Cooptation or Transformation? Local Policy Networks and Federal Regulatory Enforcement

John T. Scholz Florida State University
Cheng-Lung Wang National University of Singapore

Local policy networks can aid federal agencies, but they can also coopt federal resources for unintended purposes. Our empirical study finds that effective local networks increase both enforcement and compliance rates for the Clean Water Act. We discuss the circumstances under which effective networks can transform political culture, enhancing enforcement and compliance even in conservative areas generally opposed to regulation. The modified detection-controlled estimation procedure enables us to utilize official enforcement records from 1994 to 2000 to study both enforcement and compliance.

Decentralized governance has recaptured the attention of policy scholars and practitioners alike in a form that challenges the philosophy of current federal regulatory policies in the United States. Local collaboration among government agencies (Bardach 1998; Provan and Milward 1995), local watershed partnerships (John 1994; Leach and Pelkey 2001; Lubell 1999), ecosystem management (Cortner and Moote 1999), "new governance" (Salamon 2002), and local policy networks (O'Toole 1997; Rhodes 1997; Schneider et al. 2003) have expanded rapidly over the past decade, encouraged by state and federal laws.

Proponents argue that cooperative, voluntary, locally inclusive decision-making processes can transform local policy arenas to complement the centralized command-and-control approach of regulatory policies (John 1994). Critics, on the other hand, note that these decentralized processes create autonomous policy networks that can resist central guidance (Rhodes 1997) and coopt authoritative institutions of governance (Pressman and Wildavsky 1984; Selznick 1966).

In this article we analyze the impact of the currently popular decentralized collaborative approach on the established but somewhat tarnished centralized command-and-control agencies. Can the development of local policy networks succeed in fostering cooperation between local interests and federal regulatory agencies in pursuit of federal goals, or do these networks simply increase the ability of local interests to coopt federal agencies?

Our empirical analysis focuses on water pollution policies in which centralized regulation and local watershed partnerships both play an important role. Using enforcement and compliance data for all major private permit holders in the National Pollutant Discharge Elimination System (NPDES) from 1994 to 2000, we examine the impact of watershed partnerships on government outputs (enforcement activities of the EPA) as well as on compliance outcomes by permit holders. We extend existing regulatory models not only by incorporating local partnerships, but also by modifying Feinstein's (1990, 1999) detection-controlled estimation (DCE) procedure in order to use observed compliance behavior among inspected firms to estimate unbiased impacts on true compliance rates in the full population of firms.

We begin with a brief overview of the permit system and watershed partnerships to provide the background for our theoretical discussion. We then discuss the problem of cooperation versus cooptation associated with the decentralized approach, combine the regulatory enforcement model with the institutional approach to local decisions (Lubell et al. 2002; Ostrom 1990), and use this model to analyze whether local water policy networks enhance or diminish EPA enforcement and compliance.

John T. Scholz is Eppes Professor of Political Science, Florida State University, Tallahassee, FL 32306-2230 (john.scholz@fsu.edu). Cheng-Lung Wang is assistant professor of Political Science, National University of Singapore, Singapore 117570 (polwcl@nus.edu.sg).

We thank Mark Schneider, Brad Jones, Bill Berry, and Jonathan Feinstein for comments at various points in the research, and Steven Rubin and John Veresh at EPA for their help in obtaining the enforcement data. The research was supported by the National Science Foundation under grant SES-0215426, but this study does not necessarily reflect the views of NSF.

American Journal of Political Science, Vol. 50, No. 1, January 2006, Pp. 81–97

 ISSN 0092-5853

Policy Context: The NPDES Permit System and Watershed Partnerships

The two divergent policy approaches of centralized regulation and decentralized collaboration both continue to play critical roles in water pollution policies. In particular, one office in the Division of Water at the EPA oversees the centralized, command-and-control-oriented National Pollutant Discharge Elimination System (NPDES: http://cfpub.epa.gov/npdes/), while other offices at the EPA pursue the decentralized, collaborative approach by developing local watershed partnerships such as Community-Based Environmental Protection Projects (CBEP: http://www.epa.gov/ecocommunity/) and the National Estuary Program (NEP: http://www.epa.gov//owow/estuaries/).

The NPDES permit system was authorized by Section 402 of the Federal Water Pollution Control Act of 1972 (known as the Clean Water Act or CWA) and provided the first major national program to control industrial and municipal discharge of effluents into the nation's waterways. The national regulatory strategy initially offered several advantages (Kraft and Vig 2000). A centralized agency could regulate pollution problems that generally spilled over municipal, county, and even state jurisdictions. A single federal agency had resources required to develop scientific knowledge and sufficient regulatory clout to take on large industrial and municipal plants that were responsible for a large proportion of the pollution existing at the time. The NPDES required all dischargers to obtain permits limiting allowable discharges. Like most regulatory policies associated with the command-and-control model, these limits are enforced through a regime of inspections carried out by the EPA and by designated State agencies to monitor compliance and impose sanctions for violations on permit conditions.

The decentralized, collaborative approach to water pollution, on the other hand, has expanded rapidly in the past decade, partly in response to observed shortcomings of NPDES, for tackling the remaining nonpoint pollution problems and related water management issues (John 1994; Lubell et al. 2002; Rosenbaum 1998). Furthermore, stress on water resources caused by population growth and development has created multiple federal, state, and local agencies that deal independently with competing water users concerned with water supply, water quality, navigation, drainage and runoff, recreational uses, and habitat conservation requirements (Scholz and Stiftel 2005). This plethora of independent agencies, combined with the confrontational relationship among competing water interests fostered by the command-and-control permit system, produced an uncoordinated, unstable set of regulations and projects that satisfied none of the stakeholders competing in a local watershed. The diversity and complexity of the natural ecosystem and of interactions among users within watersheds provide considerable opportunity to create locally devised standards and modifications to national regulations that will be preferred by all stakeholders to even the most optimally coordinated national standards.

As a consequence, many policy analysts (John 1994; Wheeler et al. 1996) and federal programs (USEPA 1997) alike have encouraged the development of local, watershed-based plans for coordinating the actions of existing authorities to resolve remaining pollution and other water-use issues. By 1994 the EPA had joined 17 other federal agencies in adopting policies to encourage local ecosystem management (Cortner and Moote 1999; USEPA 1997). In response to the perceived need and to federal and state incentives, informal coordinating institutions of all sorts have flourished in local watershed areas (Imperiam 1999; NAPA 1997; Yaffee et al. 1996). By 1997, the Conservation Technology Information Center (CTIC, http://www.ctic.purdue.edu) identified 958 watershed partnerships across the United States operating to coordinate local water policies, using the definition that partnerships must play a neutral coordinating role involving multiple stakeholders in developing and implementing strategies for voluntary actions to enhance water usage and quality in the local watershed. Three quarters of those partnerships with known starting dates were formed after 1990, as were 60% of the 105 partnerships studied by Yaffee et al. (1996).

Initial information suggests that these partnerships are poised to play two potential roles discussed in policy network literature—the local coordination of government policy in federalist systems and interest group representation in governmental decisions affecting them (Dowding 1995; Marsh and Rhodes 1992). Partnerships tend to develop where the mounting environmental problems in watersheds and the weakness of existing institutions to manage those problems increase the potential benefits from watershed partnerships, and where greater stocks of human, social, and financial capital are available to resolve the problems (Lubell et al. 2002, 159). They include a broad base of participation by commercial resource users and environmentalists alike, with a predominant role played by government agencies. (Leach, Pelkey, and Sabatier 2002; Schneider et. al. 2003; Woolley and McGinnis 2002)

Preliminary assessments have found that partnerships at least tend to increase satisfaction with water management policies in the watershed (Schneider et al. 2003), but little is known about the effectiveness of these local institutions in controlling pollution (Leach, Pelkey, and Sabatier 2002) and even less is known about their impact on the NPDES and other regulatory programs. Yet in 2004 the EPA was developing guidelines to allow direct but limited participation of partnerships in the NPDES program. Are partnerships likely to invigorate the program by coordinating with local stakeholders, as the EPA contends, or are they likely to coopt federal programs for local purposes, as critics of local participation in other programs have charged (Cortner and Moote 1999; Meyer 2001)?

Decentralized Policy Networks: Cooptation or Transformation?

Although supporters of partnerships and similar local collaborations emphasize the potential gains to participating federal agencies, classic studies in the implementation tradition emphasize the costs involved in coopting well-organized local interests. Agency decisions reflect local interests at some cost to the agency's federal mandate when implementing agencies depend on local resources (Pressman and Wildavsky 1984; Selznick 1966), when field officers interact routinely with local residents (Sabatier, Loomi, and McCarthy 1995) and particularly when regulatory enforcement officials continuously confront local regulatees (Blau 1963; Russell, Harrington, and Vaughan 1986; Scholz, Twombly, and Headrick 1991).

From this perspective, the development of water partnerships and effective local policy networks would appear to facilitate cooptation. The *cooptation hypothesis* argues that partnerships will magnify the effectiveness of local political cultures in influencing agencies and the firms they regulate, further reducing compliance and enforcement actions in conservative areas but further increasing compliance and enforcement actions in liberal ones. If this is true, partnerships might provide no net gain or loss to federal regulatory goals, but would exacerbate existing politically induced variations in enforcement.

Policy Networks and the Transformation Hypothesis

Proponents of partnerships argue that the voluntary nature of these new local institutions encourages a transformation of local and federal interests that alleviates the potential problem of cooptation by local elites. Specifically, the *transformation hypothesis* argues that the development of local policy networks and local institutions transforms the strategic choices of local interests and government agencies by increasing the likelihood of mutually advantageous outcomes (Scholz and Stiftel 2005), which in turn enhances their strategic preferences for stringent enforcement and compliance. Since this hypothesis is less familiar and more complex than the cooptation hypothesis, it requires greater elaboration.

The argument is based on the extensive local conflicts over water usage and the potential for mutually advantageous water policy agreements among fragmented authorities. By reducing the transaction costs for reaching agreements, local institutions and the policy networks they nurture expand the options available to government agencies and local interests alike ranging from simple agreements between a few government agencies and/or stakeholders to more complex multiparty plans for larger projects (Hindmoor 1998; Schneider et al. 2003; Scholz and Stiftel 2005). Partnerships are just the most visible part of a continuum of local policy networks, which range from very rudimentary contact systems based on email and rolodex lists, to casual contacts incidental to policies, to purposeful networks or alliances, to common participation in projects, to formal planning authorities (Bardach 1998; Dowding 1995). Specifically, water policy networks range from completely unorganized watersheds through those with informal but regular contacts among some stakeholders to those with more formalized partnerships and more inclusive memberships that begin to resemble policy communities (Marsh and Rhodes 1992).

But how does the development of local policy networks affect enforcement and compliance, particularly since regulatory officials are seldom directly involved in local partnerships? We contend that the search for consensus within water policy networks transforms conflicts over the NPDES program in two ways that support enforcement and compliance goals.

First, compliance with existing laws provides a powerful focal point in the search for broader collective solutions: to the extent that NPDES standards are met, other competing water users gain cleaner water or face fewer demands for reducing their own effluents. Debates within partnerships focus on finding additional methods of alleviating stresses on water resources, and all stakeholders are concerned with avoiding costly new commitments without some compensating gain (Imperiam 1999). Since most network participants are not permit holders, they would generally prefer to maximize the gain from stringent enforcement and compliance of existing permits.

Effective networks are likely to translate support for NPDES standards into effective demands for enforcement. Well-organized local users possess considerable advantages over centralized enforcement agencies in their ability to detect violations and their stronger motivation to impose meaningful punishments (Ostrom 1990). Of course, legal barriers and agency control mechanisms limit direct intervention by local stakeholders in enforcement matters. Nonetheless, well-organized networks can publicize allegations in the press and complain to the agency's political overseers. Local enforcement officials would ignore such allegations at their peril.

Second, effective networks not only ensure that permit holders face a greater threat of sanctions from the NPDES enforcement agency, but also increase the impact of observed NPDES violations on the permit holder's general reputation. The large plants that need NPDES permits inevitably interact with a broad spectrum of regulators and local groups. A reputation for abiding by agreements is particularly valuable in gaining the benefits of cooperative relationships with regulators and their constituency groups (Lewis and Henkels 1996; Scholz 1984), and reputation has been demonstrated to affect compliance and the effectiveness of enforcement in other regulatory settings (Scholz and Gray 1997). An effective network not only increases the probability that violations will be detected and punished, but also ensures that allegations and detected violations will be widely publicized among stakeholders of interest to the plant.

In sum, contrary to the cooptation hypothesis, the transformation hypothesis implies that effective local water policy networks will increase both NPDES enforcement and compliance rates, even in conservative communities that would otherwise be expected to favor reduced rates. By providing a focal point around which concerned agencies and groups can organize, partnerships both align interests in support of the NPDES program goals and create effective pressures on the enforcement agency and firm alike. The more organized the network, the greater the expected impact on compliance and enforcement.

The Empirical Study

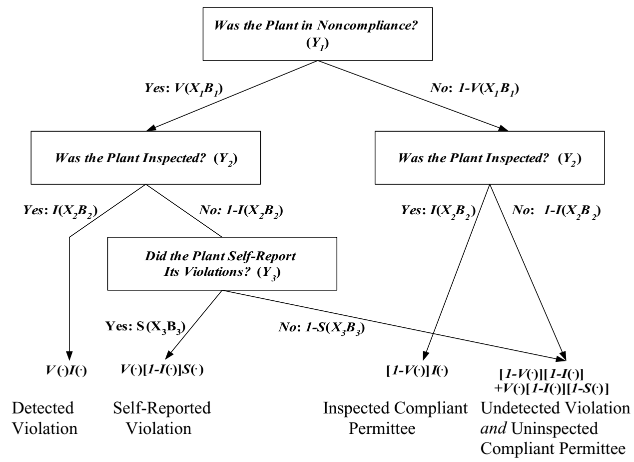
Our empirical study extends the political model of regulatory behavior in two directions. First and foremost, we incorporate local policy network variables to test the cooptation and transformation hypotheses. Second, we utilize the detection-controlled estimation procedure that overcomes one of the biggest problems facing regulatory analysis—the problem of analyzing true compliance in the full population using the potentially biased data of observed compliance in the subpopulation of inspected entities. This procedure encourages the healthy trend in regulatory analysis of simultaneously analyzing policy outputs (enforcement decisions by regulatory agencies) and outcomes (compliance decisions by regulated firms or individuals) (Helland 1998a, 1998b; Mete 2002; Olsen 1995, 1999).

The political model generally relies on deterrence theory to link the behavior of regulatory agencies and regulated entities—enforcement actions by the agency determine optimal levels of compliance by regulated entities. Since policy supporters expect regulatory agencies to ensure compliance within their area of authority, maximizing political support requires the agency to allocate resources in order to optimally deter not all violations, but rather optimally deter the kinds of violations that will cause the most trouble (Scholz and Wood 1998, 1999). Thus, Scholz and Wood argue that agencies respond "efficiently" to task-related factors by increasing enforcement activities in areas where marginal returns produce greater deterrence, but that this allocation is biased to produce greater enforcement activities in times and geographic areas dominated by policy supporters than in comparable times and areas dominated by policy opponents. Since liberal, Democratic areas are likely to respond more negatively to compliance failures and to provide greater support for aggressive enforcement efforts in the case of environmental policies like the NPDES program, we expect agency preference functions to weigh liberal Democratic areas most heavily in allocating enforcement resources to deter violations.

Deterrence theory assumes that regulated entities choose compliance levels based on factors affecting the costs of compliance and the likelihood that violations would be detected by the enforcement authority. The political model adds the assumption that the same political influences affecting agency activities also affect regulated entities. That is, firms (Olson 1995, 1999) and taxpayers (Mete 2002) increase compliance levels when pro-regulation forces (usually Democrats) are dominant and decrease compliance when antiregulation forces (usually Republicans) win. Deterrence signaling theory (Olson 1995, 1999) explains this surprising political responsiveness of firms in terms of imperfect information; given the uncertainty facing firms in predicting agency behavior, they rely on political signals to estimate likely changes in enforcement efforts, and they adjust their compliance investments accordingly. We add that an effective local policy network favoring regulatory compliance may also create direct incentives for firms to comply that are independent of anticipated regulatory agency sanctions (Mete 2002), as discussed previously.

The analysis focuses on two dichotomous dependent variables, *inspections* and *violations*. The first variable reflects the agency's decision to inspect the plant in a given quarter, while the second dependent variable reflects whether or not the regulated plant's compliance decision led to a violation during that quarter. We use the same definitions of inspections and violations developed by EPA for their annual reports, which exclude minor reportable noncompliance from violations. For both dependent variables, our regression models are based on quarterly plant-level observations. The equations for both dependent variables include the standard political variables as well as the local network variables to test the cooptation and transformation hypotheses. In addition, the inspection equation contains task-related variables and the violation equation contains deterrence-related variables as well as other control variables described below. Thus, we can compare the relative impacts of network, political, task, and deterrence factors on the enforcement and compliance measures.

FIGURE 1 Modified Detection Controlled Estimation



Unobserved Violations and Detection-Controlled Estimation

Perhaps the greatest difficulty in studying regulatory systems is due to the difficulty in observing violations with accuracy. As in most enforcement studies, we use reported violations detected by inspections as the basic measure. In addition, we also use violations reported by the automated reporting system, which we will refer to as self-reported violations. The permit compliance system (PCS) requires permit holders to report total effluent discharges every month, and automatically flags reports that exceed permitted amounts. Even with these two measures of violations, the problem of undetected violations remains as a potential source of bias in our analysis. A subset of permittees with no reported violations may actually be in violation if these violators have neither been inspected nor self-reported their violations.

To minimize potential biases in using data based on observed violations, Feinstein (1990, 1999) developed the detection-controlled estimation (DCE) method in order to estimate true compliance rates based on violation rates observed from enforcement actions. In our modification, information about violations observed for inspected plants is used to partition the set of uninspected plants into likely violators and compliant plants. This process also controls for the potential selection bias among inspected firms, since this selection is not random. We use Helland's (1998b) modification of Feinstein's DCE which incorporates data from the self-reported violations as well, as summarized pictorially in Figure 1. The far-left path refers to the observed category of detected violations—violators who were inspected and violations were observed. The next path to the right refers to the uninspected violators with self-reported violations. The third path leads to compliant permit holders who were inspected and no violation was found. The final set of multiple paths leads to the problematic far-right category. The previous three categories are directly identifiable from the data, but this final category contains not only the uninspected compliers, but also the violators who were not inspected and also failed to report violations.[1]

The DCE estimator utilizes information from all categories in a maximum-likelihood procedure that simultaneously estimates the inspection, violation, and self-reporting equations. Since this technique is relatively new and unfamiliar in political science, the appendix describes the procedure in detail. Our remaining discussion describes the variables used in the inspection and violation equations, as listed with our results in Table 1.

Data

Data for this estimation is based on quarterly observations for the period FY 1994–2000 of enforcement and compliance for all 1,648 major private NPDES permit-holders with full data in EPA's Permit Compliance System. We exclude government permit holders because public ownership creates different constraints that alter their

[1]The modified DCE assumes (1) an inspection discovers the true compliance status of a permit holder, (2) inspections preempt self-reporting, and (3) compliant plants do not falsely self-report violations (Helland 1998b). Although inspections do not always accurately observe compliance status, these assumptions resolve the more serious problem of violations among the uninspected.

TABLE 1 Maximum-Likelihood Estimation for Inspections and Violations

Independent Variables	Inspection	Violation
Local Network Context		
Local institutions	0.055*** (0.003)	−0.060** (0.019)
Voter turnout in the 1996 election	2.028*** (0.736)	−1.19102 (1.498)
Census response rate in the 2000 Census	1.216 (0.847)	−1.444** (0.678)
Per capita income	0.028*** (0.006)	−0.040** (0.017)
Percent college graduate	0.608 (0.414)	−1.00131 (0.981)
Percent black residents	−0.757 (0.676)	0.410*** (0.122)
Percent Hispanic residents	−1.612*** (0.129)	0.912*** (0.152)
agricultural runoff	0.092*** (0.014)	−0.173*** (0.029)
urban runoff	0.005*** (0.001)	−0.006** (0.003)
Political Context		
Federal legislative preference	0.144*** (0.029)	−0.409*** (0.052)
State government (elite) ideology	0.089** (0.044)	−0.062*** (0.161)
State citizen ideology	0.640*** (0.103)	0.067 (0.077)
Local Democratic strength	0.073*** (0.025)	−0.190*** (0.045)
Political Interations		
Institution × federal legislative preference	0.092*** (0.014)	−0.039*** (0.013)
Institution × state government ideology	0.039 (0.024)	−0.023* (0.013)
Institution × local Democratic strength	—	−0.028*** (0.010)
Task Variables		
State government has primacy on NPDES	0.269*** (0.024)	—
Percent state budget from federal aid	−0.430*** (0.058)	—
Number of private major permits in the watershed	−0.010 (0.013)	—
The permittee was in violation last quarter	0.184*** (0.026)	—
Number of quarters since last inspection	0.034*** (0.003)	—
Deterrence Variables		
Inspected six months ago	—	−0.070** (0.033)
Inspected one year ago	—	−0.058* (0.031)
Inspected one and half years ago	—	−0.017 (0.030)
Inspection rate in the watershed	—	−0.140* (0.081)
Notice of violation six months ago	—	0.272*** (0.034)
Notice of violation one year ago	—	0.134*** (0.043)
Selective (sampling) inspection last year	—	−0.048* (0.026)
Fined during last year	—	−0.328*** (0.119)
Control Variables		
Compliance cost	0.024*** (0.004)	−0.110*** (0.035)
Compliance cost (squared)	—	0.007*** (0.002)
In violation one quarter ago	—	1.305*** (0.048)
In violation two quarters ago	—	0.635*** (0.048)
In violation three quarters ago	—	0.410*** (0.053)
Quarter (1)	0.022*** (0.020)	0.024 (0.035)
Quarter (2)	0.183*** (0.020)	−0.029 (0.036)
Quarter (3)	0.377*** (0.020)	−0.206*** (0.046)
Pulp and Paper Industry	−0.066*** (0.021)	−0.262*** (0.041)
Steel and Metal Industry	0.068** (0.031)	−0.153*** (0.051)
Petroleum Refining Industry	0.109*** (0.035)	0.244*** (0.049)
Violation rate in the watershed	−0.171* (0.090)	—
Southeastern states	−0.046* (0.025)	—
Constant	−1.820*** (0.457)	−1.449*** (0.548)
N	37688	37688
LL	−29617.3	−29617.3
Correct prediction	77.49%	78.25%

Note: ***$p < 0.01$; **$p < 0.05$; *$p < 0.10$. Standard errors in parentheses.

responses to enforcement, and we exclude minor permit holders because of inconsistencies in data and because the majors account for the lion's share of permitted effluents. We will refer to these nongovernmental permit holders as plants. Given our primary concern with policy networks within natural ecosystems that shape the policy coordination problem, community-related data affecting a given permit holder in a given quarter are measured at the watershed level using the eight-digit hydrological unit codes (HUC) developed by the U.S. Geological Survey. We use the HUC geographic location data in the PCS to combine enforcement, violation, and permit characteristics from the PCS with data from census and other sources for the 611 watersheds in 48 states in which the sampled permit-holders are located.

Local Network Context

To test the transformation hypothesis that effective local networks increase inspection and decrease violation rates, we include two types of network measures. The most direct measure focuses on the presence of local institutions dealing with water issues, since these institutions provide visible evidence of a relatively advanced level of policy network development. The *Local institutions* variable sums the number of watershed partnerships identified in the CTIC survey for the relevant watersheds. Since these partnerships tend to be underrepresented in rural districts, we also add the number of Soil and Water Conservation Districts (SWCD) in the watershed. The first of these institutions reflects the kind of voluntary institution building described above and the second reflects one of the oldest attempts by the federal government to develop local capabilities to govern water resources in rural communities. The result is a variable that averages about two institutions per watershed and equals zero for watersheds one standard deviation below the mean and 6.25 for watersheds one deviation above the mean.

Obtaining direct survey-based measures of local policy networks in all watersheds would be prohibitive, so we develop *network proxy* measures to represent the expected size and effectiveness of local networks. Lubell et al. (2002) demonstrate that factors affecting the "transaction costs" of developing and maintaining networks, institutions, and other forms of collective action provide significant predictors of watershed partnerships. By including measures both of observed institutions and of the background variables associated with these institutions, the coefficient for the institution variable reflects the specific contribution of a more formalized institution, while the coefficients for watershed characteristics provide a proxy for the added contribution from unobserved informal networks likely to evolve in the watershed.

These background variables primarily reflect social capital factors that reduce transaction costs. We include two measures of citizen participation in government—voter turnout in previous presidential election, and census response rate in the 2000 Census—that are expected to enhance social capital (Putnam 2000). We also include income and the percentage of college graduates to reflect economic and educational conditions conducive to more extensive networks.[2] Watersheds with higher social and economic capital are expected to have more effective networks that will demand more stringent enforcement, so positive coefficients would confirm the hypothesized transformation effect. We also include a measure of heterogeneity—the proportion of black and Hispanic residents—that creates a barrier to effective network organization (Lubell et al. 2002), so we expect negative coefficients for both measures. In addition to these social capital indicators, we include two measures reflecting the extent of the unregulated pollution problem that translates into greater potential benefits if local actions can control the problem. Both urban and industrial runoff are major contributors to nonpoint source pollution, and therefore are particularly likely to motivate both greater network action and greater pressure within the network to control NPDES pollution.[3]

Political Context

Political context variables retest the general finding that liberal political influences lead to greater probability of inspection and lower rates of violation. On the federal level, we use the League of Conservation Voter scores for the House member representing the Congressional district in which the permit holder is located. Since state agencies enforce permit agreements under EPA supervision, both state and local officials have direct oversight links with enforcement agencies. On the state level, we use the measures developed in Berry et al.'s (1998) state government ideology studies to represent ideology

[2]Census data are all aggregated to watershed levels. Per capita income was rescaled to $1,000,000 for faster maximum likelihood convergence. Percentages of black and Hispanic residents and of college graduates are squared to capture the indicated nonlinear relationship.

[3]Measures of urban and agricultural runoff are taken from EPA's *Index of Watershed Indicators* (http://www.epa.gov/iwi/, October 1998 release). Agricultural runoff is a composite index that consists of three components: nitrogen runoff potential, sediment delivery to rivers and streams, and pesticide leaching/runoff. Urban runoff indicates the % of land area per watershed that has greater than 25% imperviousness.

positions of state elites. On the local level, we use the proportion of Democratic votes in the previous presidential election to measure the local dominance of Democratic voters. Note that preference scores of House representatives and Democratic strength are both interpolated to the watershed level on the basis of population proportions common to watersheds and to the relevant political jurisdictions.

By including political measures in both equations, the coefficients for local institutions and networks estimate the direct impact on inspections and violations, independent of the partisan influences estimated by the political variables. To provide a complete test of the cooptation versus transformation hypotheses, we include an interaction term between local institutions and state/federal/local political variables (*Political interactions*) in both equations.[4] Significant positive coefficients for the interaction terms would indicate that local institutions magnify the strength of local political cultures.

Task Variables in the Inspection Equation

The inspection equation includes *task* variables to test the extent to which the agency allocates inspections to optimize deterrence effects. The most important variable is past noncompliance by the permit holder, represented as a dummy variable of violations in the previous quarter. As Scholz and Wood (1998) noted, effective enforcement agencies presumably target previously identified noncompliers. In addition, we include measures of the time since the last inspection, which should have a positive effect on inspections if the agency is monitoring firms efficiently, and the number of permittees in the watershed, which increases workload and would presumably have a negative impact on inspections. Finally, we include two measures reflecting the relative state-level support given to enforcement efforts, one reflecting the successful application by the state to take over enforcement functions (primacy) and the other reflecting the dependence of the state enforcement effort on federal funding—the former should have a positive impact and the latter a negative impact on inspections.

Deterrence Variables in the Violation Equation

We test for the direct *deterrence* effects of enforcement actions on violations by using a set of dummy variables representing past enforcement actions against the specific permit holder in the previous year, including general inspections, intensive sampling inspections,[5] warning of violations, and fines. Generally, enforcement actions should impact compliance with decreasing magnitudes as we go from fines (producing the greatest deterrence threat) to warnings of violations and intensive inspections to more general inspections (producing the least deterrence threat). We also test for general deterrence effects by including the aggregate number of inspections in the watershed during the previous year. Note that we exclude the task variables from the violation equation in part to meet the identification requirement for the system of equations, but also because the deterrence variables in the equation measure agency capabilities that directly affect the permit holder. Deterrence variables provide a more direct estimation of the impact of actual administrative outputs on violations than the more general task proxies can provide.[6]

Control Variables

To control for other factors known to influence inspections and violations, we include dummy variables representing seasonal effects and important industry sectors in both inspection and violation equations. A dummy variable in the inspection equation accounts for the potentially unique political environment in the 11 southeastern states, where regulatory enforcement has generally lacked vigor.[7] Previous studies have found that compliance costs and past violations have robust effects on a firm's current status of compliance, reflecting the lengthy and costly process required to make the changes necessary to return to compliance (Helland 1998a; Magat and Viscusi 1990). To control for this path dependence, lagged dependent variables representing noncompliance during the previous three quarters are included in the violation equation. The cost of compliance is represented by natural log of annual effluent discharges in tons. The lagged dependent variables also control for other unmeasured effects on

[4]The interaction including local Democratic strength was dropped from the inspection equation due to potential multicollinearity problems.

[5]Compliance sampling inspections are the most resource intensive of EPA's general inspections, and may therefore be more likely to detect violations.

[6]When task variables are added to the violation equation reported in Table 1, primacy reduces violations (coefficient = .9) and dependence on federal aid increases them (−.38), as expected. The impact of the lagged inspection variables become more marginal in significance when these proxies for administrative capacity are included, but the larger deterrence effects from inspection rates, citations, and fines and all other results are not affected.

[7]These eleven states are Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, South Carolina, Tennessee, and Virginia

violations. Violations are accounted for in the inspection equation by the violation rate in the watershed as well as specific violations of the plant in the third quarter. These variables not only guard against spurious effects from factors found to influence inspections in other research, but the difference in controls between the equations also mitigate the identification problem of estimating simultaneous equations with the overlapping set of theoretically most interesting variables.

The Self-Reported Violation Equation

We include a self-reporting equation to take full advantage of available information in the detection-controlled estimation process. The results are reported only in appendix Table A1, since our primary focus is on violations and not on this self-reporting process. We follow Helland (1998b) to model a violator's probability of self-reporting violations as a function of past detected effluent violations and past violations related to late- or nonfiling of the required monthly discharge monitoring reports.

Results

The results of simultaneously estimating the probability of inspection, violation, and self-reporting are reported in Table 1 for inspections and violations and in Appendix Table A1 for the self-reporting equation.[8] Since the estimated coefficients in probabilistic models are difficult to interpret, we summarize in Table 2 the estimated percentage of firms that are in violation and that are inspected when each variable of interest is set at low and high values (one standard deviation below and above the mean, or zero and one for dichotomous variables) and all other variables are held at their mean (or mode for dichotomous variables). The third column under each dependent variable indicates the change in percentage in moving from low to high values, and the stars indicate the significance level of the coefficient in the estimated equation. Since we are interested in the relative magnitude of effects from policy networks, political context, and deterrence (for violations) and task context (for inspections), we have also calculated the *overall* change for each group when all variables in the group shift from low to high.

[8]Maximum likelihood estimates were obtained by using the *BHHH* (Berndt, Hall, Hall, and Hausman) algorithm to calculate the asymptotic covariance matrix of parameter estimates and standard errors, with tolerance set to 10^{-4}. Several sets of starting values have been tried to verify the stability of global maximum.

The results provide a picture consistent with much of the literature on regulatory behavior in which agencies respond to political and task contexts and firms respond to political and deterrence measures. We will first discuss our focal issue of local networks and then consider more briefly the other factors.

Local Network Context

Overall, the results confirm that local networks deserve an equal place along with the already recognized influence of the political context and the task and deterrence settings for the role they play in shaping both regulatory outputs and compliance outcomes. The strongest case is provided by the count of local institutions, which is significant in both equations. Local institutions increase inspection rates from 24% to 45% and decrease violation rates from 21% to 9% in moving from zero to 6.25 institutions (from the lowest value one standard deviation below to one standard deviation above the mean count of 2.3). This difference is the highest for any single variable in both equations, confirming that institutions strongly influence both agency and firm behavior. Since deterrence measures included in the violation equation are themselves increased by local institutions, the drop in violations from 21% to less than half that rate (9%) estimates only the direct impact of local institutions. The full effect of local institutions on compliance would include some proportion of the overall deterrence impact as well.

The indirect measures included to proxy for other characteristics of local networks suggest that the informal networks contribute additional motivation to enforcement and compliance above and beyond the impact of formal institutions. As a group, the local network variables account for a far greater difference in inspections (42%) and violations (−36%) than either political, task, or deterrence measures included in this study. As expected, the transaction cost proxies for networks—voter turnout, census response, college graduates, income, and urban and rural runoff—all increase inspections and decrease violations, although they differ in their significance across the two equations. The heterogeneity indicators—percent black and Hispanic—decrease inspections and increase violations, consistent with the hypothesis that heterogeneity reduces the effectiveness of policy networks.

The inference from network proxies should be treated cautiously for two reasons. First, alternative interpretations suggest that some of the social capital indicators may reflect "post modern" preferences for clean water and other environmental policies associated with higher income and education, the runoff indicators may simply

TABLE 2 Changes in the Predicted Probabilities of Inspection and Violation

	Inspection				Violation			
Variable	**Low**	**High**	**Difference**	**Sig**	**Low**	**High**	**Difference**	**Sig**
Local Network Proxies								
Overall	13.2%	54.7%	41.5%		38.6%	2.9%	−35.7%	
Local Institutions	23.8%	44.7%	20.9%	***	20.5%	9.1%	−11.4%	**
Voter Turnout	31.9%	36.9%	5.0%	***	17.1%	13.3%	−3.8%	
Census Response	31.9%	36.7%	4.8%		16.9%	12.7%	−4.2%	**
Percent Black	34.2%	27.9%	−6.3%		13.5%	14.5%	1.0%	***
Percent Hispanic	35.4%	29.8%	−5.6%	***	12.3%	15.6%	3.3%	***
College Graduate	30.5%	33.8%	3.3%		14.9%	11.8%	−3.1%	
Income	27.1%	36.9%	9.8%	***	18.1%	9.3%	−8.8%	**
Agricultural Runoff	28.2%	35.8%	7.6%	***	18.2%	9.2%	−9.0%	***
Urban Runoff	31.1%	31.9%	0.8%	***	13.5%	12.4%	−1.1%	***
Political Context								
Overall	27.5%	46.9%	19.4%		25.2%	5.8%	−19.4%	
Federal Legislative Preference	31.6%	35.9%	4.3%	***	16.3%	10.5%	−5.8%	***
State Government Ideology	33.1%	35.5%	2.4%	**	18.8%	8.8%	−10.0%	***
State Citizen Ideology	31.6%	38.5%	6.9%	***	13.0%	13.4%	0.4%	
Local Democratic Strength	34.1%	35.8%	1.7%	***	15.2%	11.4%	−3.8%	***
	No(0)/Low	**Yes(1)/High**	**Difference**	**Sig**	**No(0)/Low**	**Yes(1)/High**	**Difference**	**Sig**
Task Proxies								
Overall	28.0%	56.1%	28.1%		—	—	—	
State primacy	33.6%	43.4%	9.8%	***	—	—	—	
Federal aid to state	35.9%	31.1%	−4.8%	***	—	—	—	
Number of permits in watershed	34.0%	32.9%	−1.1%		—	—	—	
Permittee in violation last quarter	33.4%	40.2%	6.8%	***	—	—	—	
Time since last inspection	30.7%	36.3%	5.6%	***	—	—	—	
Deterrence Measures								
Overall	—	—	—		13.2%	3.8%	−9.4%	
Inspected six months ago	—	—	—		13.2%	11.7%	−1.5%	**
Inspected one year ago	—	—	—		13.2%	12.0%	−1.2%	*
Inspected one and half years ago	—	—	—		13.2%	12.8%	−0.4%	
Inspection rate in the watershed	—	—	—		13.2%	10.4%	−2.8%	*
Ssampling inspection last year	—	—	—		13.2%	12.2%	−1.0%	*
Fined during last year	—	—	—		13.2%	7.3%	−5.9%	***
Mean Prediction		35.62%				14.24%		

Note:
1. Predicted probabilities are computed with other variables held at their means (for continuous variables) or modes (for dummy variables)
2. Overall effects are calculated by letting independent variables of the same category (e.g., networks, political context, and task) have a consistent direction of influence on the dependent variables. For instance, we calculate overall effect of increases in network proxies on predicted probabilities by letting both black and Hispanic vary from high to low while allowing other proxy variables to move from low to high at the mean time.
3. Significance of coefficients is indicated in column labeled Sig.: ***$p < 0.01$; **$p < 0.05$; *$p < 0.10$.

reflect motivating characteristics not related to post modern preferences, and the heterogeneity indicators are also consistent with the social justice literature that emphasizes minority status as causally connected to greater pollution (Ringquist 2001). Although our research design cannot distinguish whether the variables operate as preference and resource indicators or network proxies, the impact of preferences is likely to be mediated by networks in any case, suggesting that both explanations are likely to play a role in the observed effects.

Second, network dynamics require more elaborate longitudinal research design and better measures of network characteristics to provide a fully conclusive test of the causal linkage between effective networks and higher enforcement and compliance rates. The positive impact of local institutions is less in doubt, since Lubell et al. (2002) find that the creation of partnerships is negatively related to enforcement rates. This would suggest that there were lower enforcement rates prior to the establishment of the partnerships in the watersheds where partnerships formed, which would suggest that our estimates may underestimate the positive impact of partnerships, if anything. To firmly establish the reputational and enforcement-supporting role of policy networks that do not have a formal institutional presence, on the other hand, both a stronger theory of network characteristics associated with such capacities and better measures of these characteristics will be required.

In sum, the local institution variable provides persuasive evidence that formalized local policy institutions have significant impacts on enforcement and compliance. The remaining variables at least suggest that informal networks may also be very important, perhaps even more important than the presence of formal institutions. Although we cannot in this analysis distinguish what part of the large influence from these proxy variables truly represents local network development and what represents other factors also connected with these variables, our finding should encourage the ongoing search for a stronger theory about specific characteristics that identify effective informal networks and a research design capable of measuring and testing the impact of those characteristics (Burt 2000).

Political Context

The impact of the political context on agencies offers little surprise, with inspection rates falling from 47% in a predominantly liberal environment to 28% in a conservative one. Federal, state, and local factors all contribute significantly to this change. State citizen ideology accounts for the greatest difference, followed by federal and state government preferences and finally by local Democratic Party strength. However, these measures are not sufficiently precise to establish anything beyond an impressionistic image of the relative impact of citizen versus elected official ideology at each level. What is perhaps more surprising is that the local institutions variable alone accounts for the same magnitude of change (21%) as the combined impact of changes in all political context variables (19%).

The strong political impact on violation rates is less familiar in political science, although it is consistent with prior research (Mete 2002; Olsen 1999). Expected violation rates increase from 6% in predominantly liberal communities to 25% in conservative ones, a fourfold increase over the liberal community. This difference is twice as large as the expected difference in moving deterrence values from lax to stringent, which reduces violations from 13% to 4%. Some of the political effect is undoubtedly due to signaling (Olsen 1999), in which firms use political signals as proxies for expected levels of enforcement. But the magnitude of the political effect even after controlling for observed levels of enforcement suggests that even a modified deterrence theory cannot explain this impact without considering alternative ways in which the political context and political culture influence the willingness to comply with the laws of the state.

Deterrence and Task Context

Consistent with other compliance studies (Gray and Scholz 1993), fines imposed on the firm in the past year change expected current violation rates by the largest amount, from 13% in firms with no fines to 7% when the average firm was fined. The general and specific deterrence of inspections without fines is less consistent in compliance studies (Gray and Scholz 1993), although we find evidence here that both are significant in NPDES inspections. In particular, the general deterrence measure of inspection rates within the watershed has substantial impacts, changing violation rates by 3%. Controlling for these factors, past inspections lead to a relatively small decrease in violations in the inspected firms, but nonetheless have statistically significant impacts.

Turning to task impacts on agency behavior, all coefficients were in the expected direction and four were significant. The overall impact of a two-deviation change in task variables doubles inspection rates from 28% in unfavorable task environments to 56% in more favorable ones. This difference of 28% in inspection rates is greater than the 19% increase accounted for by the political context variable, which is consistent with the argument that task-related principles are at least as important as political principals in explaining agency behavior (Scholz and Wood 1998). Of course, this comparison is by no means conclusive in weighing the relative impact of political and task factors. State primacy and dependence on federal aid are task factors that reflect past political decisions, for example, suggesting the complexity of the relationship between task and political variables.

Do Local Institutions Magnify or Transform Political Culture?

The model reported in Table 1 includes interaction terms between local institutions and political context variables to test whether these institutions simply magnify political effects of the existing political culture or transform that culture for issues relevant to the institution. Since interaction coefficients are difficult and potentially misleading to interpret directly for dichotomous dependent variables (Berry 1999), they were not included in Table 2. Figure 2 portrays this interaction by presenting the estimated inspection and violation rates at low and high values of local institutions for liberal and conservative communities, holding all other variables at their mean. Note that the lower line represents conservative areas for inspections and liberal areas for violations, since conservatives were found to depress inspection rates and increase violation rates in comparison with liberals. We have added a dotted line to illustrate a hypothetical case with a pure cooptation effect in which differences between liberal and conservative communities diverge as institutions grow stronger.

The bold lines in Figure 2 indicate stronger support for the transformation than the cooptation hypothesis, since an increase in local institutions increases inspection rates and decreases violation rates in liberal and conservative communities alike. These institutions transform interests to such an extent that permit holders in conservative communities with well-developed local institutions have about the same probability of inspections and violations as those in liberal communities with no institutions.

There is a small cooptation effect for inspections, however, since the difference between the conservative and liberal communities increases from a difference of 14% with no local institutions to a difference of 18% with more local institutions—a magnification of 4 percentage points. On the other hand, the difference in violation rates actually diminishes from a difference between conservative and liberal areas of 24% with no institutions to a difference of only 9% with more institutions.[9] Contrary to the cooptation hypothesis, increasing the number of institutions substantially decreases the difference in violation rates.

In sum, the major story is that local institutions transform existing interests in a manner that is consistent with the goals of the federal agency, effectively increasing inspections and decreasing violations regardless of the political characteristic of the area. The results are consistent with our hypothesis that the development of a coherent local policy network transforms interests as it increases the likelihood of successful collaborative resolution of the underlying policy problem. Although competition over resources continues among members of local water policy networks, the search for solutions providing greater joint gains includes as a prominent solution a preference for compliance with existing regulations. The greater the reduction in pollution from NPDES compliance, the greater the degrees of freedom in policy choices open to the network.

We note in passing that enhanced NPDES effectiveness does not imply enhanced efficiency in the allocation of enforcement resources. Since local networks enhance compliance independently of agency resources, marginal returns for agency enforcement resources may actually be greater in less organized areas, suggesting that an efficient agency would reallocate resources away from more organized areas. Yet we observe the opposite to be true. This problem is most evident in the most liberal communities in Figure 2, where violation rates are already so low that additional enforcement resources are unlikely to have much impact at all. In this case, agency responsiveness to local networks favors those communities most capable of resolving problems on their own, not those communities most in need of federal resources.

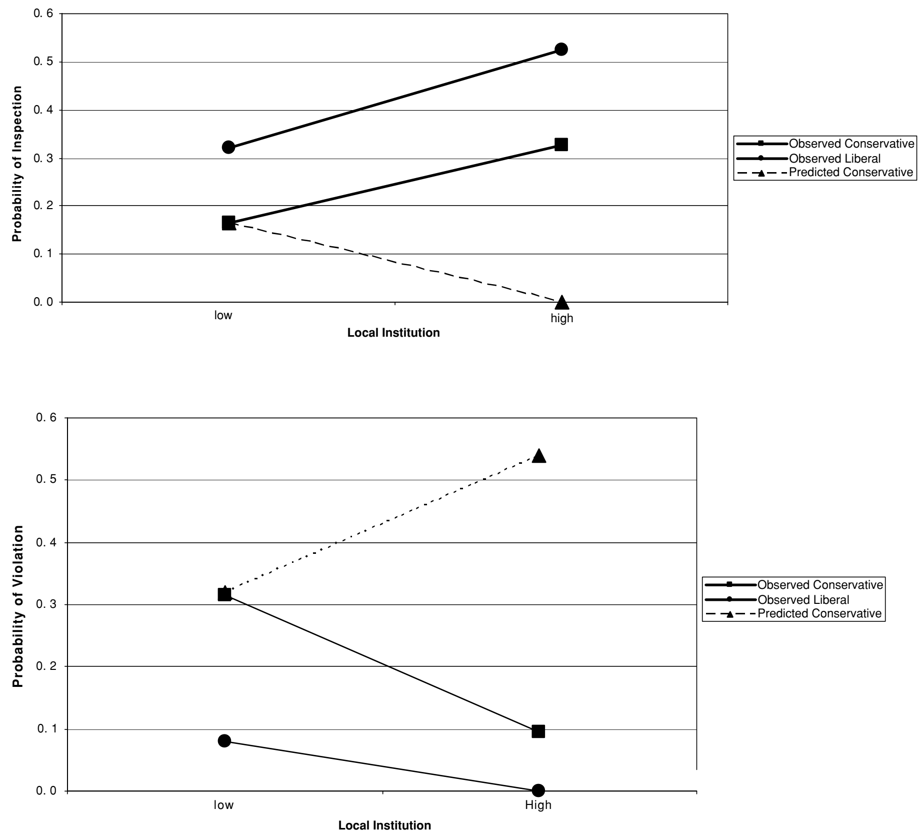
Conclusion

We find evidence that local institutions and the policy networks that spawn them significantly alter both the behavior of federal and state agencies and their ability to regulate firms. Instead of simply magnifying the effect of local political cultures, however, local institutions alter the strategic choices of actors in ways that transform their relationship with federal and state regulators. In particular, local water policy networks complement federal regulations, enhancing bureaucratic outputs and compliance outcomes even in conservative areas that otherwise tend to undermine enforcement efforts.

We argue that this observed complimentarily between local and federal interests arises from the specific problem that drives the development of local water policy networks—mitigating stress from competition over water resources by coordinating the otherwise fragmented

[9]The negative interaction among political and local institution variables in determining the probability of violation occurs despite three significant positive interactions among variables in influencing the latent unbounded variable (Table 1). As Berry, Berkman and Schneiderman (2000) note and Berry (1999) discusses at greater length, statistical significance of the interaction term in such cases is only of interest if the underlying latent variable rather than the observed rate is of interest.

FIGURE 2 Local Institutions Increase Inspections and Decrease Violations in both Liberal and Conservative Communities



Liberal and conservative areas are calculated to be one standard deviation above (liberal) or below (conservative) the mean for all political variables and the comparable range of institutions for low and high values corresponds to the zero to 6.25 value range for local institutions that was used in Table 2.

authorities governing those resources. Whether similar complementarity will develop from local institutions in other policy arenas, as proponents of community-based consensual institutions argue, depends on the incentives at play in local policy networks.

For regulatory analyses, the detection-controlled estimation procedure we utilize reduces one major impediment to the simultaneous study of regulatory agencies and regulated entities, for it allows the use of enforcement records to analyze observed as well as unobserved violations. The broader picture that emerges from our analysis is that of a highly interdependent regulatory arena in which formal institutions of government provide only one part of the picture. Formal, authoritative political controls (including task variables that reflect the assigned statutory goals of the agency) explain a good part of the variance in how laws are enforced, and formal enforcement actions explain a good part of the variance in how regulated facilities respond to the law. But equally important are the informal political influences as transformed by local policy networks on both enforcement and compliance.

For watershed partnership analyses, the significant impact on enforcement and compliance rates supports the general policy assumption that appropriately designed local institutions can play an effective role in managing natural resources. The transformation effect suggests that interactions within these local institutions not only enhance the network's effectiveness in dealing with environmental problems, but might also transform local preferences to enhance the breadth of support for such policies. At the same time, the ability of local networks to demand a greater share of federal resources highlights the problem of dealing with local areas that are less organized and less endowed with social capital.

Our results underscore the importance of developing a better understanding of local policy networks that appear destined to play an increasing role in public policy. Empirically, we need more precise descriptions of the informal and formal collaborative devises that we have referred to loosely as networks, and studies linking these networks and institutions directly to observed environmental improvements and enhanced policy support. Theoretically, we need clearer analyses of the characteristics of networks that affect their capacities to enhance collective decision mechanisms and improve the welfare of network members. To validate resultant hypotheses in empirical settings, we need to develop a consensus on conceptually relevant network measures of these characteristics. Pragmatically, we need to understand how federal policies can incorporate the potential advantages of informal policy networks illustrated in this study while avoiding the potential conflicts likely to appear in other settings.

Appendix

Detection-Controlled Estimation

The detection-controlled estimation shown in Figure 1 consists of three equations—*violation, inspection,* and *self-*
Q1 *reporting*. The violation and self-reporting equations refer to a permit holder's compliance decision. The inspection decision refers to the EPA's inspection decision.

Violation Equation

We adopt a latent variable approach of a binary-choice model to model the probability of violation. Let a latent variable *Violation* (Y_{1i}^*) denote the probability that the i^{th} permit holder is in noncompliance or violation. Y_{1i}^* is explained by a vector of independent variables X_{1i} (e.g., local network proxies, political context, and deterrence measures) and an error term ε. This gives:

$$Y_{1i}^* = X_{1i}\beta_1 + \varepsilon_{1i}$$

$$Y_{1i} = \begin{cases} 1 & \text{(in violation) if } Y_{1i}^* > 0 \\ 0 & \text{(in compliance)} \end{cases}$$

where Y_{1i} is the observed binary compliance status of the permittee; ε_{1i} is the disturbance term assumed to be normally distributed, $\varepsilon_{1i} \sim N(0, 1)$; and β_1 is the column vector of parameters to be estimated. (We omit the subscript for time periods here for simplicity.) Under the distributional assumption on the error term ε_{1i}, the probability of violation equals $Pr(Y_{1i} = 1) = \Pr(X_{1i}\beta_1 + \varepsilon_{1i} > 0) = V(X_{1i}\beta_1)$, where $V(\bullet)$ is the cumulative normal distribution function for the violation equation. Consistent with the fact that $0 \leq V(\bullet) \leq 1$, the probability of compliance is simply $1 - V(X_{1i}\beta_1)$ or $V(-X_{1i}\beta_1)$.

Inspection Equation

We use the same approach to specify an agency's decision to inspect the i^{th} permit holder. A latent variable *Inspection* (Y_{2i}^*) denotes the probability that the i^{th} permittee was inspected. This latent variable is modeled by another vector of independent variables X_{2i} (e.g., local networks, political context, and task measures) and random errors (ε_{2i}) such that:

$$Y_{2i}^* = X_{2i}\beta_2 + \varepsilon_{2i}$$

$$Y_{2i} = \begin{cases} 1 & \text{(the permittee was inspected) if } Y_{2i}^* > 0 \\ 0 & \text{(the permittee was notinspected)} \end{cases}$$

where Y_{2i} is the observed indicator for inspection and ε_{2i} follows normal distribution. Thus, the probability of inspection $I(X_{2i}\beta_2)$ is the cumulative normal distribution function for the inspection equation.

Self-Reporting Equation

Finally, the self-reporting equation explains a permit holder's decision to self-report its violations. Let Y_{3i}^* and Y_{3i} be the latent *Self-Reporting* variable and its observed indicator respectively, then it gives:

$$Y_{3i}^* = X_{3i}\beta_3 + \varepsilon_{3i}$$

$$Y_{3i} = \begin{cases} 1 & \text{(the permittee reported its violations)} \\ & \quad \text{if } Y_{3i}^* > 0 \\ 0 & \text{(the permittee did not report its violations)} \end{cases}$$

The probability of self-reporting can be denoted by $S(X_{3i}\beta_3)$ where $S(\bullet)$ is the cumulative normal distribution function for the self-reporting equation. Self-reporting is also modeled by a vector of independent variables X_{3i} (e.g., local networks, past compliance history, and economic factors) and random errors (ε_{3i}).

The detection-controlled estimation deals with the problem of partial observability by deriving five mutually exclusive log-likelihood functions to capture the different events depicted in Figure 1: (1) detected violations (*DV*), (2) inspecting a compliant facility (*IC*), (3) self-reported violations (*SR*), (4) undetected violation (*UDV*), and (5) not inspecting a compliant plant (*NIC*).

1. The log-likelihood function of detected violation (*DV*):

$$lnL_{DV} = \sum_{i \in DV} log[V(X_{1i}\beta_1)I(X_{2i}\beta_2)] \qquad (1)$$

2. The log-likelihood function of inspecting a compliant firm (IC):

$$lnL_{IC} = \sum_{i \in IC} log\{[1 - V(X_{1i}\beta_1)]\,I(X_{2i}\beta_2)\} \quad (2)$$

3. The log-likelihood function of self-reported violation (SR):

$$lnL_{SR} = \sum_{i \in SR} log\{V(X_{1i}\beta_1)[1 - I(X_{2i}\beta_2)]\,S(X_{3i}\beta_3)\} \quad (3)$$

4. The log-likelihood function of undetected violation (UDV):

$$lnL_{UDV} = \sum_{i \in UDV} log\{V(X_{1i}\beta_1)[1 - I(X_{2i}\beta_2)] \times [1 - S(X_{3i}\beta_3)]\} \quad (4)$$

5. Finally, the log-likelihood function of not inspecting a compliant permit-holder (NIC):

$$lnL_{NITC} = \sum_{i \in NIC} log\{[1 - V(X_{1i}\beta_1)][1 - I(X_{2i}\beta_2)]\} \quad (5)$$

As noted previously, the fourth and the fifth situations (*i.e.*, undetected violation and a true compliant permittee without being inspected) are not distinguishable in official PCS records and are therefore observationally equivalent. Combining these two likelihood functions (4 and 5) makes the full information of log-likelihood function specified as

$$\begin{aligned} lnL_{DCE} = & \sum_{i \in DV} log[V(X_{1i}\beta_1)I(X_{2i}\beta_2)] \\ & + \sum_{i \in IC} log[V(-X_{1i}\beta_1)I(X_{2i}\beta_2)] \\ & + \sum_{i \in SR} log[V(X_{1i}\beta_1)I(-X_{2i}\beta_2)S(X_{3i}\beta_3)] \\ & + \sum_{i \in (UDV \cup NIC)} log[V(X_{1i}\beta_1)I(-X_{2i}\beta_2) \\ & \times S(-X_{3i}\beta_3) + V(-X_{1i}\beta_1)I(-X_{2i}\beta_2)] \end{aligned} \quad (6)$$

The full log-likelihood function given by Equation (6) enables us to estimate the three equations of interests (violation, inspection, and self-reporting) simultaneously even though violations are only partially observable in the data. Equation (6) can be estimated by maximum-likelihood estimation if it is identified. Feinstein (1990, 1999) and Helland (1998b) have shown that a DCE model is identified if two conditions are satisfied: (1) A parametric distribution can be specified for the link or error function, and (2) at least one explanatory variable in each of these three structural equations needs to be continuous and unbounded. As noted previously, we use a probit link function (normal distribution) to model three binary choice models. Thus, the first requirement of identification is satisfied. The second requirement is also satisfied as we included at least one continuous independent variable for each equation.

TABLE A.1 Maximum-Likelihood Estimation for Self-Reporting Violation

Independent Variables	Self-Reporting Violation
Local institutions	0.129** (0.055)
Compliance cost	0.056* (0.032)
In violation one quarter ago	0.039 (0.187)
In violation two quarters ago	−0.211 (0.196)
In violation three quarters ago	0.559** (0.251)
Inspected but no violation found one quarter ago	−0.443*** (0.141)
Inspected but no violation found two quarters ago	−0.466*** (0.127)
Inspected but no violation found three quarters ago	−0.475*** (0.121)
Failed to submit DMR one quarter ago	−1.291*** (0.148)
Failed to submit DMR two quarters ago	−0.175 (0.199)
Failed to submit DMR three quarters ago	−0.642*** (0.209)
Constant	0.859*** (0.282)
N	37688
LL	−29617.3
Correct Prediction	70.25%

Note: ***$p < 0.01$; **$p < 0.05$; *$p < 0.10$. Standard errors in parentheses.

References

Bardach, Eugene. 1998. *Getting Agencies to Work Together: The Practice and Theory of Managerial Craftsmanship*. Washington: The Brookings Institution.

Berry, William D. 1999. “Testing for Interaction in Models with Binary Dependent Variables.” The Society for Political Methodology. Working Paper. (http://polmeth.wustl.edu)

Berry, William D., Michael Berkman, and Stuart Schneiderman. 2000. “Legislative Professionalism and Incumbent Reelection: The Development of Institutional Boundaries.” *American Political Science Review* 94(4):859–74.

Berry, William D., Evan J. Ringquist, Richard C. Fording, and Rusell L. Hanson. 1998. “Measuring Citizen and Government Ideology in American States.” *American Journal of Political Science* 42(1):327–48.

Blau, Peter. 1963. *The Dynamics of Bureaucracy*. Chicago: University of Chicago Press.

Burt, Ronald S. 2000. "The Network Structure of Social Capital." In *Research in Organizational Behavior*, Volume 22. ed. Robert I. Sutton and Barry M. Staw. St. Louis: Elsevier Science. 345–423.

Cortner, Hanna J., and Margaret A. Moote. 1999. *The Politics of Ecosystem Management*. Washington: Island Press.

Dowding, Keith. 1995. "Model or Metaphor? A Critical Review of the Policy Network Approach." *Political Studies* 43(1):136–58.

Feinstein, Jonathan. 1990. "Detection-Controlled Estimation." *Journal of Law and Economics* 33(1):233–76.

Feinstein, Jonathan. 1999. "Approaches for Estimating Noncompliance: Examples from Federal Taxation in the United States." *The Economic Journal* 109(456):360–69.

Gray, Wayne B., and John T. Scholz. 1993. "Does Regulatory Enforcement Work? A Panel Analysis of OSHA Enforcement." *Law and Society Review* 27(1):177–213.

Helland, Eric. 1998a. "Environmental Protection in a Federalist System: The Political Economy of NPDES Inspections." *Economic Inquiry* 36(2):305–19.

Helland, Eric. 1998b. "The Enforcement of Pollution Control Laws: Inspections, Violations and Self-Reporting." *Review of Economics and Statistics* 80(1):141–153.

Hindmoor, Andrew. 1998. "The Importance of Being Trusted: Transaction Costs and Policy Network Theory." *Public Administration* 76(1):25–43.

Imperiam, Mark T. 1999. "Institutional Analysis and Ecosystem-Based Management: The Institutional Analysis and Development Framework." *Environmental Management* 24(4):449–65.

John, Dewitt. 1994. *Civic Environmentalism.* Washington: Congressional Quarterly Press.

Kraft, Michael E., and Norman J. Vig. 2002. "Environmental Policy from the 1970s to 2000: An Overview." In *Environmental Policy: **New Directions for the Twenty-First Century***, ed. Norman J. Vig and Michael E. Kraft. (Fifth edition). Washington: Congressional Quarterly Press. 1–32.

Leach, William D., and Neil W. Pelkey. 2001. "Making Watershed Partnerships Work: A Review of the Empirical Literature." *Journal of Water Resources Planning and Management* 127(6):378–85.

Leach, William D., Neil W. Pelkey, and Paul A. Sabatier. 2002. "Stakeholder Partnerships as Collaborative Policymaking: Evaluation Criteria Applied to Watershed Management in California and Washington." *Journal of Policy Analysis and Management* 21(4):645–70.

Lewis, Sanford, and Diane Henkels. 1996. "Good Neighbor Agreements: A Tool for Environmental and Social Justice." *Social Justice* 23(4):134–52.

Lipsky, Michael. 1980. *Street-Level Bureaucracy: Dilemmas of the Individual in Public Services.* New York: Russell Sage Foundation.

Lubell, Mark. 1999. "Cooperation and Institutional Innovation: The Case of Watershed Partnership." Ph.D. dissertation. State University of New York—Stony Brook.

Lubell, Mark, Mark Schneider, John T. Scholz, and Mihriye Mete. 2002. "Watershed Partnerships and Emergence of Collective Action Institutions." *American Journal of Political Science* 46(1):148–63.

Magat, Welsey A., and W. Kip Viscusi. 1990. "Effectiveness of the EPA's Regulatory Enforcement: The Case of Industrial Effluent Standards." *Journal of Law and Economics* 33(2):331–60.

Marsh, David, and R. A. W. Rhodes. 1992. "Policy Communities and Issue Networks: Beyond Typology." In *Policy Networks in British Government*, ed. David Marsh and R. A. W. Rhodes. Oxford: Oxford University Press, pp. 248–68.

Mete, Mihriye. 2002. "Bureaucratic Behavior in Strategic Environments: Politicians, Taxpayers and the IRS." *Journal of Politics* 64(2):384–407.

Meyer, Steven M. 2001. "Community Politics and Endangered Species Protection." In *Protecting Endangered Species in the United States*, ed. Jason F. Shogren and John Tschirhart. Cambridge: Cambridge University Press. pp. 138–65.

NAPA (National Academy of Public Administration). 1997. *Resolving the Paradox of Environmental Protection: An Agenda for Congress, EPA, and the States*. Washington: National Academy of Public Administration.

O'Toole, Laurence J. 1997. "Implementing Public Innovations in Network Settings." *Administration and Society* 29(2):115–38.

Olson, Mary K. 1995. "Regulatory Agency Discretion among Competing Industries: Inside the FDA." *Journal of Law, Economics, and Organization* 11(2):379–407.

Olson, Mary K. 1999. "Agency Rule-Making, Political Influence, Regulation, and Industry Compliance." *Journal of Law, Economics, and Organization* 15(3):573–601.

Ostrom, Elinor. 1990. *Governing the Commons: The Evolution of Institutions for Collective Action.* New York: Cambridge University Press.

Pressman, Jeffrey L., and Aaron B. Wildavsky. 1984. *Implementation.* 3rd ed. Berkeley: University of California Press.

Provan, Keith G., and H. Brinton Milward. 1995. "A Preliminary Theory of Interorganizational Network Effectiveness: A Comparative Study of Four Community Mental Health Systems." *Administrative Science Quarterly* 40(1):1–33.

Putnam, Robert. 2000. *Bowling Alone: The Collapse and Revival of American Community*. New York: Simon and Schuster.

Rhodes, R. A. W. 1997. *Understanding Governance: Policy Networks, Governance, Reflexivity, and Accountability*. Buckingham: Open University Press.

Ringquist, Evan J. 2001. "The Need for Sound Judgment in Analyzing U.S. Environmental Protection Agency Enforcement Actions." *Law and Society Review* 35(3):683–98.

Rosenbaum, Walter A. 1998. *Environmental Politics and Policy*. 4th ed. Washington: Congressional Quarterly Press.

Russell, Clifford S., Winston Harrington, and William J. Vaughan. 1986. *Enforcing Pollution Control Laws*. Washington: Resources for the Future.

Sabatier, Paul A., John Loomi, and Catherine McCarthy. 1995. "Hierarchical Controls, Professional Norms, Local Constituencies, and Budget Maximization: An Analysis of U.S. Forest Service Planning Decisions." *American Journal of Political Science* 39(1):204–42.

Salamon, Lester M. ed. 2002. *The Tools of Government: A Guide to the New Governance*. New York: Oxford University Press.

Schneider, Mark, John T. Scholz, Mark Lubell, Denisa Midruta, and Matthew Edwardsen. 2003. "Building Consensual Institutions: Networks and the National Estuary Program." *American Journal of Political Science* 47(1):143–58.

Scholz, John T. 1984. "Cooperation, Deterrence, and the Ecology of Regulatory Enforcement." *Law and Society Review* 18(2):179–224.

Scholz, John T., and Wayne Gray. 1997. "Can Government Facilitate Cooperation? An Informational Model of OSHA Enforcement." *American Journal of Political Science* 41(3):693–717.

Scholz, John T., and Bruce Stiftel. 2005. *Adaptive Governance and Water Conflict: New Institutions for Collaborative Planning*. Washington: Resources for the Future Press.

Scholz, John T., and Dan B. Wood. 1998. "Controlling the IRS: Principals, Principles, and Public Administration." *American Journal of Political Science* 42(1):141–62.

Scholz, John T., and Dan B. Wood. 1999. "Equity, Efficiency, and Politics: Democratic Controls on the Tax Collector." *American Journal of Political Science* 43(4):1166–88.

Scholz, John T., Jim Twombly, and Barbara Headrick. 1991. "Street-level Political Controls over Federal Bureaucracy." *American Political Science Review* 85(3):829–50.

Selznick, Phillip. 1966. *TVA and the Grass Roots*. New York: Harper & Row.

U.S. Environmental Protection Agency (EPA). 1997. *Community-Based Environmental Protection: Promoting Sustainable Ecosystems and Communities*. Washington: EPA.

Wheeler, Keith A., S. Hulbert, M. Schaefer, and C. Wacey. 1996. *Education for Sustainability: An Agenda for Action*. Washington: U.S. Government Printing Office (available at http://www.gcrio.org/edu/pcsd/toc.html).

Woolley, John T., and Michael V. McGinnis. 2002. "The California Watershed Movement: Science and the Politics of Place." *Natural Resources Journal* 42(1):133–83.

Yaffee, Steven L., Ali F. Phillips, Irene C. Frentz, Paul W. Hardy, Sussanne M. Maleki, and Barbara E. Thorpe. 1996. *Ecosystem Management in the United States: An Assessment of Current Experience*. Washington: Island Press.

Query

Q1 Au: Please check Equation no.