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Should You Turn Yourself In? The Consequences of Environmental Self-Policing

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Abstract

Facilities that self-police under the Environmental Protection Agency's Audit Policy are eligible for reduced penalties on disclosed violations. This paper investigates whether self- policing has additional consequences, in particular whether self-policing reduces future enforcement activity. Using data on U.S. hazardous waste enforcement and disclosures, I find that facilities that self-police are rewarded with a lower probability of inspection in the future, although facilities with good compliance records receive a smaller benefit than facilities with poor records. Additionally, facilities that are inspected frequently are more likely to disclose than facilities that face a low probability of inspection. The results suggest that facilities may be able to strategically disclose in order to decrease future enforcement.

JEL Codes: K32, K42, Q52, Q58

Keywords: Self-Policing, Enforcement, Targeting, Compliance, Hazardous Waste

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1. Introduction

In 1995 the U. S. Environmental Protection Agency (EPA) issued the Audit Policy, a policy designed to encourage greater compliance with environmental regulations by providing incentives for regulated facilities to conduct environmental audits and voluntarily disclose any violations that they discover.[1] Under the Audit Policy facilities that self-police – that is, voluntarily disclose a violation to regulators – are eligible for significant penalty reductions. EPA's website for environmental auditing also notes that when facilities self-police, it can render "formal EPA investigations and enforcement actions unnecessary."[2] This statement implies that as well as rewarding self-policers with reduced penalties, EPA's Audit Policy may provide additional incentives in the form of reduced future enforcement.

Although the Audit Policy has been in effect for about a decade, there has been relatively little analysis of its implementation or effect on regulated entities. EPA provides anecdotal evidence of the Audit Policy's use as well as statistics on self-disclosures made under the policy, but its only formal evaluation is a 1999 voluntary survey of a small number of companies that disclosed environmental violations under the policy.[3] While the respondents to the survey generally indicated a favorable experience with the policy, there was no analysis of the factors that induced facilities self-police. In a non-EPA study, Pfaff and Sanchirico (2004) examine all cases filed in the Audit Policy Docket from 1994 to 1999 and compare the profile of voluntarily disclosed violations to the profile of violations detected by regulators in terms of the statutes

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[1] EPA issued "Incentives for Self-Policing: Discovery, Disclosure, Correction, and Prevention of Violations," more commonly referred to as the Audit Policy, on December 22, 1995 (60 *Federal Register* 66705).
[2] See http://www.epa.gov/compliance/incentives/index.html, last accessed September 6, 2006.
[3] See U.S. EPA (1999).

violated, types of violations, and average fines. They find that the typical disclosed violation is relatively minor: in particular, reporting and recordkeeping violations constitute over 90 percent of disclosed violations. While there is no formal analysis of the factors that drive facilities to self-police, the authors provide a number of potential explanations for their finding that self-disclosed violations are very different in nature from detected violations including the structure of the Audit Policy's incentives and the cost of auditing.[4] Pfaff and Sanchirico also speculate that facilities could be using the disclosure of minor violations as "red herrings" to discourage future inspections or distract regulators from other problems.

Although EPA implies that self-policing may have future consequences and Pfaff and Sanchirico suggest that facilities might be strategically disclosing violations to affect future enforcement, to date no study has examined whether facilities that self-police actually do receive differential treatment in the future. It is important to understand what the future consequences of self-policing are to be able to fully evaluate EPA's Audit Policy. This paper uses data on self-disclosures and enforcement activity at regulated hazardous waste facilities to examine whether disclosures do affect future enforcement activity. In addition, the analysis provides insight into other factors that motivate self-policing. A more complete understanding of the factors that drive facilities to self-police will also help to assess the effectiveness of the current policy and potentially can be used to fine-tune the program to increase its effectiveness. While the results of the analysis are obviously most relevant for EPA's Audit Policy, they will also provide important lessons on the use of self-policing as regulatory tool in other policy arenas.

[4]As discussed in more detail in Section 2, since EPA does not forgive the portion of the penalty that is based on economic benefit, self-policing benefits are greatest for those violations where the economic benefit is a relatively small portion of the overall fine.

The remainder of this paper is organized as follows: Section 2 describes EPA's self-policing policy in more detail; Section 3 provides a theoretical framework for considering the self-policing decision; Section 4 outlines the empirical approach for the analysis and describes the data; Section 5 presents the results of the analysis; Section 6 discusses the implications of the analysis for EPA's Audit Policy and, more generally, for self-policing as a regulatory tool; and Section 7 concludes.

2. EPA's Self-Policing Policy

Starting in the 1980's EPA began encouraging facilities to voluntarily undertake environmental audits. In 1986, EPA issued an Environmental Auditing Policy Statement which recommended the use of environmental auditing and encouraged states and local governments to develop environmental auditing initiatives. In December of 1995 EPA issued "Incentives for Self-Policing: Discovery, Disclosure, Correction and Prevention of Violations," which both revised the 1986 policy statement and provided incentives for facilities to voluntarily disclose and correct violations of environmental regulations. The provision of explicit incentives for self-policing extended the revised policy well beyond environmental auditing. However, because it evolved from EPA's initial policy on environmental auditing, the revised policy is commonly referred to as the Audit Policy. In fact, facilities do not have to conduct environmental audits to benefit from the incentives contained in this policy. Any facility that voluntarily identifies, discloses, and corrects violations of environmental regulations is eligible for a reduction in the penalties associated with those violations. Additionally, as long as no actual harm has occurred, EPA will not recommend criminal prosecution for facilities "acting in good faith to identify, disclose, and correct violations."[5]

To be eligible for a complete waiver of punitive penalties the self-disclosure must meet all of the following nine conditions:

1. Systematic discovery: discovery must either take place during an environmental audit or during a self-evaluation that is part of a due diligence program.
2. Voluntary discovery: the process though which the violation is discovered cannot be required by federal, state or local authorities and cannot be required by statute, regulation, permit or consent agreement.
3. Prompt disclosure: violations must be disclosed within 21 days of discovery.[6]
4. Independent discovery and disclosure: the disclosure cannot be made after an inspection or investigation has been announced or notice of a suit has been given.
5. Correction and remediation: any harm from the violation must be remediated and the violation must be corrected within 60 days of the date of discovery unless technological issues are a factor.
6. No recurrence: the facility must identify why the violation occurred and take steps to ensure that it won't recur.
7. No repeat violations: the same or a closely related violation can't have occurred within the past three years at the facility or within the past five years at other facilities owned by the same parent organization.

[5] 60 FR 16876.
[6] The initial disclosure period was 10 days, but the time frame was increased to 21 days in 2000 (65 FR 19618, April 11, 2000).

8. Not excluded: no serious harm or imminent endangerment to human health and the environment can have occurred as a result of the violation and the violation cannot have been a violation of an order, consent agreement, or plea agreement.
9. Cooperation: the facility must cooperate with EPA, including providing all requested documents.

If the disclosure meets conditions two through nine but does not meet the first condition for systematic discovery, it is eligible for only 75 percent mitigation of the punitive penalties rather than complete mitigation.

Importantly, the Audit Policy does not apply to the portion of the penalty that is based on the economic benefit gained from noncompliance. For example, if a facility neglects to sample a particular wastestream for several months and discovers this violation through an environmental audit, assuming the violation meet all of the conditions above, the facility would receive a complete reduction in the punitive portion of the penalty but would continue to owe a penalty equal to the savings it received from not having conducted those samples. This requirement is necessary to ensure that regulated entities have no incentive to deliberately violate and then self-police. In the example above, there would be no benefit to deliberately not sampling and then self-policing if the regulated entity has to pay the cost of sampling after disclosure.

During the development of the Audit Policy, EPA repeatedly sought comments from the regulated community. One commenter on an early version of the policy suggested that EPA should commit to taking audits into account when assessing enforcement actions. In response, EPA stated that agreeing to forgo inspections or reduce enforcement responses is “fraught with legal and policy obstacles”.[7] However EPA also noted that, since effective audit programs

[7] See the “Final Policy Statement”, July 9, 1986, 51 FR 25004, Section I.

should improve compliance, facilities that audit should have improved environmental performance which is likely to be considered in setting inspection priorities. Such language is consistent with EPA's current statements that self-policing can make formal inspections less necessary.

3. Theoretical Framework

A number of theoretical papers have examined the concept of voluntary self-policing in a static model.[8] For example, Kaplow and Shavell (1994) model a probabilistic enforcement regime and show that if regulated facilities that self-police face a reduced fine equal to the certainty equivalent of the sanction they would receive if they did not disclose but instead took their chances that the violation would be discovered, self-policing will not affect deterrence. Facilities for which the reduced fine is less than the cost of compliance will violate and self-police, while facilities for whom the reduced fine is greater than the cost of compliance will comply. Additionally, such a regime will result in a welfare improvement because enforcement effort is reduced as self-policers need not be inspected. Innes (1999) extends this model by considering the potential benefits of remediation under a self-policing policy. As in the Kaplow and Shavell model, facilities will self-police and remediate as long as the total cost of self-policing (any fines plus the cost of remediation) is less than or equal to the expected cost of detection. With self-policing remediation will increase because self-policers remediate with certainty while non-disclosers only remediate when caught. However, Innes also shows that

[8] The term self-policing is used in this paper to denote a situation in which a facility voluntarily notifies authorities that it has violated a regulation. Other authors such as Kaplow and Shavell (1994) have termed this same activity "self-reporting." However, the term self-reporting has also been used to describe situations where facilities are required by law to report information to regulators (such as the self-reported emissions data required for the Toxics Release Inventory).

self-policing may result in a reduction in the initial level of care taken to prevent environmental harm.[9] In a separate paper, Innes (2001) shows that if violators can engage in avoidance activities, self-policing can increase efficiency by reducing such activities and, in turn, allowing the government to achieve the same level of deterrence with a reduced enforcement effort.[10]

Mishra, Newman, and Stinson (1997) also construct a model of self-policing. Unlike the Kaplow and Shavell model and the Innes models, which are all general models of regulatory enforcement, this model is designed to capture specific aspects of EPA's Audit policy. Thus the focus is on a facility's incentive to conduct a compliance audit as well as its decision to self-police. In this model, welfare improvements result from increased remediation and decreased enforcement effort, but since violations are probabilistic and do not depend on the facility's actions, there is no change in the level of deterrence. Friesen (2006) also assumes that violations are probabilistic and that facilities can learn of their compliance status only through costly compliance audits. Assuming that facilities must remediate any disclosed violations, Friesen shows that facilities will only audit if they intend to remediate the violation, although not all facilities will disclose their remediated violations. Friesen also shows that the regulators will not inspect a facility that has disclosed a violation.

In all of the environmental self-policing models, a facility's decision to self-police depends on the cost of disclosure relative to the likelihood of detection and the cost of

[9] For example, if environmental damages increase over time, it may be optimal to induce additional self-policing (and thus early remediation) by setting the cost of self-policing below the expected cost of detection. However, lowering the cost of self-policing decreases the level of deterrence and thus can result in a decrease in the initial level of care.

[10] Since avoidance activities are reduced, the cost of increasing penalty levels is reduced and the government can substitute higher penalties for lower enforcement effort.

detection.[11] Obviously, the models vary significantly in the factors that affect the cost of disclosure (e.g., whether a compliance audit or remediation is required), the likelihood of detection (e.g., whether facilities face different probabilities of detection or whether audits increase the likelihood of detection) and the cost of detection (e.g. whether remediation costs increase over time). However, none of the existing self-policing models allow regulated facilities and regulators to repeatedly interact or allow for optimal actions take future consequences into account.[12] In a repeated setting, regulators could use decreased future enforcement as an added inducement for self-policing. Thus, when deciding whether or not to self-police, facilities would compare the cost of disclosure to the likelihood of detection, the cost of detection, and any future changes in enforcement. Since EPA's website implies that self-policing can affect future enforcement activity, I develop a dynamic model of self-policing to provide a theoretical framework for this empirical analysis.

Although there are no self-policing models that incorporate a dynamic enforcement regime, a number of papers have considered dynamic enforcement of regulations more generally. Two of the most influential models are Harrington's (1988) targeted enforcement model and Scholz's (1984) cooperative regulatory enforcement model. Harrington's targeted enforcement model uses changes in future inspection activity to motivate current compliance and shows that such a regime can maintain a higher level of compliance than can be obtained through more

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[11] In addition to the models discussed above, there several other papers that address environmental self-policing including Heyes (1996), Innes (2000), Kesan (2000) and Pfaff and Sanchirico (2000).

[12] Friesen's (2006) model is sequential (i.e., regulators can incorporate self-policing into their enforcement strategy) but it is not dynamic. Livernois and McKenna (1999) and Hentschel and Randall (2000) both present dynamic self-reporting models. In these two models, self-reporting is mandatory, and thus facilities must decide whether to comply as well as whether to truthfully report their compliance status while regulators use fines and inspection probabilities to both maximize compliance and induce truthful reporting.

traditional, non-targeted enforcement.[13] Scholz's model of cooperative regulatory enforcement also uses future consequences to encourage compliance and shows that such a strategy can be more beneficial than a strict deterrence approach. However, in Scholz's model regulators use differences in sanctions (i.e., harsh sanctions versus a more cooperative approach) rather than differences in inspections as both a punishment and a reward. Given Harrington's focus on changes in the probability of enforcement it was chosen as the starting point for the dynamic self-policing model.

In Harrington's targeted enforcement model, regulators classify all regulated facilities into one of two groups: G_1 is the "good" group and G_2 is the targeted or "bad" group. Inspection probabilities vary across the groups with the inspection probability for G_1 less than the inspection probability for G_2.[14] Facilities found in violation of regulations are always moved into the target group while facilities found to be in compliance can transition to the non-target group with some positive probability. Each period, facilities choose whether or not to comply. The regulator then inspects the facility with a probability based on the facility's group and facilities are moved from one group to the other if warranted. Facilities that are not inspected stay in their group for the next period. This targeted enforcement regime can lead to higher levels of compliance than would occur under a regime where all facilities face the same probability of inspection.[15]

[13] While Harrington was not the first to introduce targeted or state-dependent enforcement (see, for example, Landsberger and Meilijson (1982)), he was the first to develop a model of targeted enforcement in an environmental context.
[14] Fines for discovered violations also vary across the two groups.
[15] There have been a number of extensions to Harrington's basic model (see for example, Harford and Harrington (1991) and Friesen (2003)). However, none of them have incorporated self-policing.

Additionally, anecdotal and empirical evidence suggests that the targeted enforcement model is consistent with current EPA enforcement practices.[16]

Using Harrington's model as a starting point, I develop a model of self-policing in a targeted enforcement regime (hereafter referred to as the SEPTER model). The remainder of this section provides an overview of the model, focusing on its predictions for facility and regulator behavior. A companion paper, Stafford (2006), presents the SEPTER model in more detail. As in Harrington, facilities start in one of two groups based on past compliance behavior. Inspection probabilities vary across the groups with the inspection probability for G_1 (π) less than the inspection probability for G_2 (ρ). Facilities found in violation of regulations are always moved into the target group while facilities found to be in compliance can transition to the non-target group with some positive probability. Additionally, in the SEPTER model facilities that self-police can be rewarded with some positive probability of transitioning to the non-target group.

There are two possible types of noncompliance, deliberate and inadvertent.[17] By including both deliberate and inadvertent compliance, the SEPTER model captures the fact that self-policing is not possible for all violations.[18] Facilities are required to abate pollution at a cost of c per period. If a facility does not abate and is inspected, the deliberate violation will be discovered and the facility will be fined Z. Facilities are also subject to probabilistic spills that occur with probability p and will inadvertently render the facility noncompliant. To discover

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[16] For example, the introduction to EPA's Fiscal Year 2002 Enforcement and Compliance Assurance Report states that EPA uses "data analysis and other relevant information to marshal and leverage resources to target significant noncompliance," (U.S. EPA 2003, page 3). Helland (1998) examines enforcement of the Clean Water Act using data on the pulp and paper industry and finds that regulator behavior is generally consistent with a targeted enforcement model.
[17] Harrington (1988) assumes only deliberate compliance.
[18] As noted in Section 2, some violations are expressly excluded from the Audit Policy.

whether a spill has occurred, facilities must conduct an audit at a cost of a. Returning to compliance costs k, but once remediated the spill cannot be detected by regulators. If the spill occurs and a facility does not remediate but is inspected, it is assessed a fine F which includes the cost of remediation as well as a punitive fine. Alternatively, if the facility discovers the occurrence, remediates, and discloses it to regulators, the facility receives a fine R. Since R does not include the cost of remediation, $R + k$ must be less than F. To be consistent with EPA's Audit policy, facilities must make the disclosure decision prior to an inspection occurring. Finally, note that facilities cannot disclose deliberate violations to receive a reduced fine.

Each period regulators receive one of four possible signals about the facility's compliance status:

i. Compliance: the facility is inspected and there is no detected violation;

ii. Violation: the facility is inspected and a violation (deliberate and/or inadvertent) is detected;

iii. Disclosure: the facility discloses an inadvertent violation and there is no deliberate violation (either because the facility abated or because there is no inspection); or

iv. No information: the facility does not disclose and there is no inspection.

As shown in the transition matrix presented in Table 1, with no new information the facility's group does not change. Facilities in G_2 that are found in compliance will move to G_1 with probability g. Facilities found to be in violation will be in G_2 next period, regardless of their starting point. Finally, facilities that disclose but have not been found to be in violation through an inspection will stay in G_1 if they begin in G_1 and will move to G_1 with probability q if they begin in G_2. Assuming that inspection probabilities and fines are constant, as long as future payoffs are discounted by δ where $0 \leq \delta < 1$, the optimal facility policy is a stationary policy that will be independent of the initial state of the system.

With respect to deliberate violations, the facility has two possible choices, to abate or to pollute. With respect to the probabilistic violations, the facility must make three decisions: (1) whether to audit; (2) whether to remediate a violation is one if discovered; and (3) whether to disclose a violation. If a facility decides not to audit, it has no more decisions to make. If it does audit, it can choose to remediate but conceal the violation, remediate and disclose the violation, or to not remediate and not disclose. This is consistent with EPA's Audit Policy, as remediation is required as a part of disclosure. However, auditing without remediating or disclosing is dominated by not auditing, as the facility saves the cost of auditing with no change in the probability of detection. Thus there are three viable actions with respect to probabilistic violations: No Audit; Audit-Remediate-Conceal; or Audit-Remediate-Disclose. Combining these actions with the actions for deliberate violations yields six possible strategy combinations:

1. Abate/No Audit
2. Pollute/No Audit
3. Abate/Conceal
4. Pollute/Conceal
5. Abate/Disclose
6. Pollute/Disclose

Given these strategies, one can write down the expected cost of each strategy based on whether the facility is in G_1 or G_2. The facility then has 36 possible policies denoted by f_{ij} where i describes the strategy taken in G_1 and j describes the strategy taken in G_2. To evaluate the expected cost of each policy, one solves the system of equations formed by taking (1) the expected cost of strategy *i* using G_1 as a starting point and (2) the expected cost of strategy *j* using G_2 as a starting point. Some of the expected cost functions are very straightforward. For example, a facility that chooses a policy of abatement and disclosure in both groups (f_{55}) is always in full compliance and has an expected present value cost of

$$\frac{c \quad a \quad p(k \quad R)}{1 - \delta} .$$

However, other policies have much more complicated expected costs as the regulated facility will move in and out of the two groups based on inspections and disclosures.

Given the regulator's targeting plan and the facility's costs, the goal of the facility is to choose the policy that minimizes the present value of expected costs. Which policy will ultimately be most profitable depends on the relative costs of abatement and auditing as shown in Table 2.[19] As long as audit costs are low, facilities will always audit. However, whether they will abate or disclose depends on abatement costs and fines for disclosed violations. As long as abatement costs are low, facilities will always abate but whether they will audit and disclose depends on the relative costs of auditing and the fines for disclosed violations. When both audit and abatement costs are low, facilities will always audit and abate, but will not disclose because facilities do not care about the probability of inspection. When neither audit or abatement costs are low, the optimal strategy is more difficult to determine and depends not only on the relative costs of auditing and abatement, but also on the rates at which facilities are moved between the two groups and the fines imposed for disclosed violations.

Regulators can affect a facility's optimal strategy by manipulating the self-policing policy parameters (that is, the setting of *R* and *q*) as well as other enforcement parameters such as

[19] Since auditing without remediation is never optimal, in the following discussion, the cost of remediation is subsumed in the cost of auditing.

the inspection rate and the fines for violations. For example, decreasing the fine for disclosed violations (*R*) or increasing the probability that a facility that discloses in the target group will be moved to the non-target group (*q*) will increase both audits and disclosures at facilities in the target group, although such changes will not affect auditing or disclosure in the non-target group.[20] However, such actions are likely to result in decreased abatement overall, as disclosure will become a more cost effective method of decreasing future enforcement relative to abatement. This effect is consistent with Pfaff and Sanchirico's (2004) proposition that facilities might use the disclosure of minor violations as "red herrings" to discourage inspections or distract regulators from other problems. In fact, as discussed in more detail in Stafford (2006), any changes to the self-policing or enforcement policy parameters will involve tradeoffs between increased auditing and disclosures and increased abatement.

Given the tradeoffs between auditing, disclosures and abatement, it is not possible to explicitly solve for the optimal self-policing policy without specifying both the joint distribution of abatement and audit costs as well as the relative benefit from auditing (i.e., remediation of probabilistic violations), disclosure, and abatement. Such data do not currently exist and would be very difficult to obtain. However, we can determine empirically whether the SEPTER model provides an appropriate description of regulator and facility behavior. There is already some existing anecdotal and empirical evidence suggesting that EPA uses targeted enforcement, so we should find that compliance histories affects inspection probability even if SEPTER is not an appropriate model of EPA's self-policing policy. Additionally, all self-policing models imply that facilities with a high probability of enforcement are more likely to disclose than facilities with a low probability of enforcement, ceteris paribus. However, only the SEPTER model

[20] If *R* is greater than 0, facilities in the non-target group will never disclose, so decreasing *R* or increasing *q* will have no affect on their optimal strategies.

implies that disclosures in the recent past should decrease the probability of future inspections and that the effect of disclosures on future inspections should depend on the facility's compliance history (i.e., whether or not they are in a target group).

4. Empirical Approach

Because federal environmental regulations are media-specific, there are separate programs that regulate air, water, toxic materials, and hazardous waste. Although facilities may be regulated under more than one program, each program conducts its own enforcement actions. It is very difficult, therefore, to consider overall enforcement activity. Thus to analyze enforcement and disclosure behavior, this analysis focuses only on facilities subject to hazardous waste regulations, more formally known as Subtitle C of the Resource Conservation and Recovery Act (RCRA). The analysis includes approximately 631,000 regulated hazardous waste facilities that were identified using EPA's RCRAInfo database.[21] The RCRAInfo database includes data each facility's location, size, regulatory status, compliance history, enforcement history, and whether the facility is regulated by another media program. However, it does not include comprehensive disclosure information.[22] Therefore EPA's Office of Enforcement and Compliance Assistance provided a list of all facilities that voluntarily self-disclosed in 2001.[23]

[21] The RCRAInfo database is available on-line through EPA's Envirofacts data warehouse (http://www.epa.gov/enviro/). The data for this study was extracted from files on the FTP server in May 2004. All facilities with a valid Generator Status that were not classified as "Non-Notifiers" were included in the analysis.

[22] While there is some data on disclosures in RCRAInfo, disclosure information is not a required data element. Additionally, a comparison of the disclosure data in RCRAInfo to other EPA sources of disclosure information suggests that the data provided in RCRAInfo are quite incomplete.

[23] Data were obtained through a Freedom of Information Act request. After removing duplicate entries from the list of facilities supplied by EPA, there were 431 disclosures representing at least 1,158 facilities.

Cross-referencing the 1,158 facilities with disclosures with the facilities regulated under RCRA resulted in 325 matches.

The analysis examines the effect a disclosure in 2001 has on the probability that a facility is inspected in 2002. Because whether or not a facility is inspected is a binary variable, the appropriate regression for this analysis is a probit. However, according to the SEPTER model, whether a facility discloses will depend in part on expected enforcement activity, that is whether or not the facility is in the target group. Thus I use a bivariate probit regression similar to that used in Morgenstern and Al-Jurf (1999) to control for the fact that disclosures should be endogenous.[24] More specifically, let $INSP_i^* \quad X_i \;{}_1 \quad DISC_i \;{}_2 \quad {}_i$ represent the benefit to the regulator of inspecting facility *i*, where X_i is a vector of explanatory variables, $DISC_i$ indicates whether the facility disclosded a violation in the previous year, and ε_i is a random error term. Although $INSP_i^*$ is not observable, $INSP_i$ is observable and takes the following form:

$$INSP_i \quad \begin{cases} 1 \text{ (inspected)} & \text{if } INSP_i^* \quad 0 \\ 0 \text{ (not inspected)} & \text{if } INSP_i^* \quad 0 \end{cases}.$$

Let $DISC_i^* \quad Z_i\delta \quad \eta_i$ represent the benefit to facility *i* of disclosing a violation where Z_i is a vector of explanatory variables and η_i is a random error term. Since the benefit of disclosure depends in part on the probability that a facility will be inspected, Z_i includes X_i. Although $DISC_i^*$ is not observable, *DISC* is observable and takes the following form:

[24] This method is also discussed in Chapter 15 of Wooldridge (2002). A secondary concern is that disclosures are a very rare event, occurring at only 325 of 630,832 hazardous waste facilities (approximately 0.05 percent) in 2001. King and Zeng (2001) present a rare event logit model that can be used in such situations. However, there is no analogous rare event correction for use in a bivariate probit model and since a Rivers-Vuong test rejects the exogeneity of the disclosure variable, controlling for the endogeneity of disclosures is more critical than correcting for a rare event. Moreover, there is only one qualitative difference in the results of a rare event logit regression of disclosures compared to a standard probit regression of disclosures (i.e., one explanatory variable loses significance).

$$DISC_i \quad \begin{cases} 1 \text{ (disclosure)} & \text{if } DISC_i^* \quad 0 \\ 0 \text{ (no disclosure)} & \text{if } DISC_i^* \quad 0 \end{cases}.$$

The error terms ε_i and η_i are assumed to have a bivariate normal distribution and I apply the Huber-White sandwich variance estimator to correct for possible heteroskedasticity.

This model can be estimated using maximum likelihood, although the effect of disclosures on the inspection decision is only identified subject to either an exclusion or a covariance restriction. For an exclusion restriction to be valid, the variable excluded from X_i should be theoretically as well as statistically related to the facility's benefit from disclosure but unrelated to the regulator's benefit from inspection. This analysis exlcudes the variable *State Audit Immunity* from the Inspection equation to identify the model. *State Audit Immunity* is a dummy variable indicating whether or not the state in which the facility is located has a law providing immunity from civil penalties to facilities that self-disclose. State immunity laws decrease the cost of disclosure for a facility because they limit the penalty that can be assessed for disclosed violations. However this immunity does not apply to violations that are discovered during the course of a regulator's inspection and therefore should not affect the incentives of a regulator to inspect a facility. Thus in theory *State Audit Immunity* should affect the disclosure decision but not the inspection decision. Moreover, *State Audit Immunity* does not have a significant effect if it is included in a standard probit regression of the Inspection equation that excludes the disclosure variables, so it is not statistically related to the likelihood of an inspection. However, as discussed in more detail in the Results section, it does have a significant effect on the likelihood that a facility discloses.

Table 3 lists the explanatory variables used in this analysis, along with their means, standard deviations, and expected effects in the Inspection and Disclosure equations. In the SEPTER model presented in Section 3, a facility's group is the only factor that affects the likelihood of an inspection. In practice, however, other factors are likely to affect the probability of an inspection such as the potential for environmental damage at the facility (and thus the benefit to a regulator from deterring a violation), the cost of compliance, and the regulator's resource constraints. Therefore, the reduced-form Inspection equation includes variables that proxy for a facility's group as will as variables that capture these other additional factors. The reduced-form Disclosure equation includes the explanatory variables from the Inspection equation (other than the disclosure variables) as well as *State Audit Immunity* to identify the model. While the primary role of the Disclosure equation is to control for the endogeneity of the disclosure variables used in the Inspection equation, the results should also provide insight into the factors that affect disclosure. However, it is important to remember that disclosures cannot occur if a facility does not have a violation and since the analysis does not directly model the violation process, the interpretability of the Disclosure results will be limited.[25]

All of the facility-level variables are extracted from EPA's RCRAInfo database, with the exception of *Disclosure in 2001*. The first six variables indicate the type of regulated facility. *Large Quantity Generators* are facilities that generate over 1,000 kilograms of hazardous waste a month, while *Small Quantity Generators* generate between 100 and 1,000 kilograms a month and *Conditionally Exempt Generators* generate less than 100 kilograms a month.[26] Because the

[25]A detection controlled estimation (DCE) model like that used in Helland (1998) would allow for the estimation of the violation equation in addition to the inspection and disclosure equations. However, the DCE model does not allow for correlated errors, and the results of our bivariate probit model indicate that, at a minimum, the errors in the Inspection and Disclosure equations are correlated. Moreover, the DCE is not designed to control for endogenous explanatory variables.

[26] The omitted category is non-generators, that is facilities that do not generate hazardous waste themselves. Non-generators could include transporters, transfer facilities, and some types of hazardous waste management facilities. While a facility may only fall into one of the three possible generator categories, a regulated facility can concurrently be a generator, treatment facility, and a transporter.

quantity of hazardous waste generated by a facility should be highly correlated with the potential for environmental damages at a site, in the Inspection equation I expect the coefficients on these variables to be positive. Additionally, the more waste on site, the higher the probability of a spill or violation and thus I expect positive coefficients in the Disclosure equation as well. Similarly, since facilities that treat, store, or dispose hazardous waste (*Treatment, Storage, or Disposal Facility*) have a higher potential for environmental releases than facilities that only generate waste but do not manage it on site, I expect a positive coefficient in the Inspection equation. Because such facilities are also subject to additional regulations, I anticipate that they are more likely to be in violation and thus more likely to disclose as well.

Transporters are facilities that transport hazardous waste. Given that the paperwork requirements for waste transport are quite extensive and paperwork violations are one of the more common types of disclosures, I expect a positive coefficient on this variable in the Disclosure equation. However it is not clear whether transporters should be more or less likely to be inspected than other types of facilities. First, it is not obvious whether transporter <u>facilities</u> pose more or less of a risk than other types of facilities and second, transporters are also subject to Department of Transportation inspections which may act as a substitute for EPA inspections. The last variable that captures the nature of the regulated facility is *Other Permit* which indicates whether the facility is permitted under an environmental program other than the hazardous waste program. This indicates that the facility is complex and has significant environmental exposure, so I expect a positive coefficient in the Inspection equation. Also because disclosures may occur for violations of other environmental programs, I also expect a positive coefficient in the Disclosure equation.

The next set of variables captures the enforcement and compliance history of the facility over the previous five years, that is, from 1997 to 2001. *Inspected in 2001* indicates whether the facility was inspected in 2001. Obviously EPA cannot inspect every facility each year as only 3 percent of the universe was inspected in 2001. Therefore, I expect a negative coefficient on this variable in the Inspection equation. Since facilities that face a lower probability of inspection are less likely to disclose, I also expect a negative coefficient in the Disclosure equation. *Five Year Inspection History* is a count of the number of years between 1997 and 2001 that the facility was inspected. If this variable is high, it suggests that the facility is in the target group, and thus I expect a positive coefficient in the Inspection equation and a positive coefficient in the Disclosure equation. The variable *Ignored* is equal to one if the facility was not inspected at all over the past five years. If a facility is ignored, as almost 90 percent of this universe is, the facility is likely to be in the non-target group and thus I expect a negative coefficient in both equations.

Violated in 2001 indicates whether a violation was detected at the facility in 2001. If a facility discloses a violation in 2001, but no other violation is detected by regulators, this variable is equal to zero. *Newly Caught in 2001* is equal to 1 if a violation was detected in 2001, but no violations were detected between 1997 and 2000. While only one percent of facilities have a detected violation in 2001, note that only 3 percent of facilities were inspected, so that violations are detected at approximately one-third of all inspected facilities. Additionally, note that most of the facilities that violated in 2001 were also newly caught. I expect positive coefficients on both of these variables in the Inspection equation, as a violation in 2001 should move a facility into (or keep a facility in) the target group. Since facilities in the target group are more likely to disclose, I also expect a positive coefficient in the Disclosure equation. *Five Year*

Violation History is a count of the number of detected violations at the facility between 1997 and 2001. If there are only two groups, a target group and a non-target group, this variable should have no effect in the Inspection equation. However, if there are several target groups or if it takes more than one violation to move into the target group I would expect a positive coefficient in both equations. Finally, *Good Compliance Record* is equal to 1 if the facility had no detected violations from 1997 to 2001. This variable is also a proxy for membership in the non-target group, and I expect negative coefficients in both equations.

The explanatory variable *Disclosure in 2001* indicates whether the facility disclosed any violations (not just hazardous waste violations) in 2001. In the SEPTER model, a disclosure will decrease the likelihood of an inspection for facilities in the target group, but will not change the likelihood of inspection for facilities in the non-target group. However, if in practice there is a continuum of inspection probabilities rather than just two groups, one would expect disclosures to be rewarded for all facilities and thus I expect a negative coefficient on *Disclosure in 2001.* Although I could not directly include state dummies in the analysis as there are so few facilities that disclose in any given state, I do include a number of variables in the analysis to control for state differences in enforcement programs as well as dummies for the different EPA regions. Other research has shown that states with self-policing policies (*State Self-Policing Policy*) or audit privilege (*State Audit Privilege*) may use such policies as substitutes for more traditional enforcement, so I expect a negative sign on these two variables in the Inspection equation.[27]

[27] In theory, one benefit of such policies is that enforcement resources can be reduced with no effect on deterrence, and thus I would expect them to have a negative effect on the likelihood of inspection. See, for example, Kaplow and Shavell (1994) and Innes (1999). Additionally, Stafford (2005) finds that state audit privilege and self-disclosure policies do appear to decrease the likelihood of inspections. Data on state audit legislation and self-policing policies is provided by the National Conference of State Legislatures at http://www.ncsl.org/programs/esnr/audits.htm.

Along with *State Audit Immunity*, these policies are designed to encourage the use of audits and disclosures, and thus I expect a positive sign on all three variables in the Disclosure equation.

State Inspections measures the total number of inspections conducted in the state in 2001, normalized by the total number of regulated facilities in the state, and *State Inspection Intensity* is equal to the number of inspections divided by the number of unique facilities inspected.[28] The higher the number of state inspections, the more likely it is that any one facility will be inspected. The higher the inspection intensity, the more likely it is that a state conducts multiple inspections as a single facility, and thus the lower the probability of inspection at any given facility. Since the higher the probability of an inspection, the higher the benefit from disclosure, I expect consistent signs across the Inspection and Disclosure equations. *State Violations* measures the total number of violations detected in the state in 2001, normalized by the total number of regulated facilities in the state. Since regulators often follow up past violations with inspections to confirm that the violation has been corrected, I expect a negative coefficient on this variable in the Inspection equation. However, if there are numerous state violations, more facilities may be in the target group and thus have higher incentives to disclose. Finally, *State Regulated Facilities* measures the number of regulated facilities in the state. This variable is included to control for possible size effects. States with larger workloads are likely to be larger and more industrialized than other states. However, the effect of this variable on Inspections is not obvious. On one hand states with larger workloads may have relatively well established environmental programs. On the other hand, such states could face a resource constraint. Similarly the effect on disclosures is not obvious. Finally, I include dummies for nine of EPA's

[28] The state inspection, enforcement, and workload variables were aggregated from EPA's RCRAInfo database.

ten regions to control for regional differences in enforcement policies although I have no prior expectations as to the effect of these dummies on the likelihood of inspections or disclosures.

5. Results

The primary objective of this analysis is to determine whether voluntary disclosures under EPA's self-policing policy are rewarded with a decrease in future enforcement. The results of the bivariate probit regression, presented in Table 4, demonstrate that disclosures do affect the probability of future inspections. The coefficient on *Disclosure in 2001* is negative and significant indicating that regulators do reward disclosures by decreasing future enforcement. To get a rough estimate of the size of the disclosure effect, I calculated the change in the probability (in percentage points) that a "representative facility" would be inspected in 2002 if it discloses in 2001. This representative facility is given the mean values for all continuous explanatory variables and the median values for discrete explanatory variables. As shown in Table 5, the representative facility has an initial inspection probability of 1.87 percent. If this facility discloses a violation it will be rewarded with a 1.83 percentage point decrease in the likelihood of inspection. Thus after disclosure, the probability of inspection would be 0.04 percent. If a facility's characteristics are not the same as those of the representative facility, both the initial inspection probability and the size of the effect of a disclosure will change. However, on average a disclosure in 2001 reduces the probability of inspection in 2002 by four-fifths.[29] It is also interesting to note that for the representative facility the reward for a disclosure is of similar magnitude as the punishment the facility would receive for a violation (an increase of

[29] For each facility I estimated the probability of inspection given the facility's characteristics and no disclosure as well as the probability of inspection given the facility's characteristics and a disclosure. I then calculated the average decrease in the probability of inspection as a percentage of the initial probability of inspection.

2.39 percentage points if the facility is newly caught or an increase of 1.02 percentage points if the facility has violated previously). Thus disclosures can significantly mitigate the consequences of a bad inspection (i.e., one where violations are discovered).

The SEPTER model implies that a disclosure will decrease the likelihood of an inspection for facilities in the target group, but will not change the likelihood of inspection for facilities in the non-target group. To determine whether the reward to disclosure differs for facilities with good and bad compliance records, I ran the bivariate probit regression on two separate subgroups, those facilities with no detected violations from 1997 to 2001 and those facilities with a least one detected violation during that period.[30] Table 6 presents the estimated effect of a disclosure on the probability of inspection for these two subgroups.[31] Since facilities with good compliance records represent approximately 95 percent of the total population of RCRA-regulated facilities, it is not surprising that the results for facilities with good compliance records are quite similar to the results for all facilities. However, for facilities with poor compliance records, that is facilities with at least one violation from 1997 to 2001, the probability of inspection is significantly higher at the representative facility, as is the probability of a disclosure. As implied by the SEPTER model, the reward to disclosure is also much larger for facilities with poor compliance records. In fact, although the representative "poor" facility is almost ten times more likely to be inspected than the representative "good" facility in the absence of a disclosure, the estimated probability of inspection is approximately the same for a good facility that has disclosed and a poor facility that has disclosed. Thus the assumption that regulators reward disclosures by moving facilities out of the target group is consistent with

[30] Because *Disclosed in 2001* is an endogenous variable, it is not possible to simply interact *Disclosed in 2001* with the *Good Compliance Record* variable.

[31] Complete results of the bivariate probit regression for these two subgroups are available from the author upon request.

evidence. However, although facilities with good compliance records that disclose get a smaller benefit from disclosure than facilities with poor records, even facilities with good records receive a positive reward from disclosure. While the SEPTER model implies that facilities in the non-target group should not be rewarded by disclosure, this is due to the assumption that there are only two groups of facilities. If instead there is a continuum of inspection probabilities rather than just two groups, one would expect disclosures to be rewarded for all facilities.

Although the focus of this analysis is on self-policing and disclosures, it should be noted that the other coefficients in the Inspection equation are generally consistent with the expectations discussed in Section 4 and provide additional evidence of a targeted enforcement regime. However, there are a couple of interesting results that warrant discussion. First, given that EPA cannot inspect every facility each year I expected the coefficient on *Inspected in 2001* to be negative, although it is positive and significant. This suggests that in addition to compliance history and the other factors measured in this analysis, there are unobserved or omitted characteristics that the enforcement agency is targeting such as specific activities or substances at the facility that make the facility more likely to be inspected. Second, the coefficient on *Ignored* is also positive and significant, the opposite of our expectation. Thus facilities are not ignored by regulators forever; rather there is a higher probability of being inspected, *ceteris paribus*, if the facility has been ignored in the past. This suggests that inspections in a given year may not be random, that is regulators may have some underlying schedule that they use to determine where to employ enforcement resources and that time since last inspection may be an important determinant of a facility's likelihood of inspection. If this is true, models that assume probabilistic inspection such as the model presented in Section 3 are missing an important feature of the enforcement system.

Next consider the Disclosure equation. As discussed in Section 4, in interpreting these results one must remember this is a reduced form model and does not consider the underlying violation process. However, the findings do provide useful insights into the factors that affect disclosures under EPA's Audit Policy. According to the SEPTER model, facilities in the target group should be more likely to disclose than facilities that are not in the target group. Assuming that the variable *Ignored* provides a rough proxy for membership in the non-target group, the results show that non-target facilities are significantly less likely to disclose than facilities that are not ignored. The positive and significant coefficient on *Five Year Inspection History* is also consistent with expectations that facilities that face a higher probability of inspection are more likely to disclose. Also as expected, *Large Quantity Generators*, *Small Quantity Generators* and facilities that are subject to regulation under other media programs (i.e., *Other Permit*) are more likely to disclose. However, the negative and significant coefficient on *Treatment, Storage, and Disposal* facility is not consistent with the expectation that such facilities are subject to more regulation and thus more likely to violate and to disclose. It could be that since treatment, storage, and disposal facilities are both highly regulated and heavily inspected, these facilities are less likely to discover inadvertent violations, that is, the types of violations for which the Audit Policy is most appropriate. The other findings from the Disclosure equation that are particularly interesting are the results for *State Self-Policing Policy*, *State Audit Privilege* and *State Audit Immunity.* These programs were all adopted specifically to increase audits and disclosures. While the results show that state self-policing policies and audit immunity legislation are effective at increasing disclosures, the insignificant coefficient on *State Audit Privilege* suggests that such legislation does not increase disclosures. The most likely explanation for this result is that privilege alone does not provide direct incentives to facilities to disclose, although it does decrease the potential risks from auditing.[32]

Finally, as shown in Table 5 a large quantity generator is over three times more likely to be inspected than the representative facility and seven times more likely to disclose. Therefore, as a robustness check Table 7 presents the results of the bivariate probit analysis when only large quantity generators are included in the regression, approximately 35,000 facilities. There are a few qualitative differences between the results for large quantity generators and the results for all facilities. First, in the Inspection equation the coefficients on *Inspected in 2001* and *Ignored* have significant but opposite signs in the two regressions. In fact, the negative coefficients in the large quantity generator regression are consistent with the ex ante predictions that facilities inspected in 2001 and ignored facilities would be less likely to be inspected in 2002. Second, a number of coefficients that were significant in the regression for all regulated facilities are no longer significant in the regression for large quantity generators (and in some cases, the sign of the coefficient changes). However, despite the qualitative differences between the two regressions, the primary results are the same and generally support the SEPTER model. In particular, regulators do reward large quantity generators that disclose with lower probabilities of inspection in the future.

6. Implications for EPA's Audit Policy and Self-Policing in General

Given the empirical evidence presented above, the SEPTER model appears to provide a reasonable description of self-policing under EPA's Audit Policy. It is important to note that in

[32] However, privilege may indirectly decrease the cost of disclosure as it protects information gathered during the course of an environmental audit from being used in judicial or administrative proceedings. Without privilege, facilities might be reluctant to disclose as that would indicate the presence of environmental audit records that could be subpoenaed.

the SEPTER model, facilities may increase the level of auditing and abatement without making disclosures, so that one cannot evaluate the effectiveness of a self-policing policy by looking at disclosures alone. Another key feature of the SEPTER model is that facilities may make tradeoffs between self-policing and other forms of regulatory compliance. For example, facilities may strategically disclose violations in order to decrease future enforcement and then take advantage of the "enforcement holiday" to commit more significant violations of environmental regulations. The results of this empirical analysis show that the decrease in future enforcement is quite dramatic and thus the possibility for using disclosures as "red herrings" is very real.

In light of the low level of participation of hazardous waste facilities in EPA's self-policing policy, one might ask whether the potential for strategic disclosure really poses a significant concern. As shown in Table 3, only 5 of every 10,000 RCRA-regulated facilities disclosed a violation in 2001, compared to 1 in 100 facilities that had a violation detected by regulators. While self-policing is slightly more common in the entire regulated community – in 2001, approximately 1 of every 1,000 regulated facilities disclosed a violation – it is still not a frequent annual occurrence.[33] Given current participation levels, unless the consequences from self-disclosure persist for a very long time the percentage of facilities on "enforcement holidays" will be insignificant relative to the large percentage of facilities that are already "ignored" by regulators.

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[33] According to EPA's Envirofacts database, in July of 2002 there were approximately 1.1 million unique facilities regulated by EPA (http://www.epa.gov/enviro/html/frs_demo/presentations/frs_factsheet_July2002.pdf). In 2001, 1,158 facilities voluntarily disclosed a violation to EPA.

It is clear that EPA would like to significantly increase the number of facilities participating in the self-policing program.[34] One obvious way to increase participation is to make sure that the regulated community is fully aware of the benefits to self-policing, particularly the reduction in future enforcement. However, this could significantly increase the number of strategic disclosures. Unfortunately, there is no easy solution to the problem of strategic disclosure either for EPA's Audit Policy or for self-policing in general. Since self-policing can increase the level of auditing and remediation, as well as allow regulators to shift enforcement resources from self-policers to other facilities, it can have a significant positive impact on environmental performance. However, if reduced penalties alone are not enough to induce auditing and disclosure, decreased future enforcement may be necessary to motivate self-policing. Thus, regulators need to carefully weigh the benefits of increased self-policing against the potential that facilities may strategically disclose.

Both the empirical results and the SEPTER model also demonstrate that facilities that are currently targeted by regulators are much more likely to self-police than facilities that are not targeted. One reason for this is that the cost of self-policing for facilities with a relatively low probability of inspection is high compared to the expected cost of detection. Additionally, non-target facilities might be concerned that a disclosure would draw the regulators' attention and might increase the likelihood of future enforcement. The fact that non-target facilities are unlikely to self-disclose can explain, at least in part, the current low level of participation with EPA's Audit Policy. Of the more than 600,000 regulated hazardous waste facilities, approximately 90 percent appear to be in the non-target group. Non-target facilities have the lowest level of contact with regulators and thus are more likely to inadvertently violate

[34] See Goal 5.2 in the "Fiscal Year 2005 Performance and Accountability Report, " U.S. EPA, 2005, page 5-11.

regulations than facilities that have learned about the appropriate way to comply through their encounters with regulators. To increase the participation of these facilities in the Audit Policy, EPA might want to draw attention to the fact that disclosures will not result in increased future enforcement even for facilities with low ex ante probability of inspection and, to the contrary, usually results in a significant decrease in future enforcement. More generally, since non-target facilities are less likely to participate in self-policing, regulators that are developing or modifying self-policing policies might want to focus outreach efforts on such facilities or consider methods for increasing the incentives for these facilities.

7. Conclusion

This paper presents an empirical analysis of the effect of Audit Policy disclosures on future enforcement efforts. The most important finding is that facilities that self-disclose under EPA's Audit Policy are rewarded with a significantly lower probability of inspection in the near future. While there is some evidence that the reward for disclosure is smaller for facilities with relatively good compliance records, there is no evidence that disclosures increase future enforcement efforts for these facilities. This lends support to Pfaff and Sanchirico's (2004) concern that facilities could use the disclosure of minor violations under the Audit Policy as "red herrings" to discourage future inspections.

The analysis also provides insight into the factors that motivate self-policing. Facilities that have not been inspected over the past five years are less likely to disclose while facilities that are inspected frequently are more likely to disclose, in part because they have more to gain from decreasing future enforcement efforts. Large and small quantity generators are more likely to disclose, as are facilities that are regulated under more than one media program. However, hazardous waste treatment, storage, and disposal facilities are less likely to disclose, perhaps because these facilities are less likely to discover inadvertent violations, that is, the types of violations for which the Audit Policy is most appropriate. Finally, facilities in states with environmental audit immunity or self-policing policies are more likely to disclose as such policies provide additional incentives for disclosure.

The results of the analysis generally support the theoretical model of self-policing in a targeted enforcement regime that is summarized in this paper. This model suggests that some facilities will increase their level of auditing and abatement without making disclosures, implying that one should not evaluate the effectiveness of a self-policing policy by looking at disclosures alone. Additionally, the model indicates that some facilities may strategically disclose violations in order to decrease future enforcement and then take advantage of the "enforcement holiday." Thus, regulators need to carefully weigh the benefits of increased self-policing against the potential that facilities may strategically disclose. Finally, both the empirical results and the theoretical model suggest that facilities that are not on regulators' target list are the least likely to self-police even though such facilities might benefit significantly from self-policing. Thus regulators may want to focus their outreach efforts on such facilities or consider methods for increasing the incentives for these facilities.

This paper provides the first evidence on the consequences of self-policing. However, there are a number of complementary analyses that would further expand our understanding of how the Audit Policy is being implemented and how it affects overall environmental performance. First, this analysis only considers hazardous waste enforcement. It would be interesting to see whether disclosures have similar effects on enforcement for other environmental media or in non-environmental self-policing programs. Second, this analysis only considers the effect of disclosures on the immediate future. A panel analysis would provide information on the persistence of the rewards to self-disclosure. Finally, a more focused analysis of a facility's decision to disclose that also models the likelihood that a facility has something to disclose would provide a much deeper understanding of the factors that motivate self-policing.

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Table 1: Transition Matrix for Each Target Group

Regulator's Information for Period *t*	Starting in G_1		Starting In G_2	
	Stay in G_1	Move to G_2	Move to G_1	Stay in G_2
Compliance	1	0	g	1-g
Violation	0	1	0	1
Disclosure	1	0	q	1-q
No Information	1	0	0	1

Table 2: Optimal Facility Policies as a function of Audit and Abatement Costs

Audit Costs	Abatement Costs		
	Low: $\pi Z > c$	Moderate: $\rho Z > c > \pi Z$	High: $c > \rho Z$
Low: $\pi pF > a + pk$	f_{33}	f_{43}, f_{45}	f_{43}, f_{44}, f_{45}, f_{46}
Moderate: $\rho pF > a + pk > \pi pF$	f_{13}, f_{15}	f_{13}, f_{15}, f_{23}, f_{25}	f_{13}, f_{14}, f_{15}, f_{16}, f_{23}, f_{24}, f_{25}, f_{26}
High: $a + pk > \rho pF$	f_{11}, f_{13}, f_{15}	f_{11}, f_{13}, f_{15}, f_{21}, f_{23}, f_{25}	f_{11}, f_{12}, f_{13}, f_{15}, f_{16}, f_{21}, f_{22}, f_{23}, f_{25}, f_{26}

1=Abate/No Audit, 2=Pollute/No Audit, 3=Abate/Conceal, 4=Pollute/Conceal, 5=Abate/Disclose, 6=Pollute/Disclose.

Table 3: Variable Means and Expected Effects

Explanatory Variable	Mean	Standard Deviation	Expected Effect: Inspection Equation	Expected Effect: Disclosure Equation
Large Quantity Generator	0.06	0.23	+	+
Small Quantity Generator	0.29	0.45	+	+
Conditionally Exempt Generator	0.25	0.43	+	+
Treatment, Storage, or Disposal Facility	0.002	0.04	+	+
Transporter	0.03	0.17	?	+
Other Permit	0.02	0.15	+	+
Inspected in 2001	0.03	0.17	-	-
Five Year Inspection History	0.15	0.51	+	+
Ignored	0.89	0.31	-	-
Violated in 2001	0.01	0.11	+	+
Newly Caught in 2001	0.008	0.09	+	+
Five Year Violation History	0.20	1.48	?	?
Good Compliance Record	0.95	0.21	-	-
Disclosure in 2001	0.0005	0.02	-	NA
Disclosure in 2001 x Good Comp. Record	0.0003	0.02	+	NA
State Self-Policing Policy	0.39	0.49	-	+
State Audit Privilege	0.40	0.49	-	+
State Audit Immunity	0.36	0.48	NA	+
State Inspections	0.04	0.03	+	+
State Inspection Intensity	1.36	0.22	-	-
State Violations	0.04	0.03	-	+
State Regulated Facilities	0.25	0.16	?	?
Region 1	0.06	0.16	?	?
Region 2	0.14	0.34	?	?
Region 3	0.10	0.29	?	?
Region 4	0.13	0.34	?	?
Region 5	0.25	0.43	?	?
Region 6	0.09	0.29	?	?
Region 7	0.05	0.23	?	?
Region 8	0.03	0.16	?	?
Region 9	0.11	0.31	?	?

Table 4: Bivariate Probit Results for All RCRA-Regulated Facilities

	Inspection Equation		Disclosure Equation	
Explanatory Variable	**Coefficient**	**Standard Error**	**Coefficient**	**Standard Error**
Large Quantity Generator	0.73**	0.01	0.64**	0.05
Small Quantity Generator	0.21**	0.01	0.19**	0.05
Conditionally Exempt Generator	0.12**	0.01	0.03	0.06
Treatment, Storage, or Disposal Facility	0.63**	0.06	-0.30**	0.12
Transporter	0.22**	0.02	-0.11	0.09
Other Permit	0.21**	0.02	0.33**	0.06
Inspected in 2001	0.07**	0.02	0.09	0.08
Five Year Inspection History	0.39**	0.01	0.12**	0.03
Ignored	0.04**	0.02	-0.18**	0.06
Violated in 2001	0.12**	0.04	0.04	0.10
Newly Caught in 2001	0.18**	0.04	0.02	0.13
Five Year Violation History	0.01**	0.002	-0.0003	0.004
Good Compliance Record	-0.17**	0.02	-0.03	0.07
Disclosure in 2001	-1.28**	0.28		
State Self-Policing Policy	-0.06**	0.01	0.10**	0.05
State Audit Privilege	-0.08**	0.01	-0.04	0.07
State Audit Immunity			0.18**	0.06
State Inspections	7.07**	0.18	0.51	0.95
State Inspection Intensity	-0.28**	0.02	-0.18**	0.08
State Violations	1.67**	0.16	1.63**	0.82
State Regulated Facilities	-0.58**	0.04	-0.74**	0.21
Region 1	0.07**	0.02	-0.28**	0.11
Region 2	0.02	0.03	0.13	0.13
Region 3	-0.07**	0.02	-0.07	0.09
Region 4	-0.33**	0.02	-0.24**	0.09
Region 5	-0.05**	0.02	-0.30**	0.10
Region 6	-0.21**	0.02	-0.03	0.09
Region 7	-0.22**	0.02	0.01	0.10
Region 8	-0.33**	0.03	-0.21*	0.12
Region 9	-0.36**	0.03	-0.37**	0.13
Constant	-1.86**	0.04	-3.04**	0.17
Correlation Coefficient (ρ)	0.45**	0.09		

**Statistically significant at 5%, *Statistically significant at 10%.

Table 5: Factors that Affect the Probability of Inspection and Disclosure

	Inspection	Disclosure
Probability for Representative Facility:	**1.87%**	**0.02%**
Change in Probability if the Facility:		
Is a Large Quantity Generator	**+7.03%**	**+0.15%**
Is a Small Quantity Generator	**+1.19%**	**+0.02%**
Is a Conditionally Exempt Generator	**+0.62%**	+0.002%
Is a Treatment, Storage, or Disposal Facility	**+5.50%**	**-0.01%**
Is a Transporter	**+1.29%**	-0.01%
Has Another Permit	**+1.21%**	**+0.04%**
Was Inspected in 2001	**+0.34%**	+0.01%
Increase Five Year Inspection History by one standard deviation	**+1.11%**	**+0.004%**
Has Not Been Ignored	**-0.16%**	**+0.02%**
Violated in 2001*	**+1.02%**	+0.01%
Was Newly Caught in 2001*	**+2.39%**	+0.01%
Increase Five Year Violation History by one standard deviation	**+0.04%**	-0.000%
Does Not Have Good Compliance Record	**+0.91%**	+0.002%
Disclosed in 2001	**-1.83%**	–
State Has Self-Policing Policy	**-0.28%**	**+0.01%**
State Has Audit Privilege	**-0.35%**	-0.003%
State Has Audit Immunity	**–**	**+0.02%**
Increase State Inspections by one standard deviation	**+1.20%**	**+0.001%**
Increase State Inspection Intensity by one standard deviation	**-0.27%**	**-0.003%**
Increase State Violations by one standard deviation	**+0.23%**	**+0.003%**
Increase State Regulated Facilities by one standard deviation	**-0.39%**	-0.006%

Statistically significant changes (at 10%) indicated in bold.
*Since this change cannot occur in isolation, all other variable changes that must have occurred are also taken into account. For example, facilities that are newly caught must also have been inspected in 2001 and have violated in 2001. The change in probability reported in the table is the cumulative effect of all of the variable changes, not the marginal effect. However, the statistical significance indication refers to the marginal effect only.

Table 6: Estimated Effect of Disclosure on Inspection

	All Facilities	Facilities with Good Compliance	Facilities with Poor Compliance
Number of Observations	630,862	601,702	29,160
Prob. of Inspection at Representative Facility	1.87%	1.57%	15.33%
Prob. of Disclosure at Representative Facility	0.02%	0.01%	0.22%
Change in Prob. of Inspection if Representative Facility Disclosed in 2001	-1.83%	-1.45%	-15.25%

Table 7: Bivariate Probit Results for Large Quantity Generators Only

		Inspection Equation		Disclosure Equation	
Explanatory Variable	**Mean**	**Coefficient**	**Std. Error**	**Coefficient**	**Std. Error**
Treatment, Storage, or Disposal Facility	0.03	0.86**	0.06	-0.32**	0.13
Transporter	0.04	0.09**	0.04	-0.06	0.12
Other Permit	0.12	0.27**	0.03	0.39**	0.07
Inspected in 2001	0.15	-0.16**	0.04	0.05	0.11
Five Year Inspection History	0.72	0.33**	0.01	0.10**	0.03
Ignored	0.64	-0.09**	0.03	-0.37**	0.11
Violated in 2001	0.08	0.11**	0.05	0.07	0.12
Newly Caught in 2001	0.04	0.04	0.06	-0.21	0.18
Five Year Violation History	0.36	0.01**	0.003	-0.003	0.005
Good Compliance Record	0.76	-0.13**	0.03	0.01	0.09
Disclosure in 2001	0.004	-1.21*	0.69		
State Self-Policing Policy	0.36	-0.08**	0.03	0.13	0.10
State Audit Privilege	0.40	-0.06*	0.03	-0.005	0.13
State Audit Immunity	0.29			0.14	0.12
State Inspections	0.04	6.03**	0.59	-0.77	1.52
State Inspection Intensity	1.37	0.03	0.05	0.24	0.17
State Violations	0.04	-0.75	0.49	1.30	1.66
State Regulated Facilities	0.30	-0.65**	0.12	0.31	0.39
Region 1	0.04	-0.24**	0.07	-0.28	0.20
Region 2	0.19	-0.22**	0.08	-0.33	0.23
Region 3	0.08	-0.08	0.06	-0.22	0.16
Region 4	0.09	-0.17**	0.07	-0.34**	0.16
Region 5	0.29	-0.21**	0.06	-0.70**	0.20
Region 6	0.09	-0.42**	0.07	-0.13	0.17
Region 7	0.03	-0.16**	0.08	-0.10	0.20
Region 8	0.01	0.05	0.10	-0.33	0.25
Region 9	0.16	-0.34**	0.07	-0.42*	0.24
Constant		-1.14**	0.10	-2.75**	0.31
Correlation Coefficient (ρ)		0.42	0.27		

**Statistically significant at 5%, *Statistically significant at 10%.