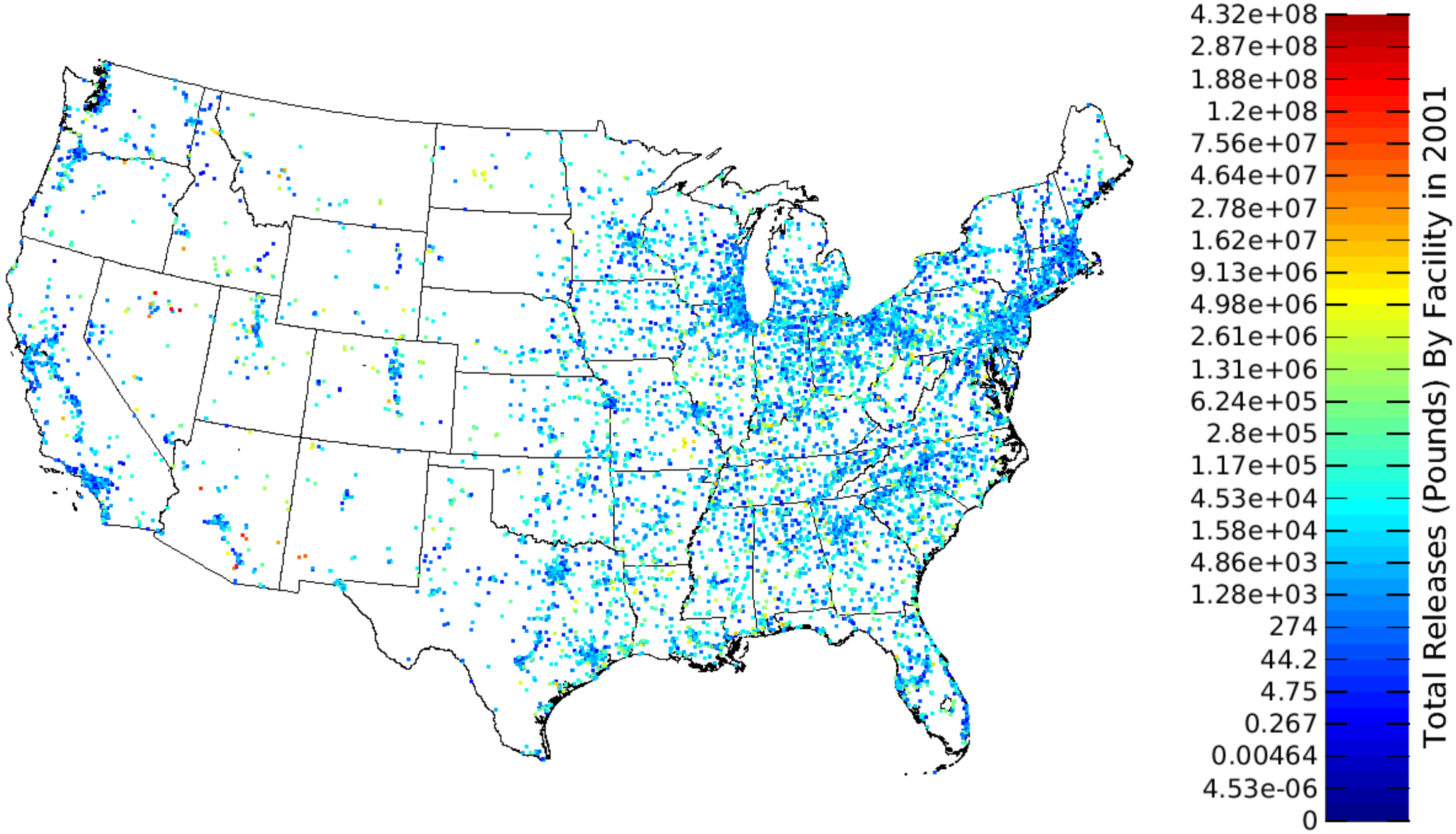
Notes: Table replicates column (1b) of Table 3, but separates releases by medium. Total onsite releases are the sum of the first four columns (1a-1d). Column (2) includes transfers for further waste management, which are not included in either onsite or offsite releases. Column (3) weights onsite releases by a toxicity index. The evolution of releases by medium over time are shown in Figure 3 for the TRINET data. Errors are clustered at the state level. Significance levels are indicated by *** 1%, ** 5%, * 10%.

Table 6: Placebo Regression: Counting Newly Covered Facilities One Year Prior in 1997

Variable	(1a)	(1b)	(1c)	(2a)	(2b)	(2c)
Out of Top 10	-0.086	-0.025	0.007	-0.096	-0.343	-0.007
	(0.206)	(0.133)	(0.154)	(0.085)	(0.213)	(0.152)
F-stat (1st stage)	613.56	268.18	191.35	1586.24	296.09	235.51
Observations	1853	1857	1849	1913	1916	1911
Facilities	468	470	469	483	484	483
Time Diff τ	1	2	3	1	2	3
Years in Sample	1994-1997	1994-1997	1994-1997	1994-1997	1994-1997	1994-1997
Release Estimates	Scorecard	Scorecard	Scorecard	TRINET	TRINET	TRINET

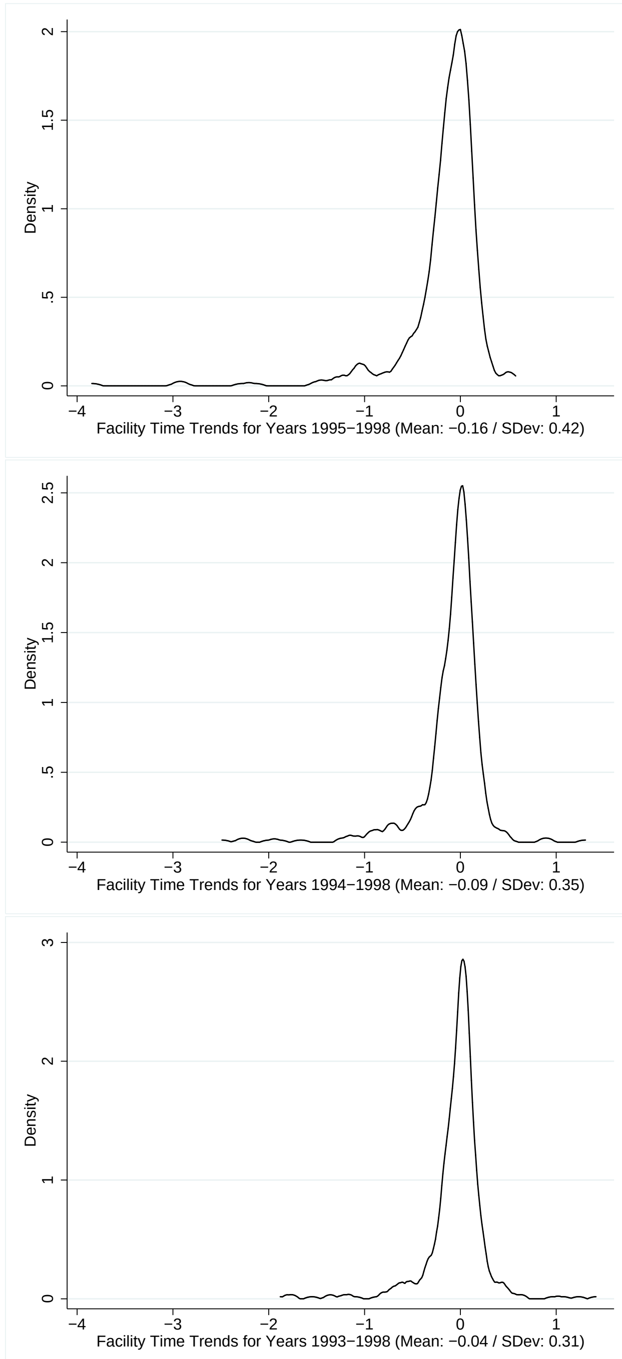
Notes: Table conducts a placebo test where facilities in sectors that are newly covered in 1998 are merged with existing 1997 facilities, i.e., one year prior. Columns (1a)-(1c) use releases and facility rankings from Scorecard, while columns (2a)-(2c) use onsite releases and facility rankings from TRINET. Columns (b) include year fixed effects, while columns (a) do not. All regression use data from 1994-1997 and include facility fixed effects, facility-specific time trends. Errors are clustered at the state level. Significance levels are indicated by *** 1%, ** 5%, * 10%.

Figure A1: Location and Releases of TRI Facilities in 2001



Notes: Figure displays location of TRI facilities in the contiguous United Sates in 2001 (Source: TRINET). Total releases in pounds are color-coded using a nonlinear scale to better illustrate the range of releases.

Figure A2: Distribution of Facility-Specific Time Trends



Notes: Figure displays the distribution of the facility-specific timer trends. The three panels use time periods 1995-1998, 1994-1998, and 1993-1998, respectively. Regression results are given in column (1c) of Table 2, and columns (2) and (1) of Table A3, respectively. The average of the 1998 state rank fixed effects are: -0.37, -0.52, and -0.60, respectively.

Table A1: The Effect of Being a "Top 10" Facility - First Stage (Scorecard Data)

Variable	(1a)	(1b)	(1c)	(2a)	(2b)	(2c)
No. New Top 10	0.093***	0.093***	0.091***	0.093***	0.093***	0.090***
	(0.004)	(0.006)	(0.006)	(0.004)	(0.006)	(0.006)
$I_{\textbf{rank 1 in 1998}}$	-0.993***	-0.960***	-0.921***	-0.787***	-0.937***	-0.716***
	(0.023)	(0.034)	(0.048)	(0.068)	(0.040)	(0.074)
$I_{\textbf{rank 2 in 1998}}$	-0.937***	-0.903***	-0.865***	-0.734***	-0.884***	-0.668***
	(0.045)	(0.049)	(0.060)	(0.074)	(0.059)	(0.078)
$I_{\textbf{rank 3 in 1998}}$	-0.801***	-0.787***	-0.736***	-0.602***	-0.772***	-0.546***
	(0.068)	(0.069)	(0.075)	(0.083)	(0.070)	(0.085)
$I_{\textbf{rank 4 in 1998}}$	-0.673***	-0.591***	-0.566***	-0.477***	-0.580***	-0.379***
	(0.080)	(0.084)	(0.084)	(0.085)	(0.083)	(0.084)
$I_{\textbf{rank 5 in 1998}}$	-0.522***	-0.498***	-0.439***	-0.330***	-0.489***	-0.255***
	(0.085)	(0.086)	(0.084)	(0.079)	(0.085)	(0.074)
$I_{\textbf{rank 6 in 1998}}$	-0.354***	-0.339***	-0.281***	-0.143**	-0.313***	-0.080*
	(0.082)	(0.080)	(0.076)	(0.056)	(0.078)	(0.046)
$I_{\textbf{rank 7 in 1998}}$	-0.284***	-0.250***	-0.200***	-0.081*	-0.225***	
	(0.078)	(0.073)	(0.066)	(0.044)	(0.070)	
$I_{\textbf{rank 8 in 1998}}$	-0.208***	-0.185***	-0.100*		-0.161***	0.097*
	(0.071)	(0.063)	(0.053)		(0.060)	(0.052)
$I_{\textbf{rank 9 in 1998}}$	-0.079	-0.020		0.125**		0.195***
	(0.049)	(0.044)		(0.058)		(0.065)
$I_{\textbf{rank 10 in 1998}}$			0.066	0.203***	0.019	0.260***
			(0.048)	(0.070)	(0.043)	(0.076)
$I_{\textbf{year 1996}}$	-0.238***	0.161***	0.091***	-0.236***	0.166***	0.088***
	(0.023)	(0.031)	(0.022)	(0.024)	(0.031)	(0.022)
$I_{\textbf{year 1997}}$	-0.476***	0.323***	0.179***	-0.472***	0.332***	0.174***
	(0.044)	(0.062)	(0.044)	(0.049)	(0.061)	(0.044)
$I_{\textbf{year 1998}}$	-0.165***	1.008***	0.773***	-0.361***	1.004***	0.576***
	(0.054)	(0.128)	(0.078)	(0.070)	(0.131)	(0.098)
Observations	1863	1863	1874	1899	1905	1922
Facilities	468	469	473	477	480	486
Include Territories	No	No	No	Yes	Yes	Yes
Time Diff τ	1	2	3	1	2	3

Notes: Table presents the first stage results for panel A of Table 2 in the main paper. Errors are clustered at the state level. Significance levels are indicated by *** 1%, ** 5%, * 10%.

Table A2: The Effect of Being a "Top 10" Facility - First Stage (TRINET Data)

Variable	(1a)	(1b)	(1c)	(1d)	(2a)	(2b)	(2c)	(2d)
No. New Top 10	0.094***	0.094***	0.092***	0.091***	0.093***	0.092***	0.091***	0.090***
	(0.003)	(0.006)	(0.006)	(0.006)	(0.004)	(0.006)	(0.007)	(0.006)
$I_{\textbf{rank 1 in 1998}}$	-0.977***	-0.963***	-0.894***	-0.998***	-0.878***	-0.898***	-0.882***	-0.983***
	(0.036)	(0.038)	(0.052)	(0.017)	(0.051)	(0.047)	(0.051)	(0.020)
$I_{\textbf{rank 2 in 1998}}$	-0.958***	-0.944***	-0.884***	-0.985***	-0.867***	-0.888***	-0.880***	-0.979***
	(0.038)	(0.040)	(0.053)	(0.031)	(0.056)	(0.051)	(0.052)	(0.031)
$I_{\textbf{rank 3 in 1998}}$	-0.837***	-0.802***	-0.734***	-0.816***	-0.755***	-0.756***	-0.740***	-0.819***
	(0.062)	(0.066)	(0.073)	(0.065)	(0.072)	(0.071)	(0.072)	(0.064)
$I_{\textbf{rank 4 in 1998}}$	-0.657***	-0.642***	-0.574***	-0.636***	-0.579***	-0.599***	-0.583***	-0.643***
	(0.079)	(0.079)	(0.083)	(0.079)	(0.082)	(0.081)	(0.082)	(0.078)
$I_{\textbf{rank 5 in 1998}}$	-0.517***	-0.502***	-0.434***	-0.507***	-0.441***	-0.462***	-0.446***	-0.517***
	(0.083)	(0.083)	(0.083)	(0.083)	(0.082)	(0.082)	(0.082)	(0.082)
$I_{\textbf{rank 6 in 1998}}$	-0.359***	-0.324***	-0.220***	-0.302***	-0.267***	-0.267***	-0.216***	-0.295***
	(0.080)	(0.078)	(0.068)	(0.076)	(0.072)	(0.072)	(0.067)	(0.075)
$I_{\textbf{rank 7 in 1998}}$	-0.236***	-0.220***	-0.132**	-0.230***	-0.145**	-0.165***	-0.129**	-0.224***
	(0.071)	(0.069)	(0.054)	(0.071)	(0.056)	(0.060)	(0.053)	(0.070)
$I_{\textbf{rank 8 in 1998}}$	-0.161**	-0.146**	-0.058	-0.155**	-0.072*	-0.093**	-0.057	-0.152**
	(0.062)	(0.059)	(0.042)	(0.063)	(0.039)	(0.045)	(0.041)	(0.062)
$I_{\textbf{rank 9 in 1998}}$	-0.087	-0.052		-0.056				-0.055
	(0.055)	(0.051)		(0.040)				(0.039)
$I_{\textbf{rank 10 in 1998}}$			0.095*		0.085	0.050	0.093*	
			(0.053)		(0.054)	(0.050)	(0.051)	
$I_{\textbf{year 1996}}$	0.022	0.111***	0.059**	0.073***	0.077***	0.109***	0.058**	0.072***
	(0.024)	(0.027)	(0.023)	(0.019)	(0.023)	(0.026)	(0.023)	(0.018)
$I_{\textbf{year 1997}}$	0.044	0.223***	0.118**	0.145***	0.155***	0.218***	0.116**	0.143***
	(0.048)	(0.053)	(0.047)	(0.037)	(0.045)	(0.052)	(0.046)	(0.036)
$I_{\textbf{year 1998}}$	0.597***	0.862***	0.656***	0.799***	0.684***	0.813***	0.663***	0.803***
	(0.086)	(0.084)	(0.051)	(0.022)	(0.053)	(0.078)	(0.050)	(0.022)
Observations	1927	1925	1930		1983	1981	1986	
Facilities	483	483	484	482	497	497	498	496
Include Territories	No	No	No	No	Yes	Yes	Yes	Yes
Time Diff τ	1	2	3	4	1	2	3	4

Notes: Table presents the first stage results for panel B of Table 2 in the main paper. Errors are clustered at the state level. Significance levels are indicated by *** 1%, ** 5%, * 10%.

Table A3: The Effect of Being a "Top 10" Facility - Different Years for Pretrend

Variable	(1)	(2)	(3)	(4)
	A: Data from Scorecard			
Out of Top 10	0.524**	0.550**	0.534**	0.388
	(0.223)	(0.223)	(0.216)	(0.236)
F-stat (1st stage)	266.75	247.19	239.10	217.49
Observations	2764	2323	1874	1383
Facilities	475	475	473	461
	B: Data from TRINET			
Out of Top 10	0.693***	0.784***	0.774***	0.585**
	(0.247)	(0.261)	(0.292)	(0.259)
F-stat (1st stage)	213.95	197.56	202.46	178.35
Observations	2855	2401	1930	1443
Facilities	487	487	484	481
Years in Pre-trend	1993-1998	1994-1998	1995-1998	1996-1998

Notes: Table regresses log releases on whether the facility dropped out of the "Top 10" list, which is instrumented by the number of newly covered facilities in the top 10 after the 1998 program expansion. Columns vary what years are used in the analysis ranging from 1993-1998 in column (1) to 1996-1998 in column (4). All regressions include facility fixed effects, facility-specific time trends, and year fixed effects. Panel A uses data from Scorecard for onsite releases, while panel B uses data from TRI.NET. Errors are clustered at the state level. Significance levels are indicated by *** 1%, ** 5%, * 10%.