COMING CLEAN…AND CLEANING UP? EXAMINING THE EFFECTS OF SELF-POLICING

MICHAEL W. TOFFEL*
Harvard Business School
mtoffel@hbs.edu

JODI L. SHORT
Department of Sociology
University of California, Berkeley
jodishort@earthlink.net

Version: 3/19/07

As regulators increasingly embrace cooperative approaches to governance, voluntary public-private partnerships and self-regulation programs have proliferated. However, because few have been subjected to robust evaluation, little is known about whether these innovative approaches are achieving their objectives. In the context of a nationwide self-policing program that encourages companies to voluntarily self-disclose regulatory violations, we examine the behaviors of facilities and regulators to gain empirical insights on the theoretical promise of self-policing. We find evidence that on average regulators reduce their scrutiny over self-policing facilities, especially those facilities with better historical compliance records. We also find some evidence that self-policing is associated with improved future compliance records.

1. INTRODUCTION

As part of a trend toward collaboration between the public and private sectors, regulatory agencies have developed a variety of "self-policing" programs that shift the burden of monitoring regulatory compliance from the government to firms themselves. For example, firms with comprehensive safety management programs and low injury rates can join the US Occupational Safety and Health Administration's (OSHA) *Voluntary Protection Program*, which exempts participants from routine OSHA inspections (Chelius and Stark 1984). The US Department of Veterans Affairs sponsors an initiative that encourages medical professionals to self-disclose medical errors (Andrus *et al.* 2003). And the US Department of Justice, the US Department of Defense, and the Securities and Exchange Commission offer incentives including amnesty, limited liability, prosecutorial leniency, and

* Corresponding author. Harvard Business School, Soldiers Field, Boston MA 02163. (617) 384-8043. Insightful comments by Neil Fligstein, Robert Kagan, David I. Levine, John W. Maxwell, Howard Shelanski, Bill Simpson, and Jason Snyder are gratefully acknowledged. Ara Abrahamian provided excellent research assistance.

confidentiality to encourage companies to disclose fraudulent or other illegal behavior (Duggin 2003; Fleder 1999; Medinger 2003).

While these kinds of programs have proved exceedingly popular in an era of shrinking regulatory budgets, little is known about the effects of the programs themselves or the motivations of those who participate in them. The act of self-policing presents a behavioral paradox. Tasked with policing the legality of its own operations, it is not clear why a firm would turn itself in to regulators. Nor is it obvious why regulators would voluntarily forfeit enforcement powers to regulated entities. The goal of this paper is to explore what sort of benefits might justify each party's participation in a self-policing arrangement.

There has been surprisingly little research evaluating the outcomes of self-policing programs. The literature on self-policing is largely theoretical and primarily focuses on program design (e.g., Innes 1999a, b; Innes 2001; Kaplow and Shavell 1994; Malik 1993; Pfaff and Sanchirico 2000). And existing evaluations of voluntary programs typically address themselves to the achievements of "beyond compliance" programs rather than self-policing initiatives (Khanna and Damon 1999; Vidovic and Khanna 2005). As self-policing programs proliferate, it is important to understand what kind of results these programs produce. We address this need by conducting one of the first empirical evaluations to assess the effects of self-policing on regulatory outcomes. Specifically, we examine the US Environmental Protection Agency's (EPA) *Audit Policy*, a self-policing program that encourages firms to self-disclose environmental compliance violations by offering to mitigate their associated penalties. We examine whether regulators reduce their scrutiny over self-policing facilities, and whether self-policing is associated with improved future compliance records.

We explore these questions in the enforcement context of two of the most widely applicable federal environmental statutes, the Clean Air Act (CAA) and the Resource Conservation and Recovery Act (RCRA). We find that, in both statutory contexts, self-disclosures result in significantly reduced regulatory scrutiny, but only for firms that have clean compliance records when they self-disclose. Our findings on compliance rates are mixed, evidencing improvement in the CAA context, but not under

RCRA. These findings raise important questions about both firm participation in self-policing as well as the appropriate role of self-policing programs in a broader enforcement scheme.

2. LITERATURE REVIEW

Much of the prior literature on self-policing uses economic models to better understand the self-reporting of legal violations (Innes 2001; Kaplow and Shavell 1994; Pfaff and Sanchirico 2000; Stafford 2006). This literature suggests a number of reasons why self-policing might benefit both regulator and regulated. Firms that voluntarily turn themselves in, for instance, are said to economize on avoidance costs (Innes 2001) and optimize their levels of self-auditing (Pfaff and Sanchirico 2000). Regulators benefit because self-policing has been shown to save enforcement resources that otherwise would have to be spent identifying self-disclosing wrongdoers (Kaplow and Shavell 1994) and to ensure lower-cost remediation of voluntarily disclosed violations (Innes 1999a).

The limited empirical research on self-policing programs has, however, called into question some of these assumptions. Short and Toffel (Forthcoming), for instance, demonstrate that regulators must devote substantial enforcement resources to get firms to participate in self-policing. And Pfaff and Sanchirico (2004) suggest that firms do not report significant violations under the EPA Audit Policy because it is a "bad deal" for companies. In short, we know very little about this behavior that has come to underlie so many new agency programs.

The few empirical studies of self-policing have identified some factors that encourage firms to "turn themselves in" by self-reporting undetected compliance violations. In essence, what these studies find is that companies are most likely to come clean when they fear they will get caught. So, for instance, Short and Toffel (Forthcoming) find that facilities are more likely to self-report if they were subjected to recent regulatory inspections, prosecuted in an enforcement action, or targeted for heightened scrutiny by a compliance incentive program. Stretesky and Gabriel (2005) find that, compared to companies whose Clean Air Act violations were uncovered by regulators, companies located in industries and regions with high inspection levels are more likely to self-disclose such violations under the Audit Policy. Similarly,

related studies find that recently inspected firms are more likely to comply with regulations requiring them to self-report pollution levels and violations (Helland 1998; Laplante and Rilstone 1996).

While there is some literature examining the determinants of self-policing, to our knowledge, no studies have examined the consequences of self-policing programs. For example, the US General Accounting Office recently noted that "OSHA currently lacks the data needed to fully assess the effectiveness of its voluntary compliance programs" (US GAO 2004b: 29) including its *Voluntary Protection Program,* which has been offered since 1982. Similarly, despite the FAA's having launched its *Aviation Safety Reporting Program*'s in 1975, "FAA and NASA have no formal national evaluation program to measure the overall effectiveness of the program" (US GAO 2004a: 43). The US EPA's *Audit Policy*, the subject of the current study, has only been "evaluated" once. Three years after the program's inception 1995, the US EPA surveyed participants and state regulators who were involved in the program and reported high levels of participant satisfaction, including several anecdotes from participants who claimed the program helped them reduce risks to the environment and human health (Federal Register 1999). Thus, to our knowledge, the current study is the first robust empirical examination of the consequences of self-policing.

In this way, our work will contribute to two related literatures evaluating outcomes under different kinds of voluntary programs. A few studies have examined third-party monitoring of regulatory compliance. For example, Esbenshade (2001) and Weil (2005) examined an innovative initiative by the US Department of Labor that encouraged major apparel companies to monitor their Los Angeles-based garment suppliers. In her qualitative study, Esbenshade (2001) found that while such independent monitoring was erratic and often failed to follow the agency's guidelines, it was nonetheless prolific: apparel companies and the independent monitors they hired conducted more than 10,000 audits of garment manufacturers in 1998 alone, ten times the number of inspections conducted by state and federal regulators. A second study, based on a robust quantitative evaluation, concluded that garment contractors monitored by their buyers exhibited fewer, and less egregious, violations of minimum wage regulations (Weil 2005).

A second related body of work evaluates the outcomes of government-initiated voluntary programs that encourage firms to (1) perform beyond minimal compliance thresholds (Khanna and Damon 1999; Vidovic and Khanna 2005) or (2) promote regulatory objectives in domains where the regulator has no formal sanctioning authority, such as encouraging energy efficiency to reduce carbon dioxide emissions (Welch et al. 2000). Similarly, some evaluations have examined self-regulation programs purporting to achieve regulatory objectives such as reducing pollution and enhancing worker safety that are initiated by industry associations (King and Lenox 2000; Rivera et al. 2005) and international consortia (Toffel 2006). These studies find that voluntary programs have very little effect.

This paper represents an important contribution to the literature on self-policing and self-regulation. First, it expands previous work on the determinants of self-policing. Existing studies explain self-policing behavior solely in terms of the risks of non-disclosure, but this paper addresses the potential benefits of voluntary disclosure, and thus provides additional explanations for self-policing. Second, it provides a rigorous empirical analysis of self-policing outcomes that, to date, does not exist. Moreover, it examines outcomes from the perspective of both the regulator and the regulated entity. Finally, it overcomes some of the limitations of prior evaluative studies, which typically focus on a single industry (Esbenshade 2001; King and Lenox 2000; Rees 1994; Rivera et al. 2005; Weil 2005). Our study spans a wide variety of industries, which should produce more generalizable insights about the dynamics of industry self-regulation.

3. EMPIRICAL CONTEXT: US EPA AUDIT POLICY

The US EPA's "Incentives for Self-Policing: Discovery, Correction and Prevention of Violations" (Audit Policy), launched in 1995, provides the empirical setting for our research. The main objective of the Audit Policy is to encourage facilities to implement "systematic, objective, and periodic" environmental auditing and to develop a "documented, systematic procedure or practice which reflects the regulated entity's due diligence in preventing, detecting, and correcting violations" (Federal Register 1995: 66708). Under this program, when a facility promptly discloses a violation to US EPA, corrects the

violation, and takes steps to prevent future violations, US EPA reduces or waives the penalties that would have accrued and provides a loose assurance that it will not refer the voluntarily reported case to the US Department of Justice for criminal prosecution. The Audit Policy cannot be applied to violations that are similar to others the facility experienced within the past several years, or to violations that "resulted in serious actual harm or which may have presented an imminent and substantial endangerment to public health or the environment" (Federal Register 1995: 66709). Overall, nearly 3500 facilities have self-disclosed violations under the Audit Policy during 1997-2003.

The US EPA's Audit Policy is an attempt to alter significantly the enforcement dynamic between regulator and regulated. In fact, US EPA has expressed hope that private sector self-policing will "[render] formal EPA investigation and enforcement action unnecessary" (US EPA 2005). The Audit Policy attempts to achieve this by requiring participating firms to maintain a systematic, internal auditing system to monitor compliance with environmental regulations. While the particular violations disclosed under the program are certainly helpful to the regulator, the real leverage of the program is its insistence on company-wide compliance monitoring. If self-disclosing is a reliable indicator that the company is conducting effective internal compliance audits that lead to adequate regulatory compliance, then US EPA could improve its inspection efficiency by reallocating its enforcement resources to focus on non-participants, who would thus be more likely to have violations.

4. HYPOTHESES

We evaluate the effects of the EPA Audit Policy on regulatory enforcement effort and outcomes. To assess the benefits of the program from the participants' perspective, we examine whether voluntarily self-disclosing earns the regulator's goodwill. We also evaluate the program's benefits from the regulator's perspective, by examining whether firms that engage in the compliance monitoring required by the Audit Policy "clean up their act" more broadly and improve their overall regulatory compliance by exhibiting fewer violations.

4.1 Inspections

Firms may self-report violations under the Audit Policy to generate goodwill with the regulator that might result in fewer inspections (Short and Toffel Forthcoming; Pfaff and Sanchirico 2004). However, US EPA provides no assurances of reduced inspections for facilities that self-report violations under the Audit Policy and has adopted the formal stance that: "Auditing does not…replace regulatory agency inspections" (Johnson and Frey 2000: 4). US EPA's Office of Enforcement Policy has noted that regardless of self-policing efforts, "inspections play a major role in assuring quality and lending credibility to self-monitoring programs" and that "inspections remain the backbone of agency compliance monitoring programs" (Wasserman 1990). Despite these claims, US EPA does nonetheless leave open the possibility that facilities that self-disclose violations to the Audit Policy might be subjected to fewer inspections (Johnson and Frey 2000; US EPA 1997).[1] Although the agency cautiously avoids making any explicit promises, US EPA acknowledges that the Audit Policy can only attract self-disclosures if it avoids the impression that self-disclosing will attract increased regulatory scrutiny.[2]

An "inspection holiday," or a decrease in regulatory scrutiny following self-disclosure, would provide significant benefits to participating firms. It reduces direct costs associated with the conduct of inspections, including the staff time and resources that would be distracted from business activities (Shover *et al.* 1984) and the cost of tests conducted during inspections that the firm would have to bear (US EPA 1986). In addition, inspection holidays reduce the likelihood that the firm's violations will be discovered and punished (Dimento 1989).

---

[1] For example, US EPA noted in 1997 that "EPA's longstanding policy is not to agree to limit its non-penalty enforcement authorities as a provision of settlement or otherwise. While EPA may consider such a facility to be a lower inspection priority than a facility that is not known to be auditing, whether and when to conduct an inspection does, and should, remain a matter of Agency discretion" (US EPA 1997: vi). Also, US EPA's Regional Council notes that "While EPA inspections of self-audited facilities will continue, to the extent that compliance performance is considered in setting inspection priorities, facilities with a good compliance history may be subject to fewer inspections" (Johnson and Frey 2000: 5).

[2] In a conversation with one of the authors, a US EPA program administrator noted, "The Agency has to avoid the perception that it is picking on companies who participate in the Audit Policy." (Personal communication, March 16, 2004).

Inspection holidays also provide potential benefits to regulators. First, they can be used as an incentive to encourage self-reporting and participation in compliance monitoring and auditing. Second, regulators may use inspection holidays as a part of a broader targeting strategy, to free up enforcement resources that can then be used to pursue less cooperative firms. Some regulatory agencies are explicitly using their industry partnerships to hone their inspection targeting. For example, the US Occupational Safety and Health Administration (OSHA) publicizes reduced inspection priority as a benefit to participants of its *OSHA Star Program* (Hunt and Wilkins 1992), while the US EPA does the same for participants of its *National Performance Track* program (US EPA 2006). US EPA also uses a "carrot and stick" approach in many of its Compliance Incentive Programs, which notify targets that they are more likely to be inspected if they fail to participate by auditing themselves and disclosing violations.[3] Because inspection holidays provide substantial potential benefits to both regulators and regulated firms, we hypothesize that self-reporters subsequently will face fewer inspections.

However, because the regulator's approach to inspections is highly discretionary, it is important to consider the possibility that self-disclosures may produce different results under different circumstances. Voluntary disclosure does not occur in a vacuum, but rather against a tapestry of existing impressions and ongoing relationships, including the firm's prior reputation with the regulator. Regulators tend to categorize firms as "good apples" or "bad apples" based on their past compliance records for purposes of targeting inspection resources (Harrington 1988; Helland 1998). Self-disclosures provide regulators with new information that may influence (or be influenced by) these existing assessments of firms. However, it is not clear how regulators will interpret the mixed signal that voluntary disclosure sends. Will it be seen as an admission of wrongdoing or a gesture of cooperation and future compliance?

[3] For example, in its letter encouraging iron and steel mini-mills to report violations under the Audit Policy, EPA wrote: "This is a unique opportunity to ensure compliance with environmental requirements before EPA and authorized states begin increased inspections of minimills."

On the one hand, voluntarily disclosing violations might be a strategic way of changing regulators' impressions. Some have argued, for instance, that historically poor compliers may be motivated to self-disclose in an effort to burnish their reputation with the regulator and shake their "bad apple" status (Pfaff and Sanchirico 2004; Short and Toffel Forthcoming). If self-disclosing violations changes regulators' impressions, however, this represents a risk to "good apples", as their disclosures might tarnish their good reputation and spur increased regulatory scrutiny.

On the other hand, voluntary disclosures may reinforce regulators' existing impression of firms as "good apples" or "bad apples." A substantial literature on cognitive biases suggests that regulators will "construe information and events in such a way as to confirm prior attitudes, beliefs, and impressions" (Langevoort 1997: 135). Especially when a signal is ambiguous, people will interpret it in light of what they already know to be true, discarding interpretations that conflict with their pre-existing knowledge (Langevoort 1997; Nelson et al. 1997; Tannen and Wallat 1987). If this occurs systematically as regulators interpret voluntary disclosures, then "good apples" will see benefits from self-disclosing, while "bad apples" may further cement their status.

We empirically examine whether and how regulators respond differently to self-disclosures depending on the facilities' past compliance records.

4.2 Compliance Record

Both firms and regulators are motivated to participate in self-policing by the prospect of improved compliance records following self-disclosure. As Short & Toffel (Forthcoming) and Pfaff & Sanchirico (2004) suggest, firms may see self-disclosure as a way to garner the regulator's goodwill. One manifestation of regulatory favor might be more lenient future inspections in which firms are cited for fewer violations. This expectation is bolstered by research documenting that inspectors' citation practices differ depending on their attitude toward the firm (Aoki and Coiffi 2000; Hawkins 1984).

Improved compliance records are central to the regulator's interest as well. Self-policing is part of a targeting strategy to enhance the overall efficiency of the enforcement regime by identifying

compliant firms and thus enabling regulators to shift their resources to less cooperative firms. Toward this end, US EPA only allows an organization to self-disclose violations to the Audit Policy if the organization discovered the violation through its own internal auditing program. This emphasis on internal auditing is meant to encourage managers to identify and correct compliance problems before regulators arrive to conduct inspections. By actively auditing their own compliance, the agency is hoping that self-reporters "clean up their act" and improve their regulatory compliance more broadly. To the extent this occurs, regulatory inspections should yield fewer violations at organizations with effective internal auditing systems in place. Accordingly, we hypothesize that, whether it is the result of improved compliance or regulatory goodwill, the compliance record of participating companies will improve following a voluntary disclosure.

5. METHODS

5.1 Sample

We gathered data on facilities located across the United States that are subject to the US Clean Air Act (CAA) or the US Resource Conservation and Recovery Act (RCRA). These include 50,436 facilities that emit air pollutants beyond CAA regulatory thresholds, which subjects them to CAA regulations, and 25,351 facilities that generate, manage, store, or treat hazardous waste, which subjects them to RCRA regulations. We focus on these two federal regulations because they apply to a wide range of facilities and activities.

To compare self-disclosing facilities to only those non-disclosers that appeared "similar" in the years preceding the self-disclosures, we developed a matched sample. This enables us to more rigorously estimate the effect of self-disclosures, since the counterfactual is now based only on "similar" non-disclosers. We created the matched sample as follows. For each facility that self-disclosed in a given year, we identified as matches all non-disclosing facilities that were in the same industry (3-digit SIC Code) and that shared an identical record of inspections, violations, and enforcement actions during the two

years prior to the self-disclosure. This resulted in matched samples consisting of 14,706 facilities for the CAA analysis and 9,629 facilities for the RCRA analysis.

5.2 Data and Measures

We measured *voluntary disclosure* as a dummy variable, coded 1 for a facility in a year when it disclosed a compliance violation in conjunction with the US EPA Audit Policy. We compiled data on self-disclosures from the US EPA Integrated Compliance Information System (ICIS) database, the US EPA Audit Policy Docket, and lists of facilities that participated in Compliance Incentive Programs (discussed below). Our sample includes 1142 self-disclosed violations.

We obtained data on regulatory *inspections* to which each facility was subjected during 1991 through 2003 from the US EPA's Resource Conservation and Recovery Act Information (RCRIS) database and Aerometric Information Retrieval System (AIRS)/AIRS Facility Subsystem database.[4] From on these databases, we also calculated the number of annual inspections as well as the number of *years since the facility was last inspected* for compliance with RCRA or CAA. We also calculated the annual number of RCRA and CAA *violations* and *penalties*, as well as the annual *penalty dollar values*, which we log after adding one. We created a dummy variable coded 1 when the facility had at least one *enforcement action*, based on data from the US EPA's ICIS database.[5]

We gathered data on two forms of general deterrence. First, we considered the *National Priority Sectors* that US EPA announced every two years that would be targeted as nationwide enforcement priorities. We coded this as a dummy variable based on data from the US EPA's website.[6]

Second, we gathered data on the facilities targeted by US EPA Compliance Incentive Programs**.**

---

[4] To avoid spurious results, we recoded annual inspection tallies beyond 12 to 12. This affected only 0.08% of observations with RCRA inspections, and 0.55% of observations with CAA inspections

[5] Over 80% of facilities with enforcement actions had only a single one in a particular year. To be conservative and avoid spurious results, we created a dummy variable rather than a count variable to measure enforcement actions.

[6] National Priority sectors relevant to our sample include chemical preparation (1998-9), coal-fired power plants (1996-9), industrial organic chemicals (1996-9), iron and basic steel products (1996-9), metal electroplating and coating (2000-3), mining (1996-7), petroleum refining (1996-2003), plastic materials and synthetics (1996-7), primary nonferrous metals (1996-9), printers (1996-7), and pulp mills (1996-9). http://www.epa.gov/compliance/data/planning/shortterm.html (last updated March 17, 2005)

These programs encourage facilities in particular EPA Regions or industries or that conduct specific regulated activities to reexamine their compliance status regarding a particular regulatory issue and self-disclose and correct any violations they discover. We coded *Compliance Incentive Program targets* as a dummy variable based on data we obtained via a Freedom of Information Act Request of the US EPA.[7]

To distinguish whether regulators treat self-disclosures differently depending on facilities' recent compliance records, we created *any recent CAA violations,* a dummy variable coded 1 if the facility had any CAA violations during the two years preceding the year it self-disclosed, and 0 otherwise. Likewise, we created *any recent RCRA violations* as a dummy variable.

Descriptive statistics and correlations are provided in Tables 1 and 2.

5.3 Models

Inspection holiday model. To assess the effect of self-disclosures on regulatory inspections, we estimate the following equation:

$$y_{it} = f(\beta_1 D_{i,t} + \beta_2 X_{i,t-j} + \beta_3 C_{i,t} + \beta_4 S_{i,t} + \beta_{5t} \lambda_t + \alpha_i, \varepsilon_{i,t}) \quad (1)$$

The dependent variable y_{it} refers to the number of CAA or RCRA inspections to which the facility has been subjected. Our key explanatory variable is *D*, a dummy variable coded 1 when the facility has self-disclosed in any prior year.[8]

We control for many potential determinants of inspections in $X_{i,t-j}$. According to several economic models, regulators can bolster the effectiveness of their limited enforcement budgets by targeting their inspections based on facilities' prior compliance records (Friesen 2003; Harrington 1988). In addition, US

---

[7] Compliance Incentive Programs relevant to our sample include several nationwide programs (Above-Ground Storage Tank Emission Reduction, Airlines, Asphalt Emulsifiers, Bakery Partnership, Food & Kindred Products, Industrial Organic Chemicals, Iron & Steel Mini-mills, Natural Gas Processors, Nitrate Compounds, Pork Producers Cap, Telecommunications, VADEN) and many programs implemented by EPA Regional offices (Region 1: Chemical Industry, Municipal Department of Public Works Audit Initiative, Colleges & Universities; Region 2: Healthcare, Colleges & Universities; Region 3: WV-N. Branch Potomac R. Coal Facility Self Audit & Self Disclosure Projects; Region 5: Iron & Steel Mini-mills; Region 7: Wood Treaters, Continuous Release, Grain Processing; Region 9: Colleges & Universities; Region 10: Oil & Gas). For a listing of the states in each US EPA Region, see www.epa.gov/regions

[8] A statistically significant negative estimate of β_1 would indicate that on average, facilities faced fewer inspections after they self-disclosed a violation and committed to conduct internal compliance auditing.

EPA notes that achieving compliance given its limited resources "is dependent on effective targeting of the most significant public health and environmental risks" (US EPA 1999: 20). This means not only targeting enforcement resources in the most pressing problem areas, but also at the firms most likely to be creating those problems, "taking into account… compliance/enforcement history" (US EPA 1999: 20). Indeed, facilities found in violation are often targeted for more frequent inspections in the near future (Harrington 1988; Helland 1998; US EPA 1990). Thus, we include the number of CAA or RCRA violations for which the facility was cited, and a dummy variable indicating whether the facility was subjected to an Enforcement Action, each lagged one and two years. Because regulators may attempt to ensure that they return to inspect facilities before a certain time lag occurs, we create a counter variable to capture the number of years since the facility was last subjected to a CAA or RCRA inspection. Because this duration may have a non-linear effect on the probability of inspections, we include dummy variables to denote 2, 3, or 4-or-more years since the last inspection.

We include two dummy variables ($C_{i,t}$) to control for whether the facility was targeted for heightened inspector scrutiny via an EPA Compliance Incentive Program or an EPA National Priority sector (described below). To control for variation in enforcement strategies within states over time, we include the log of total penalties environmental regulators assessed and the log of total regulated facilities in each state-year ($S_{i,t}$).

We include year dummies (λ_t) to control for year-specific factors. Finally, we include conditional fixed-effects (α_i) to control for all time-invariant facility-level variables that might influence inspection rates, such as heterogeneity across state regulatory authorities, the facility's year of construction, industry, proximity to the inspection agency, and the affluence of the facility's community (Helland 1998). We include additional dummy variables that denote the number of years prior to or after the match (i.e., 1-year-before match year, match year, etc. 1-year-after the match year, etc).

We use the two year period before the match as the benchmark, against which we compare the facility's experience in the two subsequent years, and then the five subsequent years. To examine

whether regulators treat facilities differently depending on their compliance history in the years immediately preceding their self-disclosure, we create two sub-samples. The "good apples" includes the matched groups of facilities that had no compliance citations (violations or enforcement actions) during the previous two years. The "bad apples" includes the matched groups of facilities that had at least one compliance citation in the previous two years.

Compliance record model. To assess the effect of self-disclosures on regulatory compliance records, we change our unit of analysis from the facility-year to the individual inspection. Here, we are examining whether the likelihood of a regulatory inspection resulting in no violations increases (improves) among facilities once they begin self-policing. We estimate the following equation:

$$y_{id} = f(\beta_1 D_{i,d} + \beta_2 X_{i,t-j} + \beta_3 I_{i,t} + \alpha_i , \varepsilon_{i,d}) \quad (2)$$

The dependent variable y_{id} is a "clean inspection" dummy variable that refers to a facility's regulatory inspection on date *d*, and is coded 1 if the inspection resulted in no compliance violations (i.e., it was "clean"), or else coded 0 if the inspector cited the facility for a violation (i.e., it was "dirty"). This distinction between whether or not inspections resulted in violations has been used by other empirical analyses of regulatory compliance (e.g., Gray and Scholz 1993). We include a "post-voluntary disclosure" dummy variable to denote observations for facilities that had already self-disclosed a violation to the Audit Policy. [9]

We control for several factors that can affect a facility's compliance behavior. We include as $X_{i,t-j}$ the number of inspections and violations, each lagged 1 and 2 years, because a facility's recent regulatory experience can affect its current compliance (Gray and Deily 1996; Gray and Jones 1991; Gunningham et al. 2005; Helland 1998; Magat and Viscusi 1990; Olson 1999; Shimshack and Ward 2005; Weil 1996).

Because the perceived likelihood of being inspected can affect compliance behavior (Laplante and Rilstone 1996; Shimshack and Ward 2005), we include the predicted probability of being inspected

[9] A statistically significant negative estimate of β_1 would indicate that facilities' inspections were more likely to be "clean" after self-disclosing than before self-disclosed, compared to the control group over the same time period.

($I_{i,t}$) as a control variable (Earnhart 2004; Gray and Deily 1996; Laplante and Rilstone 1996). We measure this using the predicted value from the baseline inspection models specified above, run as a pooled logit model that estimates the probability of being inspected at least once in the current year.

Finally, as in the inspection models, we include facility-level conditional fixed effects (α_i) to control for all time-invariant factors that might affect violation rates, such as the facility's and parent company's size, year of construction, state and EPA Region, industry, and headquarters country location (Delmas and Toffel 2005; Gawande and Bohara 2005; Gray and Deily 1996; Helland 1998; Shimshack and Ward 2005).

6. RESULTS

Inspection holidays. For the inspection holiday analysis, we model the annual number of inspections with a conditional fixed-effects negative binomial specification. Table 3 presents our results, which indicate that regulators grant inspection holidays to self-disclosers. Comparing inspections during the two years prior to self-disclosure to the two years after, the matched sample results indicate that self-disclosing is associated with an 18% reduction in the annual number of CAA inspections ($p<0.01$) compared to matched non-disclosers over the same time period (column 1). Among "good apple" facilities (those that had no CAA violations or enforcement action during the two years preceding their self-disclosure or match year), self-disclosing facilities experienced a 13% reduction in inspections ($p<0.01$) compared to "good apple" non-disclosers (column 2). Among the matched group of "bad apples," we find no evidence that regulators altered their inspection scrutiny after facilities self-disclosed.

The inspection holiday results from the RCRA matched sample are similar in some respects to the CAA results. Compared to the two years prior to self-disclosing, self-disclosers were subjected to 43% fewer RCRA inspections ($p<0.01$) during the two years following self-disclosing (column 4). We also find "good apple" self-disclosers experienced a 34% decline in inspections ($p<0.01$) compared to the matched group of "good apple" non-disclosers (column 5). In contrast to the CAA results, we find some

indication that self-disclosing may have invited increased scrutiny for "bad apples," but the estimate is not statistically significant (column 6).

Our CAA and RCRA results were nearly identical when we extended the post-disclosure period to five years. We find that inspection holidays endure at similar magnitudes during the extended post-period (Table 4). The point estimates reveal slightly larger inspection holidays overall and for "good apples" over this longer time period. In addition, we find more significant evidence that RCRA-regulated "bad apples" who self-disclosed attracted additional scrutiny: self-disclosing "bad apples" were subsequently subjected to 21% more inspections than the non-disclosing "bad apples" ($p=0.07$).

Compliance record. The conditional fixed-effects logistic models provide some evidence that self-policing is associated with improved compliance records (Table 5). Our results indicate that inspections conducted during the 2 years subsequent to self-disclosure were three times more likely be "clean" ($p<0.01$) than those conducted during the 2 years prior to self-disclosure (Column 1), compared to the matched controls over the same time period. When we broaden the comparison window to include the 5 year period subsequent to self-disclosure, post-disclosure inspections are twice as likely to be clean as pre-disclosure inspections, compared to the matched controls over the same time period. (Column 2). Together, these results strongly suggest that CAA compliance records improved subsequent to self-disclosure. In contrast, the RCRA results provide no evidence of any change in compliance records subsequent to self-disclosure, regardless of which of these time windows we analyzed (Columns 4-5).

These models use much smaller samples than those in the inspection holiday analysis for two reasons: (1) they examine only facilities that had at least one inspection in each of the pre- and post-inspection periods, and (2) the conditional fixed-effects logistic specification is identified only for facilities that had at least one "clean" inspection and at least one "dirty" inspection during the time windows analyzed. These smaller sample sizes may have contributed to the non-significant results in the RCRA analysis. Therefore, we also ran the compliance model on all facilities nationwide that were regulated by CAA or RCRA during 1995-2003, and included year dummies instead of dummies for years

until (or since) the match year. The results of these models (Columns 3 and 6) were very similar to our results based on the matched samples.

7. DISCUSSION AND FUTURE RESEARCH

Many conjecture that firms self-report legal violations to the regulator based on a belief that coming clean "might help to favorably dispose the regulator toward the firm" (Pfaff and Sanchirico 2004 :426). We demonstrate that, while this is true for facilities identified as "good apples," others should be more cautious in making this assumption. We find that facilities with good compliance records enjoy the benefit of a significant inspection holiday when they voluntarily disclose violations. However, firms with more checkered pasts receive no such benefit, and may even invite greater regulatory scrutiny. This finding suggests that regulators do not interpret each voluntary disclosure as an unambiguous signal about the discloser's willingness to cooperate and comply. Instead, it appears that that self-disclosing reinforces regulators' existing impressions of the facility as "good" or "bad." This finding is consistent with the extensive literature on cognitive biases, which suggests that regulators will process new information through the lens of what they already know about regulated firms (e.g., Fiske and Taylor 1991). In any event, our differing results between "good apples" and "bad apples" suggest that self-disclosing may be a double-edged sword, and that firms should expect differing regulatory responses depending on their pre-existing compliance status.

Any reduction in regulatory scrutiny can be justified only to the extent that voluntary disclosers' participation in self-policing improves their compliance. Unfortunately, there are few available metrics for measuring absolute compliance levels. Our findings on how self-disclosure impacts compliance records are mixed. While self-disclosing facilities' subsequent CAA inspections were less likely to result in violations, there was no change for RCRA inspections. This makes our findings especially difficult to interpret. Empirical research on regulatory compliance typically assumes that violations cited by regulatory inspectors is an unbiased estimate of actual compliance (e.g., Gray and Deily 1996; Gray and Shadbegian 2005; Helland 1998). Under this assumption, our results suggest that many self-disclosing

facilities have indeed "cleaned up their act," at least in terms of the CAA. If this is the case, the Audit Policy appears to be a "win-win": the private sector takes on some of the inspectors' role by self-policing, compliance improves, and regulators are freed up to focus on other companies presumed to be worse compliers.

However, a significant body of research suggests that compliance, at least as measured by violations cited by regulatory inspectors, is highly situational and subjective. McAllister (2006) describes how the meaning of compliance with traditional environmental statutes gets negotiated in the context of an ongoing relationship between regulator and regulated. The amount of goodwill accrued by a regulated firm cannot help but influence the nature of this relationship. Hawkins (1984), for instance, documents how a firm's compliance status emerges from the on-the-ground relationships between inspectors and regulated firms. Inspectors perceive a firm "as 'co-operative' or having a 'good attitude,' or, in contrast, as 'unhelpful,'" (Hawkins 1984:113) and this dichotomy significantly shapes the enforcement approach these officials take with different firms – in some cases, whether they cite violations at all. Similarly, Aoki and Coiffi (2000) argue that regulators tend to "throw the book at" facilities they perceive as recalcitrant by interpreting regulations legalistically to maximize the number of violations. In other words, regulatory goodwill may not be limited to decisions about how frequently to inspect facilities, but may also affect the way in which inspectors both cite and even perceive violations.

In addition, some firms play an active role in manipulating the regulator's perceptions. For instance, Gray (2006) describes how facilities create elaborate "Potemkin Villages" to mask health and safety violations when they know inspectors are going to visit the plant. In sum, the socially situated and contingent nature of compliance inspections makes it very difficult to interpret with confidence a decline in cited violations strictly as an improvement in compliance. One must consider that some portion of the decline in cited violations among self-disclosing facilities may reflect these facilities' improved status in the eyes of the regulator, which enabled them to gain leniency from inspectors.

Teasing apart the extent to which self-disclosing facilities subsequently *committed* fewer violations or were merely *cited* less often due to inspector goodwill is a question that is important not

only to those interested in the public welfare question of whether self-policing enhances actual compliance. In addition, facility managers should be interested because inspector goodwill may erode if compliance does not actually improve over time. Parsing apart these interpretations presents an important opportunity of future research. Developing techniques that can tease apart actual facility compliance from compliance reported by inspectors is crucial for assessing the public welfare implications of voluntary compliance initiatives

Further research is also warranted to further identify the conditions under which regulators decide to grant inspection holidays. Regulatory agencies relate differently to facilities across different industries (Olson 1995), and such differences may spillover to how regulators respond to self-disclosers. For example, regulators may be more willing to provide inspection holidays to self-disclosers in less hazardous industries because their risk of doing so is lower: if these facilities reduce their compliance efforts in response to lower scrutiny, their non-compliance is inherently less likely to seriously threaten the environment or public health than non-compliance among facilities in more hazardous industries. Beyond industry differences, various agencies pursue different enforcement approaches (Bardach and Kagan 1982; Gormley 1998; Shover et al. 1984). While some are legalistic, rule-oriented, and want their inspectors to stringently assess technical compliance and cite every violation they witness, other agencies pursue a more flexible result-oriented approach that emphasizes "responsiveness, forbearance, and the transmission of information" (Shover et al. 1984: 123). While the latter agencies may be more likely to view self-disclosures as evidence of internal auditing and information sharing, more legalistic agencies may view self-disclosures as evidence that previous inspection scrutiny was insufficient.

Finally, future evaluations of self-policing could employ different types of outcomes. For example, researchers could focus on outcome metrics more closely aligned to the ultimate objectives of the regulations. For example, in the Audit Policy context, improving compliance with hazardous waste regulations' labeling and storage requirements might reduce the frequency and severity of spills and injuries, and might reduce the amount of hazardous waste being erroneously shipped to unsuitable treatment facilities. Prior research has found that voluntarily disclosing environmental liabilities can

bolster the credibility of other information such firms release, which reduces their cost of capital and attenuates negative shocks to stock prices when they release bad news (Blacconiere and Patte 1994; Cormier and Magnan Forthcoming). Researchers could investigate whether such benefits also accrue to firms that voluntarily disclose regulatory compliance violations.

8. CONCLUSIONS

We have demonstrated some of the benefits and the limitations of self-policing relationships. Voluntary disclosers with clean compliance records benefit by earning relief from regulatory oversight. On the other hand, firms with poor compliance records receive no such benefits for self disclosing. Both regulators and regulated entities appear to benefit from self-disclosers' reduced CAA violation rates, which allow both sides to claim success in improving compliance through voluntary measures. What remains to be seen is whether these arrangements benefit the public and the environment. While lower violation rates are a promising indicator, they must be accompanied by lower actual pollution rates before success can be claimed for self-regulation. In addition, we found no evidence that self-policing was associated with improved RCRA compliance rates. It may well be that self-policing has greater promise in some regulatory domains than others.

REFERENCES

Andrus, C.H., E.G. Villasenor, J.B. Kettelle, R. Roth, A.M. Sweeney, N.M. Matolo. 2003. "To err is human": uniformly reporting medical errors and near misses, a naïve, costly, and misdirected goal. *Journal of the American College of Surgeons* **196**(6) 911-918.

Aoki, K., J.W. Coiffi. 2000. Poles apart: Industrial waste management regulation and enforcement in the United States and Japan. R.A. Kagan, L. Axelrod, eds. *Regulatory Encounters*. University of California Press, Berkeley, CA.

Bardach, E., R.A. Kagan. 1982. *Going by the Book: The Problem of Regulatory Unreasonableness*. Temple University Press, Philadelphia.

Blacconiere, W.G., D.M. Patte. 1994. Environmental disclosures, regulatory costs, and changes in firm value. *Journal of Accounting and Economics* **18**(3) 357-377.

Chelius, J., H.F. Stark. 1984. OSHA's Voluntary Protection Program. *Labor Law Journal* **35**(3) 167-174.

Cormier, D., M. Magnan. Forthcoming. The revisited contribution of environmental reporting to investors' valuation of a firm's earnings: An international perspective *Ecological Economics*.

Delmas, M., M.W. Toffel. 2005. Institutional pressure and environmental management, Working Paper *Institute for Social, Behavioral, and Economic Research*, University of California, Santa Barbara.

Dimento, J.F. 1989. Can social science explain organizational noncompliance with environmental law? *Journal of Social Issues* **45**(1) 109-132.

Duggin, S.H. 2003. Internal Corporate Investigations: Legal Ethics, Professionalism and the Employee Interview. *Columbia Business Law Review* **2003** 859-964.

Earnhart, D. 2004. Panel Data Analysis of Regulatory Factors Shaping Environmental Performance. *The Review of Economics and Statistics* **86**(1) 391-401.

Esbenshade, J. 2001. The Social Accountability Contract: Private Monitoring from Los Angeles to the Global Apparel Industry. *Labor Studies Journal* **26** 98-120.

Federal Register. 1995. Incentives for self-policing: Discovery, disclosure, and prevention of violations. *Federal Register* **60** 66706-66712.

Federal Register. 1999. Evaluation of 'Incentives for Self-Policing: Discovery, Disclosure, and Prevention of Violations' policy statement, Proposed revisions for public comment. *Federal Register* **64** 26745-26756.

Fiske, S.T., S.E. Taylor. 1991. *Social Cognition (2nd Ed.)*. McGraw-Hill, New York.

Fleder, J.R. 1999. A Voluntary Disclosure Program for FDA – The Time Has Come. *Food and Drug Law Journal* **54** 389-399.

Friesen, L. 2003. Targeting enforcement to improve compliance with environmental regulations. *Journal of Environmental Economics and Management* **46**(1) 72-85.

Gawande, K., A.K. Bohara. 2005. Agency Problems in Law Enforcement: Theory and Application to the U.S. Coast Guard. *Management Science* **51**(11) 1593 - 1609.

Gormley, W.T. 1998. Regulatory Enforcement Styles. *Political Research Quarterly* **51**(2) 363-383.

Gray, G.C. 2006. The Regulation of Corporate Violations: Punishment, Compliance and the Blurring of Responsibility. *British Journal of Criminology* **46**(5) 875-892.

Gray, W., M.E. Deily. 1996. Compliance and enforcement: Air pollution regulation in the US steel industry. *Journal of Environmental Economics and Management* **31** 96-111.

Gray, W., R. Shadbegian. 2005. When and why do plants comply? Paper mills in the 1980s. *Law & Policy* **27**(2) 238-261.

Gray, W.B., C.A. Jones. 1991. Are OSHA Health Inspections Effective? A Longitudinal Study in the Manufacturing Sector. *The Review of Economics and Statistics* **73** 504-508.

Gray, W.B., J.T. Scholz. 1993. Does regulatory enforcement work? A panel analysis of OSHA enforcement. *Law & Society Review* **27**(1) 177-214.

Gunningham, N., D. Thornton, R.A. Kagan. 2005. Motivating management: Corporate compliance in environmental protection. *Law & Policy* **27**(2) 289-316.

Harrington, W. 1988. Enforcement leverage when penalties are restricted. *Journal of Public Economics* **37** 29-53.

Hawkins, K. 1984. *Environment and Enforcement: Regulation and the Social Definition of Pollution*. Oxford University Press, London.

Helland, E. 1998. The enforcement of pollution control laws: Inspections, violations, and self-reporting. *The Review of Economics and Statistics* **80**(1) 141-153.

Howard-Grevnille, J.A., J. Nash, C. Coglianese. 2006. Constructing the License to Operate: Internal Factors and their Influence on Corporate Environmental Decisions, University of Pennsylvania Working Paper.

Hunt, T.E., T.A. Wilkins. 1992. Environmental audits and enforcement policy. *The Harvard Environmental Law Review* **16** 365-427.

Innes, R. 1999a. Remediation and self-reporting in optimal law enforcement. *Journal of Public Economics* **72** 379-393.

Innes, R. 1999b. Self-Policing and Optimal Law Enforcement When Violator Remediation Is Valuable. *Journal of Political Economy* **7** 1305-1325.

Innes, R. 2001. Violator avoidance activities and self-reporting in optimal law enforcement. *Journal of Law, Economics & Organizations* **17** 239-256.

Johnson, K.A., B.C. Frey. 2000. Environmental Auditing Since EPA's 1986 Audit Policy. US Environmental Protection Agency, Office of Regional Counsel, Region 5, Chicago, IL.

Jolls, C., C.R. Sunstein. 2006. Debiasing through Law. *Journal of Legal Studies* **35** 199-241.

Kaplow, L., S. Shavell. 1994. Optimal law enforcement with self-reporting of behavior. *Journal of Political Economy* **102** 583-606.

Khanna, M., L. Damon. 1999. EPA's voluntary 33/50 program: Impact on toxic releases and economic performance of firms. *Journal of Environmental Economics and Management* **37** 1-25.

King, A., M. Lenox. 2000. Industry self-regulation without sanctions: The chemical industry's responsible care program. *Academy of Management Journal* **43**(4) 698-716.

Langevoort, D.C. 1997. Organized Illusions: A Behavioral Theory of Why Corporations Mislead Stock Market Investors (and Cause Other Social Harms). *University of Pennsylvania Law Review* **146** 101-172.

Laplante, B., P. Rilstone. 1996. Environmental inspections and emissions of the pulp and paper industry in Quebec. *Journal of Environmental Economics and Management* **31**(1) 19-36.

Magat, W.A., W.K. Viscusi. 1990. Effectiveness of the EPA's regulatory enforcement: The case of industrial effluent standards. *Journal of Law and Economics* **33** 331-360.

Malik, A. 1993. Self-Reporting and the Design of Policies for Regulating Stochastic Pollution. *Journal of Environmental Economics and Management* **24** 241-257.

McAllister, L.K. 2006. Putting Persuasion Back in the Equation: Compliance in Cap and Trade Programs *Annual Meetings of the Law & Society Association*, Baltimore, MD.

Medinger, J.D. 2003. Antitrust Leniency Programs: A Call for Increased Harmonization as Proliferating Programs Undermine Deterrence. *Emory Law Journal* **52** 1439-1481.

Nelson, T.E., Z.M. Oxley, R.A. Clawson. 1997. Toward a Psychology of Framing Effects. *Political Behavior* **19**(3) 221-246.

Olson, M.K. 1995. Regulatory Agency Discretion among Competing Industries: Inside the FDA Stable. *Journal of Law, Economics, & Organization* **11**(2) 379-405.

Olson, M.K. 1999. Agency rulemaking, political influences, regulation, and industry compliance. *Journal of Law, Economics & Organizations* **15**(3) 573-601.

Pfaff, A.S.P., C.W. Sanchirico. 2000. Environmental self-auditing: Setting the proper incentives for discovery and correction of environmental harm. *Journal of Law, Economics & Organizations* **16** 189-208.

Pfaff, A.S.P., C.W. Sanchirico. 2004. Big field, small potatoes: An empirical assessment of EPA's self-audit policy. *Journal of Policy Analysis and Management* **23**(3) 415-432.

Rees, J.V. 1994. *Hostages of Each Other: The Transformation of Nuclear Safety Since Three Mile Island*. University of Chicago Press., Chicago.

Rivera, J., P. de Leon, C. Koerber. 2005. Is greener whiter yet? The Sustainable Slopes program after five years, Working Paper, George Washington University.

Shimshack, J.P., M.B. Ward. 2005. Regulator reputation, enforcement, and environmental compliance. *Journal of Environmental Economics and Management* **50**(3) 519-540.

Short, J.L., M.W. Toffel. Forthcoming. Coerced Confessions: Self-Policing in the Shadow of the Regulator. *Journal of Law, Economics & Organizations* **24**(1).

Shover, N., J. Lynxwiler, S. Groce, D. Clelland. 1984. Regional variation in regulatory law enforcement: The Surface Mining Control and Reclamation Act of 1977. K. Hawkins, J. Thomas, eds. *Enforcing Regulation*. Kluwer Nijhoff, Boston, MA.

Stafford, S.L. 2006. Self-Policing in a Targeted Enforcement Regime *The College of William & Mary Department of Economics Working Paper*, Williamsburg, VA.

Stretesky, P., J. Gabriel. 2005. Self-policing and the environment: Predicting self-disclosure of Clean Air Act violations under the U.S. Environmental Protection Agency's Audit Policy. *Society and Natural Resources* **18** 871-887.

Tannen, D., C. Wallat. 1987. Interactive Frames and Knowledge Schemas in Interaction: Examples from a Medical Examination/Interview. *Social Psychology Quarterly* **50**(2) 205-216.

Toffel, M.W. 2006. Resolving information asymmetries in markets: The role of certified management programs. Harvard Business School Working Paper.

US EPA. 1986. Study of the Pulp and Paper Industry in Region IV. US Environmental Protection Agency, Washington, DC.

US EPA. 1990. Environmental Enforcement: A Citizen's Guide. Office Of Enforcement, United States Environmental Protection Agency, Washington, DC.

US EPA. 1997. Audit Policy Interpretive Guidance. Office of Regulatory Enforcement, US Environmental Protection Agency, Washington, D.C.

US EPA. 1999. Protecting Your Health & the Environment Through Innovative Approaches to Compliance: Highlights From the Past 5 Years. Office of Enforcement and Compliance Assurance, United States Environmental Protection Agency, Washington, DC.

US EPA. 2005. Compliance Incentives and Auditing. US Environmental Protection Agency.

US EPA. 2006. Compliance Incentives and Auditing. US Environmental Protection Agency.

US GAO. 2004a. Aviation Safety: Better Management Controls are Needed to Improve FAA's Safety Enforcement and Compliance Efforts. United States General Accounting Office, Washington, DC.

US GAO. 2004b. Workplace Health and Safety: OSHA's Voluntary Compliance Strategies Show Promising Results, but Should Be Fully Evaluated before They Are Expanded. United States General Accounting Office, Washington, DC.

Vidovic, M., N. Khanna. 2005. Can voluntary pollution prevention programs fulfill their promises? Further evidence from the EPA's 33/50 Program, Department of Economics, Binghamton University, Binghamton, NY.

Wasserman, C.E. 1990. An Overview of Compliance and Enforcement in the United States: Philosophy, Strategies, and Management Tools *First International Enforcement Workshop Proceedings, International Network for Environmental Compliance and Enforcement, Utrecht*, The Netherlands.

Weil, D. 1996. If OSHA is So Bad, Why is Compliance So Good? *RAND Journal of Economics* **27**(3) 618-640.

Weil, D. 2005. Public Enforcement/Private Monitoring: Evaluating a New Approach To Regulating the Minimum Wage. *Industrial & Labor Relations Review* **58**(2) 238-257.

Welch, E.W., A. Mazur, S. Bretschneider. 2000. Voluntary behavior by electric utilities: levels of adoption and contribution of the climate challenge program to the reduction of carbon dioxide. *Journal of Policy Analysis and Management* **19** 407–425.

Table 1. Variable Definitions & Summary Statistics

Panel A: Annual inspection models

Variable	Obs	Mean	SD	Min	Max
				(for dummy variables, number of times coded 1	
Annual CAA inspections†	47223	1.01	1.81	0	12
Annual RCRA inspections†	45586	0.33	0.89	0	12
Voluntarily disclosed in a prior year (dummy)	47223	0.04	0.18	1665	
Years since prior CAA inspection	42444	1.92	1.19	1	4
Years since prior RCRA inspection	32387	2.64	1.28	1	4
Annual CAA violations†	47223	0.03	0.17	0	3
Annual RCRA violations†	45586	0.10	0.34	0	2
Any enforcement actions (dummy)	45586	0.02	0.13	734	
Compliance Incentive Program target (dummy)	47223	0.05	0.21	2147	
National Priority sector (dummy)	47223	0.17	0.38	8005	
Log total CAA penalties in the state-year	47223	13.73	1.89	7.60	17.56
Log total RCRA penalties in the state-year	47223	11.38	4.28	0.00	17.43
Log number of CAA regulated facilities in the state-year	47223	7.32	0.64	3.93	8.29
Log number of RCRA regulated facilities in the state-year	47223	7.26	0.64	4.23	8.67

Panel B: Compliance models

Variable	Obs	Mean	SD	Min	Max
Clean CAA inspection (dummy)	2627	0.83	0.37	0	1
Clean RCRA inspection (dummy)	1999	0.65	0.48	0	1
Post-voluntarily disclosed (dummy)	4626	0.16	0.36	0	1
Predicted probability of a CAA inspection	4213	0.61	0.12	0.22	0.83
Predicted probability of a RCRA inspection	3707	0.48	0.20	0.16	0.88
Annual CAA inspections†	4213	3.16	2.35	0	6
Annual RCRA inspections†	4125	2.04	2.16	0	6
Annual CAA violations	4213	0.23	0.43	0	3
Annual RCRA violations†	4125	0.80	1.06	0	3

Notes: RCRA = Resource Conservation and Recovery Act; CAA = Clean Air Act. The unit of analysis is a facility-year in Panel A, and an inspection in Panel B. Variables denoted † are top coded at 99th percentile. Data are from the matched samples and include observations from 2 years prior to the match year to 5 years after the match year.

Table 2. Pair-wise correlations

Panel A: Annual inspection models

		1	2	3	4	5	6	7	8	9	10	11	12	13
1	Annual CAA inspections†	1.00												
2	Annual RCRA inspections†	0.06	1.00											
3	Voluntarily disclosed in a prior year (dummy)	0.07	0.07	1.00										
4	Years since prior CAA inspection	-0.21	-0.03	-0.02	1.00									
5	Years since prior RCRA inspection	-0.07	-0.19	-0.04	0.08	1.00								
6	Annual CAA violations†	0.13	0.04	0.04	-0.06	-0.04	1.00							
7	Annual RCRA violations†	0.04	0.62	0.05	0.00	-0.05	0.03	1.00						
8	Any enforcement actions (dummy)	0.03	0.06	0.23	-0.02	-0.05	0.09	0.04	1.00					
9	Compliance Incentive Program target (dummy)	0.02	0.07	-0.01	-0.02	-0.04	0.03	0.05	0.03	1.00				
10	National Priority sector (dummy)	0.00	0.10	-0.02	0.01	-0.08	0.01	0.08	0.02	0.33	1.00			
11	Log total CAA penalties in the state-year	0.08	0.04	0.06	-0.01	-0.05	0.06	0.03	0.03	0.02	0.02	1.00		
12	Log total RCRA penalties in the state-year	-0.03	0.00	0.02	0.02	0.02	0.01	0.02	0.01	0.02	-0.03	0.07	1.00	
13	Log number of CAA regulated facilities in the state-year	0.07	-0.01	-0.01	-0.09	-0.02	-0.03	-0.03	-0.01	0.01	0.00	0.31	0.14	1.00
14	Log number of RCRA regulated facilities in the state-year	-0.02	0.06	-0.03	0.04	-0.06	-0.01	0.03	0.00	0.02	0.05	0.34	0.25	0.63

Panel B: Compliance models

		1	2	3	4	5	6	7	8	9
1	Clean CAA inspection (dummy)	1.00								1.00
2	Clean RCRA inspection (dummy)	.	1.00							.
3	Post-voluntarily disclosed (dummy)	0.03	0.05	1.00						0.03
4	Predicted probability of a CAA inspection	0.17	-0.08	0.00	1.00					0.17
5	Predicted probability of a RCRA inspection	0.07	0.02	0.30	-0.08	1.00				0.07
6	Annual CAA inspections†	0.25	-0.07	-0.06	0.49	-0.16	1.00			0.25
7	Annual RCRA inspections†	0.06	0.05	0.23	-0.24	0.69	-0.36	1.00		0.06
8	Annual CAA violations	-0.20	0.00	-0.03	0.22	-0.10	0.26	-0.21	1.00	-0.20
9	Annual RCRA violations†	0.02	-0.27	0.23	-0.24	0.61	-0.32	0.82	-0.19	0.02

Notes: CAA = Clean Air Act; RCRA = Resource Conservation and Recovery Act. In Panel A, the unit of analysis is a facility-year in Panel A, and an inspection-date in Panel B. † indicates variables top coded at 99th percentile. Data are from the matched samples and include observations from 2 years prior to the match year to 5 years after the match year.

Table 3. Self-policing is associated with an inspection holiday during the subsequent 2 year period, especially for facilities with better recent compliance records

Conditional Fixed Effects Negative Binomial Models

	(1)	(2)	(3)	(4)	(5)	(6)
	Annual number of CAA inspections			***Annual number of RCRA inspections***		
	Matched sample	Matched good apples	Matched bad apples	Matched sample	Matched good apples	Matched bad apples
Post voluntary disclosure (dummy)	**-0.196**	**-0.143**	**-0.029**	**-0.566**	**-0.416**	**0.097**
	[0.059]* **	**[0.063]** **	**[0.241]**	**[0.105]*** **	**[0.154]*** **	**[0.141]**
2 years since last inspection†	0.167	0.166	-0.433	0.460	0.559	0.589
	[0.024]***	[0.024]***	[0.253]*	[0.058]***	[0.071]***	[0.112]***
3 years since last inspection†	0.107	0.110	-0.973	0.175	0.080	0.841
	[0.040]***	[0.041]***	[0.600]	[0.082]**	[0.104]	[0.158]***
4 or more years since last inspection†	0.593	0.596	0.181	1.792	1.945	1.418
	[0.033]***	[0.034]***	[0.362]	[0.064]***	[0.076]***	[0.168]***
Number of violations† 1 year ago	0.030	0.001	0.119	0.133	0.135	-0.018
	[0.043]	[0.047]	[0.146]	[0.045]***	[0.063]**	[0.065]
Number of violations† 2 years ago	0.030	0.056	-0.114	-0.102	-0.159	-0.007
	[0.045]	[0.049]	[0.136]	[0.045]**	[0.068]**	[0.061]
Any enforcement actions 1 year ago (dummy)	-0.103	-0.119	-0.185	-0.054	-0.241	-0.021
	[0.058]*	[0.062]*	[0.205]	[0.090]	[0.123]*	[0.120]
Any enforcement actions 2 years ago (dummy)	-0.146	-0.156	-0.215	-0.135	-0.216	0.102
	[0.065]**	[0.069]**	[0.241]	[0.098]	[0.141]	[0.123]
Compliance Incentive Program target (dummy)	0.094	0.109	-0.588	0.400	0.394	0.029
	[0.040]**	[0.041]***	[0.230]**	[0.069]***	[0.091]***	[0.120]
National priority sector (dummy)	-0.073	-0.086	0.184	0.066	0.005	-0.082
	[0.032]**	[0.034]***	[0.248]	[0.054]	[0.072]	[0.089]
Log total penalties† last year in the facility's state	0.004	0.011	-0.114	0.054	0.065	0.035
	[0.009]	[0.009]	[0.078]	[0.015]***	[0.018]***	[0.028]
Log total facilities† last year in the facility's state	0.358	0.336	0.551	0.573	0.249	0.742
	[0.060]***	[0.063]***	[0.486]	[0.158]***	[0.258]	[0.334]**
Year dummies	Included	Included	Included	Included	Included	Included
Dummies for *t* years before/after match year	Included	Included	Included	Included	Included	Included
Facility-year observations (N)	26,173	24,941	244	11,519	9,677	1,485
Facilities	7,276	6,887	64	3,142	2,628	398
Marginal effect of post-voluntary disclosure (difference-in-difference estimate)	**18% ↓**	**13% ↓**	3% ↓	**43% ↓**	**34% ↓**	10%↑

Unit of analysis is a facility-year. CAA = Clean Air Act. RCRA = Resource Conservation and Recovery Act. Conditional fixed effects are at the facility-level. Standard errors in brackets; * p<0.10; ** p<0.05; *** p<0.01. The results are based on the matched sample, and include observations from 2-years-before though 2-years-after the match year. The conditional fixed effects negative binomial model drops facilities that are never inspected during the sample period.

† These variables refer to inspections, violations, and penalties associated with—and facilities regulated by—CAA for the CAA models, and RCRA for the RCRA models.

Table 4. Self-policing is associated with an inspection holiday during the subsequent 5 year period, especially for facilities with better recent compliance records

Conditional Fixed Effects Negative Binomial Models

	(1)	(2)	(3)	(4)	(5)	(6)
	Annual number of CAA inspections			*Annual number of RCRA inspections*		
	Matched sample	Matched good apples	Matched bad apples	Matched sample	Matched good apples	Matched bad apples
Post voluntary disclosure (dummy)	**-0.264**	**-0.226**	**-0.082**	**-0.608**	**-0.595**	**0.188**
	[0.052]* **	**[0.055]*** **	**[0.219]**	**[0.083]*** **	**[0.131]*** **	**[0.105]***
2 years since last inspection†	0.158	0.154	-0.101	0.347	0.392	0.508
	[0.019]***	[0.019]***	[0.196]	[0.045]***	[0.054]***	[0.094]***
3 years since last inspection†	0.096	0.089	-0.871	0.331	0.307	0.784
	[0.033]***	[0.034]***	[0.501]*	[0.062]***	[0.075]***	[0.128]***
4 or more years since last inspection†	0.377	0.370	0.239	1.382	1.470	1.183
	[0.026]***	[0.027]***	[0.309]	[0.049]***	[0.058]***	[0.134]***
Number of violations† 1 year ago	0.034	0.016	0.095	0.166	0.161	0.056
	[0.034]	[0.036]	[0.137]	[0.035]***	[0.047]***	[0.050]
Number of violations† 2 years ago	0.004	0.016	-0.103	-0.014	-0.053	0.024
	[0.036]	[0.038]	[0.136]	[0.033]	[0.047]	[0.048]
Any enforcement actions 1 year ago (dummy)	-0.060	-0.055	-0.152	-0.040	-0.090	-0.077
	[0.046]	[0.049]	[0.196]	[0.066]	[0.094]	[0.087]
Any enforcement actions 2 years ago (dummy)	-0.087	-0.083	0.063	-0.104	-0.119	-0.027
	[0.049]*	[0.052]	[0.207]	[0.068]	[0.100]	[0.087]
Compliance Incentive Program target (dummy)	0.103	0.112	-0.440	0.313	0.330	-0.051
	[0.035]***	[0.036]***	[0.234]*	[0.062]***	[0.081]***	[0.111]
National priority sector (dummy)	-0.092	-0.107	0.244	0.047	0.024	-0.045
	[0.027]***	[0.027]***	[0.234]	[0.045]	[0.059]	[0.076]
Log total penalties† last year in the facility's state	-0.013	-0.003	-0.159	0.040	0.042	0.025
	[0.007]*	[0.008]	[0.071]**	[0.010]***	[0.012]***	[0.019]
Log total facilities† last year in the facility's state	0.442	0.417	0.313	0.299	0.272	0.487
	[0.040]***	[0.043]***	[0.340]	[0.126]**	[0.187]	[0.222]**
Year dummies	Included	Included	Included	Included	Included	Included
Dummies for *t* years before/after match year	Included	Included	Included	Included	Included	Included
Facility-year observations (N)	34,768	32,916	296	15,389	12,824	2,029
Facilities	7,276	6,887	64	3,142	2,628	398
Marginal effect of post-voluntary disclosure (difference-in-difference estimate)	**23% ↓**	**20% ↓**	8% ↓	**46% ↓**	**45%↓**	**21%↑**

Unit of analysis is a facility-year. CAA = Clean Air Act. RCRA = Resource Conservation and Recovery Act. Conditional fixed effects are at the facility-level. Standard errors in brackets; * p<0.10; ** p<0.05; *** p<0.01. These results are based on the matched sample, and include observations from 2-years-before though 5-years-after the match year. The conditional fixed effects negative binomial model drops facilities that are never inspected during the sample period.

† These variables refer to inspections, violations, and penalties associated with—and facilities regulated by—CAA for the CAA models, and RCRA for the RCRA models.

Table 5. Self-policing is associated with improved CAA compliance

Conditional Fixed Effects Logistic Models

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable	***CAA inspection is "clean" (no associated violations)***			***RCRA inspection is "clean" (no associated violations)***		
Sample	Matched sample	Matched sample	All facilities	Matched sample	Matched sample	All facilities
Time period	*t-2* to *t+2*	*t-2* to *t+5*	1995-2003	*t-2* to *t+2*	*t-2* to *t+5*	1995-2003
Post voluntary disclosure (dummy)	**3.577**	**2.456**	**1.764**	**1.310**	**0.997**	**0.966**
	[1.441]* **	**[0.798]*** **	**[0.253]*** **	**[0.413]**	**[0.226]**	**[0.091]**
Probability of an inspection†	0.070	0.323	0.556	1.459	2.872	11.291
	[0.090]**	[0.336]	[0.091]***	[1.832]	[2.514]	[1.801]***
Number of inspections† 1 year ago	0.967	0.948	0.991	0.901	1.005	0.997
	[0.079]	[0.057]	[0.010]	[0.091]	[0.064]	[0.012]
Number of inspections† 2 years ago	0.972	0.984	0.999	0.986	1.029	0.995
	[0.077]	[0.056]	[0.010]	[0.106]	[0.067]	[0.011]
Number of violations† 1 year ago	8.588	4.518	2.221	1.316	1.051	1.099
	[2.289]***	[0.909]***	[0.081]***	[0.251]	[0.122]	[0.023]***
Number of violations† 2 years ago	8.187	2.608	2.261	1.342	0.956	0.914
	[2.824]***	[0.598]***	[0.090]***	[0.271]	[0.127]	[0.022]***
Dummies for *t* years before/after match year	Included	Included		Included	Included	
Year dummies			Included			Included
Inspections (N)	1,670	2,627	69,310	1,100	1,999	70,796
Wald chi-squared	134.7***	159.5***	1684.0***	10.1	14.0	907.3***

Values reported are odds ratios, with standard errors in brackets; * p<0.10; ** p<0.05; *** p<0.01. Unit of analysis is a facility's inspection. CAA = Clean Air Act. RCRA = Resource Conservation and Recovery Act. Dependent variable is coded 1 if the inspection results in no cited violations, and coded 0 if at least one violation is cited. Conditional fixed effects are at the facility-level. These results are based on the matched sample. Models 1 and 4 include observations from 2 years prior to 2 years after the match year; Models 2 and 5 extend the post-period to the 5 years after the mach year. Models 3 and 6 include observations from all CAA and RCRA-regulated facilities across the United States. The conditional fixed effects logistic model drops facilities that have only "clean" inspections or only "dirty" inspections throughout the sample period.

† For CAA models, this variable refers to CAA-associated inspections, violations, penalties, and facilities. For RCRA models, this variable refers to RCRA-associated inspections, violations, penalties, and facilities.