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Effectiveness of Government Interventions at Inducing Better Environmental Performance: Does Effectiveness Depend on Facility or Firm Features?

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EFFECTIVENESS OF GOVERNMENT INTERVENTIONS AT INDUCING BETTER ENVIRONMENTAL PERFORMANCE: DOES EFFECTIVENESS DEPEND ON FACILITY OR FIRM FEATURES?

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Abstract: Environmental agencies have several options for dealing with alleged noncompliance with environmental regulations. These options include pursuit of administrative or judicial civil penalties and injunctions to prevent future violations. Scholars have begun exploring whether these options induce better performance by regulated entities. This Article addresses a largely neglected question: whether a regulated facility's characteristics affect the efficacy of the different enforcement options. The Article stems from a study of compliance by the chemical industry with federal Clean Water Act permits. It assesses whether facility characteristics, including effluent limit level and type, permit modifications, facility size, capacity utilization, discharge volatility, and ownership structure, theoretically should make a difference and actually appeared to do so at the facilities covered by the study. The findings should be of interest to both facilities regulated under the Clean Water Act and federal and state regulators seeking to maximize the impact of their enforcement actions.

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Introduction

In October 2007, the U.S. Senate approved by unanimous consent a "sense of the Senate" resolution commemorating the thirty-fifth anniversary of the adoption of the federal Clean Water Act (CWA).[1] The resolution noted the tremendous value and importance of clean water to the United States; the substantial improvements in water quality that have resulted from a partnership among government, the private sector, and the public; the "resounding public support for the continued protection" of the nation's surface water bodies; the link between maintenance and improvement of water quality and protection of the public health and wildlife; and the availability of abundant opportunities for public recreation and economic development.[2] The resolution sounded a cautionary note, indicating that "water pollution problems persist throughout the United States, and significant challenges lie ahead in the effort to protect and restore the water resources of the United States."[3] It also enumerated the portions of the nation's surface waters that remain impaired.[4] Nevertheless, the Senate invited all citizens and all levels of government to "celebrate the accomplishments of the United States" and "recommit to achieving" the statutory goals of restoration and maintenance of "the chemical, physical, and biological integrity of the waters of the United States."[5]

Amidst all the mirth and revelry, there was one notable omission: the resolution made no reference to either compliance with or enforcement of the provisions of the CWA.[6] The omission is troublesome because recent reports reveal that noncompliance rates with the CWA are disturbingly high. According to a report by the U.S. Public Interest Research Group (PIRG) Information Fund issued in the same month in which the Senate adopted its laudatory CWA resolution, more than 3600 major facilities—fifty-seven percent of the total number of such regulated facilities—exceeded their CWA permits at least

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[1] S. Res. 354, 110th Cong. (2007). The CWA is the current name of the statute adopted in 1972 called the Federal Water Pollution Control Act Amendments. Clean Water Act of 1977, 33 U.S.C. §§ 1251–1387 (2000 & Supp. 2005) (originally enacted as Federal Water Pollution Control Act Amendments of 1972, Pub. L. No. 92-500, 86 Stat. 816).

[2] S. Res. 354, 110th Cong. (2007).

[3] *Id.*

[4] *Id.*

[5] *Id.*; *see also* 33 U.S.C. § 1251(a).

[6] S. Res. 354, 110th Cong. (2007). Three days before adoption of the Senate resolution, the House passed a similar resolution. H.R. Res. 725, 110th Cong. (2007). It too omitted any reference to compliance or enforcement. *Id.*

once during calendar year 2005.[7] More than 600 facilities exceeded their permit limits for at least half of the monthly reporting periods during 2005, and, on average, the facilities reporting violations discharged more than four times the amounts allowed by their permits.[8] Despite the frequency with which CWA permit violations occurred, the total budget of the U.S. Environmental Protection Agency (EPA) fell by 13%, adjusted for inflation, between 1997 and 2006.[9] During the same period, EPA's enforcement funding fell by 5%.[10] Enforcement funds for the Agency's regional offices, which carry most of the enforcement load under the CWA, fell by 8%.[11] The result of these funding cuts was a decline in regional enforcement staffing of about 5%.[12] Further, EPA grants to the states to implement and enforce environmental programs generally fell by 9% between 1997 and 2006, and by 22% between fiscal years 2004 and 2006.[13]

The compliance figures provided by the PIRG report for 2005 do not appear to be anomalous. According to EPA, for example, more than half of all major facilities violated their CWA permits during fiscal year 1998 and more than twenty percent of these dischargers were in significant noncompliance.[14] A 2001 report issued by EPA's Office of Inspector General revealed compliance rates for major dischargers of less than seventy-five percent in twenty states in fiscal year 2000 and more than one-third of the states reported that more than half of the

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[7] Christy Leavitt, U.S. PIRG Educ. Fund, Troubled Waters: An Analysis of 2005 Clean Water Act Compliance 1 (2007), *available at* http://www.uspirg.org/html/troubled waters07/troubled_waters07.pdf. The 3600 facilities reported more than 24,400 exceedances of their CWA permit limits during 2005. *Id.*; *see infra* note 57 and accompanying text (defining major facilities).

[8] Leavitt, *supra* note 7, at 2. Eighty-one facilities reported violations for every monthly reporting period in 2005. *Id.*

[9] *Id.* at 15.

[10] *Id.*

[11] *Id.*

[12] *Id.*

[13] *Id.* (citing U.S. Gov't Accountability Office, GAO-07-883, EPA-State Enforcement Partnership Has Improved, but EPA's Oversight Needs Further Enhancement 15 (2007)).

[14] For purposes of the CWA, EPA defines significant noncompliance (SNC) with respect to conventional pollutants, such as total suspended solids, as "exceeding an average monthly limit by 40% in any two months of a six-month period." Clifford Rechtschaffen, *Enforcing the Clean Water Act in the Twenty-First Century: Harnessing the Power of the Public Spotlight*, 55 Ala. L. Rev. 775, 781–82 (2004) (citing U.S. Gen. Accounting Office, Water Pollution: Many Violations Have not Received Appropriate Enforcement Attention 3 (1996)).

major facilities with significant violations in fiscal year 1999 had recurring violations in 2000.[15]

As one attorney involved in environmental enforcement matters has stated, "Although an appropriate metric for measuring the effectiveness of enforcement is elusive, low compliance rates are indicative of ineffective enforcement."[16] Moreover, "[R]egulatory law and compliance are so systematically intertwined that neither can be understood without understanding both. This is surely the case with environmental protection law."[17] If Congress, EPA, the states, and the American public are indeed as concerned about *recommitting* to the achievement of the CWA's goals as the October 2007 Senate resolution indicates, they should be analyzing ways to make the government's environmental enforcement activities more effective than they seem to have been in recent years.

This Article is designed to provide information that may enable the federal and state agencies involved in enforcement of environmental requirements—particularly requirements derived from the CWA—to make their enforcement activities more effective at improving environmental performance by regulated entities. Environmental agencies at both the federal and state levels have a variety of options when faced with alleged noncompliance with environmental statutes, regulations, and permits. These options, which we refer to as government interventions, or simply interventions, include inspections of regulated facilities, actions to impose administrative or judicial civil penalties for past violations, efforts to enjoin ongoing violations, and the approval of supplemental environmental projects. Scholars have begun to explore whether some of these enforcement options are more effective at inducing better environmental performance by regulated entities than others.[18] They have also assessed whether a traditional deterrence-based approach to enforcement or an approach based on co-

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[15] Richard Webster, *Federal Environmental Enforcement: Is Less More?*, 18 Fordham Envtl. L. Rev. 303, 314 (2007) (citing Office of Inspector Gen., EPA, Rep. No. 2001-P-00013, Water Enforcement: State Enforcement of Clean Water Act Dischargers Can Be More Effective 55, 57 (2001)).

[16] *Id.*

[17] Peter Cleary Yeager, *Industrial Water Pollution*, 18 Crime & Just. 97, 99 (1993) [hereinafter Yeager, *Water Pollution*].

[18] *See generally* Robert L. Glicksman & Dietrich H. Earnhart, *The Comparative Effectiveness of Government Interventions on Environmental Performance in the Chemical Industry*, 26 Stan. Envtl. L.J. 317 (2007) (providing examples of methods of government intervention and discussing their effectiveness).

operation and the provision of compliance assistance is more likely to result in greater improvements in environmental performance.[19]

One question that has by and large been neglected to date is whether the features of a regulated facility are likely to affect the efficacy of government interventions, such as inspections, civil penalty proceedings, or actions for injunctive relief, in improving environmental performance. This Article addresses that question by examining a study of compliance with CWA permits by major facilities in the chemical industry. It assesses whether the following factors should make a difference in the effectiveness of interventions as a theoretical matter: (1) facility features relating to the regulatory program, such as the effluent limit level; (2) facility characteristics related to the production process of the facility being regulated, such as facility size, as measured by flow capacity; and (3) firm ownership structure. The Article also evaluates whether those factors appear to have made a difference at the facilities covered by the study. The findings should be of interest not only to facilities regulated under the CWA, but also to federal and state regulators seeking to maximize the impact of their enforcement actions, improve compliance rates, and minimize the adverse effects of regulatory violations on the environment.

Part I of the Article describes the insights provided by previous theoretical and empirical studies on the influence of either facility or firm features on the effectiveness of the government interventions we explore. For each of the facility and firm features we analyze, we rely on these previous studies to explain the anticipated effects of each feature on environmental performance following an intervention. Part II describes our sample selection and data collection techniques. In Part III, we explain our statistical analysis and interpret the results of our study of environmental performance by facilities in the chemical industry. As part of this interpretation, we determine whether these results conform to, or deviate from, the expectations we generate in Part I of the Article.

Our empirical results provide only weak or mixed support for the identified expectations. For example, larger facilities are expected to be more responsive to actual or threatened government interventions, yet only one of the eight empirical results supports this expectation. As an-

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[19] *See* CLIFFORD RECHTSCHAFFEN & DAVID L. MARKELL, REINVENTING ENVIRONMENTAL ENFORCEMENT AND THE STATE/FEDERAL RELATIONSHIP 60–61 (2003). *See generally* Robert L. Glicksman & Dietrich H. Earnhart, *Depiction of the Regulator-Regulated Entity Relationship in the Chemical Industry: Deterrence-Based vs. Cooperative Enforcement*, 31 WM. & MARY ENVTL. L. & POL'Y REV. 603 (2007) (comparing deterrence-based governmental intervention with a cooperative approach).

other example, higher effluent limit levels—in other words, less stringent limits—are expected to improve the effectiveness of government interventions. Yet, only one of the eight empirical results is consistent with this expectation, while five of the eight results are inconsistent with it. As the final example, greater discharge volatility is expected to improve the effectiveness of government interventions. Only two of the eight empirical results, however, support this expectation, while four of the eight results run directly counter to it. We suggest that further empirical studies be conducted to determine whether facility and firm features, including but not limited to the ones analyzed in this Article, influence the effectiveness of government interventions on environmental performance.

I. Insights from Previous Studies: Expectations About the Influence of Facility/Firm Features on the Effectiveness of Government Interventions

We assess the influence of three categories of facility features on the effectiveness of government interventions at inducing better environmental performance. The first category includes three features that relate to the nature of the regulatory program: limit level, limit type, and permit modification. We also assess the influence of three features that are inherent to a regulated facility's production process: flow capacity, which serves as a proxy for facility size; the flow-to-flow capacity ratio, which serves as a proxy for capacity utilization; and discharge volatility. Finally, we assess the influence of one facility feature that is more accurately described as a firm characteristic: ownership structure.

In this Part, we summarize previous studies that bear on the relevance of these seven facility features for capturing the full effect of government interventions on environmental performance, measured in our study by the amounts actually discharged divided by the amount of discharge authorized by an applicable permit. For each of the seven features, we develop a set of expectations—or, in some cases, a set of alternative expectations—as to how the effectiveness of government interventions should be affected by the presence or greater magnitude of these features. In Part III, we compare these expectations to the performance of facilities in the chemical industry during the period of our study to determine whether they conform to, or deviate from, the expectations.

A. *Facility Features Related to the Regulatory Program*

1. Limit Level

The first facility feature we assess is the stringency of the effluent limit to which a particular facility is subject. The question addressed is whether a facility subject to an effluent limit under the CWA is likely to be more or less responsive to an intervention than a similarly situated facility with a less stringent limit. We found no previous studies that assessed the relationship between limit level and responsiveness to government interventions. Previous studies have addressed a related question: the relationship between limit level and environmental performance. One study summarized literature postulating that under higher levels of regulation, facilities were less likely to perceive economic incentives to engage in the development of environmentally innovative technology.[20] Another study focusing on the behavior of regulatory agencies, rather than the performance of regulated entities, inquired whether systematic biases operated in regulatory law enforcement. The study found that permit stringency under the CWA affected the frequency of violations. In particular, "[W]here the legal requirements [were] most substantial, violations [were] more common."[21] Neither of these studies, however, sought to assess whether regulatory stringency affected the degree to which a regulated entity responded to government interventions.

Although neither of these two studies addresses the precise question at issue in our study, their findings are consistent with the supposition that it is more difficult for facilities subject to stringent limits to improve their performance than it is for facilities subject to less stringent limits. The costs of reducing discharges to the levels needed to comply with stringent limits may be higher, for example, than the costs of making reductions needed to comply with more lenient limits. Similarly, a facility operating with pollution-control technology that is capable of achieving compliance with stringent effluent limits may find it more difficult to improve its performance in response to an interven-

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[20] Mark Sharfman, Regulation and Sustainable Development: The Management of Environmentally Conscious Technological Innovation Under Alternative Market Conditions (June 4, 2001), *in* BEYOND COMPLIANCE: WHAT MOTIVATES ENVIRONMENTAL BEHAVIOR? 1–2 (Sylvan Envtl. Consultants ed., 2001), *available at* http://es.epa.gov/ncer/publications/workshop/bynd_com_sess2.pdf (editor's summary of presentation).

[21] Peter C. Yeager, *Structural Bias in Regulatory Law Enforcement: The Case of the U.S. Environmental Protection Agency*, 34 SOC. PROBS. 330 (1987) [hereinafter Yeager, *Regulatory Law Enforcement*].

tion following noncompliance than a facility operating with similar technology but subject to a higher and more easily achieved limit. These considerations induce us to test the proposition that the tougher a facility's limit is, the harder the regulated source is already being pushed, and thus, the harder it will be for the facility to reduce discharge levels in response to an intervention.

2. Effluent Limit Type

The second feature related to the regulatory program we seek to assess is the type of limit to which a regulated facility is subject. Some limits are initial or interim. These interim limits represent weigh stations on the road to the imposition of a final effluent limit. Under other federal regulatory programs, interim limits are typically less stringent than final limits. Under the Resource Conservation and Recovery Act, for example, some facilities for the treatment, storage, and disposal of hazardous waste that qualified for interim status were allowed to comply for a limited time with a set of waste management standards that were less stringent than the standards that went into effect after the expiration of interim status.[22] Under the CWA, facilities are sometimes required to comply with interim limits while they are undergoing treatment technology upgrades.[23] In our study, however, we controlled for the level of the limit. Our interest is in determining whether the label placed on the limit, interim versus final, is itself a significant factor in the nature of a facility's performance following an intervention.

One previous study found that publicly owned treatment plants subject to final limits under the CWA outperformed those subject only to an interim limit.[24] That study concluded that regulators could improve performance by avoiding the issuance of interim limits.[25] That aspect of the study, however, did not involve an effort to assess the impact of interventions on facilities with different features. We did not locate other studies with findings relevant to the question of whether

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[22] *See* Adam Babich, *Too Much Science in Environmental Law*, 28 COLUM. J. ENVTL. L. 119, 163 (2003) ("'[I]nterim status' facilities operate pursuant to generic regulations, which are lax in contrast to the detailed and stringent permits that apply to non-grandfathered operations.").

[23] *See, e.g.*, Notice of Lodging of Consent Decree Under the Clean Water Act, 69 Fed. Reg. 68,979, 68,979 (Nov. 26, 2004); *see also* 40 C.F.R. § 131.41(f)(7) (2007).

[24] Dietrich Earnhart, *Regulatory Factors Shaping Environmental Performance at Publicly-Owned Treatment Plants*, 48 J. ENVTL. ECON. & MGMT. 655, 676 (2004).

[25] *Id.*

interventions affect performance differently at facilities subject to interim and final limits.

Because an interim limit does not represent the long-term, final regulatory obligation with which a regulated facility must comply, regulated sources may not take interim limits as seriously as final limits. If facilities do not, they are not likely to react as seriously to interventions directed at interim limits as they would to interventions directed at final limits. If interim limits are not taken as seriously, performance improvements should be relatively greater after interventions directed at noncompliance with final limits than after interventions directed at noncompliance with interim limits. Our study seeks to determine whether the performance of facilities in the chemical industry in response to deterrence from government interventions is consistent with this explanation of likely facility performance.

3. Permit Modification

The third facility feature that relates to the regulatory program is the presence or absence of a permit modification. Regulators may be willing to modify a facility's permit following a determination that the facility has not complied with the obligations reflected in the permit in lieu of imposing sanctions at that time. We are interested in determining whether the fact that a facility's permit has been modified is likely to affect the responsiveness to interventions.[26] We regard the presence or absence of a permit modification to be a proxy for the degree of cooperation between regulators and regulated facilities.[27]

Once again, we found few previous studies that are relevant to this question. Previous research supports the notion that a facility's reputation with its environmental regulator may affect the regulator's willingness to be flexible in crafting and enforcing permits.[28] Facilities that have built up *reputational capital* with the regulator may be treated more

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[26] Once again, we controlled for the limit level in testing for the influence of permit modifications on the effectiveness of interventions at inducing better performance so that our results are independent of limit level; only the context in which the interventions take place or are threatened is different, that is, either a facility's permit has been modified or it has not.

[27] The proxy is less than perfect because we cannot tell from the data the nature of a particular permit modification, for example, whether it reflects a significant or insignificant modification and whether it was unilaterally imposed by the regulator or the product of negotiations between the regulator and the regulated facility.

[28] Robert A. Kagan et al., *Explaining Corporate Environmental Performance: How Does Regulation Matter?*, 37 LAW & SOC'Y REV. 51, 74–75 (2003).

leniently or flexibly than those that have not.[29] Another study found that plants regulated under the federal Clean Air Act (CAA) that had fewer instances of noncompliance received permits from regulators more quickly than did plants with more instances of noncompliance.[30]

One nonempirical, theoretical study is more directly on point, and it supports the analysis in the preceding paragraph. One of the norms described in Professor Michael Vandenburgh's study of social norms in environmental compliance is the norm of reciprocity.[31] Vandenburgh defines this norm as expressing the idea that "[a]n individual should give benefits to those who have given her benefits."[32] He provides one example of the manner in which this norm may operate in the context of environmental compliance, suggesting that the provision of compliance assistance by a regulator "may trigger a sense of obligation to reciprocate by the managers of the regulated entity."[33] The reciprocity

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[29] *Id.*

[30] Christopher S. Decker, *Corporate Environmentalism and Environmental Statutory Permitting*, 46 J.L. & Econ. 103, 106, 126 (2003). Both of these studies deal with the manner in which compliance or noncompliance affects the behavior of regulators. Our concern, however, is the manner in which facility features affect the responsiveness of regulated facilities to interventions. Nevertheless, the anticipated behavior of regulators may impact the manner in which regulated facilities respond to interventions. If a facility believes that it is likely to be treated more harshly by regulators if it has already squandered its reputational capital as a result of past noncompliance, it may be more committed to improving its performance following an intervention directed at a modified permit than if the intervention had not followed a modification triggered by a previous violation.

EPA guidance documents on enforcement of the CWA may reinforce the motivation of regulated entities to avoid antagonizing regulators. EPA determines the size of the civil penalties it assesses against regulated facilities found to be in noncompliance with their regulatory obligations by calculating the amount necessary to recover from the violator all of the economic benefits of noncompliance. *See, e.g.*, Calculation of the Economic Benefit of Noncompliance in EPA's Civil Penalty Enforcement Cases, 70 Fed. Reg. 50,326, 50,326 (Aug. 26, 2005). It then adds to that amount a gravity factor that can either mitigate or enhance the amount of the penalty. *See* EPA, Interim Clean Water Act Settlement Penalty Policy 12–13 (1995), *available at* http://www.epa.gov/Compliance/resources/policies/civil/cwa/cwapol.pdf [hereinafter Interim CWA Settlement Penalty Policy]. EPA has indicated that it will increase the gravity factor based on lack of cooperation; bad faith; unjustified delay in preventing, remedying, or mitigating the violation; or past noncompliance. *Id.* at 12. Conversely, EPA will reduce the gravity factor based on cooperation by regulated facilities, such as negotiations leading to quick settlement. *Id.* at 13. Regulated facilities may be highly motivated to avoid noncompliance with a modified permit if the modification resulted from an instance of past noncompliance because they may fear that another violation will trigger an enhanced gravity factor in the calculation of administrative civil penalties. *See id.* at 12–13.

[31] Michael P. Vandenburgh, *Beyond Elegance: A Testable Typology of Social Norms in Corporate Environmental Compliance*, 22 Stan. Envtl. L.J. 55, 108–12 (2003).

[32] *Id.* at 108.

[33] *Id.* at 109.

norm thus suggests that if a regulator has already afforded slack to a regulated facility by modifying its permit, the facility's managers may believe that it is important for the facility to provide a quid pro quo in the form of future improvements in environmental performance to maintain a good working relationship with the regulator. Put in slightly different terms, a facility with a permit that has been modified may feel that it has used up its storehouse of goodwill with regulators and that regulators will not respond favorably to future noncompliance. As a result, a facility with a modified permit may be more committed to improving performance in response to interventions, or their threat, than a facility with an unmodified permit.

It is possible, however, that a permit modification may send quite a different signal to the managers of regulated facilities. If the response of the regulator to a facility's past noncompliance has been to modify its permit to make it more lenient, the facility's managers may conclude that all regulatory obligations are open to negotiation and that none should be taken too seriously. As a result, interventions do not warrant much concern because, should the modified permit be violated, the facility is likely to be able to persuade the regulator to modify the permit again, with a still more lenient effluent limit. Therefore, facilities with permits that have been modified may be no more likely, and may even be less likely, to improve performance in response to interventions, or their threat, than facilities with permits that have not been modified. This line of reasoning runs directly opposite to the analysis suggested by the reciprocity norm. One question we address in Part III is whether the results of our study are more consistent with one or the other of the expectations outlined in this subsection.

B. *Facility Features Inherent to the Production Process*

1. Facility Size

The first of the three features that are inherent to a facility's production process in which we are interested is the size of the facility. One way to measure the size of the facility is to count the number of employees. Because we lack information about the number of employees at the facilities for which we have performance data, we are unable to use the number of employees as a proxy for facility size. Instead, we chose to use a facility's flow capacity—the amount of wastewater it is capable of discharging over the course of an entire day—as a proxy for its size.

Some researchers have produced empirical studies of the impact of firm size on environmental compliance, and some of it has even related to the effect of government interventions. One study of compliance with air pollution controls by U.S. pulp and paper mills found that plants owned by large firms, whether measured by number of firm employees or number of other mills owned by the firm, are less sensitive to inspections but more sensitive to other enforcement actions than those owned by smaller firms.[34] That conclusion related to firm size rather than facility size.

The theoretical literature suggests a reason to expect that larger facilities are more responsive to government interventions or their threat than are smaller facilities. One study postulated that larger facilities are likely to enjoy "regulatory economies of scale" that are not available to smaller facilities to the extent that they can amortize compliance costs over larger volumes of production.[35] Similarly, researchers have asserted that larger firms, as opposed to facilities, tend to be better environmental performers than smaller firms because the former have more resources to spare for environmental engineering and management.[36]

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[34] Wayne B. Gray & Ronald J. Shadbegian, *When and Why Do Plants Comply? Paper Mills in the 1980s*, 27 Law & Pol'y 238, 255–56 (2005).

[35] Yeager, *Regulatory Law Enforcment*, *supra* note 21, at 340. Larger facilities also may be able to pass on regulatory compliance costs to their customers more easily than smaller facilities operating in more competitive environments. *Id.*; *see* Yeager, *Water Pollution*, *supra* note 17, at 130. Another study suggests that "administrative economies of scale" may also affect regulatory compliance efforts in that smaller organizations may have fewer resources to discover and interpret the regulations and that these disadvantages can affect ability to comply. Thomas J. Dean & Robert L. Brown, *Pollution Regulation as a Barrier to New Firm Entry: Initial Evidence and Implications for Future Research*, 38 Acad. Mgmt. J. 288, 291 (1995). *But cf.* Earnhart, *supra* note 24, at 675 (reporting that publicly owned treatment plants experience diseconomies of scale in treatment of biological oxygen-demanding material); Louis W. Nadeau, *EPA Effectiveness at Reducing the Duration of Plant-Level Noncompliance*, 34 J. Envtl. Econ. & Mgmt. 54, 75 (1997) (postulating that there may be no economies of scale in CAA compliance by the pulp and paper industry). "Firms that can spread these administrative compliance costs over a larger volume of production will likely gain a per unit cost advantage." Dean & Brown, *supra*, at 291.

[36] *See* Daniel J. Fiorino, *Toward a New System of Environmental Regulation: The Case for an Industry Sector Approach*, 26 Envtl. L. 457, 481 (1996) (asserting that "[l]arger firms have greater access to capital, better economies of scale, [and] greater sources of technical advice and support," providing them with greater capacity to avoid noncompliance with environmental requirements); Kagan et al., *supra* note 28, at 80. The authors found empirical support for the proposition that pulp and paper mills owned by larger corporations, and those with larger current profits and rising stock prices, had better environmental performance than those owned by corporations with lower sales, smaller earnings, and declining share prices. *Id.*; *cf.* Shameek Konar & Mark A. Cohen, Why Do Firms Pollute (and Reduce) Toxic Emissions 31 (2000), *available at* http://sitemason.vanderbilt.edu/files/

Accordingly, our results permit us to assess whether interventions in the chemical industry tend to induce greater improvements in environmental performance at larger facilities than at smaller ones. If so, that result would be consistent with the expectation that larger facilities find it easier to make cost-effective reductions than smaller facilities because they have greater economies of scale. A larger facility may have unexhausted economies of scale that it chooses not to take advantage of because of the low risk of getting caught. If the risk rises or the facility is actually caught, the facility may decide to improve its performance to take advantage of those economies of scale. Those unexhausted economies of scale are less likely to be available at a smaller facility, making improvements in performance in response to actual interventions, or their threat, more costly and more difficult to achieve.[37]

Additional considerations support the expectation that larger facilities respond better to interventions than do smaller ones. A facility's owners may choose to avoid making the expenditures necessary to produce compliance in order to bolster the facility's profitability and hope that the facility does not become the subject of an enforcement action. If the employees who implement the decisions that result in either compliance or noncompliance do not share the owners' concern for maximizing profitability, they may choose to take the steps necessary to comply, notwithstanding the owners' wishes. They may do so for altruistic reasons, a commitment to the goals of environmental protection laws, or a general preference for compliance with the law. Professor David Spence has suggested that "in smaller firms the organizational distance between owners and employees who make actual compliance decisions is shorter, offering fewer opportunities for these kinds of agency losses. According to this logic, we would expect to see more noncompliance among smaller firms than larger ones."[38] This logic ought to extend to decisions concerning whether to improve environmental performance following an intervention. Professor Spence's analysis, however, applies at the firm, not the facility level, and there is likely to be less of a difference in *organizational distance* at the

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fnddVm/why%20do%20firms%20pollute.pdf ("Firms in more concentrated industries and with higher cash flows tend to be lower baseline emitters of toxic chemicals.").

[37] As we use the term in this Article, a firm refers to the corporation or other business entity that owns a facility. A facility is a particular discharging plant. A firm may own more than one facility.

[38] David B. Spence, *The Shadow of the Rational Polluter: Rethinking the Role of the Rational Actor Models in Environmental Law*, 89 Cal. L. Rev. 917, 971 (2001) (footnotes omitted).

facility than at the firm level.[39] If so, this explanation for why we might expect larger facilities to respond more effectively to interventions than smaller facilities appears to be less significant than the economies of scale rationale.

Yet another factor provides an alternative explanation for greater responsiveness to government interventions at larger facilities. Larger facilities may be more sensitive to negative publicity surrounding noncompliance with environmental responsibilities. Local public interest groups may pay more attention to the compliance status of larger facilities and, therefore, exert more pressure on larger facilities to remedy noncompliance than they do at the smaller facilities, where noncompliance may not have as great an impact on the surrounding environment. In addition, larger facilities will have more employees than smaller ones and may depend on a positive image within the community to attract and retain a qualified workforce. For these reasons, larger facilities may have a larger reputational stake in compliance status than smaller facilities do and may, therefore, have stronger incentives to avoid repeat noncompliance events. Various researchers have noted this greater reputational stake as a possible reason that larger firms and facilities may be better environmental performers than smaller firms and facilities generally, although they have not addressed the question in the specific context of the impact of government interventions on environmental performance.[40]

Another set of considerations, however, may generate the opposite expectation—that smaller facilities are more likely to respond to interventions than are larger facilities. If plant managers and other decisionmakers concerning environmental compliance at larger facilities believe that those facilities are less likely to become the subjects of government interventions than smaller facilities with less political clout, they may have less incentive to avoid noncompliance. In this vein, one study found that larger companies had a degree of *insulation* from interventions that was not available to smaller companies because they had greater resources to take advantage of available legal remedies, such as appeals to challenge or slow down government ef-

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[39] *Id.* at 919 (discussing "the idea of the firm as a rational polluter").

[40] *See, e.g.*, Konar & Cohen, *supra* note 36, at 11–12 (claiming that large firms have more at stake concerning negative publicity about environmental compliance due to their size and visibility); Kagan et al., *supra* note 28, at 66 (noting the "greater visibility and reputational concerns" of larger firms).

forts to impose liability on them.[41] The study suggested that if larger facilities feared interventions less than smaller ones because larger facilities believed regulators were loathe to intervene against regulated entities with the resources to fight the charges vigorously, these larger facilities saw less need than smaller facilities to avoid noncompliance. This argument would seem to be weaker, however, if a larger facility has already been the subject of an intervention, because the intervention indicates that regulators are at least sometimes willing to tackle large and well-funded facilities.[42]

We can test the validity of the theory that larger facilities have less to fear from interventions than smaller ones and, therefore, will tend to be less responsive to the threat of interventions than smaller facilities, by comparing the general deterrent effect of an inspection with the general deterrent effect of the imposition of a judicial or administrative sanction. All facilities are inspected. Further, the size and resource position of larger facilities is likely to be less effective in blocking inspections than in impeding government interventions that require administrative or judicial proceedings before a sanction may be imposed. Accordingly, if the belief by larger facilities that they are not likely to be targeted by government interventions does in fact lessen the incentives of such firms to improve performance relative to smaller facilities, we would expect to see a greater degree of responsiveness by larger facilities to the threat of an inspection than to the threat of a sanction.

In summary, the size of the regulated facility may make a difference in how it responds to interventions, or their threat, for several reasons. The environmental compliance literature most strongly supports the view that larger facilities will respond more strongly to interventions than will smaller ones because larger facilities have economies of scale

[41] *See* Yeager, *Regulatory Law Enforcement*, *supra* note 21, at 338, 340; *cf.* Yeager, *Water Pollution*, *supra* note 17, at 130–31, 136 (finding that larger firms are more likely to participate in adjudicatory hearing procedures available in CWA enforcement proceedings and that use of those procedures was associated with lower violation rates). One source describes the "belief of many close observers," not adequately subject to empirical examination, "that serious enforcement efforts . . . are rarely directed at large corporations deserving of them and instead are focused on smaller firms less likely to put up formidable resistance." *Id.*

[42] In our empirical analysis, we measure the number of inspections completed at specific facilities and the dollar value of sanctions imposed against those facilities as our measure of specific deterrence. If larger facilities are less likely to receive interventions, then the size of a facility and the degree of intervention are strongly correlated. In this case, the empirical analysis will not be able to discern effectively the separate effects of facility size and specific deterrence and the influence of facility size on the effectiveness of specific deterrence.

not available to smaller facilities. The greater distance between ownership and environmental management at larger facilities or firms, and the likelihood that larger facilities will experience adverse publicity and public pressure, may provide additional, though perhaps less important, reasons to expect greater responsiveness from larger facilities as compared to smaller ones. Finally, the relatively greater ability of larger facilities to exercise the political clout needed to block interventions or to force the government to spend more resources pursuing interventions has the potential to weaken the incentives of larger facilities to avoid noncompliance in response to the threat of interventions.

2. Capacity Utilization

The second characteristic we choose to study that is related to features inherent in a facility's production process is the flow-to-flow capacity ratio. This feature serves as a proxy for capacity utilization by providing information that indicates whether a facility is operating at or below full capacity. We found no studies that address the relevance of capacity utilization to environmental performance, either generally or in the specific context of government interventions. Our study is, therefore, the first one of which we are aware that empirically evaluates the relevance of this characteristic to environmental performance.

Our expectation is that facilities with a relatively low flow ratio—those not operating at or near full capacity—ought to be more responsive to government interventions than those with a relatively high flow ratio. As capacity utilization increases, a facility's ability to adjust operations in ways that improve environmental performance ought to decline because a plant operating at or near full capacity generally has less operational flexibility than one operating at a lower degree of capacity utilization. Our results permit us to test that expectation.[43]

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[43] EPA's enforcement policies seem to favor facilities operating with low rather than high flow ratios because EPA's civil penalty calculation methodology includes a reduction in the gravity factor corresponding to flow reduction. Under that methodology, the greater the reduction in average daily wastewater discharge flow, in gallons per day, the greater the percentage reduction of the gravity factor. *See* Interim CWA Settlement Penalty Policy, *supra* note 30, at 12. Perhaps EPA seeks through that approach to discourage facilities from seeking to present a misleading picture of their discharges by diluting wastewater to decrease concentrations of regulated pollutants.

3. Discharge Volatility

The third and final feature relating to the production process that we measure in our study is discharge volatility. This characteristic measures the degree of variation in discharge levels at a facility from month to month over the course of a calendar year. We found a series of studies by a pair of researchers that analyze the impact of discharge volatility, or variability, in the context of CWA compliance.[44] The studies do not involve, however, the effects of government interventions on compliance. The authors of the studies describe the relevance of volatility to compliance status as follows:

> Plants are posited to pollute below their permitted level, on average, to provide a safety margin in the case of an unexpectedly large discharge. We call this the *safety margin* explanation of overcompliance. Plants reduce their average discharge so that they are more likely to fall below a discharge rate of 1.0 during a very bad month.[45]

The authors further stated:

> The claim that discharges are low on average to compensate for discharge variability implies that discharges will be lower, relative to the permit level, for plants with more variable discharges. A plant with highly variable discharges should aim for lower average discharges than a plant with low discharge variability. This is a straightforward hypothesis, but its import has not been recognized to our knowledge.[46]

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[44] Sushenjit Bandyopadhyay & John Horowitz, *Do Plants Overcomply with Water Pollution Regulations? The Role of Discharge Variability*, B.E. J. ECON. ANALYSIS & POL'Y, Jan. 2006, at 1, 1, *available at* http://www.bepress.com/cgi/viewcontent.cgi?article=1486&context=bejeap. The authors state that "[n]o other studies have explicitly modeled discharge variability to our knowledge." *Id.* at 4.

[45] *Id.* at 3. The authors found that "[d]ischarges exhibit considerable variability on a month-to-month basis," and that "[v]ariability arises due to natural variability in the composition of complex organic wastes, environmental factors, and operational factors." *Id.* at 6 (citations omitted); *see also* Sushenjit Bandyopadhyay & John K. Horowitz, *Overcompliance with the Clean Water Act?*, *in* BEYOND COMPLIANCE: WHAT MOTIVATES ENVIRONMENTAL BEHAVIOR?, *supra* note 20, at 10 ("Because plants cannot control discharges exactly, they aim to pollute below their permitted levels, so that when they have a stretch of exceptionally high discharges they will still likely be in compliance with their permits. This factor leads discharges to be below the permitted level on average."). The authors in their 2001 paper found an inverse relationship between discharge variability and median discharges. *Id.* at 14.

[46] Bandyopadhyay & Horowitz, *supra* note 44, at 11–12 (footnote omitted).

The authors ultimately found "strong evidence that uncontrollable discharge variability leads water-polluting plants to reduce their average discharges. Plants pollute below—sometimes far below—their permitted levels to reduce the chance of a violation."[47]

The previous studies on discharge volatility do not assess the impact of government interventions on facilities with high and low levels of discharge volatility. Their explanation for how facilities are likely to respond to volatility, however, is useful in formulating expectations for the impact of discharge volatility on the effectiveness of interventions. As described above, facilities will attempt to maintain safety margins to minimize instances of noncompliance. To maintain the same margin of safety as the volatility of discharges increases, a facility must push down its chosen level of discharges relative to the amounts allowed by its permit to create the same probability of being at or below the permit level. A facility with greater discharge volatility is, therefore, more likely to reduce discharges in response to interventions, or their threat, than one with less volatility. In other words, when a facility is facing greater volatility, a greater reduction in the mean discharge level is needed to demonstrate the same degree of commitment to compliance in some probabilistic sense—when, for example, the probability of an effluent limit exceedance drops from five percent to one percent. Our results enable us to test whether discharge volatility is linked to reduced responsiveness to government interventions.

C. *Ownership Structure*

The sole characteristic relating to the firms rather than the facilities that we address in this study is ownership structure. We distinguish exclusively between publicly held and privately held firms. We choose not to explore this characteristic in depth. The literature, both theoretical and empirical, relating to the impact of ownership structure on environmental performance is far more extensive than it is for most of the facility features described above. This literature makes it possible to offer a variety of competing hypotheses, angles, and perspectives concerning the relevance of ownership structure. We choose to describe a limited range of these hypotheses without providing much insight into their significance or strength. For the purposes of our empirical analy-

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[47] *Id.* at 25–26. The authors suggest that, because of differences in the variability of measures over different time periods, enforcement of standards over a shorter time, such as daily limits, "would likely reduce discharges further; while a move to enforce standards over a longer time (say, annual quantity) would likely raise discharges." *Id.* at 26.

sis, we include ownership structure and its interactions with the various government intervention measures as regressors in our multivariate regression analysis in order to avoid omitted variable bias so that we can properly and accurately assess the other interactions.[48] Even though the interactions between ownership structure and interventions are not our primary interest, we nevertheless include these interactions as regressors in order to isolate properly the interactions between interventions and the facility-related features addressed in our study.

Our assessment of expectations is brief. On the one hand, investor pressure might be expected to induce greater responsiveness to actual or threatened interventions from a privately held firm than from a publicly held firm.[49] The relative susceptibility of privately held and publicly held firms to agency costs may tend to support the same expectation. On the other hand, the desire to avoid a fall in stock prices seems to provide reason to expect greater responsiveness to actual or threatened government interventions from publicly held facilities.[50] These considerations, however, are hedged with qualifications that weaken the theoretical reason to believe that privately held and publicly held firms respond differently to a significant extent.

II. Empirical Analysis: Sample Selection and Data

In this Part, we describe our empirical analysis. The first subsection describes our reasons for choosing to analyze the relationship

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[48] Omitted variable bias occurs when a regression fails to include, or *omits*, a variable, other than the one being tested, upon which the decisionmaker actually based a decision. Under those circumstances, the regression can erroneously indicate that the decisionmaker relied on the variable being tested. *See, e.g.*, Stuart T. Rossman, *Analyzing Disparate Impact Credit Discrimination in the Subprime Lending Market*, 1533 PLI/Corp 601, 609 (2006).

[49] *See* Konar & Cohen, *supra* note 36, at 16 (arguing that "firms whose managers and directors have a higher percentage ownership of the firm are more likely to be responsive to shareholder needs"; those firms tend to be privately held firms).

[50] *See* Rechtschaffen, *supra* note 14, at 806–07 (citing studies finding that stock prices rise and fall in response to the release of positive or negative information about firms' environmental performance and asserting that "the stock market also can create strong incentives for firms to improve environmental compliance as investors increasingly look to environmental performance as a relevant investment criterion"); Spence, *supra* note 38, at 969; *cf.* Jérôme Foulon et al., *Incentives for Pollution Control: Regulation or Information?*, 44 J. Envtl. Econ. & Mgmt. 169, 175 (2002) (citing evidence that investors are increasingly scrutinizing environmental performance in investment decisions); Madhu Khanna & William Rose Q. Anton, *Corporate Environmental Management: Regulatory and Market-Based Incentives*, 78 Land Econ. 539, 541 (2002) (stating that reputation among shareholders is contributing to the growth of "corporate environmentalism" and that "bankers are beginning to include environmental considerations in their lending decisions and viewing poor environmental performers as financially risky").

between government interventions and facility features in the context of the performance of chemical manufacturing facilities regulated under the CWA. The second subsection explains the manner in which we selected our sample of regulated facilities and the reasons why we anticipate that the sample will be representative of environmental performance in the chemical industry. Subsequent subsections describe the multiple sources of our data and how we integrate these sources, while explaining our sample selection criteria.

A. *Scope of Empirical Analysis*

Our study assesses the efficacy of various government interventions on facilities in the industrial sector of chemical and allied products that are regulated under the CWA's National Pollutant Discharge Elimination System (NPDES) permit program.[51] The study is based on statistical analysis of performance displayed by individual chemical manufacturing facilities. Our analysis relates to a specific type of environmental performance: wastewater discharges by facilities in the chemical industry that are regulated under the CWA. We choose to focus on this measure of environmental performance because federal and state regulators systematically record both wastewater discharge limits, which are critical for calculating the level of compliance or noncompliance, and actual discharges. We choose the industrial sector of chemical and allied products as the focus of our study because it serves as an excellent vehicle for examining the efficacy of government interventions on corporate environmental performance. EPA has demonstrated a strong interest in this sector,[52] and regards one of the subsectors, industrial organics (Standard Industrial Classification or SIC-code 2869), as a priority industrial sector.[53] The chemical industry is responsible for a significant component of the nation's industrial output and a significant portion of all wastewater discharges by facilities subject to

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[51] *See* Clean Water Act of 1977, 33 U.S.C. § 1342 (2000 & Supp. 2005) (authorizing the program and governing its operation).

[52] *See, e.g.*, EPA & Chem. Mfrs. Ass'n, EPA-305-R-99-001, EPA/CMA Root Cause Analysis Pilot Project: An Industry Survey 3 (1999), *available at* http://www.epa.gov/Compliance/resources/publications/assistance/sectors/rootcauseanalysis.pdf; Office of Enforcement & Compliance Assurance, EPA, EPA-305-R-96-002, Chemical Industry National Environmental Baseline Report 1990 to 1994, at ES-4 (1997), *available at* http://www.epa.gov/compliance/resources/publications/assistance/sectors/chembaseline9094.pdf [hereinafter Chemical Industry Baseline Report].

[53] *See, e.g.*, Paul S. Farber et al., *EPA's Multi-Media Enforcement & Inspection Program*, Kerley Ink, Jan. 1999, http://www.kerleyink.com/technology/epas_multi-media_enforcemen.html.

CWA regulation.[54] Nevertheless, the chemical industry is not necessarily representative of all industrial sectors. Indeed, its unique attributes contribute to our interest in studying it. Some firms in the chemical industry, for example, have demonstrated an interest in promoting pollution reduction and prevention through efforts prompted by the Responsible Care program, which is a voluntary management initiative supported by the American Chemical Council.[55]

Finally, our study focuses on discharges of the pollutant most common to regulated facilities—total suspended solids (TSS)[56]—thereby maximizing the number of facilities for which data on wastewater discharge levels are available, while avoiding the need to combine potentially disparate measures of pollution. We examine an adjusted measure of TSS discharges, in which each level of discharge is scaled relative to its relevant TSS-specific effluent limit; we denote the resulting measure as relative discharges. Given our focus on compliance, this adjustment with respect to the effluent limit is needed since the level of the effluent limit varies across facilities and varies over time for several facilities in the sample. TSS-related discharges represent a comprehensive measure of environmental performance because they capture the full extent of both noncompliance and over-compliance. This latter dimension is important since the sample reveals a strong prevalence of substantial over-compliance.

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[54] *See, e.g.*, James L. Beebe, *Inherently Safer Technology: The Cure for Chemical Plants Which Are Dangerous by Design*, 28 HOUS. J. INT'L L. 239, 242 (2006) (stating that the chemical industry in the United States "is a $450 billion business, one of the largest sectors in the economy," and that "the more than 66,000 chemical facilities across the nation employ more than one million workers"); *cf.* James T. Hamilton, *Is the Toxic Release Inventory News to Investors?*, 16 NAT. RESOURCES & ENV'T 292, 294 (2001) (finding that the chemical industry was responsible for more than half of the toxic releases reported as part of the Toxic Release Inventory in 1989).

[55] *See* Dow, Our Commitments, Responsible Care, http://www.dow.com/commitments/care (last visited Apr. 30, 2008) (describing Responsible Care as "a voluntary initiative within the global chemical industry to safely handle our products from inception in the research laboratory, through manufacture and distribution, to ultimate disposal, and to involve the public in our decision-making processes"); *see also* CHEMICAL INDUSTRY BASELINE REPORT, *supra* note 52, at 58 (providing examples of environmental initiatives sponsored by trade associations and industries).

[56] *See* Clean Water Act of 1977, 33 U.S.C. § 1314(a)(4) (2000) (describing conventional pollutants, including TSS). Conventional pollutants have been the focus of EPA's control efforts. *See* Glicksman & Earnhart, *supra* note 18, at 324 n.20.

B. *Selection of Sample*

To examine the effectiveness of government interventions at inducing better environmental performance—lower relative discharges—from facilities in the chemical industry, we examine wastewater discharges by the 499 major chemical manufacturing facilities operating across the United States during the years 1995 to 2001. We choose major facilities for several reasons. First, EPA focuses its regulatory efforts on facilities that it classifies as *major*—in other words, those that either possess a discharge flow of one million gallons per day or that cause a significant impact on the receiving waterbody.[57] According to one source, "The distinction between a major and minor permit is of critical importance because it has a direct impact on the subsequent enforcement process. Enforcement priority is given to major permittees, meaning that NPDES personnel generally act first on major permittees."[58] Second, EPA's Permit Compliance System (PCS) database only systematically records wastewater discharges and effluent limits for major facilities in the NPDES program. Information on wastewater discharge levels is unavailable in any reasonably accessible form for minor facilities. Third, the 499 major facilities represented 20.1% of the 2,481 chemical facilities in the NPDES program in 2001. Moreover, they represented the bulk of wastewater discharges from this sector. The results from this sample of facilities, therefore, should be strongly representative of the chemical industry as far as pollution control is concerned.

C. *Data Collection*

To examine the effectiveness of government interventions on the environmental performance of U.S. chemical manufacturing facilities, we gather data from various databases maintained by federal and state environmental agencies and private entities. The PCS database

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[57] *See* Marilyn Lee Nardo, *Feedlots—Rural America's Sewer*, 6 Animal L. 83, 98 (2000); *see also* Susan Hunter & Richard W. Waterman, Enforcing the Law: The Case of the Clean Water Acts 36 (1996) ("The main distinction between [major and minor] permits involves the amount of water discharged into nearby waters."). *But cf.* Definitions, 40 C.F.R. § 122.2 (2007) (defining "major facility" as "any NPDES 'facility or activity' classified as such by the Regional Administrator, or, in the case of 'approved State programs,' the Regional Administrator in conjunction with the State Director"). There are far fewer major facilities than minor facilities that are subject to effluent limits under the CWA. As of January 1999, for example, there were 6749 major facilities with NPDES permits and 82,560 minor facilities. David L. Markell, *The Role of Deterrence-Based Enforcement in a "Reinvented" State/Federal Relationship: The Divide Between Theory and Reality*, 24 Harv. Envtl. L. Rev. 1, 56 (2000).

[58] Hunter & Waterman, *supra* note 57, at 36.

maintained by EPA provides information about effluent limits applicable to individual facilities under NPDES permits as well as amounts actually discharged by those facilities.[59] The PCS database also includes data on inspections performed by federal and state regulators.[60] Both the PCS and EPA Docket databases include data on federal fines imposed by federal administrative agencies and courts. In addition, the EPA Docket database includes data on federal injunctive relief sanctions and supplemental environmental projects (SEPs).[61] Our study integrates these two databases.

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[59] Our data collection process focused on certain information within this database. Facilities monitor their discharge levels and facility-specific effluent limits and restrict discharges according to two pollution measures: monthly average and monthly maximum. Both conversations with government officials and EPA's definition of SNC, however, suggest that regulators especially care about the average limit. *See, e.g.*, U.S. GOV'T ACCOUNTING OFFICE, GAO/RCED-96-23, WATER POLLUTION: MANY VIOLATIONS HAVE NOT RECEIVED APPROPRIATE ENFORCEMENT ATTENTION 3 (1996), *available at* http://www.gao.gov/archive/1996/rc96023.pdf.

> According to the EPA, SNC is "not regulatory," but is used by the agency "solely for management purposes and contains those instances of noncompliance . . . that EPA feels merit special attention from NPDES administering agencies. These priority violations are tracked through the Strategic Planning and Management System (SPMS) to ensure timely enforcement."

Glicksman & Earnhart, supra note 18, at 327 n.31 (quoting OFFICE OF WATER, EPA, THE ENFORCEMENT MANAGEMENT SYSTEM: NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM, ch. VII, pt. B, at iv (1989)). Further, facilities may monitor discharge levels and facility-specific effluent limits, and may restrict only quantities, only concentrations, or both. By focusing on compliance levels, our study is able to compare across all facilities regardless of the form of their discharge measurement and effluent limit. The analysis calculates relative discharges—the ratio of absolute discharges and effluent limits—regardless of the type of discharge and limit. If both quantity and concentration limits apply, the analysis calculates the mean level of compliance.

[60] The PCS database provides the following data elements for each permitted chemical facility: (1) permit issuance dates; (2) type of discharge limit: initial, interim, or final; (3) indication of changes to a permit during the current five-year issuance period; (4) monthly wastewater flow in millions of gallons per day; (5) TSS monthly discharge limits; (6) TSS monthly discharges; (7) four-digit SIC-code; and (8) location.

[61] RECHTSCHAFFEN & MARKELL, *supra* note 19, at 65 ("SEPs are 'environmentally beneficial projects which a defendant/respondent agrees to undertake in settlement of an enforcement action, but which the defendant is not otherwise legally obligated to perform.'" (quoting EPA, SUPPLEMENTAL ENVIRONMENTAL PROJECTS POLICY 79 (1998))); *see also* Steven Bonorris et al., *Environmental Enforcement in the Fifty States: The Promise and Pitfalls of Supplemental Environmental Projects*, 11 HASTINGS W.-NW. J. ENVTL. L. & POL'Y 185, 187 (2005) (describing SEPs as "environmentally beneficial projects voluntarily undertaken by violators of environmental laws, for which EPA may partially mitigate the civil penalties they would otherwise face").

D. *Selection of Sample: Revisited*

The broadest sample of facilities includes all major chemical facilities for all months across the entire sample period: January 1995 to October 2001. This sample includes 499 facilities that were active at some point during the sample period. Even though most major chemical facilities discharge TSS, some do not. To remain in the sample, a given facility must have discharged TSS at least once during the seven-year sample period. Based on this restriction, the sample drops to 475 facilities. Moreover, not all facilities discharging TSS possess a permit that imposes an effluent limit on this specific pollutant. Given the focus on compliance level as a measure of environmental performance, to remain in the sample, a given facility must have been subject to an effluent limit for the relevant pollutant in the particular month of discharge.[62]

III. Statistical Analysis of Collected Data and Interpretation of Analytical Results

In this Part, we describe the statistical analysis of the collected data described in Part II above and interpret the results of our statistical analysis. We first describe the statistical methods used to analyze the data and the two forms of deterrence—specific and general—in which we are interested, as well as explain the interactions between government interventions and facility features. The second subsection summarizes the results of our analyses, providing a description of whether particular facility or firm features had a positive or negative influence on the deterrent effect of various government interventions.

A. *Statistical Analysis*

We seek to gauge the effectiveness of various government interventions using multivariate regressions, which attempt to isolate and identify the effects of government interventions on the level of wastewater discharges relative to the facility-specific effluent limit. By employing regression analysis, we are able to assess the specific and gen-

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[62] *See* Dietrich Earnhart, Donald Haider-Markel, Tatsui Ebihara & Robert Glicksman, Shaping Corporate Environmental Behavior and Performance: The Impact of Enforcement and Non-Enforcement Tools § 5.2 (2006), *available at* http://www.ipsr.ku.edu/CEP/EPA/finalreport.pdf (providing a more complete description of the data collection process). This report also includes a full description of the statistical approach used to analyze the effects of government interventions on environmental performance. *See id.* § 5.3.

eral deterrent effects of various interventions on TSS discharges relative to permit limits. Moreover, we wish to assess whether these specific and general deterrent effects depend on the features of the facilities discharging the TSS-related wastewater. In particular, we assess whether the effectiveness of government interventions depends on permit conditions, including permitted effluent limit level, permit limit type, and the presence of a permit modification; facility size as measured by flow design capacity; capacity utilization as measured by the flow-to-flow capacity ratio; discharge volatility; or ownership structure. While most of these features apply to specific facilities, ownership structure is not a facility-level characteristic. Instead, ownership structure represents a firm-level characteristic. Nevertheless, we describe the set of features as facility features as a matter of convenience.

Our study measures deterrence in two forms: specific deterrence and general deterrence. First, consider inspection-related deterrence. Our study measures inspection-related specific deterrence as the count of inspections completed at a specific facility in the preceding twelve-month period. In a parallel fashion, our study measures inspection-related general deterrence as the count of inspections completed at all *other* similar facilities, divided by the number of all other similar facilities. By considering inspections at other facilities, the general deterrence measure does not overlap with the specific deterrence measure. In this way, the general deterrence measure is more likely to reflect the facility's perceived threat of an inspection independent of its own recent experience with inspections. The analysis generates two separate regressors for each type of inspection-related deterrence. One regressor reflects only state inspections, while the other regressor reflects only federal inspections. In total, the analysis generates and utilizes four regressors related to inspections.

Second, consider sanction-related deterrence. Our study measures sanction-related specific deterrence as the sum of sanctions—measured in dollars—imposed against a specific facility in the preceding twelve-month period. In a parallel fashion to the inspection-related analysis, our study measures sanction-related general deterrence as the sum of sanctions—measured in dollars—imposed against *other* similar facilities, divided by the number of other similar facilities. The resulting measure represents the unconditional average sanction amount imposed against other similar facilities. The analysis generates two separate regressors for each type of sanction-related deterrence. One regressor reflects only administrative sanctions, while the other regressor reflects only civil sanctions. In total, the analysis generates and utilizes four regressors related to sanctions.

In order to appreciate whether the effectiveness of these various deterrence measures depends on facility features, our study interacts the various measures of specific and general deterrence with various facility features. Our analysis creates the interactions between the intervention measures and facility features by multiplying each deterrence type with each feature. The resulting product is denoted as an interaction term. For example, to create the interaction term involving state inspection-related specific deterrence and the effluent limit level, denoted as *C*, we multiply the regressor that captures state inspection-related specific deterrence, denoted as *A*, and the regressor that captures the effluent limit level, denoted as *B*. Thus, $C = A \times B$. After creating these interaction terms, we include these interactions as regressors in our estimation of TSS-relative discharges. These interactions help to indicate whether different types of facilities or facilities facing different corporate conditions respond differently to government interventions. In other words, the analysis tests whether the effects of deterrence differ according to facility features. To test for these differences, the analysis assesses whether the coefficients on the interactive terms are significantly different from zero, as described in more depth below.

Due to insufficient variation, the analysis is not able to estimate certain interactions. For administrative sanction-related specific deterrence, our analysis cannot estimate interactions with limit type and permit modification. The lack of variation is not surprising since most facilities face a final limit type and hold a permit that lacks modification. The lack of variation indicates that no administrative sanctions were imposed against facilities facing initial or interim limits and no administrative sanctions were imposed against facilities possessing permits lacking modification. For civil sanction-related specific deterrence, our analysis cannot estimate interactions with limit type, permit modification, and ownership structure. Again, the lack of variation for limit type and permit modification is not surprising. Even though facilities owned by privately held firms represent over thirty percent of the sample, civil sanctions are sufficiently infrequent that the lack of variation for the interaction between civil sanctions and publicly held ownership structure is not surprising.

Table 1 reports the estimation results for the interaction terms relating to facility features.[63] We do not report the actual coefficient

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[63] Each facility in our sample is represented by multiple observations in the dataset used for multivariate regression. This feature of the data structure implies that the dataset is actually a panel dataset, that is, the dataset extends across both facilities and time. Three primary regression estimators address this data structural feature: pooled ordinary least

magnitude estimates along with their associated standard errors. Instead, Table 1 simply indicates whether or not a particular interaction is statistically at significance levels at or below accepted levels, for example, a ten percent significant level. We assess statistical significance based on the *p*-value associated with the *t*-test of whether the null hypothesis of a zero coefficient magnitude can be rejected. In Table 1, a zero (0) indicates a statistically insignificant coefficient, regardless of the sign of the coefficient. A plus sign (+) indicates a positive statistically significant coefficient, while a minus sign (–) indicates a negative statistically significant coefficient.

Table 1: Interactions between government interventions and facility features based on multivariate regression of TSS relative discharges

Facility Characteristic Interacted with Government Interventions	Government Intervention							
	Federal Inspections		State Inspections		Administrative Sanctions		Civil Sanctions	
	SD	GD	SD	GD	SD	GD	SD	GD
Effluent Limit Level	0	+	+	–	+	+	0	+
Final Limit Type	0	0	0	–	N/A	0	N/A	+
Permit Modification	0	–	+	0	N/A	–	N/A	–
Facility Size	0	0	0	0	0	0	0	–
Capacity Utilization	+	–	0	0	0	+	0	0
Discharge Volatility	–	+	–	+	0	+	+	0
Publicly Held Ownership	0	+	0	0	0	0	N/A	0

SD = specific deterrence
GD = general deterrence
"0" indicates a statistically insignificant interaction (p>0.10)
"+" indicates a positive, statistically significant interaction (p≤0.10)
"–" indicates a negative, statistically significant interaction (p≤0.10)
"N/A" indicates that the interaction term lacks variation in the sample

B. *Interpretation of Interactions Between Interventions and Facility Features*

In this subsection, we examine the interactions between interventions and facility features. We assess whether the deterrent effects of government interventions depend on features of facilities in the chemical manufacturing industry. For the purposes of interpretation, a positively signed interaction indicates a positive connection between a particular deterrent effect and a given characteristic. A positively signed

squares (OLS) estimator, fixed effects estimator, and random effects estimator. We use two tests to identify the *best* estimator from this set. Based on an *F*-test of facility-specific fixed effects, the fixed effects estimator dominates the pooled OLS estimator. Based on a Hausman test of random effects, the fixed effects estimator dominates the random effects estimator. Thus, the fixed effects estimator is *best*. Accordingly, the analysis focuses on results generated by the fixed effects estimator.

interaction is recorded as a plus sign in Table 1, indicating that the relevant coefficient sign is positive and the associated *p*-value lies at or below ten percent. This *positive connection* in turn indicates that the particular deterrent is *less effective at inducing better environmental performance* when the given characteristic is relevant or greater in magnitude. In other words, a positive interaction indicates that the particular deterrence type generates a more positive, or less negative, effect on relative discharges when the given characteristic is relevant or greater in magnitude. A deterrence type is effective at inducing better environmental performance when it drives down the level of relative discharges, which implies a negative effect. Obviously, a less negative effect implies less success at inducing lower relative discharge levels. Conversely, a *negatively signed interaction* indicates a negative connection between a particular deterrent effect and a given characteristic, which in turn indicates that the particular deterrent is *more effective at inducing better environmental performance* when the given characteristic is relevant or greater in magnitude. Such a negatively signed interaction is recorded as a minus sign in Table 1, indicating that the relevant coefficient sign is negative and the associated *p*-value lies at or below ten percent.

When assessing interactions between interventions and facility features, we examine whether the effectiveness of government interventions depends on permit conditions, facility size, capacity utilization, discharge volatility, or ownership structure. From this perspective, we assess each type of intervention-related deterrence in turn. For each deterrence type, we analyze whether its effectiveness depends on any of the identified facility features. For example, we may find that the effectiveness of state inspection-related specific deterrence depends on effluent limit level and facility size. In particular, we may find that this effectiveness is enhanced by higher effluent limit levels, yet undermined by greater facility size.

We first assess the interactions relating to federal inspections. First, consider federal inspection-related specific deterrence. The effect of federal inspection-related specific deterrence is positively influenced by increases in the flow-to-flow capacity ratio. Thus, a facility utilizing a greater share of its flow capacity responds less strongly to the completion of federal inspections at its own facility. In other words, actual federal inspections are less effective against facilities pushing their wastewater treatment systems more greatly, as expected. Second, the effect of federal inspection-related specific deterrence is negatively influenced by increases in discharge volatility. Thus, a facility facing greater volatility responds more strongly to the completion of federal inspections at its own facility, as expected.

Next, consider federal inspection-related general deterrence. First, the effect of federal inspection-related general deterrence is positively influenced by increases in the effluent limit level. Thus, facilities facing higher—meaning less stringent—effluent limits respond less strongly to the threat of federal inspections against facilities in general, contrary to our expectation. Second, the effect of federal inspection-related general deterrence is positively influenced by the presence of a permit modification. Thus, facilities enjoying a modification to their permit respond more strongly to the threat of federal inspections, consistent with our primary expectation. Third, contrary to specific deterrence, the effect of federal inspection-related general deterrence is negatively influenced by increases in the flow-to-flow capacity ratio. Thus, facilities utilizing a greater share of their flow capacity respond more strongly to the threat of federal inspections, contrary to our expectation. Fourth, in contrast to specific deterrence, the effect of federal inspection-related general deterrence is positively influenced by increases in discharge volatility. Thus, facilities facing greater volatility respond less strongly to the threat of federal inspections, contrary to our expectation. Fifth, the effect of federal inspection-related general deterrence is positively influenced by the presence of publicly held ownership. Thus, facilities owned by publicly held firms respond less strongly to the threat of federal inspections than do facilities owned by privately held firms.

We next assess interactions relating to state inspections. Initially, consider state inspection-related specific deterrence. The effect of state inspection-related specific deterrence is positively influenced by increases in the effluent limit level. Thus, a facility facing a higher—meaning less stringent—effluent limit responds less strongly to the completion of state inspections at its own facility, contrary to our expectation. Second, the effect of state inspection-related specific deterrence is positively influenced by the presence of a permit modification. Thus, a facility enjoying a modification to its permit responds less strongly to the completion of state inspections at its own facility, contrary to our primary expectation, but consistent with the notion that facilities perceive modifications as signals of greater future regulatory flexibility. Third, similar to federal inspection-related specific deterrence, the effect of state inspection-related specific deterrence is negatively influenced by increases in discharge volatility. Thus, a facility facing greater volatility responds more strongly to the completion of state inspections at its own facility, as expected.

Next, consider state inspection-related general deterrence. First, the effect of state inspection-related general deterrence is negatively influenced by increases in the effluent limit level. Thus, facilities facing higher effluent limits respond more strongly to the threat of state inspections against facilities in general, as expected. Second, the effect of federal inspection-related general deterrence is negatively influenced by the presence of a final limit type. Thus, facilities facing final limits respond more strongly to the threat of state inspections, as expected. Third, similar to federal inspection-related general deterrence, the effect of state inspection-related general deterrence is positively influenced by increases in discharge volatility. Thus, facilities facing greater volatility respond less strongly to the threat of state inspections, contrary to our expectation.

Next, we assess interactions relating to federal administrative sanctions.[64] Consider administrative sanction-related specific deterrence. The effect of administrative sanction-related specific deterrence is positively influenced by increases in the effluent limit level. Thus, a facility facing a higher effluent limit responds less strongly to the imposition of administrative sanctions at its own facility, contrary to our expectation.

We also consider administrative sanction-related general deterrence. First, the effect of administrative sanction-related general deterrence is positively influenced by increases in the effluent limit level. Thus, facilities facing higher effluent limits respond less strongly to the threat of administrative sanctions imposed against facilities in general, contrary to our expectation. Second, the effect of administrative sanction-related general deterrence is negatively influenced by the presence of a permit modification. Thus, facilities enjoying a modification to their permits respond more strongly to the threat of administrative sanctions, consistent with our primary expectation. Third, the effect of administrative sanction-related general deterrence is positively influenced by increases in the flow-to-flow capacity ratio. Thus, facilities utilizing a greater share of their flow capacity respond less strongly to the threat of administrative sanctions, as expected. Fourth, the effect of administrative sanction-related general deterrence is positively influenced by increases in discharge volatility. Thus, facilities facing greater volatility respond less strongly to the threat of administrative sanctions, contrary to our expectation.

We also assess interactions relating to federal civil sanctions. First, consider civil sanction-related specific deterrence. The effect of civil

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[64] For purposes of this analysis, sanctions include judicial or administrative penalty assessment proceedings, the imposition of injunctive relief in court, and the imposition of SEPs approved by a court.

sanction-related specific deterrence is positively influenced by increases in discharge volatility. Thus, a facility facing greater volatility responds less strongly to the imposition of civil sanctions at its own facility, contrary to our expectation.

Finally, consider civil sanction-related general deterrence. First, similar to administrative sanctions, the effect of civil sanction-related general deterrence is positively influenced by increases in the effluent limit level. Thus, facilities facing higher effluent limits respond less strongly to the threat of civil sanctions imposed against facilities in general, contrary to our expectation. Second, the effect of civil sanction-related general deterrence is negatively influenced by the presence of a final limit type. Thus, facilities facing final limits respond less strongly to the threat of civil sanctions, contrary to our expectation. Third, the effect of civil sanction-related general deterrence is negatively influenced by the presence of a permit modification. Thus, facilities enjoying a modification to their permit respond more strongly to the threat of civil sanctions, consistent with our primary expectation. Fourth, the effect of civil sanction-related general deterrence is negatively influenced by increases in flow capacity. Thus, larger facilities, as measured by their flow capacity, respond more strongly to the threat of civil sanctions, consistent with our primary expectation.

Conclusion

If the noncompliance figures cited at the beginning of this Article[65] are indicative of larger trends in environmental compliance status, both under the federal CWA and elsewhere, the federal and state governments seem to have much to learn about how to go about inducing regulated entities to improve their environmental performance track records. The empirical work described in this Article is designed to provide insights into the influence of seven particular facility and firm features on the effectiveness of government interventions at improving environmental performance of major facilities in the chemical industry regulated under the CWA.

In some instances, our findings correspond to the expectations generated by our analysis of the theoretical literature and previous empirical studies on environmental performance and compliance. We expected to find, for example, that interventions directed at facilities with a great deal of volatility in discharge levels would improve perform-

[65] *See supra* notes 6–15 and accompanying text.

ance, by reducing discharges relative to permitted levels, more than interventions directed at facilities with less volatility. We found that a facility facing greater volatility responds more strongly to both federal and state inspections at its own facility. Other findings confound our expectations. The general deterrent effect of both federal and state inspections was weaker, for example, at facilities with volatile discharges than at those not experiencing as much volatility. In still other cases, our findings are consistent with one of two or more alternative expectations we generated, but inconsistent with others. Facilities with permits that have been modified respond more strongly to the threat of federal inspections, administrative sanctions, and civil sanctions than facilities without such modifications. These findings are consistent with the expectation that the norm of reciprocity will influence facilities whose permits have been modified—inducing them to improve performance—to a greater extent than it will affect firms that have not experienced permit modifications.[66] They conflict, however, with the theory that facilities with permits that have been modified are less likely to take interventions seriously than facilities without modified permits because the former may believe that all permit limits are subject to negotiation.

The findings described in Part III do not provide definitive answers to the question of how facility and firm features relate to the effectiveness of government interventions on environmental performance. This conclusion is true even with respect to the influence on performance by major facilities regulated under the CWA of the seven features we choose to study, in part because of the inconclusive nature of some of our findings, and in part because data from a different period might provide different results. We hope that our study illustrates, however, the potential utility to both regulators and regulated entities of considering the influence of facility and firm features on environmental performance. Regulators may be able to allocate their enforcement resources more effectively if they direct interventions at facilities with features that make them likely to respond strongly to interventions. They may be able to predict what facilities are likely to respond to a greater or lesser extent to different kinds of interventions and shape their interactions with regulated facilities accordingly. Regulated facilities may be able to assess whether certain features make it easier or more difficult for them to improve performance and plan accordingly.

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[66] *See* discussion *supra* Part I.A.3.

If our study is to serve as an effective starting point in providing these kinds of insights, more work needs to be done to assess the influence of facility features on environmental performance, both in and outside the context of government interventions. Our study can provide guidance on both the design—by providing examples of the kinds of questions to ask—and implementation—by describing the methodology we use to answer these questions—of future empirical work. Perhaps when legislators and agency officials celebrate the CWA's fiftieth anniversary, they will be able to toast high rates of compliance with regulatory obligations, instead of ignoring evidence of troublesome compliance figures.