Discovery vs. Disclosure: EPA's Audit Policy and Hazardous Waste Compliance

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Abstract: EPA's Audit Policy is a voluntary self-policing program that reduces penalties for violations of environmental regulations. This paper examines the Audit Policy's effect on compliance with hazardous waste regulations using data for 9,500 facilities across the U.S. The analysis also considers the effect of state audit and self-policing programs. The federal Audit Policy appears to decrease the number of reported hazardous waste violations as do state programs that only include audit privilege. However, state programs that include both audit privilege and immunity appear to encourage violation. Finally, state self-policing programs that do not require audits appear to decrease violations.

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1. Introduction

In 1995, the Environmental Protection Agency (EPA) issued a policy on "Incentives for Self-Policing: Discovery, Disclosure, Correction, and Prevention of Violations."[1] This policy, more commonly referred to as the Audit Policy, is designed to encourage greater compliance with environmental regulations by providing incentives for facilities to voluntarily disclose and correct violations of environmental regulations. More specifically, the policy eliminates or reduces civil penalties for violations that facilities disclose as the result of a documented self-audit procedure and correct within 60 days. Additionally, regulators may choose not to recommend criminal prosecution for these facilities. Repeated violations, violations that present a "serious or imminent harm" to human health and the environment, or violations that involve criminal activity are not covered by the policy.

Supporters of the Audit Policy argue that it is an "efficient and economical means of ensuring and improving compliance environmental laws and regulations."[2] Opponents argue that it could have a detrimental effect on the environment because it lowers the expected financial penalty associated with a violation and thus facilities have less incentive to comply. Many who do not directly oppose the policy are nonetheless skeptical about its ability to measurably affect compliance because of the uncertain legal status of environmental audits, particularly whether the results of the audit can be used against them in court. The goal of this paper is to determine

[1] The Audit Policy was issued on December 22, 1995 (60 FR 66705) and took effect on January 22, 1996. EPA issued minor revisions to the policy on April 11, 2000 (65 FR 19617).
[2] "Audit Policy Update," U.S. EPA (EPA 300-N-99-001), Spring 1999, page 2.

whether the Audit Policy has affected compliance with hazardous waste regulations. The results of this analysis will provide important feedback on the effectiveness of the Audit Policy.

The remainder of this paper is organized as follows. Section 2 presents an overview of the related literature on self-policing and compliance. Section 3 follows with a description of the theoretical framework and empirical approach employed in this analysis. Section 4 discusses the data used and Section 5 presents the results of the analysis. Finally, Section 6 concludes.

2. Related Literature

The term self-policing, as it is used in this paper, denotes a situation in which a regulated entity notifies authorities that it has violated a regulation or law. In comparison, the term self-reporting denotes a situation in which a regulated entity provides authorities with information about its conduct that does not necessarily include violating a regulation. For example, some environmental programs require that facilities self-report emission levels regardless of whether these emissions are within or exceed regulatory limits. For the most part, self-reporting is mandatory. Thus entities subject to self-reporting face two decisions, whether or not to self-report and whether to self-report correctly.[3] Self-policing, on the other hand, is generally voluntary. The key decision is whether or not to turn one's self in. However, this distinction between self-policing and self-reporting is not generally observed in the literature. In particular, the term self-reporting is often used to describe self-policing.

A number of theoretical papers have examined the concept of voluntary self-policing in the context of environmental regulation. Kaplow and Shavell (1994) model a probabilistic law enforcement regime with self-policing. If self-policers pay a fine equal to the certainty equivalent

[3] See, for example Harford (1987) and Malik (1993).

of the sanction they would face if they did not disclose but instead took their chances that the violation would be discovered, self-policing will not affect deterrence. Additionally, such a provision results in a welfare improvement because enforcement effort and risk are reduced.

Innes (1999) extends the Kaplow and Shavell model by considering the potential benefits of remediation under a self-policing policy. Because self-policers remediate with certainty while non-disclosers only remediate when caught, self-policing can be welfare enhancing even if enforcement costs are not reduced. If violators have heterogeneous probabilities of apprehension, Innes (2000) shows that self-policing can increase efficiency by inducing violators with high probabilities of apprehension to self-police.[4] Additionally 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.[5]

Mishra, Newman, and Stinson (1997) explicitly model EPA's Audit policy. They construct a single-period compliance model and consider the effects of audit privilege and penalty reductions for disclosure on the facility's decision to conduct an audit. In this model, however, compliance is exogenous. Thus the policy only affects compliance indirectly: facilities that undertake audits reduce the costs of compliance by correcting their violation more quickly. Pfaff and Sanchirico (2000) also incorporate exogenous compliance into their self-policing model. They compare the information requirements and efficiency benefits of policies based on different potentially observable proxies for self-investigation.

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[4] Because only some violators self-police, the government can tailor penalties based on violator type. In particular, the government can set a penalty closer to the maximal sanction without overpenalizing violators with high probabilities of apprehension.

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

To date there has been relatively little assessment of EPA's Audit policy. EPA's Office of Regulatory Enforcement publishes an *Audit Policy Update* on an annual basis, but the newsletter does not include any statistical or econometric analyses.[6] In 1999, EPA completed an Audit Policy Evaluation based on a voluntary survey of companies that disclosed environmental violations under policy, but the analysis is limited primarily to descriptive statistics about the users.[7] Pfaff et al. (2002) conduct a statistical analysis of Audit docket cases for 1994 to 1999. They compare the profile of disclosed violations to all violations in terms of the statutes violated, types of violations, and average fines. They find that the typical disclosed violation is relatively minor and that the impact of the Audit policy has been relatively insignificant. However, the authors do not examine the effect of the policy on compliance behavior overall.

3. Theoretical Framework and Empirical Approach

First consider the facility's compliance decision prior to the implementation of the Audit Policy. Note that unlike the Mishra, Newman, and Stinson (1997) and Pfaff and Sanchirico (2000) models of EPA's Audit Policy, in this model the facility decides whether or not it will comply. To simplify the model, assume that facilities make a discrete choice to comply or not comply with environmental regulations.[8] Let p be the probability that the facility violates the regulations given that the facility chooses not to comply. Let s be the probability that the regulators inspect the facility and discover the violation. Finally, let F be the fine associated

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[6] The *Audit Policy Update* is available at http://www.epa.gov/compliance/resources/newsletters/auditupdate/index.html.

[7] Federal Register, May 17, 1999.

[8] In reality, firms make a continuous choice about how much to invest in compliance. The probability of a violation should be decreasing in the level of investment, although it may not be possible to reduce the probability of violation to zero. In this model if the facility chooses to

with the violation. Thus facilities compare the cost of compliance, C, with the expected cost of noncompliance, psF and choose to comply when $C < psF$. If $C > psF$ the facility will choose to not comply. It should be noted that C, s, and F are likely to be facility-specific and thus we should expect to see some facilities in compliance and others not.[9]

Next consider a policy whereby facilities that disclose violations receive a reduced fine, R. Now facilities will disclose their violations as long as $R < sF$.[10] As pointed out in Section 2, such disclosure may reduce enforcement costs and increase the level of remediation. However, the reduced fine may affect a facility's compliance decision as it will now compare C to pR (rather than to psF) and thus more facilities may find it in their interest to not comply. The policy cannot increase compliance as the only effect it can have is to reduce the expected cost of non-compliance.[11]

If facilities must conduct an environmental audit to determine if there has been a violation or if the fine reduction is contingent on the facility discovering the violation during an environmental audit, non-complying facilities also will have to decide whether to conduct an

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comply, there is no violation. However, introducing inadvertent violations will not affect the model as long as they are white noise.

[9] The cost of compliance, C, depends on the type and quantity of waste the firm generates. The probability of inspection, s, will also be facility specific as EPA targets sites based on human health and environmental risks and past compliance history. Finally, the penalty if the firm is caught, F, depends on the economic benefit gained through noncompliance and site compliance history.

[10] This assumes that facilities can costlessly determine whether or not they are in violation of the regulation.

[11] This assumes that F is fixed. This is an appropriate assumption for hazardous waste as there has been no official change in penalty levels since the Revised RCRA Penalty Policy was implemented in 1991. Other models do examine the optimal combination of self-policing policies and fine levels (see, for example, Innes (2000)). If F increases as a result of the self-policing policy, there could be an increase in the level of compliance.

environmental audit. Assume the audit program costs A to implement.[12] Figure 1 shows the facility's decision tree with the associated cost of each outcome.[13] As before, if $C > psF$ the compliance decision will be unaffected as the policy can only serve to decrease the expected cost of noncompliance. Additionally, if $R > sF$, the facility will not implement an audit program and the compliance decision will be unaffected.[14] If $R < sF$, facilities that are eligible for the penalty reduction (those that audit) will choose to self-police. In deciding whether to implement an audit program, the facility would then compare $A + pR$ to psF. If $A + pR > psF$, the facility will not implement an audit program and the compliance decision will be unchanged. If $A + pR < psF$, the facility will implement the audit program if it decides to not comply. The facility will then compare the cost of compliance (C) to the cost of the audit program and the expected penalty from self-policing ($A + pR$) and make its compliance decision accordingly. Thus the policy will decrease compliance at facilities where $psF > C > A + pR$ and $R < sF$. However, these facilities will audit and self police. Additionally, facilities where $C > psF > A + pR$ will begin to audit and self police, saving enforcement resources and increasing the level of remediation.

EPA's Audit Policy is a hybrid of these two situations. To be eligible for the full reduction facilities must discover the violation in the course of an environmental audit. If the facility does not have an audit program in place, the facility is only eligible for a 75% reduction. Let Q be the penalty for facilities that self-police but do not audit ($Q > R$). Figure 2 presents the facility's decision tree under a hybrid policy and Table 1 summarizes the effect of such a

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[12] The cost of implementing the audit, A, must be adjusted to reflect the same time period as the compliance decision.
[13] Although the tree looks different if the timing of the two decisions is reversed, the timing of the decision does not affect the results.
[14] This assumes that there is no benefit to facilities of implementing an audit program other than being eligible to receive a penalty reduction. Thus the cost of the audit, A, should be the cost of the audit net of any other benefits.

policy.[15] If $sF < R < Q$, the penalty reductions do not provide any incentives for the facility to change its compliance decision or implement an audit program. If $R < sF < Q$ the penalty reduction in the absence of an audit program is ineffective and the conditions discussed earlier determine the facility's decision. If $R < Q < sF$, the only facilities that will comply are those where $C < psF$ and $C < A + pR$. Facilities where $A + pR < C < psF$ will switch from compliance to non-compliance and facilities where $psF < C$ will continue to not comply, but all of these facilities will self-police. Thus non-complying facilities will conduct audits only if $A + pR < pQ$.

Ideally, an empirical analysis of EPA's Audit Policy would examine the effect of the policy of self-policing, auditing and compliance. Unfortunately the data required to conduct such a comprehensive analysis are not available. First, because facilities do not need to inform EPA of their audit program in advance, there is no comprehensive data on facilities that have implemented an audit program.[16] Second, comprehensive data on facilities that self-police is not available. EPA is only required to make data on settled cases available in the Audit Policy docket.[17] Because cases may not be settled for several years after the violation is disclosed, there can be a significant lag between the act of self-policing and the data being publicly available. Finally, if regulators decide not to pursue a matter because if the Audit Policy were invoked there would be no monetary penalty associated, the case may not be placed in the docket. For example, on the EPA Region 5 (covering Illinois, Indiana, Michigan, Minnesota, Ohio,

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[15] The effects are the same even if the order of the compliance and audit decisions are reversed.
[16] EPA does negotiate some audit agreements in advance. These are generally for companies with multiple facilities and allow for disclosure of violations beyond the 21-day disclosure requirement for single-facility disclosures (http://www.epa.gov/Compliance/incentives/auditing /auditagree.html).

Wisconsin) website lists 31 self-disclosure cases but only 6 of these (less than 20 percent) are in the Audit Policy docket.[18]

Since data on auditing and self-policing is not available, this paper focuses solely on the effect of the Audit Policy on facilities' compliance decisions. The objective of the paper is to examine facility compliance behavior before and after the enactment of EPA's Audit policy to assess whether the policy had any significant effect on compliance. Additionally, the analysis will examine the impact of the establishment of state audit policies on compliance since many states have recently enacted environmental audit privilege or immunity laws.[19] This approach is similar to that used in Stafford (2002) which analyzed the effect of an increase in the penalties for RCRA violations on compliance behavior.

Except for violations disclosed under the Audit Policy, violations can only be discovered during the course of a facility inspection. If a facility is not inspected there is no data on whether the facility is in compliance. Thus any empirical analysis of compliance must control for this censoring of data by using data on whether or not a facility has been inspected. Additionally, compliance and inspections are jointly determined. That is, a regulator's decision to inspect a particular facility depends in part on the likelihood that the facility will be noncompliant and the

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[17] "Upon formal settlement, EPA places copies of settlements in the Audit Policy Docket." (Section I.I.3. Release of Information to the Public in "Incentives for Self-Policing: Discovery, Disclosure, Correction and Prevention of Violations, Final Policy Statement" (65 FR 19617).

[18] See http://www.epa.gov/region5/orc/audits/audit_r5cases.htm. The 31 cases include 6 cases resolved by letter where no formal compliant was filed and no violations pursued because the facilities satisfied all of the criteria for the Audit Policy.

[19] Some state laws prevent state enforcement authorities from obtaining audit data. Some shield companies from liability if they disclose and correct violations discovered through an environmental audit. EPA policy is generally less favorable to industry than much state privilege and immunity legislation.

facility's decision to comply depends in part on the likelihood of inspection. The censored bivariate probit model developed by Greene (1992) can account for both of these factors.[20]

The compliance decision is modeled as a function of explanatory variables, $Y_{1i}^* = x_{1i}\beta_1 + \varepsilon_{1i}$. The value of Y_{1i}^* is not directly observable, but one can observe whether the facility is in compliance. Thus compliance is modeled as a binary variable equal to 1 if the facility violates the regulations:

$$Y_{1i} = \begin{cases} 1 \text{ if } Y_{1i}^* > 0 \\ 0 \text{ if } Y_{1i}^* \leq 0 \end{cases}$$

The inspection decision is modeled similarly. $Y_{2i}^* = x_{2i}\beta_2 + \varepsilon_{2i}$,

$$Y_{2i} = \begin{cases} 1 \text{ if } Y_{2i}^* > 0 \\ 0 \text{ if } Y_{2i}^* \leq 0 \end{cases}$$

Thus, the likelihood of observing a detected violation (Y_{1i}=Y_{2i}=1) is:

$$L_{Y_{1i}=1,Y_{2i}=1} = \sum_{Y_{1i}=1,Y_{2i}=1} \log \Phi_2 \left[x_1\beta_1, x_2\beta_2, \rho \right]$$

where Φ_2 is the bivariate normal cumulative distribution function and ρ is the covariance between ε_{1i} and ε_{2i}. The likelihood of inspecting a non-violator (Y_{1i} = 0, Y_{2i} = 1) is:

$$L_{Y_{1i}=0,Y_{2i}=1} = \sum_{Y_{1i}=0,Y_{2i}=1} \log \Phi_2 \left[-x_1\beta_1, x_2\beta_2, -\rho \right].$$

If a facility is not inspected, whether the facility is in violation is unknown. Thus the maximum likelihood function for the censored bivariate probit can be expressed as:

[20] This method is similar to the "detection controlled estimation" model developed by Feinstein (1990) and used in other compliance analyses such as Helland (1998), except that it allows for the errors in the inspection and violation equations to be correlated.

$$L = L_{Y_{1i}=0,Y_{2i}=1} + L_{Y_{1i}=1,Y_{2i}=1} + L_{Y_{2i}=0} = \sum_{Y_{1i}=1,Y_{2i}=1} \log \Phi_2 [x_1\beta_1, x_2\beta_2, \rho] + \sum_{Y_{1i}=0,Y_{2i}=1} \log \Phi_2 [-x_1\beta_1, x_2\beta_2, -\rho] + \sum_{Y_{2i}=0} \log(1 - \Phi[x_2\beta_2])$$

4. Data

The universe for this analysis includes all large quantity hazardous waste generators and management facilities in the U.S., excluding newly regulated facilities and federal facilities. Newly regulated facilities are excluded because they are likely to behave differently than established companies as they have less knowledge about the regulations and the best way in which to comply. Federal facilities are excluded because the impact of penalties on federal facilities is not the same as the impact on for-profit companies. Finally, small quantity generators are not included because the regulations governing them are significantly more lenient than those governing other generators and because they are excluded from some EPA data collection efforts. Thus, approximately 9,500 facilities are included in the panel data set which covers the period from 1992 to 2001.

Because of the complexity of hazardous waste regulations there is no simple measure of compliance. There are approximately 40 "areas of violation" which roughly correspond to the subparts of the Code of Federal Regulations for hazardous waste. Within each area, there are numerous specific violations that could occur. Moreover, the severity of each violation can vary. Thus for the purposes of this analysis, a facility is out of compliance if it commits at least one violation. Specifically, the dependent variable Violation is equal to 1 if there is any RCRA violation at the facility during the calendar year.[21] The second dependent variable, Inspection, is equal to 1 if any state or regional official inspects the facility, regardless of the purpose of the inspection.[22]

To determine the impact of EPA's Audit Policy on compliance, both the inspection and the violation equations include a dummy variable indicating whether or not the policy was in effect (i.e. post 1995). Additionally because there may have been a lag between the effective date of the policy and when the regulated community began to make decisions based on it, the equations include a Transition dummy for the years 1996 and 1997. To control for differences in state policies relating to self-policing and audits, the equations also contain dummy variables for State Privilege, State Immunity, and State Self-Police.[23] Respectively, for each year these variables measure whether the state considers audit results to be privileged, whether the state grants immunity from penalties for violations disclosed as a result of the audit, and whether the state has a self-disclosure policy (which does not generally require an audit to have taken place to receive some relief).

The inspection and violation equations also control for a variety of facility-specific and state-specific factors. One set of facility-specific variables characterizes the level and nature of hazardous waste activities at the facility. Permit indicates whether the facility has a RCRA operating permit; Generated and Received measure the quantity of hazardous waste generated at

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[21] Both the Violation and the Inspection variables are derived from enforcement and compliance data recorded in EPA's RCRA Information System (RCRIS) which can be accessed via the Envirofacts database on EPA's website, www.epa.gov.

[22] Inspections may be conducted to monitor compliance with regulations, to evaluate specific systems such as groundwater monitoring devices, to review records, or to verify compliance with enforcement orders.

[23] Data on state policies through 1998 is provided by the National Conference of State Legislatures at http://www.ncsl.org/programs/esnr/audits.htm and through 2001 at Region 5's

the facility and the quantity received at the facility for management, respectively; and Combustion and Land indicate whether the facility operates a hazardous waste combustion unit (e.g., an incinerator or industrial furnace) or land disposal unit (e.g., landfill or surface impoundment), respectively.[24] Because there is more potential for environmental damages at facilities that manage large quantities of waste or conduct certain types of management operations, enforcement authorities are likely to target facilities based on hazardous waste activity. Although such targeting increases the probability that a facility will be inspected, facilities with more waste activity and thus higher compliance costs receive higher benefits from non-compliance.

The state-specific variables are included to control for differences in state enforcement. Two of these variables, State Inspections and State Violations Last, measure the level of inspection and enforcement activity in the state.[25] To measure local enforcement pressure the equations also include Environmental Membership, a measure of the proportion of citizens in the state that are members in environmental organizations such as the Sierra Club.[26] State Gross Product is included as a proxy for the enforcement burden that a state's environmental agency

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Office of Regional Counsel at http://www.epa.gov/region5/orc/audits/audit_apil.htm. These data were supplemented with information collected from state statutes and websites.

[24] This information in extracted from RCRIS and from EPA's Biennial Reporting System (BRS). The BRS contains information on the amount and type of waste generated and the waste management systems used at the facility. The data are collected biennially for the odd years, so waste quantities for even years are interpolated. Additionally, due to the time lag between collection and dissemination of the data, 2001 quantity data is not yet available. Thus 1999 data has been used for both 2000 and 2001. The results of analysis with respect to the audit and self-policing variables do not change qualitatively if the quantity data are excluded.

[25] These variables include all inspections and violations in the state according to RCRIS, not just those at facilities in this analysis. Both variables are normalized by the Gross State Product.

[26] Environmental Membership was taken from the 1991-92 Green Index, Hall and Kerr (1991).

faces.[27] A dummy variable indicating whether the state has a Strict Liability regime is included in both equations because the liability regimes may affect the incentives for enforcement agencies to find potentially responsible parties in the case of an accident or spill.[28] Finally, dummy variables for the EPA regions are included in the equations to control for any differences across regions.

5. Results

Table 2 presents the results of the censored bivariate probit regression. First consider the facility-specific variables. Except for the coefficients on Land in the violation equation, the coefficients on these variables are positive and significant in both equations. This suggests that the increased costs of compliance for permitted facilities, facilities that generate or receive large quantities of waste, and facilities with combustion units outweigh the increased probability that the facility will be inspected.[29] For facilities with land disposal units, there is no significant difference in the probability of inspection, although these facilities are less likely to violate the regulations.

The coefficient on Inspected_{-1} is positive and significant in the inspection equation, indicating that firms that were inspected in the previous year are more likely to be inspected in the current year. This suggests that there may be an unobserved or omitted characteristic of the

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[27] To control for the workload faced by state environmental agencies, many studies use the level of manufacturing or number of manufacturers in a state. However, because a significant portion of hazardous waste is produced by facilities in sectors that are not considered manufacturing (i.e., service sectors), this analysis uses the state's gross product. Gross State Product data was obtained from the Bureau of Economic Analysis, Department of Commerce website (http://www.bea.doc.gov/bea/regional/gsp/gspsum_c.htm).

[28] The data on adoption of Strict Liability come from analyses of state Superfund Programs conducted by both the Environmental Protection Agency and the Environmental Law Institute.

[29] These results are consistent with Stafford (2003).

facility that the enforcement agency is targeting. For example, there may be specific activities or substances at the facility that make the facility more likely to be inspected, or the facility could be conveniently located (close to a regional office or other regulated facilities). The coefficient on $Inspected_{-1}$ in the violation equation is negative and significant, perhaps because facilities that were inspected in the previous year believed (correctly) that they were more likely to be inspected in the current year and thus if they violated were more likely to be caught.

Facilities that were found in violation in the previous year are more likely to be inspected in the current year, as expected. The coefficient on $Violated_{-1}$ in the violation equation is positive and significant, which seems to be inconsistent with the higher probability of an inspection for these facilities and the fact that penalties are higher for repeat violators.[30] There may be an unobserved or omitted variable such as compliance cost or corporate culture that make a facility more or less likely to violate. Also, it may take time to correct a violation, particularly if it requires installing new technology, so that past violations may in part determine current violations.

The coefficient on State Inspections has the expected positive and significant sign in the inspection equation, as a higher level of inspection activity increases the probability that a given facility will be inspected. The coefficient in the violation equation is also positive and significant, which appears inconsistent with a higher probability of inspection. However, if the same facilities violate regulations repeatedly, the number of inspections may reflect higher levels of past violations. State $Violations_{-1}$ is included in the inspection equation but is excluded in the violation equation to identify the model. Although the number of violations in the state in a previous year should affect the probability that an inspection will be conducted in the current

[30] The results for $Inspected_{-1}$ and $Violated_{-1}$ are consistent with Stafford (2003).

year, data on the level of violations will not generally be common knowledge to facilities and therefore should not affect the facility's violation decision. The coefficient on State Violations$_{-1}$ is negative, as expected, and significant.

Environmental Membership is included in the Violation equation because Hamilton (1996) finds that penalties are higher in states where a larger percentage of citizens are members in environmental organizations. To identify the model, Environmental Membership is omitted from the Inspection equation because there is no obvious relationship between citizen membership in environmental organizations and the probability of inspection for a facility. Moreover, when Environmental Membership was included in a probit regression of the Inspection equation, it was not significant. Environmental Membership has the expected negative (and significant) coefficient.

The coefficient on State Gross Product in the inspection equation is negative and significant as expected because a higher workload means less resources are available to inspect the facilities in this analysis. Additionally, states with heavier workloads may be forced to target enforcement efforts and inspections will be less evenly distributed. The coefficient in the violation equation is also negative and significant which appears to be inconsistent. However, states with high gross products are the larger, more industrialized states and thus are likely to have relatively well established environmental programs which could result in higher compliance levels. The coefficient on Strict Liability in the inspection equation is positive and significant, indicating that strict liability may provide stronger incentives for regulators to inspect facilities because damages can be recovered from such parties without proof of negligence or intent in a strict liability regime.[31] For the violation equation, however, the coefficient is not significant.

[31] This result is consistent with Stafford (2003).

Next, consider the results for the two federal audit policy variables, Audit Policy and Transition. The positive and significant coefficient on Audit Policy in the inspection equation suggests that the policy increases likelihood of an inspection. However, as shown in Figure 3, during this period the overall number of inspections decreased slightly. Lower overall inspections combined with a higher likelihood of inspection suggests that inspections were less targeted after the imposition of the Audit Policy. During the transition, on the other hand, the probability of inspection was lower than prior to the imposition of the policy.[32] In the violation equation, both Audit Policy and Transition have negative and significant coefficients. This result is somewhat surprising as theoretically the Audit Policy should only serve to increase the number of violations. However, since the likelihood of inspections is higher after the Audit Policy, the decrease in compliance could be a result of an increase in the likelihood of detection. Alternatively, if a significant number of violations are disclosed (rather than detected) and are not reported as violations, it could look as if the Audit Policy increases compliance even when it does not. This explanation is supported to some extent by anecdotal evidence that regulatory authorities may not follow up on violations that would receive complete relief under the Audit Policy.[33] Additionally, the Audit Policy could actually decrease violations if facilities that implement an audit program are able to identify and correct problems before they become violations.

Finally, consider the results for the state audit policy and self-policing variables. In the inspection equation the coefficient on State Privilege is negative and significant while the coefficient on State Immunity is positive and significant. However, because only one state has

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[32] The net effect of the Transition and Audit Policy dummies is -0.044.

Immunity and not Privilege, the net effect of state audit policies is generally negative, that is a lower probability of inspection.[34] A similar pattern holds in the violation equation: State Privilege has a negative and significant coefficient and State Immunity has a positive and significant coefficient. In this case the net effect for states that have both is positive. For states with both Privilege and Immunity thus the results are consistent: a lower probability of inspections and a higher probability of violation. This is the result about which critics of audit policies are concerned. Lowering the financial penalties associated with self-disclosed violations decreases the incentives for compliance, particularly if such policies are used as a substitute for enforcement efforts (i.e., inspections). However, in states with audit privilege only (and not reduced penalties), although the probability of inspection decreases, so does the probability of violation. This suggests that providing privilege may provide incentives for firms to implement audit programs that can in turn decrease violations. Lastly, the coefficients on State Self-Police are negative and significant in both the inspection and violation equations. Thus it appears that state self-policing statutes may be used as a substitute for inspections. The decrease in violation that is associated with state self-policing statutes may also be the result of disclosed violations not being reported as violations, as discussed above.

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[33] Region 5 reports several disclosure cases where no formal compliant was filed or violations pursued because the facility satisfied all of the criteria under the Audit Policy. (See http://www.epa.gov/region5/orc/audits/audit_r5cases.htm.)

[34] Only Rhode Island grants immunity from penalties disclosed as a result of an audit but does not consider the audit to be privileged. Additionally, three states (Nebraska, South Dakota, and Utah) passed Immunity regulation prior to passing Privilege legislation. Five states (Arkansas, Indiana, Illinois, Mississippi, and Oregon) have only Privilege legislation.

6. Conclusions

This analysis examines the effect of EPA and state voluntary self-policing policies on hazardous waste compliance. The federal Audit Policy appears to decrease the number of reported hazardous waste violations. There are several possible explanations for this result. First, the Audit policy is correlated a higher probability of inspection which would increase the expected cost of violations. Second, a significant level of self-disclosure under the policy could decrease the number of reported violations, either because disclosed violations are not reported or because authorities may not follow up on some disclosed violations. Third, the Audit Policy could actually increase compliance if a significant number of facilities implement an audit program and are thus able to identify and correct problems before they become violations.

On the other hand state audit privilege and immunity legislation appears to increase violations in some cases. For states with both audit privilege and immunity, inspections are less likely and violations more likely. This is the result that critics of self-policing programs fear: lowering the financial penalties associated with self-disclosed violations decreases the incentives for compliance. However, in states with audit privilege only the probability of violation is lower, perhaps because such programs provide incentives for firms to implement audit programs that can in turn decrease violations without the disincentives to compliance that penalty reductions bring. Finally, state self-policing programs that do not require audits also appear to decrease violations, perhaps because disclosed violations are not reported.

These results suggest the need for additional theoretical and empirical analysis of the effect of self-policing policies. In particular analyses that examine the effect of such policies on both the decision to implement an audit program and the decision to self-disclose violations are critical. Such information would help to more clearly determine whether such policies increase or decrease compliance. Also, a more thorough understanding of the effects of the existing policy will help regulators to design new policies or modify existing policies in order to cost-effectively improve compliance with environmental laws and regulations.

Table 1: Effects of a Hybrid Audit Policy on Compliance, Audit Implementation, and Self-Policing

Conditions				In Compliance?*	Implements Audits?	Self Polices?
$sF<R<Q$	$C<psF$			Yes	No	No
	$psF<C$			No	No	No
$R<sF<Q$	$C<psF$	$C<A+pR$		Yes	No	No
		$A+pR<C$		**No**	Yes	Yes
	$psF<C$	$A+pR<psF$		No	Yes	Yes
		$psF<A+pR$		No	No	No
$R<Q<sF$	$C<psF$	$C<A+pR$		Yes	No	No
		$A+pR<C$	$A+pR<pQ$	**No**	Yes	Yes
			$pQ<A+pR$	**No**	No	Yes
	$psF<C$	$A+pR<pQ$		No	Yes	Yes
		$pQ<A+pR$		No	No	Yes

*Boldface indicates a change from the decision that would be made without a self-policing policy.

Table 2: Results of the Censored Bivariate Probit

Variable	Inspection Equation		Violation Equation	
	Coefficient	Standard Error	Coefficient	Standard Error
Constant	-0.82*	(0.03)	-0.67*	(0.07)
Permit	0.79*	(0.02)	0.47*	(0.02)
Generated	0.06*	(0.01)	0.05*	(0.01)
Received	0.04*	(0.01)	0.03*	(0.01)
Combustion	0.18*	(0.04)	0.25*	(0.03)
Land	-0.01	(0.02)	-0.07*	(0.02)
Inspected$_{-1}$	0.42*	(0.01)	-0.14*	(0.02)
Violated$_{-1}$	0.07*	(0.01)	0.29*	(0.02)
State Inspections	0.42*	(0.02)	0.09*	(0.01)
State Violations$_{-1}$	-0.27*	(0.02)		
Environmental Membership			-0.13*	(0.04)
State Gross Product	-0.24*	(0.03)	-0.14*	(0.04)
State Strict Liability	0.09*	(0.01)	0.02	(0.02)
State Privilege	-0.09*	(0.02)	-0.09*	(0.02)
State Immunity	0.08*	(0.02)	0.21*	(0.02)
State Self-Police	-0.18*	(0.02)	-0.17*	(0.02)
Audit Policy	0.07*	(0.01)	-0.11*	(0.02)
Transition	-0.10*	(0.01)	-0.06*	(0.02)
ρ	0.91*	(0.02)		

*Statistically significant at 5%.
Regional dummies are not reported.

Figure 1: Compliance and Audit Decision if Audit Required

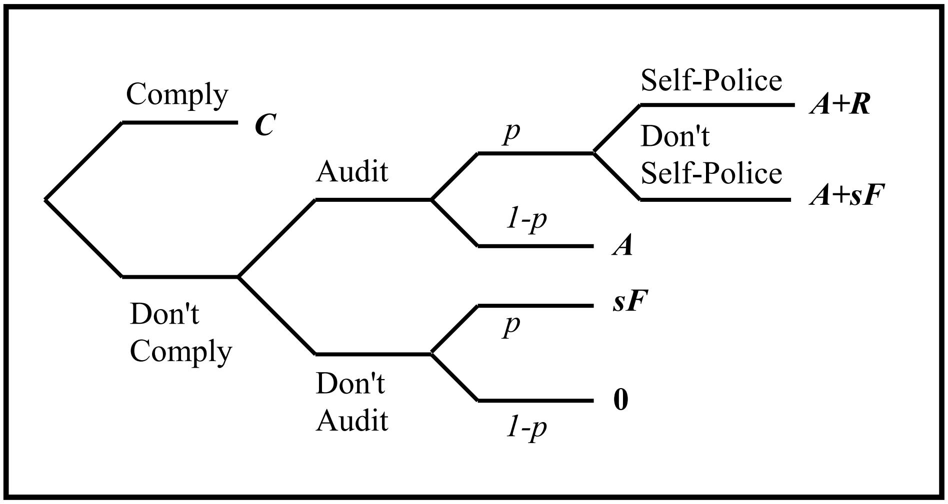


Figure 2: Facility's Decision under a Hybrid Policy

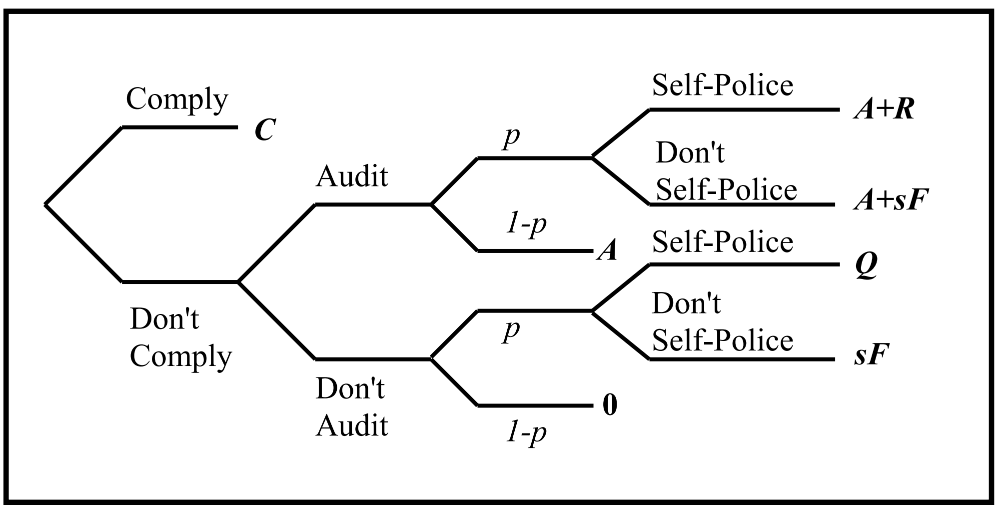
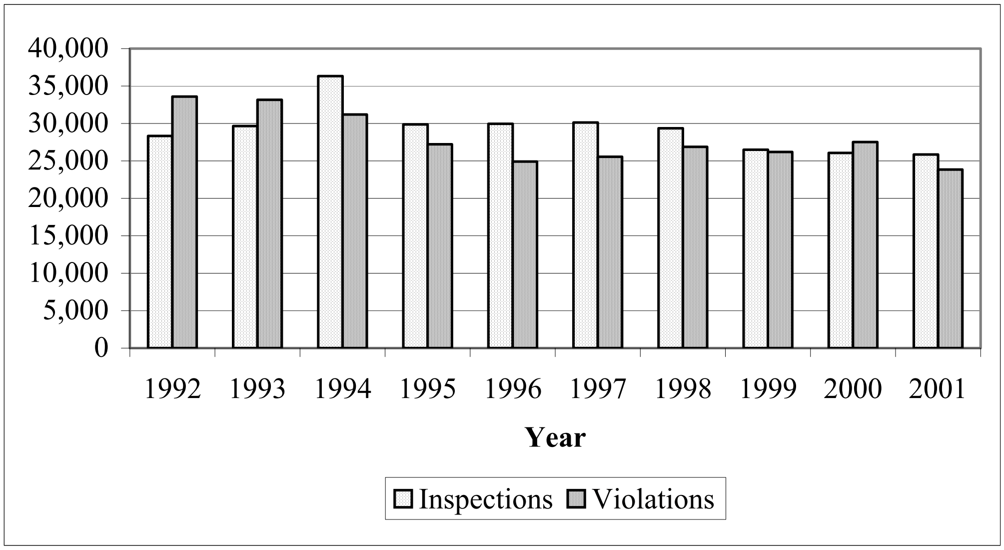


Figure 3: RCRA Inspections and Violations, 1992 - 2001



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