Regulation and Revelation: Policy Tool Interactions and Toxic Releases *

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Abstract

Toxics information disclosure programs have been hailed by some as the most successful environmental programs in history. Yet critics have argued that these policies may invite abuse by reducing traditional regulatory monitoring and enforcement, leading to poorer policy outcomes. In this study we leverage variation in U.S. state toxics information programs to examine these conflicting claims. Our analyses indicate that information disclosure policies significantly impact both agency monitoring and enforcement actions and changes in emission levels, but that these effects are mediated by the prior level of toxic releases. Thus, the effect of these informational policies appears to be conditional upon what the information being disseminated signals regarding the severity of the pollution problem. Ultimately, our evidence suggests that public information policies and traditional forms of regulation are imperfect substitutes, and successfully reducing toxic emissions requires both policy tools working in concert.

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Introduction

One of the most significant recent trends in regulatory policy involves the widespread adoption of approaches that are designed to provide lower cost, more flexible alternatives to traditional "command and control" regulation. Such approaches come in many flavors, but in general they afford regulated businesses greater discretion, with governments relying on market forces and third parties to monitor corporate compliance, in theory overcoming the information asymmetry faced by traditional regulators. Specific practices include market-based incentives, public-private partnerships, environmental management systems, devolution, and corporate self-reporting (Press and Mazmanian 2019). Depending on the context, these measures can be implemented independently or in conjunction with one another. Various forms of these practices have been termed enforced self-regulation, management-based regulation, principles-based regulation, meta-regulation, and next (or second) generation regulation, and have been the focus of a wide stream of academic literature (for overviews see Coglianese and Mendelson (2010); Gilad (2010)). In the area of environmental policy, some combination of these measures have been adopted by many industrialized nations; together they are sometimes simply referred to as the "new environmental regulation" (Fiorino 2006).

In theory, these practices allow for goal-based rather then rule-based regulatory regimes, resulting in a movement away from an adversarial relationship between government and industry toward a more cooperative one. Cooperative relationships between industry and regulators may build trust between them, allowing both parties to overcome the suboptimal regulatory outcomes associated with the "regulation dilemma" (Potoski and Prakash 2004) and forge win-win policy solutions.

However, these practices are controversial. Critics have questioned the underlying assumptions, practical implementation, and general effectiveness of such policies. Scholars have found that third party involvement in policy monitoring and enforcement creates a chaotic policy environment (Simon 2017), that industry self-regulation alone is unlikely

to mitigate damage to common-pool resources (Andrews 1998), and that participation in self-governance environmental programs may actually increase firms' toxic pollution levels (Gamper-Rabindran and Finger 2013). Thus, critics maintain, credible enforcement and verification are important conditions for extracting environmental benefits (King et al. 2012).

One of the most common themes running through these varied critiques is that these next generation policies may invite abuse by reducing traditional regulatory monitoring and enforcement levels, leading to poorer policy outcomes. In this study we empirically examine the relationship between these regulatory policy tools and traditional command and control regulatory approaches within the context of toxics information disclosure policies in the United States. Such policies, which center on the U.S. Toxic Release Inventory (TRI), are considered to be among the earliest and most well-established forms of the new environmental regulation (Fiorino 2006), and many observers consider them to be among the most important and effective environmental policies ever produced (Graham 2002).

Although the federal TRI imposes uniform reporting requirements, during the 1980s and 1990s many U.S. states adopted programs designed to disseminate toxics information more broadly and aid in its interpretation. There is substantial variation in the breadth of the programs states adopted. States are also responsible for the bulk of implementation and enforcement of core federal pollution control laws such as the Clean Air Act, Clean Water Act, and Resource Conservation and Recovery Act, which governs the disposal of hazardous solid waste (Woods 2022). This allows us to exploit variation in policies, enforcement rates, and emissions across states and time to examine two questions:(1) Are policies promoting greater information disclosure associated with lower levels of traditional inspection and enforcement activity? and (2) Are these policies associated with greater reductions in toxic emissions?

The TRI Debate

It is commonplace for governments to employ multiple policy tools across a range of programs to achieve a particular policy goal (Salamon 2002). Although the characteristics of particular policy tools have been a longstanding subject of scholarly inquiry, how these tools interact, and how the interaction affects policy outcomes, has been the subject of little attention (recent exceptions in the environmental policy arena include Cheng and Yi (2017) and Yi and Feiock (2012)). In this study we explore the interaction between two important policy tools in the environmental regulatory arena: traditional command and control regulation and public information provision.

Public information provision is a cornerstone of next generation regulatory policy. In recent years governments around the world have adopted a wide variety of initiatives aimed at providing the public with the information necessary to evaluate agency and firm performance. Commonly framed around communities' or consumers' "right to know" about relevant financial, health, and environmental risks, information disclosures impact day-to-day life in a variety of circumstances, including school performance reports, restaurant grading systems, campaign finance disclosures, corporate financial reports, and consumer product disclaimers, among others (Graham 2002).

Information transparency is also an increasingly important principle within the context of environmental policy-making. One of the most important U.S. information disclosure policies is the TRI. It dates back to 1986, when Congress passed the Emergency Planning and Community Right-to-Know Act (EPCRA) in response to a toxic gas release from a pesticide plant in Bhopal, India that resulted in the deaths of over 2,000 people. EPCRA established annual reporting requirements for industrial facilities in the United States and provided communities and stakeholders with access to detailed facility-level information on the total pounds of toxic substances released annually into the air, ground, and water.

Since the inception of the TRI program the amount of toxic chemicals released in the

U.S. have declined dramatically, leading the TRI to be considered by some to be one of the most successful environmental programs in history and a model for information disclosure programs worldwide (Graham 2002). At the same time, there has been dramatic variation in observed environmental performance across both states and firms (Kraft et al. 2011). The program has also come under criticism on a variety of fronts.

The data have been criticized for not accurately reflecting environmental risk (Gerde and Logsdon 2001), for inconsistencies in reporting requirements over time (Poje and Horowitz 1990), and for having many reporting errors (Brehm and Hamilton 1996; Koehler and Spengler 2007; Marchi and Hamilton 2006). And while the data are publicly available, some critics maintain that the technical complexity of the reported information makes it challenging for non-experts to access, accurately interpret, and effectively use without supplemental analysis or additional information dissemination efforts (Bae et al. 2010; Gerde and Logsdon 2001; Weil et al. 2006). The extent to which the observed reductions in overall toxic releases can be attributed to the TRI program has also been called into question (Graham 2002; Natan Jr and Miller 1998), and some scholars have argued that relying on information disclosure without a strong traditional regulatory monitoring and enforcement infrastructure would be ineffective, and possibly counterproductive (Kraft et al. 2011).

Public Information Policies and Traditional Regulation: Substitutes or Complements?

Many scholars have argued that the TRI marks a notable transition away from the traditional command-and-control regulatory approach to environmental policy making in the U.S. (Fiorino 2006; Hamilton 2005). Yet the relationship between the TRI and traditional regulatory approaches is far from clear. Indeed, depending on the source one consults, one could conclude that environmental protection agencies treat it as either as a substitute for or a complement to their regular regulatory monitoring and enforcement activities. More-

over, as we argue below, its effect on these activities may vary depending upon the what the information being conveyed signals about severity of the environmental pollution problem, such that it acts as a substitute in some circumstances and a complement in others. Finally, the net effect of these informational policies on pollution emissions remains uncertain. We elaborate on these points in the remainder of this section.

Public Information Policies as a Substitute for Traditional Regulation

Advocates view public information policies as a more effective, lower-cost substitute for traditional forms of regulation such as formulating, monitoring, and enforcing strict standards on pollution emissions (Fiorino 2006). This substitutive approach has been termed "regulation through revelation" (Hamilton 1995).

Like other information provision policies, the TRI is premised on the idea that citizens and investors care about environmental performance, and will be empowered to utilize the information to pressure firms into reducing pollution levels, effectively taking the place of traditional regulators. Despite some mixed results, scholars have generally found that TRI reporting has impacted the behavior of consumers (Mastromonaco 2015), community and environmental groups (Grant 1997), the media (Hamilton 1995; Saha and Mohr 2013), stock market and firm values (Clarkson et al. 2010; Konar and Cohen 1997), and ultimately, polluting firms (Hamilton 2005; Kraft et al. 2011; Lee 2010). When governments adopt strong toxics information disclosure policies, then, they may rely less on traditional regulatory monitoring and enforcement activities, effectively outsourcing these regulatory functions to third parties. Thus, the *regulatory substitution hypotheses* suggests that stronger information disclosure policies lead to reduced rates of regulatory inspections and enforcement actions.

Public Information Policies as a Complement to Traditional Regulation

Alternatively, public information policies may be viewed as a complement to existing regulatory approaches. In part, this view emphasizes the ability of government agencies to

incorporate information gleaned through public disclosure into their regulatory process. In the context of toxic reduction policies, TRI information often becomes highly "embedded" in the decisionmaking of regulatory agencies (Weil et al. 2006; Yu et al. 1998). Indeed, Kraft et al. (2011) find that regulators actively utilize TRI information to set priorities and inform regulatory monitoring and enforcement, and argue that the value of informational policies is dependent on having a strong regulatory regime in place as well, a combination that they refer to as a hybrid approach. Thus, TRI reporting may be effective in reducing firms' emissions primarily when governments use the information to bolster their regulatory enforcement efforts (Bui 2005).

Moreover, the information disclosed by TRI reports may put additional pressure on regulators to more effectively deal with toxic emissions. Environmental groups and news outlets routinely publish lists of the largest emitters of toxic pollution, both in terms of facilities and states. These lists frequently receive media attention, which may put pressure on regulators, as well as on firms themselves. Thus additional public pressures on regulators lead to increased enforcement, in a process that may be termed "regulation due to revelation." Thus, the *regulatory complement hypotheses* suggests that greater information disclosure policy is associated with increased rates of regulatory inspections and enforcement actions.

The Importance of the Informational Signal

Though the two preceding hypotheses produce static (and competing) directional predictions regarding the effect of information disclosure policies on traditional forms of regulatory activity, we argue that there is a more nuanced alternative: that the effect of informational policies is conditional on the information itself. With respect to TRI, the content of the information is often interpreted as signal about the severity of a state's pollution problem.[1] It is important to observe that tons of toxic chemical released has significant limitations as

[1]This information may be interpreted at the level of individual facilities, or at the level of states. Because we are interested in state level regulatory strategies, in this paper we are focused on the latter. For an analysis of how TRI information is used for facility-level targeting of enforcement, see Li (2020).

a measure of overall state environmental pollution severity for several reasons: TRI releases are self-reported, pounds of chemical releases are a weak proxy for overall level of toxicity, and other important features of state environmental quality are omitted. Nonetheless, due to comparability across states, annual reporting, and breadth of indicators involved (including air media, water media, and hazardous waste) aggregate levels of toxic emissions across environmental media have often been used as an indicator of overall level of pollution severity in a state by both the mass media and scholars (e.g., Fowler 2020; Fowler and Kettler 2021; Woods 2008, 2015) alike.

This informational signal about the overall scope of a state's pollution problem may impact the degree to which agencies rely on informational or traditional regulatory policy tools. One could conceive of two ways this process could unfold. One perspective would suggest that wide dissemination of toxics information would have a greater impact under circumstances in which the information being conveyed suggests that the problem is more severe. In these circumstances, third parties such as interest groups, the media, investors, and consumers should step up their pressure on polluters, therefore allowing state regulatory agencies to pull back on traditional monitoring and enforcement activity. An alternative view would suggest the obverse: that regulatory agencies will step up their enforcement in cases where the problem is more severe, due to some combination of greater recognition of the intrinsic severity of the problem and increased third party pressure to do more about it. Each of these suggests a *conditional regulation hypothesis* in which the effect of public information policies is conditioned by the amount of toxic emissions. Increases in these emissions could, in theory, lead to either increased or decreased regulatory substitution.

Implications for Toxic Releases

The question of whether states use information disclosure policies as a substitute or complement for traditional regulatory activities has implications for overall levels of toxic emissions.

If strictly used as a complement, levels of toxic emissions should be lower (or, at worst, the same) as with traditional forms of regulation, because overall levels of traditional monitoring and enforcement activities will remain relatively unchanged. If used as a substitute, however, the effect is uncertain a priori. Advocates of next generation policies argue that these policies are more effective than traditional regulatory activities, suggesting that substitution should lead to greater reductions in releases. If, on the other hand, the critics are correct, it may be the case that firms respond to laxer government scrutiny by increasing emissions. That is, reliance on external actors may empower polluting firms to evade scrutiny and accountability for their actions (Li 2020). Further, if the relationship between information disclosure policies and future emissions is mediated by prior levels of toxic emissions, as suggested by the conditional regulation hypothesis, either of the above effects also could be observed.

The preceding discussion raises two questions. First what impact do policies promoting greater information disclosure have on levels of traditional inspection and enforcement activity? Second, are these policies effective in reducing future TRI emissions? Our analyses assess these questions within the context of toxics information policies in the U.S. states.

State Toxics Public Information Policies

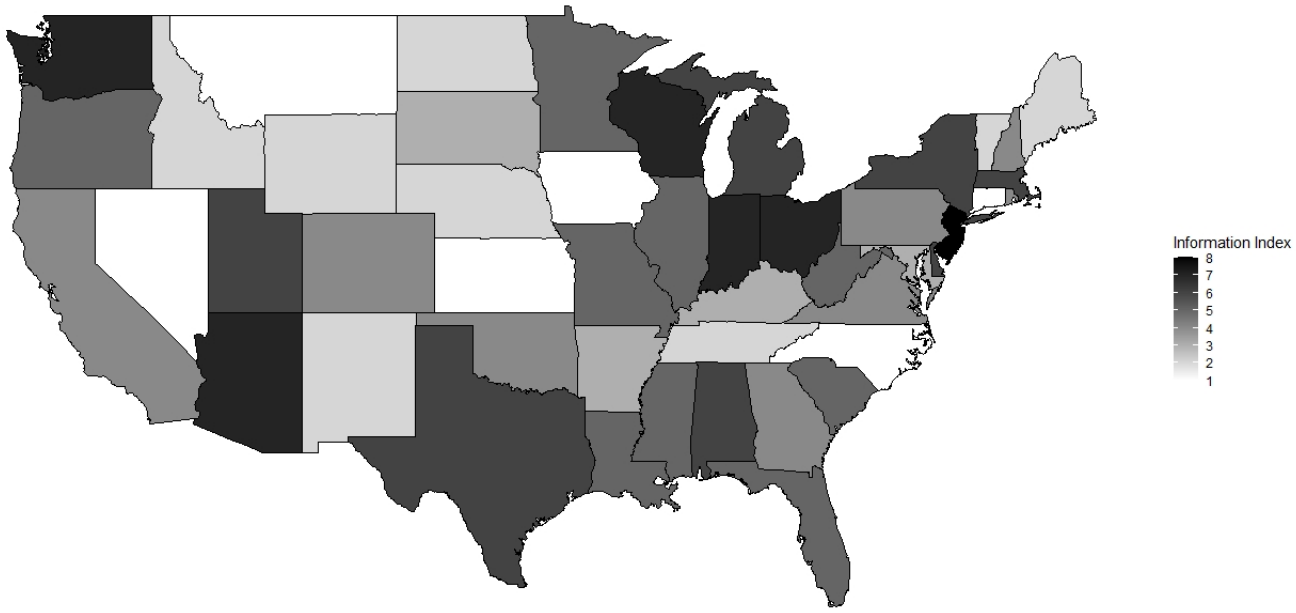
There have been numerous discussions about the difficulties citizens may encounter in trying to make sense of TRI data. In recent years there has been an increased effort by the EPA to make TRI data more comprehensible to average citizens, including providing modeling tools to help citizens understand the toxicity of air emissions in their community. Today, such information dissemination features tend to be primarily internet-based, hosted on interactive platforms on the EPA website. With the dominance of the web as an information dissemination platform, there is today relatively little variation across states in the ease of access to the data or ability to interpret it. However, this was not always the case. During the 1990s, overall internet usage was far lower, most TRI data was not web-accessible, and state

governments played a much bigger role in the dissemination of this information and with assisting citizens, local media, and interest groups to interpret and make use of it. Critically, in the early days of the TRI state governments adopted different policies regarding information diffusion that could potentially enhance the ability of this information to achieve the goals that disclosure policy advocates have articulated. The baseline complexity of interpreting raw-releases makes state-level interpretation, processing, or public accessibility initiatives potentially important factors in the effectiveness of the TRI program.

To capture variation in state public information policies, we follow other researchers (Bae et al. 2010; Shapiro 2005; Yu et al. 1998) in using a simple additive index of various state activities collected from surveys conducted by the National Conference of State Legislatures (NCSL) from 1991 to 1998. To keep the scores consistent over the period of analysis, we include only the 9 survey items that appear across all years.[2] The NCSL survey results, which were reported by the EPA in its annual TRI State Fact Sheets, represent the most consistent and reliable source for evaluating state dissemination initiatives for publicly disclosed toxic emissions information. These initiatives include: providing public forms, public reading rooms, public diskettes, an annual state TRI report, additional data analysis, geographic data, maintaining a computerized database, public access to database, and providing customizable reports or other state information to the public. State scores range from 0 to 8 with an average score of 4. Figure 1 illustrates the number of these initiatives that had been adopted by the states by 1998, the latest year for which data are available.

[2]Due to data constraints, we estimate the index score for 1997 using linear interpolation.

Figure 1: State Toxics Public Information Policies



The link between a state's capacity to process or disseminate TRI information and subsequent emission reductions has been examined in a small number of prior studies. While some researchers have found that state information disclosure policies are associated with lower emissions levels (Shapiro 2005), others have found no effect (O'Toole Jr et al. 1997; Yu et al. 1998). More recently, Bae et al. (2010) find that while overall emissions may not be lowered as a function of state disclosure efforts, overall health risks are reduced.

Other researchers have examined state programs to disseminate TRI information through Local Emergency Planning Committees, which are incorporated into the information dissemination component of the broader NCSL index. While Grant and Jones (2004) find little evidence supporting the claim that these programs impact chemical emissions at the facility-level, Grant (1997) looks at the state-level and finds higher levels of funding for such programs are associated with reductions in overall toxic emissions reductions. These studies suggest that information disclosure policies are more likely to impact firm-behavior when state dis-

closure programs are well-resourced and take more extensive measures to disseminate the reported information.

Overall, the existing literature comes to conflicting conclusions regarding the relationship between information disclosure policies and levels of toxic emissions. However, prior researchers do not examine the question of how these policies affect the use of traditional regulatory monitoring and enforcement tools or assess whether their effects are conditional on emission levels. We now turn to these questions.

Data and Method

Our empirical analyses seek to determine whether information dissemination efforts drive regulatory behavior or subsequent changes in emissions. Our analyses proceed in two stages. During the first stage we examine the effects of toxics information disclosure policies on state regulatory inspection and enforcement rates, and in the second we examine their effect on changes in state-level toxic releases.

Dependent Variables

Our first analysis looks at regulatory inspections and punitive actions. Such bureaucratic outputs are commonly used as measures of environmental policy in the American states (see Konisky and Woods (2012) for an overview). The dependent variables are summary measures of overall state environmental inspection and enforcement rates. These variables are constructed from counts of the annual number of inspections and punitive actions taken by state governments during the period 1991-1998 in the course of implementing federal clean air, clean water, and hazardous waste programs. To account for differences in the levels of industrialization across states, each of these is standardized by the number of manufacturing establishments (for clean air and water pollution) and large-quantity generators of hazardous waste (for hazardous waste). This is similar to how enforcement rates have been calculated in prior work (e.g., Konisky 2007).

Because our interest is in overall levels of state inspection and enforcement stringency, we then combine these rates to create summary measures representing per facility inspection and enforcement rates that are aggregated across the air, water, and hazardous waste programs. We do this by converting the individual rates to Z scores, and then adding the standardized rates together. This creates two aggregate variables representing inspection and enforcement stringency, and mirrors the approach taken in Woods (2015).

In our second analyses, we use the annual change in statewide toxic emissions, discussed below, as our dependent variable.

Core Independent Variables

The core independent variables represent the strength of state information disclosure policies and the content of the information that is being disclosed, as well as the interaction between the two. The first is represented by our index of state information and dissemination efforts, discussed above.

A second variable represents the information that is being disseminated, in this case about the overall severity of the pollution problem in the state. We capture this by using the reported tons of TRI emissions from air, water, and hazardous waste sources. Our state-level data is collected from the U.S. EPA's Toxic Release Inventory and includes total air emissions, surface water discharges, underground injections, and all other reported releases, both on and off-site. The chemicals reported in the TRI have changed over time, so in order to make our data comparable we include only the EPA's 1991 core chemicals group. Our measure thus represents the total statewide toxic emissions to land, water, and air using 1991 core chemicals. In order to correct for skewness, this independent variable is expressed as a natural log in our analyses.

Control Variables

The models also include a set of other independent variables to control for a variety of political, economic, and demographic factors that may influence levels of regulatory enforcement and toxic releases. These variables are analogous to those commonly employed in other studies of state environmental enforcement outputs (Hopper 2017; Konisky 2007; Konisky and Woods 2010; Ringquist 1993; Sjöberg and Xu 2018; Woods 2006) and toxic releases (Bae et al. 2010; Fowler and Kettler 2021; Kraft et al. 2011). Although these two streams of literature examine different phenomena, the variables included in their empirical models are fairly comparable, and the logic for their inclusion is similar.

Both enforcement effort and emissions may be influenced by the partisan preferences of elected state political officials. We measure legislative partisanship as the percentage of the state legislature that is comprised of Democrats, calculated as the average percentage of Democrats in the upper and lower chambers. Gubernatorial partisanship is likewise included, with a dummy variable coded 1 if the governor is a Democrat and 0 if the governor is Republican.

To capture constituency influences, we also include a variable measuring pro-environment public opinion in the states, which was created by Kim and Urpelainen (2018) using a multilevel regression and post-stratification technique. The resulting annual measure is the estimated percentage of state respondents who feel that the U.S. is spending too little on environmental protection. Regulatory enforcement may also reflect interest group pressures in a state. States in which manufacturing industries wield significant political power may seek to enforce regulations less stringently than states in which the industry is relatively weak. Manufacturing gross state product as a percentage of total gross state product is therefore included as a proxy measure of manufacturing industry's economic clout. In order to represent citizen demands for heavier environmental regulation, the analyses similarly

include a variable representing annual per capita Sierra Club membership.

State economic conditions may also affect the political pressures facing state officials, with states in poorer economic climates facing greater political pressure to reduce regulatory stringency and allow greater emissions. The analyses include two indicators of these conditions. First, real personal income per capita is included to account for the availability of financial resources with the state. Greater resources may facilitate increased monitoring and enforcement effort. Second, the state's unemployment rate is included as a general indicator of the state's overall economic circumstances. States may be more willing to reduce enforcement aggressiveness during economic recessions and increase it during periods of relative prosperity.

Finally, the models include a measure of population density as a general demographic variable, as well as fixed effects for EPA region and year in order to account for spatial and temporal heterogeneity (Clark and Whitford 2011). Descriptive statistics for the independent and dependent variables are provided in Table 1, and data sources are provided in the appendix.

Table 1: Descriptive Statistics

	N	Mean	SD
Inspection Rate	384	.022	2.069
Enforcement Rate	383	.020	1.725
Change in TRI	336	.050	1.435
Public Information Policies	384	4.060	1.983
Lagged Ln(TRI)	336	16.831	1.390
Democratic Governor	384	.451	.498
Legislative Percent Democratic	376	.549	.151
Public Environmentalism	384	.612	.043
Manufacturing GSP Percent	384	.176	.067
Sierra Club Membership Per Capita	384	.002	.003
Income Per Capita	384	2.201	.386
Unemployment Rate	384	5.569	1.53
Population Density	384	175.305	240.682

Results

The Effect of State Public Information Policies on Inspections & Punitive Actions

Our first analyses assess the direct effect of toxics information disclosure policies on levels of (1) inspections, and (2) enforcement actions. The results are presented in the first two columns of Table 2. The coefficient estimates on public information policies are not significant in either model. Thus, these models provide no evidence that state information disclosure policies have an unconditional effect on compliance monitoring and enforcement actions that would be consistent with either the regulatory substitution hypothesis or the regulatory complement hypothesis.

Table 2: The Effect of Public Information Policies on Inspection and Enforcement Rates

	Inspection Rate	Enforcement Rate	Inspection Rate	Enforcement Rate
Public Information Policies	-0.033	-0.040	-1.610^{**}	-2.116^{**}
	(0.051)	(0.053)	(0.645)	(0.672)
Lagged Toxic Emissions	-0.19^{**}	-0.184^{**}	-0.502^{**}	-0.594^{**}
	(0.0846)	(0.089)	(0.152)	(0.159)
Public Information Policies X Lagged Toxic Emissions			0.093^{**}	0.122^{**}
			(0.038)	(0.039)
Democratic Governor	0.476^{**}	0.123	0.431^{**}	0.0649
	(0.190)	(0.199)	(0.189)	(0.197)
Democratic Legislature	1.212	1.758^{**}	1.491^{*}	2.125^{**}
	(0.810)	(0.849)	(0.811)	(0.846)
Public Environmentalism	2.829	-0.088	2.894	-0.002
	(4.170)	(4.373)	(4.137)	(4.313)
Manufacturing GSP Percent	7.496^{**}	10.63^{**}	7.579^{**}	10.74^{**}
	(1.878)	(1.969)	(1.863)	(1.942)
Sierra Club Membership	-30.03	-13.89	-26.50	-9.240
	(28.26)	(29.64)	(28.07)	(29.27)
Income Per Capita	0.324	-0.704	0.328	-0.698^{*}
	(0.408)	(0.427)	(0.404)	(0.422)
Unemployment Rate	-0.073	-0.036	-0.092	-0.060
	(0.091)	(0.095)	(0.090)	(0.094)
Population Density	-0.001	-0.0001	-0.001	0.0001
	(0.001)	(0.001)	(0.001)	(0.001)
Constant	-1.696	1.791	3.346	8.429^{**}
	(2.789)	(2.925)	(3.447)	(3.594)
Observations	329	329	329	329
R^2	0.577	0.304	0.585	0.325

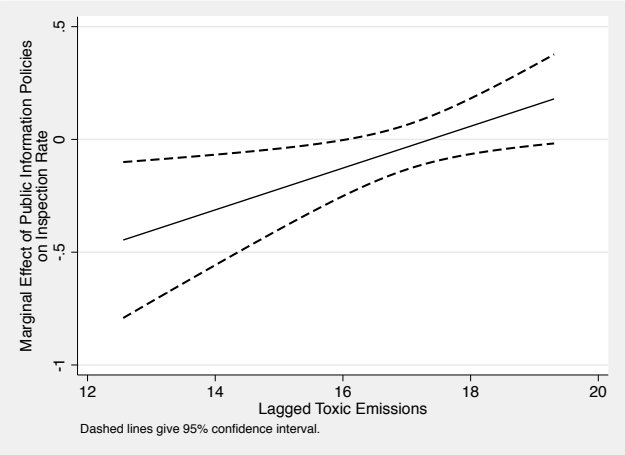
Note: All models include fixed effects for EPA region and year.
$^{**}p < 0.05$, $^{*}p < 0.1$

The picture changes, however, when one looks at results of the interactive models, which are presented in the next two columns. In both cases the coefficient estimate on the inter-

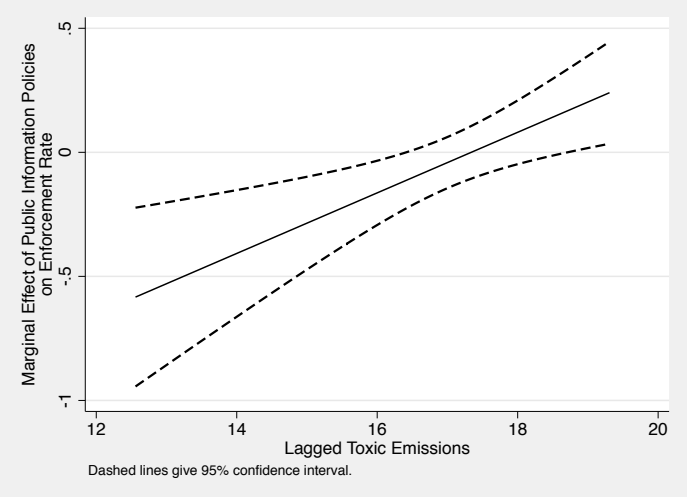
action term is positive and significant, suggesting that state policies do have a significant positive impact on both inspection and enforcement rates, but that this effect is mediated by prior toxic emissions levels, as suggested by the conditional regulation hypothesis. These effects are illustrated graphically in Figure 2. In each case, the upward sloping line shows that the effects of public information policies on inspections and enforcement actions increase as lagged emission levels increase. The overall levels of inspection and enforcement activity are relatively low over most of the range of these variables (recall that the dependent variable is standardized with a mean that is near zero in each case), suggesting that at low and moderate levels of toxic emissions states may be substituting public information policies for traditional regulatory tools. As levels of toxic emissions increase, however, state public information policies lead to elevated levels of traditional regulatory enforcement. At high levels of toxic emissions, states evidence higher than average inspection and enforcement activity, suggesting that the two act more as complements. Thus, the evidence suggests that across much of the range of toxic emissions observed in our data, regulators in states with strong public information policies may be content to outsource traditional regulatory functions to third parties (environmental interest groups, the media, investors and consumers) in accordance with the theoretical underpinnings of the new environmental regulation. However, at higher levels of toxic releases, regulators in these states may be more aware of the problem posed by these toxic emissions, and feel greater pressure to deal with it due to the concerns generated in part by these same third parties.

Figure 2: Marginal Effect of Public Information Policies on Inspection and Enforcement Rates

(a) Inspections



(b) Enforcement actions



The Effect of State Public Information Policies on Toxic Emissions

What effect does the conditional relationship between public information policies and traditional regulatory activities have on overall levels of toxic releases? In this section we take a preliminary step towards addressing that question. Our dependent variable for this analysis is the year over year change in total pounds of statewide toxic releases. Our independent variables largely mirror those used in the first set of analysis, though we have also included the total number of manufacturing facilities as a task factor potentially driving changes in emissions levels (e.g., Kraft et al. 2011).

The results of our panel regression model are presented in Table 3. Again, the interaction term is significant, suggesting that the effect of public information policies on changes in emissions is conditional on levels of prior emissions. The relationship is presented graphically in Figure 3. In this case, the downward sloping line suggests that at relatively low levels of prior toxic emissions, public information policies are associated with greater increases (or, in most cases, smaller decreases) in toxic pollution emissions. As indicated by the previous analyses, this the the area in which traditional inspection and enforcement rates were the lowest. As prior levels of toxic releases increase, public information disclosure policies are associated with greater reductions in toxic releases. Recall also that at increasingly higher levels of prior toxic emissions public information procedures were associated with increased inspection and enforcement rates.

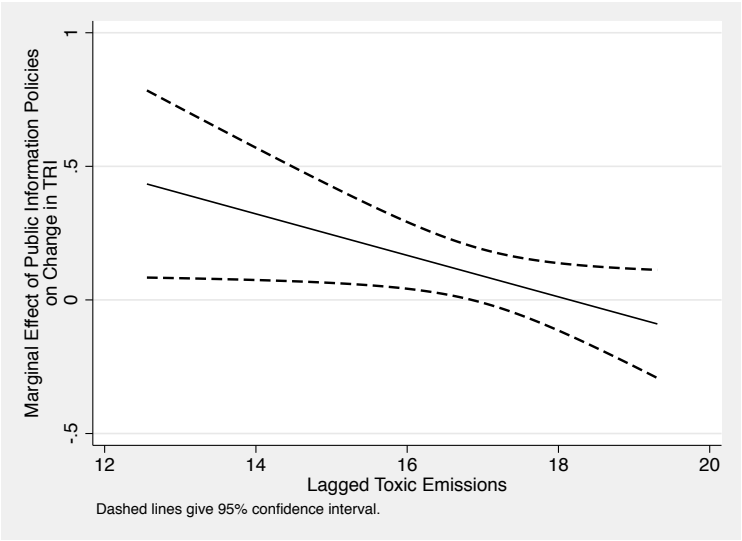
Table 3: The Effect of Public Information Policies on Toxic Emissions

	Change In Toxic Emissions
Lagged Toxic Emissions	0.261*
	(0.154)
Public Information Policies	1.409**
	(0.656)
Public Information Policies X Lagged Toxic Emissions	−0.078**
	(0.039)
Democratic Governor	-0.109
	(0.190)
Legislative Percent Democratic	1.502*
	(0.816)
Public Environmentalism	-2.391
	(4.161)
Sierra Club Membership Per Capita	-11.83
	(29.94)
Manufacturing GSP Percent	-3.008
	(1.874)
Unemployment Rate	-0.097
	(0.096)
Income Per Capita	-0.185
	(0.439)
Population Density	0.001
	(0.001)
Manufacturing Establishments	0.009
	(0.015)
Constant	-2.349
	(3.565)
Observations	329
R^2	0.092

Note: Model includes fixed effects for EPA region and year.
$^{**}p < 0.05$, $^{*}p < 0.1$

Thus, our analyses indicate that (1) as toxic releases increases, states with stronger information disclosure policies evidence increased future inspection and enforcement rates, and (2) as toxic emissions increase, states with stronger information disclosure policies evidence decreased future emissions. Taken together, the results of these analyses provide suggestive (though not dispositive) evidence that when states move toward supplementing toxics information disclosure policies with increased regulatory inspection and enforcement effort, this leads to greater reductions in overall toxic releases.

Figure 3: Marginal Effect of Public Information Policies on Toxic Emissions



Conclusion

Adoption of new tools of government within a policy arena may change how governments utilize existing tools, and the net effect of such changes on policy outcomes are often unclear a priori. In this paper we have examined how state environmental agencies have responded to the adoption of an important and widely publicized new policy tool – toxics public information policies— by changing their traditional regulatory monitoring and enforcement practices, and how these changes have impacted the release of toxic chemicals within their jurisdiction.

Our findings indicate that information disclosure policies significantly impact both agency monitoring and enforcement actions at the aggregate level, though not by always treating them as either complements or substitutes. Rather, the relationship between these sets of policy tools appears to be mediated by the content of the information being disclosed– in this case the total pounds of statewide toxic releases. This information has undeniable limitations both in terms of underlying data quality and accurately characterizing public health risk. At this same time, however, the information is widely disseminated in environmental

interest groups and local news media, incorporated into state regulatory decisionmaking, and is widely considered an important indicator of the overall health of a state's physical environment.

Our analyses suggest that this information, in combination with state policies facilitating its wide dissemination and public understanding of it, jointly affect both traditional regulatory functions and policy outcomes in complex ways. States with low and moderate levels of emissions both inspect facilities at a lower rate and issue punitive actions at a lower rater if they have stronger information dissemination policies. This suggests that state regulatory officials generally behave as if information disclosure, and subsequent monitoring by external actors, is an effective substitute for traditional regulation. As levels of toxic emissions increase, however, state public information policies lead to elevated levels of traditional regulatory enforcement. At very high levels of toxic emissions, state evidence higher than average inspection and enforcement activity, suggesting that the two act more as complements.

Our results also indicate that in states with low and moderate levels of toxic releases (those with relatively low rates of traditional inspection and enforcement activity) public information policies are associated with greater increases (or, in most cases, smaller decreases) in toxic pollution emissions. As prior levels of toxic releases increase, however (and inspection and enforcement activity rise) public information disclosure policies are associated with greater reductions in toxic releases. Thus, our analyses provide suggestive evidence that the trend toward supplementing information disclosure policies with elevated inspection and enforcement rates in cases where states have high prior levels of toxic emissions pays off in terms of greater future emissions reductions. Thus, public information policies and traditional forms of regulation may be imperfect substitutes, and successfully reducing toxic emissions may require both working in concert.

Our results, while suggestive, do not conclusively demonstrate a causal relationship between toxics disclosure policies, inspection and enforcement rates, and levels of toxic emis-

sions. In the future, scholars may seek to further unpack these interrelationships. More generally, future researchers may expand the study of policy tool interactions and their effect on policy outcomes to a variety of other policy contexts. To date, little attention has been paid to how the use of a particular policy tool impacts the use of another. Our study suggests that such policy tool interactions may have significant consequences for policy outcomes.

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Appendix: Data Sources

Variable	Source
Inspection Rate	U.S. Census Bureau's *Annual Survey of Manufacturers* (various years) EPA Biennial Hazardous Waste Report (various years) EPA ECHO Online Database
Enforcement Rate	U.S. Census Bureau's *Annual Survey of Manufacturers* (various years) EPA Biennial Hazardous Waste Report (various years) EPA ECHO Online Database
Change in TRI	EPA TRI Explorer Online Database
Public Information Policies	TRI State Fact Sheet (various years)
Lagged Ln(TRI)	EPA TRI Explorer online database
Democratic Governor	Klarner (2013)
Legislative Percent Democratic	Klarner (2013)
Public Environmentalism	Kim and Urpelainen (2017)
Manufacturing GDP Percent	Jordan and Grossman (2016)
Sierra Club Membership Per Capita	Provided by David Konisky
Income Per Capita	Jordan and Grossman (2016)
Unemployment Rate	Jordan and Grossman (2016)
Population Density	Jordan and Grossman (2016)
Number of Manufacturing Establishments	U.S. Census Bureau's *Annual Survey of Manufacturers* (various years)