Bureaucratic Corruption and Environmental Policy: Theory and Evidence from the United States

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Abstract

What determines environmental policy in the US? This paper is a first attempt to explore theoretically and empirically the effects of bureaucratic corruption on environmental policy. We develop a simple model of an industry lobby which influences corrupt bureaucrats by offering prospective bribes. The model predicts that the effect of corruption on environmental policy depends on the relative size of two competing, partial effects. First, a greater incidence of corruption increases the total number of bribes given and therefore reduces the bribe offered to each individual corrupt bureaucrat, leading to more stringent environmental policy. Second, a greater incidence of corruption allows the lobby to buy influence from a greater number of bureaucrats, resulting in lower stringency. We also find that environmental policy is more lax the more sensitive is output to regulatory changes (given are a sufficient number of corrupt bureaucrats), and more stringent the larger the bureaucracy. Finally, the theory highlights several important interactions in the determination of environmental policy. Using panel data from $1977-1987$ on corruption and environmental stringency across US states, we detect a U-shaped relationship between environmental policy stringency and corruption. Moreover, the effect of corruption depends on bureaucracy size as well as the size of the manufacturing sector.

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"[A]dministrative law, which is rightly feared for an ancient reason – *Quis custodiet ipsos custodes?* – Who shall watch the watchers themselves? John Adams said that we must have a 'government of laws and not men.' Bureau administrators, trying to evaluate the morality of acts in the total system, are singularly liable to corruption, producing a government by men, not laws."

Garrett Hardin, "The Tragedy of the Commons," (1968, p. 1246).

1 Introduction

Environmental policy in the United States is not solely motivated by environmental concerns. Politics and the bureaucracy play crucial roles in the determination of most environmental policy outcomes (see, e.g., Pashigian (1985), Cropper *et al.* (1992), and Coates (1996)).[1] However, no empirical analysis exists (to our knowledge) of the effect of *corruption* on environmental policy formation in the US. In the theoretical literature, only Lopez and Mitra (2000) explore the implications of government corruption and rent-seeking on environmental outcomes; specifically, the relationship between pollution and growth (i.e., the environmental Kuznets curve).[2] The relationship between corruption and environmental policy appears particularly relevant since a number of recent studies establish the importance of corruption in the formation of economic policies and for economic growth.[3] The present paper seeks to fill a number of gaps

[1]Pashigian (1985) shows that the Federal "prevention of significant deterioration" policy favored the regional interests of northern states by imposing relatively more stringent regulations on states in other regions (see also Becker and Henderson (2000)). Cropper *et al.* (1992) find that EPA pesticide regulations are influenced by both grower and environmental interests (see also Magat *et al.* (1986)). Moreover, Van Houtven (1996) presents evidence that bureaucratic discretion has an important role in EPA decisions as the implicit value assigned to a statistical life differs across various hazards such as asbestos and air pollutants. Coates (1996) shows that campaign contributions given by both pro- and anti-environmental regulation interest groups affect the voting behavior of politicians. Helland (1998a, 1998b) report that EPA plant inspections are influenced by political and budget considerations. See also Crandall (1983) and Yandle (1989). See Wilson (1989) for a study of various other bureaucracies in the US.

[2]Lopez and Mitra (2000) find that actual pollution trajectories may depart from the optimal ones, and argue that rent-seeking and corruption are important reasons for this. Acemoglu and Verdier (2000) argue that governments face a trade-off between correcting market failures and bureaucratic corruption (government failure). Second-best intervention may therefore involve a certain degree of corruption.

[3]Corrupt behavior and rent-seeking by public officials have been studied by, for example, Tullock (1967), Krueger (1974), Rose-Ackerman (1975, 1978), Bhagwati (1982), Appelbaum and Katz (1987), and Basu *et al.* (1992). Shleifer and Vishny (1994) analyze corruption, corporatization, and privatization, Ades and Di Tella (1997, 1999) and Laffont and N'Guessan (1999) explore the relationships between corruption, competition, and industrial policy, and Mauro (1995) and Erlich and Lui (1999) investigate the effect of corruption on growth, where the latter study in particular discusses bureaucratic corruption. The relationship between corruption and the composition of government expenditures is investigated by Mauro (1998). In

in both the theoretical and empirical literature on environmental policy formation.

The questions we seek to answer concern the effects of bureaucratic corruption and bureaucracy size on environmental policy formation. To explore these issues, we develop a simple model with an industry lobby group and a bureaucracy containing both honest and dishonest (corrupt) bureaucrats. We define the incidence of bureaucratic corruption as the fraction of bureaucrats who take bribes in return for favoring inefficiently weak environmental policy. The bureaucrats have full discretion over the final environmental regulation facing a polluting industry (e.g., through the adjustment of inspection, monitoring and enforcement intensity, and decisions to ban certain production methods and inputs (see Cropper *et al.* (1992), van Houtven (1996), and Helland (1998a, 1998b))). The industry lobby influences the corrupt bureaucrats' environmental monitoring, reporting and enforcement choices by offering prospective bribes in return for favorable intervention.[4]

We ask the following questions. First, does corruption necessarily have a negative impact on the stringency of environmental regulations? Second, how does the size of the bureaucracy and the size of the polluting industry (manufacturing) sector affect local environmental policy, respectively? Third, does the effect of corruption differ depending on other state attributes? In particular, we are concerned about the interactions between the incidence of corruption and (i) the size of the bureaucracy and (ii) the size of the polluting industry. Finally, the paper marks a departure from the previous literature on corruption by testing the model using a panel data set from US states rather than a cross-section of countries; thus, in our opinion, reducing some problems of noise and circumventing issues such as differences across cultures in the definition of corruption. We believe this to be the first empirical study of the effects of corruption on US policy formation.

The model predicts that the total effect of an increase in the incidence of corruption on the stringency of environmental policy is ambiguous and depends on the relative size of two partial effects. First, an increase in the incidence of corrupt bureaucrats (conditional on the total size of the bureaucracy) increases the total number of offered bribes. This causes the lobby to reduce the bribe offered to each individual bureaucrat, leading to an increase in the stringency of environmental policy. Second, as bureaucratic corruption becomes more pervasive, relatively more bureaucrats can be bribed. As it becomes easier for the lobby to buy influence, the stringency of environmental policy falls. The model also predicts that these

a seminal paper on instrument choice in environmental policy, Buchanan and Tullock (1975) show that pollution standards, although inefficient, are preferred by industry and policy makers because they creator greater rents.

[4] The model is a menu-auction model (developed by Bernheim and Whinston (1986); see also Grossman and Helpman (1994)) with a fixed capital stock and exogenous goods prices determined by the national market. We thus abstract from inter-jurisdictional competition issues. With a large number of firms and corrupt bureaucrats, these actors have no incentive to act strategically. Fredriksson (1997) and Aidt (1998) study the political economy of pollution taxation. See Selden and Terrones (1993) for an analysis of environmental legislation and enforcement in a voting model.

two partial effects of corruption are conditional on (i) bureaucracy size, (ii) the initial level of corruption itself, and (iii) the price elasticity of supply (reflecting the industry lobbying incentive). Since each of these three variables influence both of the two partial effects, their predicted interactions with corruption on environmental policy are ambiguous as well. Consequently, the empirical work is crucial in order to determine the nature of these relationships.

In addition, the theory predicts a direct effect of both the price elasticity of supply and bureaucracy size on environmental policy. A greater price elasticity implies that output and profits are more sensitive to pollution regulation. When more is at stake, the industry lobby offers greater bribes and policy stringency falls, provided the number of corrupt bureaucrats is sufficiently great. An increase in bureaucracy size leads to more stringent environmental policy (see also Acemoglu and Verdier (2000)). The intuition is that conditional on the share of corrupt bureaucrats, the total cost to the lobby of buying a given environmental policy from each corrupt bureaucrat is greater the larger the bureaucracy. On the margin, therefore, each corrupt bureaucrat is offered a smaller bribe and environmental policy becomes more stringent.

The model is tested using panel data from 1977 – 1987. Our main measure of environmental stringency is an index of relative environmental compliance costs across US states compiled by Levinson (1999). The index is defined as the ratio of actual pollution abatement and control expenditures (PACE) for a particular state in a given year to the predicted level of PACE if each industry within the state conformed to the national industry average. The index thus explicitly incorporates differences in industry composition across states (at the two-digit standard industrial classification (SIC) level). Corruption is measured using data from the US Department of Justice on the number of public officials convicted annually (by state) on corruption-related offenses.

We find that at low levels of corruption, greater corruption reduces environmental policy stringency. However, the negative effect is reduced – and even becomes positive – as corruption becomes more pervasive. Thus, the relationship between environmental stringency and the incidence of corruption is U-shaped. To our knowledge, this is a new finding. This empirical finding can be understood in light of the theoretical model. At a low (high) incidence of corruption, the direct effect of an increase in corruption – i.e., an increased fraction of corrupt bureaucrats allows the industry lobby to buy a more lax environmental policy – dominates (is dominated by) the indirect effect – i.e., greater corruption reduces the size of the bribe offered to each corrupt bureaucrat. In addition, consistent with the theory, the effect of corruption is conditional on bureaucracy size (measured in terms of government output) and the size of the manufacturing sector (our proxy for the supply elasticity). For a large range of the data, environmental stringency and bureaucracy size are positively related. This accords with the intuition from the theory which suggests that the size of each bribe falls when a greater number of bribes must be given. Furthermore, the greater the manufacturing sector, the less stringent is the policy, and the effect is more pronounced the greater the level of corruption. Thus, when more is at stake for the manufacturing lobby, its bribing effort increases and its influence is particularly strong where it is relatively easy to gain influence. Finally, the results are fairly robust to alternative measures of environmental policy stringency. In our view, the results indicate that corruption is an important determinant of policy outcomes in the US.

The remainder of the paper is organized as follows. Section 2 sets up a simple theoretical model. Section 3 analyzes the impacts of corruption, the output elasticity, and bureaucracy size on environmental policy. Section 4 discusses the empirical work and data. Section 5 offers a few final remarks.

2 The Model

A small open jurisdiction – for example, a US state – has two sectors: the "clean" sector produces a numeraire good z and the polluting manufacturing sector produces a good x. The state is populated by five types of individuals denoted by k, environmentalists (denoted by E), manufacturing sector producers (M), workers (W), honest bureaucrats (HB), and dishonest (or corrupt) bureaucrats (DB). Among the b (both honest and dishonest) bureaucrats in each jurisdiction, a share γ are corrupt and the remaining share $(1-\gamma)$ are honest (i.e., social welfare maximizers, see below). It follows that the number of corrupt bureaucrats is given by $b\gamma$, and the number of honest bureaucrats equals $b(1-\gamma)$. The population groups are of size e, m, w, and b respectively, and the population is normalized to one such that $e+m+w+b=1$. All non-bureaucrats have one unit of labor income, l, and producers receive factor income from ownership of a specific factor used in the manufacturing sector as well. Each bureaucrat has an exogenous wage Y^B. Only the environmentalists derive disutility from the pollution associated with local manufacturing production (we ignore spillovers).

An individual k, $k = E, M, W, HB, DB$, has preferences given by[5]

$$U^k = c^{zk} + u(c^x) - \mu^E \theta X, \tag{1}$$

where c^{zk} and c^x are consumption of the numeraire good z (by a type k) and good x, with world and domestic prices equal to 1 and p^*, respectively.[6] $u(c^x)$ is a strictly concave and differentiable sub-utility function, which yields aggregate consumer surplus from consumption of good x equal to $C(p^*)$. μ^E is an indicator variable which takes a value of one if the individual is an environmentalist and zero otherwise. The aggregate supply of good x equals X, and θ is the per-unit damage coefficient which is assumed

[5]Corner solutions may result with quasi-linear preferences. We assume interior solutions, however.

[6]The state, domestic and world market price p^* is exogenously given as each state is a price taker.

constant for simplicity.[7,8]

Good z is produced by labor alone with a constant returns to scale technology and an input-output coefficient equal to one. Labor supply is sufficiently large such that the supply of each good is positive, implying a wage rate equal to one. The inputs into the production of good x are labor and a sector-specific factor. The technology is constant returns to scale. Ignoring labor costs, producers of good x face a net price given by

$$p = p^{*} - t\theta, \tag{2}$$

where $t \in T$, $T \in R$, is the pollution tax levied by the local government per unit of pollution.[9] The aggregate factor reward, $\pi(p)$, depends solely on the producer's price p. The supply curve for good x is given by Hotelling's Lemma, i.e. $X(p) = \pi_p(p)$, where $X_p > 0$, $X_{pp} > 0$. Net revenues are given by

$$\tau(t) = t\theta X(p), \tag{3}$$

which is distributed uniformly to all individuals except factor owners.[10]

The producers' reward from the sector-specific factor thus depends on the environmental policy, and the owners of the specific capital are assumed to have sufficient stake in the policy outcome to be able to organize bribery. The producer lobby group coordinates a bribe offer to each of the $b\gamma$ identical corrupt bureaucrats involved in the determination of environmental policy.[11] Thus, each corrupt bureaucrat is offered the same bribe. We assume that no coordination or strategic behavior takes place among the corrupt bureaucrats; they operate in isolation from each other. The environmentalists are assumed to face sufficiently severe free-riding problems to be unable to organize bribery activity (see Olson (1965)).

The model defines a two-stage game between each dishonest bureaucrat and the producer lobby. It is a complete information model; thus the lobby knows which bureaucrats to approach. All players are risk

[7] Adding abatement technology would not significantly change the results.

[8] An individual k spending Y^k consumes $c^x = d(p^*) = u_c^{-1}$ and $c^{zk} = Y^k - p^* d(p^*)$. The indirect utility function of an environmentalist is expressed as $V^E(p^*, t, Y^E) = Y^E + C(p^*) - \theta X$, and for producers, workers, and bureaucrats $V^k(p^*, t, Y^k) = Y^k + C(p^*)$, $k = M, W, HB, DB$, where $C(p^*) = u[d(p^*)] - p^* d(p^*)$ is the consumer surplus derived from consumption of good x.

[9] One may argue that local bureaucrats have only limited discretion over environmental policy since federal legislation acts as a backstop on how lax state environmental standards may become. However, Helland (1998c) finds that, in the case of the Clean Water Act, when federal environmental policy is delegated to the state level, local special interests may influence national standards as well.

[10] In the absence of evidence that industry lobby groups in the US strongly emphasize pollution tax revenues, this is appears to be a natural assumption which simplifies the analysis but does not change the basic results. Factor owners may be expected to exceed the income limits for most individual transfers.

[11] See Damania and Fredriksson (2000) for a discussion of industry lobby group formation on environmental policy issues.

neutral. In stage one the producer lobby group offers each corrupt bureaucrat a bribe schedule $\Lambda^M(\tilde{t})$. That is, the lobby offers the bureaucrat a continuous bribe function $\Lambda^M : T \to R_+$, denoting a specific bribe for working towards a (distorted) policy $\tilde{t}$. The bureaucrat responds by adjusting her effort of implementing, enforcing, or monitoring the pollution tax accordingly. If all bureaucrats were corrupt, their corrupt behavior would give a final pollution tax equal to $\tilde{t}$. In the second stage, each corrupt bureaucrat determines her optimal environmental policy, given the lobby group's strategy, and collects the associated bribe from the lobby.[12] The lobby receives a monetary payoff described by the continuous function $\Omega^M : T \to R_+$. In the end of stage two, the corrupt bureaucrat is detected with an exogenous probability and punished. However, the punished bureaucrat is able to keep her income, the received bribe, and her share of tax revenues.[13]

The gross indirect utility function of the producer lobby group is given by

$$\Omega^M(t) \equiv \pi(p) + m(l + C(p^*)). \tag{4}$$

Both bribes and tax revenues are used for the dishonest bureaucrat's personal consumption.[14] Thus, each *dishonest* bureaucrat has an indirect utility function equal to

$$\Omega^{DB}(t) \equiv Y^B + \tau(t) + C(p^*) + \Lambda^M(\tilde{t}) - \rho\varphi, \tag{5}$$

where $\rho \geq 0$ is the exogenous probability of detection if corrupt, and $\varphi > 0$ is the exogenous punishment associated with detection.[15]

The *honest* bureaucrat chooses to follow her job description perfectly, and is thus assumed to care only about maximizing aggregate social welfare,

$$\Omega^{HB}(t) \equiv \Omega^A(t), \tag{6}$$

where social welfare is defined as

$$\Omega^A(t) \equiv \pi(p) - e\theta X(p) + \tau(t) + l + C(p^*) + bY^B. \tag{7}$$

[12] Both the lobby group and the government are assumed not to renege on their promises in the second stage.

[13] The punishment may, for example, take the form of a prison sentence, a fine, and the loss of accumulated retirement benefits.

[14] Note that since the population is normalized to one, the per capita tax revenues equal $\tau(t)$.

[15] Both the detection probability and the punishment are assumed to be independent of the size of the bribe. The focus of the paper is not the endogenous determination of the equilibrium corruption level. As discussed below, we only have data on the incidence of corruption, not its severity. Moreover, we assume that the lobby can not be punished for bribery activities.

Setting the first-order condition (FOC) of (7) equal to zero and solving reveals that the welfare maximizing (Pigouvian) tax equals

$$\hat{t} = e. \tag{8}$$

The Pigouvian tax equals the number of environmentalists as this is the marginal disutility of pollution.[16]

The Political Equilibrium We employ the equilibrium in the well known menu-auction agency model by Bernheim and Whinston (1986) which has been applied by, for example, Grossman and Helpman (1994) and Dixit *et al.* (1997). Goldberg and Maggi (1999) show that the policy outcome equals the Nash bargaining solution. The equilibrium tax favored by each dishonest bureaucrat can be found using the following two necessary conditions:

$$\widetilde{t} = \arg\max_t \Omega^{DB}(\widetilde{t}) \text{ on } T; \tag{9}$$

$$\widetilde{t} = \arg\max_t \Omega^{M}(\widetilde{t}) - b\gamma\tilde{\Lambda}^{M}(\widetilde{t}) + \Omega^{DB}(\widetilde{t}) \text{ on } T, \tag{10}$$

where $\tilde{\Lambda}^M$ denotes the equilibrium strategy of the lobby group. Condition (9) requires that the bureaucrat maximizes her own aggregate welfare given the offered bribe schedule. Condition (10) states that the equilibrium pollution tax maximizes the joint welfare of the lobby and the dishonest bureaucrat. For a complete set of necessary and sufficient conditions, see Bernheim and Whinston (1986).

Assume that the bribe schedule is differentiable around the equilibrium point $\widetilde{t}$. Conditions (9) and (10) imply that the following condition holds around the political equilibrium $\tilde{t}$:

$$\Omega_t^M(\widetilde{t}) = b\gamma\tilde{\Lambda}_t^M(\widetilde{t}). \tag{11}$$

By substituting (11) into the first-order condition of (9), we obtain the equilibrium characterization of the pollution tax favored by the dishonest bureaucrat,

$$\frac{1}{b\gamma}\Omega_t^M(\widetilde{t}) + \tau_t(\widetilde{t}) = 0. \tag{12}$$

[16] Alternatively, one may think of honest bureaucrats as career professionals with few dominating outside options, who put an infinitely negative weight on a corruption conviction, and therefore follow their job description perfectly. Evans (1993) discusses the determinantion of professionalization (or "Weberianism') in (developing country) state bureaucracies. Evans suggests that professionalism is related to, for example, the percentage of positions filled by civil-service entrance exams, the pass rate on such exams, and the opportunity for stable career development (as opposed to rent-seeking opportunism) in a government department as evidenced by long tenure. Rauch and Evans (2000) find empirical support for the claim that meritocratic recruitment is an important determinant of state bureaucratic performance.

From equation (12) we can find the (explicit) pollution tax favored by the corrupt bureaucrat. Taking the FOC of equations (3) and (4), and substituting into equation (12) yields an equilibrium expression equal to

$$\widetilde{t} = \frac{X}{\theta X_p}(1 - \frac{1}{b\gamma}) < 0. \tag{13}$$

We assume for simplicity that the pollution tax that emerges from the bureaucracy is the weighted average of the preferred tax rates of corrupt and honest bureaucrats, $\widetilde{t}$ and $\hat{t}$, respectively, where the weight is the share of corrupt bureaucrats.[17] This can be viewed as a situation where each of the bureaucrats has influence over one aspect of environmental policy, such as implementation, monitoring, or enforcement. Alternatively, bureaucratic intervention in environmental policy outcomes could be viewed as sequential, with each bureaucrat having an opportunity to influence the outcome in her preferred direction at a particular stage of the process. However, we do not model explicitly the spectrum of actions affecting the resulting policy outcome. The observed equilibrium pollution tax rate t^o is thus given by

$$t^o = \gamma\tilde{t} + (1-\gamma)\hat{t} = \gamma\frac{X}{\theta X_p}(1 - \frac{1}{b\gamma}) + (1-\gamma)e. \tag{14}$$

3 Corruption and the Bureaucracy: Comparative Statics Results

We now analyze the effects of corruption and the size of the bureaucracy. The aim is to derive testable implications for the empirical work. Differentiation of equation (14) with respect to γ yields

$$\frac{dt^o}{d\gamma} = \gamma\frac{d\tilde{t}}{d\gamma} + \tilde{t} - \hat{t} = \gamma\frac{\frac{1}{\gamma}\left(tX_p - \frac{X}{\theta}\right)}{X_p(\frac{1}{b\gamma} - 2) + tX_{pp}} + \frac{X}{\theta X_p}(1 - \frac{1}{b\gamma}) - e, \tag{15}$$

where the denominator of the first term on the right-hand side, $X_p(\frac{1}{b\gamma} - 2) + t\theta X_{pp}$, is the second-order condition of each bureaucrat's maximization with respect to t and must be negative for a maximum. We assume this to be the case. The numerator of the first term must also be negative since from (12), $-\frac{X}{b\gamma\theta} + (\frac{X}{\theta} - tX_p) = 0$, and since $-\frac{X}{b\gamma\theta} < 0 \implies \frac{X}{\theta} > tX_p$. Rearrangements of (15), and conversions to elasticities, yield

$$\frac{dt^o}{d\gamma} = \underbrace{\frac{t(1+\frac{1}{\epsilon}) - \frac{p^*}{\theta\epsilon}}{\frac{1}{b\gamma} - 2 + \frac{t\theta\lambda}{p}}}_{A} + \underbrace{\frac{p}{\theta\varepsilon}(1 - \frac{1}{b\gamma}) - e,}_{B} \tag{16}$$

where $\varepsilon = X_p\frac{p}{X}$ is the price elasticity of supply, the price elasticity of pollution, or alternatively the negative of the tax elasticity of pollution, and $\lambda = X_{pp}\frac{p}{X_p}$. Expression (16) is indeterminate since term A

[17] A Cobb-Douglas function where $t^o = \tilde{t}^{\gamma}\hat{t}^{1-\gamma}$ yields similar comparative statics results.

is positive whereas term B is negative. The intuition for term A in (16) is that an increase in the incidence of corruption causes a rise in the number of necessary bribes, increasing the lobby's cost of bribes, *ceteris paribus*. Therefore, each corrupt bureaucrat is offered a smaller bribe causing her to favor a higher pollution tax. Term B represents the direct effect of an increase in the fraction of dishonest bureaucrats, leading to a lower pollution tax. Consequently, the net effect of corruption on the environmental policy is ambiguous but interpretable.

In addition, the effect of corruption on the tax rate is conditional on a number of variables. In the interest of brevity, we restrict the discussion to the three (in our view) most important interactions. The impact of corruption on the pollution tax is conditional on (i) bureaucracy size, b, (ii) the initial level of corruption, γ, and (iii) the supply elasticity, ε. Increases in b and γ reduce the value of term A, and increase (i.e., reduce the absolute value of the negative) term B. When corruption is pervasive in large bureaucracies, such that $\gamma \rightarrow 1$ and $b \rightarrow 1$, term B approaches zero.

Changes in the supply elasticity may increase or reduce the effect of corruption on the tax rate since the elasticity affects both terms A and B. The supply elasticity reflects the cost of the pollution tax policy in terms of output (and therefore profits). The greater the supply elasticity the larger is therefore the industry lobby's stake in the policy outcome. In sum, the levels of b, γ, and ε interact with corruption in indeterminate but identifiable ways.

Next, we turn to the direct effect of bureaucracy size. Differentiation of (14) with respect to b yields

$$\frac{dt^o}{db} = \gamma \frac{\frac{1}{b}(tX_p - \frac{X}{\theta})}{X_p(\frac{1}{b\gamma} - 2) + tX_{pp}} = \frac{\frac{\gamma}{b}\left(t(1+\frac{1}{\epsilon}) - \frac{p^*}{\theta\epsilon}\right)}{\frac{1}{b\gamma} - 2 + \frac{t\theta\lambda}{p}} > 0, \tag{17}$$

where again the numerator is negative since $\frac{X}{\theta} > tX_p$. The effect of an increase in the number of bureaucrats on the pollution tax is unambiguously positive. An increase in bureaucracy size increases the number of bribes required of the lobby to obtain a given tax rate, and the size of each bribe is therefore reduced.[18] Note that the effect of b on t^o is conditional on variables such as the initial size of the bureaucracy, b, and the incidence of corruption γ. These interactions are similar to the ones described for (16) and are not reiterated.

Finally, we wish to investigate the direct effect on the tax of the supply elasticity, ε. By rearranging (13), we see that

[18] Thus, in a sense the size of the bureaucracy reflects the degree of competition between bureaucracts. The increase in the number of necessary bribes forces the briber to reduce the the size of each bribe, i.e. more bureaucrats compete for the available sum of bribes. Rose-Ackerman (1978) and Schleifer and Vishny (1993) argue that competition between bureaucrats for bribes would reduce corruption.

$$\tilde{t} = \frac{p}{\theta\varepsilon}\left(1 - \frac{1}{b\gamma}\right), \tag{18}$$

which can be substituted into (14). Treating ε as exogenous and constant, differentiation of (18) with respect to ε yields

$$\frac{dt^o}{d\varepsilon} = \gamma\frac{d\tilde{t}}{d\varepsilon} = -\frac{\gamma t}{\varepsilon + 1 - \frac{1}{b\gamma}}. \tag{19}$$

The influence of the manufacturing lobby is increasing in ε if the corrupt bureaucrats are sufficiently numerous such that the denominator in (19) is positive. In the empirical section below, we hypothesize that the size of the manufacturing sector is positively related to ε. Manufacturing sector size (in addition to the pollution intensity of output) is important as it represents the amount at stake for the manufacturing lobby in the determination of the policy outcome (see also Guttman (1978) and Gardner (1987)). Again, we identify several interactions. In particular, since the influence of ε depends in a positive fashion on γ, in the empirical work we hypothesize that the lobby's influence is conditional on the incidence of corruption. The manufacturing lobby may find it relatively easier to buy influence when the level of corruption is relatively greater.

In sum, the theory yields several testable implications of the relationship between policy formation, corruption, bureaucracy size, and the size of the manufacturing sector. In addition, the model leads to several instances of theoretical ambiguity, generating opportunities for the data to provide some resolution. In addition, there are significant interactions with bureaucracy size, initial levels of corruption, and manufacturing sector size (the output elasticity). At the most basic level, the theoretical model predicts important effects of corruption on environmental policy. In the interest of clarity, Table 1 presents a summary of the most important conclusions upon which the empirical work in the following section focuses.

4 Empirical Analysis

4.1 Econometric Model

The simplest econometric model expresses a measure of environmental regulation as a function of corruption, state characteristics, and state and time fixed effects to capture unobservable time invariant state characteristics as well as annual unobserved changes at the federal level. Specifically,

$$y_{it} = \alpha_i + \lambda_t + x_{it}\beta + \delta c_{it} + \epsilon_{it}, \tag{20}$$

where y_{it} is a measure of environmental compliance costs in state i at time t, α_i is the state fixed effect, λ_t is the time fixed effect, x_{it} is a vector of state characteristics, c_{it} is a scalar measure of bureaucratic corruption, and δ is the associated parameter.

The inclusion of state and time fixed effects allows one to recover consistent estimates of the parameters in (20) even if there exist time invariant unobservable state attributes which affect environmental compliance costs and are correlated with the included characteristics, particularly corruption. Such state-specific unobservables may include religious attitudes, the degree of political activism, the intensity of media scrutiny, or the physical size of the state, for example. The time effects will control for national events which occur in a given period and may impact all states directly or through a reshaping of attitudes. Changes in federal environmental regulation or well known environmental disasters such as the Exxon Valdez or the nuclear disaster at Chernobyl are prime examples.

To incorporate aspects of the theoretical model into the econometric model, the actual model estimated allows for a more complicated effect of corruption. First, the effect is allowed to be non-linear through the inclusion of second- and third-order terms. Second, among the control variables included in x are measures of bureaucracy size (along with bureaucracy size squared) as well as manufacturing sector size.[19] Third, interaction terms are included to allow for differential impacts of corruption based on bureaucracy size and the size of the manufacturing sector, where the latter reflects the incentive of the manufacturing sector to lobby. Finally, average lagged corruption (as well as lagged second- and third-order terms), where the average is obtained over the three prior years, is included to reflect the idea that past corruption may affect the ability of currently corrupt bureaucrats to influence policy due to, for example, heightened media attention or an increased fear of being detected.

As a check for robustness, we estimate several additional variants. First, we estimate the model using three measures of state-specific environmental compliance costs. The Levinson index is an industry-adjusted index of state environmental compliance costs and is discussed in greater detail in the following section. In addition, we also use aggregate state pollution abatement and control expenditure (PACE) as well as PACE per dollar of manufacturing output. Second, while the theoretical model focuses on the *absolute* size of the bureaucracy and lobby, one may hypothesize that the *relative* size is the crucial variable. Thus, we re-estimate each model replacing the absolute manufacturing and bureaucracy size variables (as well as the interactions) with the ratio of manufacturing to bureaucracy size. Finally, we estimate the models with and without controls for lagged corruption.[20]

[19] While the theoretical model indicates that the effect of changes in the price elasticity of output depends on the initial level of the elasticity, specifications including higher order terms for manufacturing sector size as well as the interactions of the higher order terms with corruption were not identified due to insufficient variation in the data.

[20] Although not reported, we also tried several different methods of incorporating lagged corruption. While the signifcance levels were somewhat affected, the sign and magnitudes remained fairly stable. In addition, we also tried replacing size of the manufacturing and bureaucracy sectors with sector shares. Under this specification, the majority of the coefficients were insignificant.

4.2 Data

The data spans the 48 contiguous US states over the period 1977 – 1987. The data on environmental compliance costs (the stringency of environmental regulations) is the industry-adjusted index of state environmental compliance costs developed in Levinson (1999) and is available from 1977 – 1986. The index is defined as the *ratio* of actual PACE in a particular state in a given year to the predicted level of PACE if each industry within the state conformed to the national average for its industry. Thus, a ratio greater than one indicates compliance costs relatively greater than the national average; a ratio less than one the reverse (see Levinson (1999) for a more detailed exposition). The benefit of the index is that it controls for the non-uniform distribution of industries across states when comparing abatement expenditures. Thus, it explicitly incorporates industry composition into the comparison. The measure is not perfect, however, as it is only computed at the two-digit standard industrial classification (SIC) level. For this reason we also use state-level PACE data which is collected by the US Census Bureau's Annual Survey of Manufacturers.

The data on political corruption come from a 1987 US Department of Justice report to Congress, which has also been used by Goel and Nelson (1998) and Fisman and Gatti (1999) (in studies attempting to explain the incidence of corruption). The report details the number of public officials convicted of corruption-related activities in each state from 1977 – 1987, although a few missing observations exist. Clearly, this is not an ideal measure of political corruption. First, convictions are only recorded if the corrupt bureaucrats are caught and evidence of their guilt is obtained; thus, it *underestimates* the number of dishonest bureaucrats. Second, the data treats all convictions as homogeneous. Third, we are only concerned with the size of and corruption levels in the state *environmental* bureaucracy (i.e., bureaucrats involved in environmental outcomes); hence, we assume that the fraction of these levels devoted specifically to environmental protection is roughly uniform across states. Finally, the date of the conviction provides no indication of when the corrupt activity actually occurred. However, we attempt to circumvent this final problem to some extent by using the number of convictions *one-year ahead* as our proxy for *current* corruption. In addition, we will return to the first two shortcomings of the data later in the paper. Nonetheless, despite these caveats, it is the best measure of political corruption across the US states currently available (Goel and Nelson (1998)).

The remaining data on state characteristics (such as gross state product (GSP) by sector, employment by sector, and population) were obtained from the US Census Bureau. We use manufacturing and non-military government GSP to measure manufacturing and bureaucracy size.[21] Table 2 provides the summary statistics. Table 3 provides the five most and least environmentally stringent states (measured by the

[21]The data is available at http://www.bea.doc.gov/bea/regional/project/projlist.htm.

Levinson index) as well as the five most and least corrupt states over the entire period. The most striking result from Table 3 is the absence of any overt negative relationship between corruption and environmental compliance costs. In fact, Wyoming has one of the lowest rates of corruption and environmental compliance costs. Overall, the Spearman rank correlation between the Levinson index and the percentage of convicted public officials is 0.04 (p=0.45).[22]

4.3 Results

The results are presented in Tables 4 through 9. Tables 4 and 5 contain the estimates when the (log) Levinson index is the dependent variable. Tables 6 and 7 present the results for the specifications using (log) aggregate state PACE as the dependent variable. Finally, Tables 8 and 9 contain the estimates when (log) PACE per dollar of manufacturing output is the dependent variable. Models I and II (presented in Tables 4, 6, and 8) use the absolute size of the manufacturing and bureaucracy sectors in the specifications and Model II also includes controls for lagged corruption. Models III and IV (presented in Tables 5, 7, and 9) use the ratio of manufacturing to bureaucracy size in the specifications and Model IV also includes controls for lagged corruption. In addition, each model is estimated twice, once with time fixed effects and once with a linear time trend (although all specifications include state fixed effects). The results of the F-tests for the joint equality of the time effects are then given. Finally, although not presented, each specification also includes controls for population size, share of legal services in GSP, per capita income, and relative government wages (defined as the ratio of per capita non-military government GSP to per capita income).

Industry-Adjusted Relative Compliance Costs (Levinson Index) The first set of results for the Levinson index are given in Table 4. Before discussing specific point estimates, notice that in both Model I and Model II we cannot reject equality of the time fixed effects (Model I: F=0.93, p=0.50; Model II: F=0.88, p=0.51). Thus, we focus on the more efficient estimates which contain only a linear time trend. In addition, when comparing the estimates from Model I to Model II (with the linear time trend), while the sign of the various coefficients do not change, the coefficients are more precisely estimated in Model II. In addition, using Model II, an F-test rejects the hypothesis that the three current corruption and three lagged corruption variables are jointly zero (F=2.55, p=0.02). Thus, we focus on the results from Model II (which includes average lagged corruption as well as higher order terms) with a linear time trend.

Specifically, the point estimates on all of the corruption variables as well as the interactions are significant at least at the 10% level. In addition, an F-test rejects the hypothesis that the three current corruption

[22]The Spearman rank correlation is -0.04 (p=0.34) between corruption convictions and PACE per dollar of manufacturing output; 0.25 (p= 0.00) for aggregate state PACE.

variables (F=3.75, p=0.01) and the three interaction terms (F=3.17, p=0.03) are jointly zero. We also easily reject the hypothesis that the three corruption variables and three interactions are all jointly zero (F=2.80, p=0.01). Finally, bureaucracy size has a significant direct effect on environmental compliance costs as well.

To interpret the coefficients given the non-linearity and interactions, Figure 1 plots various relationships using the results from Model II with only a time trend. Panels A through D plot the predicted (log) Levinson index against corruption for various combinations of manufacturing and bureaucracy size. Panel A fixes manufacturing output at (approximately) the 25^{th} percentile ($3.1 billion in 1987 US$) and then graphs the predicted impact of corruption at various levels of government output.[23] The values chosen correspond to the 25^{th}, 50^{th}, and 75^{th} percentile ($2.8 billion, $6 billion, $10.5 billion, respectively). Panel B (Panel C) fixes manufacturing output at its 50^{th} (75^{th}) percentile level ($8.8 billion ($18.3 billion)) and then graphs the predicted effect of corruption given the same three levels of bureaucracy size. Finally, because manufacturing and government size are so highly correlated (the Spearman rank correlation is 0.88 (p=0.00)), Panel D plots the relationship between compliance costs and corruption fixing manufacturing and government size at the same percentile size (i.e., both at the 25^{th}, 50^{th}, and 75^{th} percentile).

The main picture which emerges from Panels A through C is that when government size is large relative to the manufacturing sector, a higher incidence of corruption *raises* environmental compliance costs. This is consistent with term A in (16) dominating in such cases. In other words, when the bureaucracy is relatively large, an increase in the incidence of corruption (conditional on bureaucracy size) raises the number of bribes paid. However, given the relatively small manufacturing sector, the bribe per corrupt bureaucrat falls resulting in a higher level of environmental compliance costs. In the reverse case, when the manufacturing sector is relatively large, increases in the incidence of corruption lower environmental compliance costs. This is consistent with term B in (16) dominating, implying that the direct effect of an increase in corruption outweighs the fact that greater corruption entails a greater number of actual bribes being paid.

The extreme cases found in Panels A through C, while informative, are less representative of the US states as manufacturing and bureaucracy sectors are typically of similar (relative) size. Thus, Panel D depicts the effect of corruption on environmental compliance costs when both sectors are small, both sectors are medium-sized, and when both sectors are large. Two interesting observations emerge. First, in all three cases (ignoring a few extreme outliers), we find a U-shaped relationship between corruption and environmental compliance costs.[24] The theoretical model is helpful in the interpretation of this finding.

[23]Government output always excludes military-related output.

[24]In all three cases, the graphs actually depict a sideways S-shaped relationship as the plots turn back down at the end. However, given that the turn down is driven by only a few outliers, we are reluctant to draw any firm conclusions.

At low levels of corruption, compliance costs and corruption are negatively related (consistent with term B in (16) dominating), but after further increases in corruption, corruption and compliance costs become positively related (consistent with term A in (16) dominating).

Since the U-shaped relationship between environmental regulations and corruption is observed irrespective of the size of the bureaucracy and manufacturing sector, it appears that the initial corruption level is the dominant factor affecting the impact of corruption. To our knowledge, this U-shaped relationship between corruption and policy has not previously been documented. In addition, this finding is not a trivial one as roughly 25% of the observations are located on the upward sloping portion of the U-shaped curve. For these states, a reduced incidence of corruption is associated with a reduction in the stringency of environmental policy.[25]

The second interesting point to emerge from Panel D is that the U-shaped relationship between corruption is not uniform across states with different size manufacturing and bureaucracy sectors. In particular, when the incidence of corruption is sufficiently low, states with small manufacturing and bureaucracy sectors have the highest level of environmental compliance costs. However, beyond a certain threshold level of corruption, states with large manufacturing and bureaucracy sectors have the highest level of compliance costs.[26]

The final set of graphs in Figure 1, Panels E and Panel F, plot the Levinson index against bureaucracy

[25] An additional explanation for the U-shape may be that when corruption becomes sufficiently pervasive, the lobby's risk of detection increases. It may therefore reduce the size of offered bribes, or the number of bribes given relative to the number of dishonest bureaucrats. Note also that there is an asymmetry between the lobby's detection probability and each bureaucrat's probability of detection. With a large share of the bureaucrats being corrupt, the risk of detection is greater for the lobby, but it may even decrease for the individual bureaucrat. We ignore these issues in our theoretical and empirical work since it is not possible to identify this behavior empirically.

[26] Two other aspects of the graph in Panel D also warrant comment. First, the U-shaped relationship between corruption and compliance costs may have important ramifications in light of the recent theoretical work of Acemoglu and Verdier (2000). The authors posit a general equilibrium model where government intervention is required to rectify some market failure. However, the intervention creates an opportunity for bureaucratic corruption which partially offsets the intervention. The authors then argue that due to the cost of monitoring bureaucrats, the equilibrium will entail some positive level of both the original market failure and corruption. Panel D indicates, however, that relative compliance costs are not monotonically decreasing in corruption. Specifically, there is some positive level of corruption which yields the same value of the Levinson index as when corruption is nonexistent. This implies that the trade-off faced by governments may not be as severe as postulated since corruption does not have be completely eliminated in order to rectify the market failure.

A second and related point is the fact that in medium and large states, according to Panel D, compliance costs are *greater* at a corruption conviction rate of one per 50,000 government employees than zero corruption. One possible explanation for this is that bureaucratic corruption may also give rise to an environmental lobby. As discussed in Fredriksson (1997), the tax rate selected by the central government depends on the relative political influence of the environmental and industry lobbies and may be either above or below the Pigouvian tax.

(manufacturing) sector size fixing manufacturing (bureaucracy) size at its mean for three different levels of corruption corresponding to the 25^{th}, 50^{th}, and 75^{th} percentile (corruption levels of 0.005, 0.022, and 0.043, respectively). Panel E shows that compliance costs are relatively invariant to changes in bureaucracy size in states with small government sectors to begin with. However, after a certain threshold, the Levinson index increases with the size of the bureaucracy. This is consistent (albeit modestly) with the theoretical predictions (see Table 1).[27] Panel F indicates that compliance costs decrease as the manufacturing sector becomes larger (conditional on bureaucracy size). In addition, the decrease is more dramatic the greater the incidence of corruption.[28]

While the theory indicates that environmental regulations depend on absolute manufacturing and bureaucracy size, Models III and IV in Table 5 assess this claim by examining the effects of the ratio of manufacturing and bureaucracy size on corruption and compliance costs. Again, we estimate the model with and without time fixed effects and with and without controls for lagged corruption. As in Table 4, we cannot reject equality of the time fixed effects (Model III: F(9,396)=1.05 (p=0.40); Model IV: F(6,219)=0.92 (p=0.48)). In addition, while the majority of the coefficients are insignificant in all four specifications, we can at least reject that the three current corruption variables, the two interactions, and three lagged corruption variables are not jointly zero at the 10% level using Model IV with a linear time trend (F(8,224)=1.90 (p=0.06)). The results from Model IV without time fixed effects are used to generate Figure 2, although the results should be interpreted with caution.

Panel A of Figure 2 plots the Levinson index against corruption fixing the ratio of manufacturing to bureaucracy size at the at the 25^{th}, 50^{th}, and 75^{th} percentile (0.8, 1.4, and 2, respectively). We find little effect of corruption itself on compliance costs; however, the Levinson index is monotonically decreasing in the ratio of manufacturing to government size. This is confirmed by Panel B as well which plots the Levinson index against the ratio fixing corruption at the 25^{th}, 50^{th}, and 75^{th} percentile. The fact that using the ratio of manufacturing to bureaucracy size (as opposed to absolute levels) yields less informative results is not surprising given the results in Figure 1. Specifically, Panel D in Figure 1 indicates that there are substantial differences across states with relatively small versus relatively large manufacturing and

[27] This result is also consistent with La Porta *et al.* (1999) who conclude from a cross-country analysis that government size and government "quality" tend to be positively related. In addition, the fact that the effect of bureaucracy size on environmental compliance costs is increasing with corruption supports the theoretical claim made by Acemoglu and Verdier (2000, p. 195) who "find that when bureaucrats are corruptible, the optimal size of the government is *greater* than in the case where corruption is not possible."

[28] This finding suggests that free-riding is not a significant concern to the manufacturing sector lobby, contrary to Olson (1965). It may also indicate that electoral resources are important determinants of environmental policy outcomes in the US. The results lend some support to the findings of Guttman (1978) who report that an increase in the number of producers leads to an increase in political influence. He also suggests that there may be a marginally increasing effect of numbers.

government sectors. Thus, even though the ratio will differ little across these states, there are important distinctions that are only captured by examining the absolute sizes of each sector.

Abatement Expenditures As a further means of assessing the robustness of our findings, we also re-estimate each model using both aggregate state PACE and PACE per dollar of manufacturing output as the dependent variable (instead of the Levinson index). The results using aggregate state PACE are presented in Tables 6 and 7; the results using PACE per dollar of manufacturing output are given in Tables 8 and 9. PACE per dollar of manufacturing output is commonly used as a measure of regulatory intensity, although it suffers from the critique given by Levinson (1999) and others; namely, it may be an overly noisy measure given the non-uniform distribution of industries across states. Nonetheless, it provides a good check on the earlier results. In addition, while aggregate PACE is not a particularly good measure of regulation since it is clearly related to the size of the manufacturing sector, it is interesting to examine the effects of corruption and bureaucracy size *conditional* on manufacturing size. Somewhat surprisingly, the results differ little across the measures of abatement expenditures. Thus, in the interest of brevity, we discuss the results together.

In both Tables 6 and 8, we easily reject equality of the time fixed effects as well as the hypothesis that the three current and three lagged corruption variables are jointly zero. Thus, in both cases the results from Model II with time fixed effects are used to generate the figures.[29] Figure 3 uses the aggregate PACE results and Figure 5 uses the results based on PACE per dollar of manufacturing output. Both figures are analogous to Figure 1. Panels A through C in both figures indicate little direct effect of corruption on the measure of abatement expenditures, although the effect is slightly more pronounced in Figure 5 (PACE per dollar of manufacturing output). In addition, there is some indication (particularly in Panel C of Figure 5) of a U-shaped relationship between corruption and regulatory compliance expenditures. Finally, conditional on manufacturing size and the incidence of corruption, abatement expenditures are increasing in bureaucracy size.

Panel D in Figures 3 and 5 fixes manufacturing and government size at the same percentile level and looks at the relationship between abatement expenditures and corruption. In both cases there is moderate evidence of a U-shaped relationship. In addition, in both cases the curve shifts up – in essentially a parallel fashion – as we increase the size of both sectors. In Figure 3, this is not surprising since states with larger manufacturing sectors will almost certainly have higher aggregate PACE. However, in Figure 5, even PACE per dollar of output is increasing with the size of the government and manufacturing sectors

[29] In Table 6 in Model II, we reject equality of the time fixed effects (F(6,217)=4.74 (p=0.00)) and reject the hypothesis that the current and lagged corruption variables are jointly zero (F(6,217)=4.11 (p=0.00)). In Table 8 in Model II, the relevant test statistics are F(6,217)=5.33 (p=0.00) and F(6,217)=4.19 (p=0.00).

(Panels E and F confirm this conclusion in both Figures 3 and 5 as well). Given that the Levinson index is decreasing in manufacturing size (Figure 1, Panel F) but PACE per dollar of output is not (Figure 5, Panel F), one possible explanation may be that the distribution of industries across states is related to the size of the state. In particular, pollution intensive industries (with subsequently higher levels of PACE) locating in larger states would generate this outcome. However, the Levinson index controls for these types of distributional issues (at least at the two-digit SIC level).

The final set of results are presented in Tables 7 and 9. These specifications use aggregate PACE and PACE per dollar of manufacturing output, but replace the absolute level of manufacturing and bureaucracy size with the ratio. Thus, the results are analogous to Table 2. As before, in both cases we reject equality of the time fixed effects and also reject the hypothesis that the three current and three lagged corruption variables are jointly zero.[30] The results are illustrated in Figure 4 (aggregate PACE) and Figure 6 (PACE per dollar of manufacturing output). Panels A through C in both figures again indicate a U-shaped relationship between corruption and abatement expenditures, with the U-shape being more pronounced in Figure 6. In addition, while in Figure 4 the U-shaped curve shifts up in a parallel manner as we increase the ratio of manufacturing to government size (not surprisingly since aggregate PACE is the measure of abatement expenditures and the Spearman rank correlation between the ratio and absolute manufacturing size is 0.61 (p=0.00)), in Figure 6 the curves cross. Therefore, at low levels of corruption, states with large manufacturing sectors (relative to government size) have the lowest level of PACE per dollar of output. However, after a certain threshold level, states with a relatively large manufacturing sector have higher PACE per dollar of output.

Finally, Panel B in Figure 6 indicates that a higher ratio of manufacturing to government size lowers abatement expenditure per dollar of output (despite the fact that a higher ratio is indicative of a larger absolute manufacturing sector). In addition, while at low levels of the ratio, increasing corruption lowers PACE per dollar of output, after a certain level (approximately a ratio of 2.6) increases in corruption raise abatement expenditures per dollar of output. Thus, the results from the using alternative measures of environmental compliance costs – particularly PACE per dollar of manufacturing output – appear mostly consistent with the empirical results based on the Levinson index and the theoretical model. However, perhaps given the important role of the distribution of industries across states in the determination of PACE, it is not surprising that the Levinson index yields more accurate estimates and a picture which is most consistent with the theory.

[30] In Table 7 in Model IV, we reject equality of the time fixed effects (F(6,219)=5.16 (p=0.00)) and reject the hypothesis that the current and lagged corruption variables are jointly zero (F(6,219)=4.71 (p=0.00)). In Table 9 in Model IV, the relevant test statistics are F(6,217)=5.20 (p=0.00) and F(6,217)=4.54 (p=0.00).

Corruption Versus Convictions As stated earlier, a potential shortcoming of the empirical work is the measure of corruption. From the theoretical model, ideally we wish to have a measure of the fraction of dishonest bureaucrats; instead, we observe only the number of dishonest bureaucrats convicted of corruption-related activity.[31] Nonetheless, the data are still useful. Consider the following model.[32] Let the number of convicted, corrupt bureaucrats, c, equal the number of dishonest bureaucrats, d, multiplied by the (exogenous) probability of being caught and convicted, ρ ($\rho \in [0,1]$); i.e., $c = \rho d$. For simplicity, assume the econometric model estimated only allows for a linear direct effect of dishonest bureaucrats (as in (20)).[33] Specifically,

$$y_{it} = \alpha_i + \lambda_t + x_{it}\beta + \zeta d_{it} + \epsilon_{it} \tag{21}$$

where ζ is the parameter of interest. We do not observe d, but we do observe c. Substituting into (21) yields

$$\begin{aligned} y_{it} &= \alpha_i + \lambda_t + x_{it}\beta + \zeta(\frac{c_{it}}{\rho}) + \epsilon_{it} \\ &= \alpha_i + \lambda_t + x_{it}\beta + \delta c_{it} + \epsilon_{it} \end{aligned}$$

where $\delta = \zeta/\rho$ and is of the same sign but larger in magnitude than ζ. In other words, $\text{sgn}(\delta) = \text{sgn}(\zeta)$ and $|\delta| > |\zeta|$. Consequently, ζ is bounded by zero and δ. In addition, the t-statistic in the model based on conviction data is identical to the t-statistic which would be obtained if data on the number of dishonest bureaucrats were available.[34] The intuition for why the effect of convictions is larger than the effect of dishonest bureaucrats is straightforward. If $\rho < 1$, then one extra *conviction* implies an increase in the number of *dishonest bureaucrats* by more than one. Thus, the effect of one extra conviction has a greater effect on environmental policy than an equal increase in the number of dishonest bureaucrats. However, from a statistical point of view, both effects are of the same significance.

Another shortcoming of the conviction data is that all convictions are treated as homogeneous, when in fact some corruption-related activities may be more detrimental than others. In addition, more influential

[31] We ignore the possibility of false convictions.

[32] Note that the situation at hand is not that of a classical measurement error problem. We assume we observe a perfect measure of corruption convictions. The problem is that what we wish to measure is the total number of dishonest bureaucrats, not just those convicted. This is unobserved in the data, however.

[33] The analysis offered here holds for the parameters of the more complicated specifications actually estimated as well.

[34] Using the conviction data, the t-statistic, t, is given by $\widehat{\delta}/\sqrt{Var(\widehat{\delta})}$. Substituting for δ yields $t = (\widehat{\zeta}/\rho)/\sqrt{Var(\widehat{\zeta}/\rho)} = \widehat{\zeta}/\sqrt{Var(\widehat{\zeta})}$, which is the t-statistic which would be obtained if data on d were available. This is a simple case of re-scaling the independent variable by some constant; the transformation leaves the t-statistic unaltered.

bureaucrats may have a lower detection probability. This does not alter the conclusion from above. To verify this, let there be $k = 1, ..., K$ types of dishonest bureaucrats, differentiated by the severity of their actions. The number of dishonest bureaucrats of type k is given by d_k, with an associated probability of detection and conviction of ρ_k ($\rho_k \in [0,1]$). Thus, the total number of dishonest bureaucrats is $\sum_k d_k$ and the number of convictions is given by $\sum_k \rho_k d_k$.

Starting with equation (20) and substituting $c = \sum_k \rho_k d_k$ yields

$$y_{it} = \alpha_i + \lambda_t + x_{it}\beta + \delta \sum_k \rho_k d_k + \epsilon_{it} \tag{22}$$

where δ is the effect of an additional conviction (i.e., $\partial y/\partial c$). From (22) it follows that $\partial y/\partial d = \delta \sum_k \rho_k (\partial d_k/\partial d)$, where $\partial d_k/\partial d \in [0,1]$. Consequently, $\text{sgn}(\partial y/\partial c) = \text{sgn}(\partial y/\partial d)$, $|\partial y/\partial c| > |\partial y/\partial d|$, the t-statistic is again unaltered, and, $\partial y/\partial d$ is bounded between zero and $\partial y/\partial c$. Thus, although we do not observe the number of dishonest bureaucrats or the severity of their actions, we are able to bound and learn the (statistical) significance of the effect of corruption.

5 Conclusion

This paper offers a theoretical and empirical investigation into the effects of bureaucratic corruption on environmental policy formation in the United States. The theoretical model indicates that environmental policy is affected by the incidence of corruption, by the polluting manufacturing sector's supply elasticity (which represents the manufacturing sector's lobbying incentive), and by bureaucracy size. The model predicts that the final effect of an increase in the incidence of corruption on the stringency of environmental policy depends on two partial effects. First, there is a (indirect) negative effect on the size of the bribe offered to each corrupt bureaucrat because a greater number of bribes must be given, and second, there is a direct impact of more widespread corruption. The model also predicts a direct negative effect on environmental policy stringency of the supply elasticity (given a sufficient number of corrupt bureaucrats), and a positive direct impact of bureaucracy size. These effects are conditional on (i) bureaucracy size, (ii) the level of corruption, and (iii) the supply elasticity. The theory thus generates a number of predictions and interactions that in some cases are ambiguous. These are examined in the empirical work.

To examine the empirical effects of corruption on environmental policy, we use panel data across US states from 1977 – 1987 on environmental compliance costs and the number of public officials convicted of corruption-related activities. The empirical results are consistent with our theory and help resolve some of the theoretical ambiguity. Specifically, increases in corruption initially reduce the stringency of environmental policy (as measured by compliance costs), but the impact is reduced and even becomes positive as corruption becomes pervasive. Thus, a U-shaped pattern emerges. In addition, conditional on manufacturing (bureaucracy) size, increasing the size of the bureaucracy (manufacturing) sector has a positive (negative) effect on environmental compliance costs. Finally, a greater incidence of corruption exacerbates the positive (negative) effect of bureaucracy (manufacturing) size on environmental stringency.

Our findings may have important policy implications. First, bureaucratic reforms which reduce the level of corruption do not necessarily improve environmental policy outcomes. In relatively corrupt bureaucracies, states may find themselves on the upward sloping portion of the U-shaped relationship. Thus, reforms that reduce the *incidence* of corruption may actually reduce environmental stringency in some states by increasing the effectiveness of the producer lobby's bribery activities. Approximately one-quarter of the states find themselves in this situation. Second, reductions in government size, which perhaps improve efficiency, also increase the lobby's ability to buy a favorable policy outcome, particularly if the government is initially relatively large. Third, it is unlikely that the environment is the only policy area affected by corruption in the US. For example, analysis of corruption and the determination of health and safety standards may be warranted. Moreover, there may be important interactions between corruption and the effects of regions being in non-attainment under the federal Clean Air Act (see Becker and Henderson (2000)).

We believe this to be a unique study of corruption. To our knowledge, no previous work exists on the effect of bureaucratic corruption on environmental policy and no empirical study has analyzed the impact of corruption on policy formation in the US. Clearly, there appears to be a need for more research in this area.

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Table 1. Theoretical Predictions.

Derivative	Interpretation	Predicted Sign/Value	Implication
$\frac{\partial t^o}{\partial \gamma}$	Effect of corruption on the equilibrium tax rate	Ambiguous	$+ \Longrightarrow$ Term A in (16) dominates $- \Longrightarrow$ Terms B in (16) dominates
$\frac{\partial t^o}{\partial \varepsilon}$	Effect of price elasticity of supply on the impact of corruption	Ambiguous	$+ \Longrightarrow$ Denominator in (19) is negative $- \Longrightarrow$ Denominator in (19) is positive
$\frac{\partial t^o}{\partial b}$	Effect of bureaucracy size on the equilibrium tax rate	Positive	See equation (17)

Table 2. Summary Statistics, 1977 - 1986.

Variable	Mean	Std Dev	Minimum	Maximum
Corruption Convictions (per 1000 government employees)	0.03	0.04	0	0.33
Environmental Regulation (Levinson Index)	1.02	0.40	0.23	2.59
PACE (millions, 1987 US$)	47.71	55.53	0.05	311.30
PACE per dollar of manufacturing output (1987 US$)	0.004	0.003	0.000	0.021
Gross State Product (GSP per capita, 1987 US$)	15955.55	2559.70	11240.67	26037.45
Manufacturing GSP (millions, 1987 US$)	14960.49	17206.39	319.4	88626.80
Non-Military Government GSP (millions, 1987 US$)	8579.04	9325.49	740.00	56485.10
Legal Services, Share of GSP	0.01	0.00	0.01	0.02
Relative Government Wages	1.59	0.19	0.99	2.11
Population (1000s)	4687.89	4746.01	415.00	27102.00

Table 3. Most and Least Corrupt and Environmentally Stringent States, Averaged over 1977-1987.†

Corruption		Levinson Index	
Lowest	Highest	Lowest	Highest
Vermont (0.01)	Oklahoma (0.11)	Rhode Island (0.47)	Idaho (1.90)
Washington (0.01)	Tennessee (0.08)	Wyoming (0.50)	New Mexico (1.67)
Wyoming (0.01)	Mississippi (0.07)	Connecticut (0.58)	Arizona (1.62)
North Dakota (0.01)	South Carolina (0.07)	Massachusetts (0.61)	Louisiana (1.60)
Oregon (0.01)	Alabama (0.07)	South Dakota (0.61)	West Virginia (1.57)

†Mean of the appropriate index in parentheses. Levinson Index only available 1977 – 1986.

Table 4. Determinants of the Levinson Index.

Variable	Model I		Model II	
Corruption	-2.15	-2.23‡	-3.87‡	-3.70‡
	(-1.60)	(-1.73)	(-1.82)	(-1.82)
Corruption^2	20.14‡	20.15‡	32.00‡	29.23
	(1.75)	(1.82)	(1.67)	(1.58)
Corruption^3	-53.68‡	-54.37†	-84.68‡	-78.85‡
	(-1.94)	(-2.05)	(-1.87)	(1.79)
Corruption*	$-5.21*10^{-05}$	$7.38*10^{-05\ddagger}$	$-1.48*10^{-04\dagger}$	$-1.70*10^{-04\dagger}$
Manufacturing GSP	(-1.47)	(-1.90)	(-2.67)	(-2.85)
Corruption*	$1.95*10^{-04}$	$2.75*10^{-04\dagger}$	$5.61*10^{-04\dagger}$	$6.56*10^{-04\dagger}$
Government GSP	(1.50)	(-1.99)	(3.05)	(3.37)
Corruption*	$-1.91*10^{-09}$	$-2.80*10^{-09}$	$-6.86*10^{-09\dagger}$	$-8.78*10^{-09\dagger}$
(Govt. GSP)^2	(-0.90)	(-1.33)	(-1.98)	(-2.58)
Manufacturing GSP	$-4.81*10^{-06}$	$-5.49*10^{-06}$	$2.81*10^{-07}$	$-1.04*10^{-06}$
	(-0.91)	(-1.07)	(0.04)	(-0.13)
Government GSP	$-6.17*10^{-05\ddagger}$	$7.80*10^{-06\dagger}$	$-4.32*10^{-05}$	$-1.06*10^{-04}$
	(-1.85)	(-2.17)	(-0.77)	(-1.60)
Government GSP^2	$1.27*10^{-09\dagger}$	$1.34*10^{-09\dagger}$	$1.10*10^{-09\dagger}$	$1.54*10^{-09\dagger}$
	(3.12)	(3.27)	(2.08)	(2.68)
Lagged Corruption	No	No	Yes	Yes
Time Fixed Effects	No	Yes	No	Yes
	F(9,394)=0.93	(p=0.50)	F(6,217)=0.88	(p=0.51)
State Fixed Effects	Yes	Yes	Yes	Yes
Observations	465		288	

NOTES:

1. Government GSP excludes military GSP. GSP measured in millions of 1987 US$.

2. Other regressors included in each model: share of GSP in legal services, relative government (excluding military) wages, per capita income, per capita income squared, and population.

3. Lagged corruption is includes the average over the prior three years as well as the average squared and cubed.

4. Robust t-statistics in parenthesis. †significant at the 5% level. ‡significant at the 10% level.

Table 5. Determinants of the Levinson Index.

Variable	Model III		Model IV	
Corruption	-1.19	-1.33	-3.36	-2.74
	(-0.56)	(-0.65)	(-1.08)	(-0.92)
Corruption^2	14.68	14.79	21.96	16.70
	(1.20)	(1.26)	(1.07)	(0.84)
Corruption^3	-39.43	-39.09	-59.87	-45.88
	(-1.34)	(-1.38)	(-1.22)	(-0.96)
Corruption∗	0.26	0.50	2.62	2.36
(Man./Govt. GSP)	(0.16)	(0.32)	(1.07)	(0.98)
Corruption∗	-0.14	-0.20	-0.83	-0.76
$(\text{Man./Govt. GSP})^2$	(-0.38)	(-0.54)	(-1.21)	(-1.10)
Man./Govt. GSP	$-0.52^{\ddagger}$	$-0.58^{\ddagger}$	$-1.12^{\dagger}$	$-1.31^{\dagger}$
	(-1.86)	(-1.96)	(-2.06)	(-2.34)
$(\text{Man./Govt. GSP})^2$	0.06	0.07	0.16	$0.19^{\ddagger}$
	(1.39)	(1.47)	(1.64)	(1.86)
Lagged Corruption	No	No	Yes	Yes
Time Fixed Effects	No	Yes	No	Yes
	F(9,396)=1.05	(p=0.40)	F(6,219)=0.92	(p=0.48)
State Fixed Effects	Yes	Yes	Yes	Yes
Observations	465		288	

NOTES:

1. Government GSP excludes military GSP.

2. Other regressors included in each model: share of GSP in legal services, relative government (excluding military) wages, per capita income, per capita income squared, and population.

3. Lagged corruption is includes the average over the prior three years as well as the average squared and cubed.

4. Robust t-statistics in parenthesis. †significant at the 5% level. ‡significant at the 10% level.

Table 6. Determinants of Aggregate State PACE.

Variable	Model I		Model II	
Corruption	-1.67	-1.66	-4.94	-7.92‡
	(-0.41)	(-0.41)	(-1.06)	(-1.68)
$Corruption^2$	29.27	31.69	46.75	74.33‡
	(0.85)	(0.93)	(1.08)	(1.77)
$Corruption^3$	-40.21	-63.00	-77.70	-154.01
	(-0.48)	(-0.76)	(-0.75)	(-1.54)
Corruption*	$2.52*10^{-04}$†	$2.18*10^{-04}$†	$3.65*10^{-04}$†	$1.85*10^{-04}$†
Manufacturing GSP	(2.17)	(2.10)	(2.39)	(1.15)
Corruption*	$-6.37*10^{-04}$	$-4.42*10^{-04}$	$-7.67*10^{-04}$	$-2.54*10^{-04}$
Government GSP	(-1.36)	(-1.03)	(-1.48)	(-0.48)
Corruption*	$1.60*10^{-09}$	$-2.31*10^{-10}$	$-5.40*10^{-10}$	$-4.26*10^{-09}$
$(Govt. GSP)^2$	(0.22)	(-0.03)	(-0.06)	(-0.49)
Manufacturing GSP	$3.53*10^{-05}$†	$3.46*10^{-05}$†	$5.37*10^{-05}$‡	$6.70*10^{-05}$†
	(2.04)	(2.23)	(1.81)	(2.38)
Government GSP	$1.66*10^{-04}$	$2.38*10^{-05}$	$4.15*10^{-04}$†	$2.86*10^{-04}$
	(1.45)	(0.19)	(2.16)	(1.28)
Government GSP^2	$-2.01*10^{-09}$	$-1.08*10^{-09}$	$-3.76*10^{-09}$†	$-3.14*10^{-09}$
	(-1.50)	(-0.79)	(-1.99)	(-1.54)
Lagged Corruption	No	No	Yes	Yes
Time Fixed Effects	No	Yes	No	Yes
	F(9,394)=6.03	(p=0.00)	F(6,217)=4.74	(p=0.00)
State Fixed Effects	Yes	Yes	Yes	Yes
Observations	465		288	

NOTES:

1. Government GSP excludes military GSP. GSP measured in millions of 1987 US$.

2. Other regressors included in each model: share of GSP in legal services, relative government (excluding military) wages, per capita income, per capita income squared, and population.

3. Lagged corruption is includes the average over the prior three years as well as the average squared and cubed.

4. Robust t-statistics in parenthesis. †significant at the 5% level. ‡significant at the 10% level.

Table 7. Determinants of Aggregate State PACE.

Variable	Model III		Model IV	
Corruption	-3.33	-3.53	-10.85‡	-13.83†
	(–0.58)	(–0.61)	(-1.93)	(-2.44)
Corruption^2	43.53	46.27	75.16‡	99.17†
	(1.26)	(1.31)	(1.70)	(2.29)
Corruption^3	-74.45	-98.38	-147.86	-216.45†
	(-0.87)	(-1.13)	(-1.38)	(-2.07)
Corruption∗	-2.74	-1.28	-0.94	1.82
(Man./Govt. GSP)	(–0.61)	(-0.29)	(-0.20)	(0.39)
Corruption∗	1.24	0.81	1.56	0.60
(Man./Govt. GSP)^2	(1.12)	(0.75)	(1.12)	(0.43)
Man./Govt. GSP	2.34†	2.87†	0.06	1.20
	(3.07)	(3.65)	(0.05)	(1.02)
(Man./Govt. GSP)^2	-0.43†	-0.45†	-0.12	-0.23
	(-3.42)	(-3.69)	(-0.56)	(-1.10)
Lagged Corruption	No	No	Yes	Yes
Time Fixed Effects	No	Yes	No	Yes
	F(9,396)=6.79	(p=0.00)	F(6,219)=5.16	(p=0.00)
State Fixed Effects	Yes	Yes	Yes	Yes
Observations	465		288	

NOTES:

1. Government GSP excludes military GSP.

2. Other regressors included in each model: share of GSP in legal services, relative government (excluding military) wages, per capita income, per capita income squared, and population.

3. Lagged corruption is includes the average over the prior three years as well as the average squared and cubed.

4. Robust t-statistics in parenthesis. †significant at the 5% level. ‡significant at the 10% level.

Table 8. Determinants of PACE Per Dollar of Manufacturing Output.

Variable	Model I		Model II	
Corruption	-1.83	-1.84	-4.57	-7.72
	(–0.45)	(-0.46)	(-0.96)	(-1.62)
Corruption^2	31.62	34.30	44.02	$73.30^{‡}$
	(0.93)	(1.02)	(1.01)	(1.73)
Corruption^3	-46.90	-70.51	-72.45	-153.12
	(-0.57)	(-0.87)	(-0.69)	(-1.52)
Corruption∗	$2.68{*}10^{-04}$	$2.38{*}10^{-04\dagger}$	$3.73{*}10^{-04\dagger}$	$1.88{*}10^{-04}$
Manufacturing GSP	(2.36)	(2.37)	(2.51)	(1.19)
Corruption∗	$-6.55{*}10^{-04}$	$-4.70{*}10^{-04}$	$7.78{*}10^{-04}$	$-2.56{*}10^{-04}$
Government GSP	(-1.43)	(–1.13)	(-1.52)	(-0.49)
Corruption∗	$2.52{*}10^{-09}$	$8.11{*}10^{-10}$	$7.01{*}10^{-10}$	$-3.07{*}10^{-09}$
$(\text{Govt. GSP})^2$	(0.35)	(0.13)	(0.08)	(–0.35)
Manufacturing GSP	$1.76{*}10^{-05}$	$1.70{*}10^{-05}$	$3.88{*}10^{-05}$	$5.31{*}10^{-05‡}$
	(1.05)	(1.15)	(1.33)	(1.92)
Government GSP	$1.38{*}10^{-04}$	$-6.35{*}10^{-06}$	$3.71{*}10^{-04‡}$	$2.34{*}10^{-04}$
	(1.24)	(-0.05)	(1.94)	(1.06)
Government GSP^2	$-1.31{*}10^{-09}$	$-3.58{*}10^{-10}$	$-3.02{*}10^{-09}$	$-2.40{*}10^{-09}$
	(–1.03)	(-0.28)	(-1.62)	(-1.20)
Lagged Corruption	No	No	Yes	Yes
Time Fixed Effects	No	Yes	No	Yes
	F(9,394)=6.56	(p=0.00)	F(6,217)=5.33	(p=0.00)
State Fixed Effects	Yes	Yes	Yes	Yes
Observations	465		288	

NOTES:

1. Government GSP excludes military GSP. GSP measured in millions of 1987 US$.

2. Other regressors included in each model: share of GSP in legal services, relative government (excluding military) wages, per capita income, per capita income squared, and population.

3. Lagged corruption is includes the average over the prior three years as well as the average squared and cubed.

4. Robust t-statistics in parenthesis. †significant at the 5% level. ‡significant at the 10% level.

Table 9. Determinants of PACE Per Dollar of Manufacturing Output.

Variable	Model III		Model IV	
Corruption	-3.18	-3.40	-10.68‡	-13.76†
	(-0.57)	(-0.60)	(-1.90)	(-2.43)
Corruption^2	40.27	43.71	69.02	94.15†
	(1.18)	(1.25)	(1.56)	(2.17)
Corruption^3	-67.98	-92.85	-134.97	-206.18†
	(-0.80)	(-1.08)	(-1.26)	(-1.98)
Corruption∗	-2.47	-1.20	-0.05	2.58
(Man./Govt. GSP)	(-0.56)	(-0.27)	(-0.01)	(0.56)
Corruption∗	1.21	0.83	1.27	0.37
$(\text{Man./Govt. GSP})^2$	(1.11)	(0.78)	(0.92)	(0.26)
Man./Govt. GSP	1.29‡	1.77†	-1.03	0.05
	(1.71)	(2.28)	(–0.87)	(0.04)
$(\text{Man./Govt. GSP})^2$	-0.31†	-0.33†	0.03	-0.08
	(-2.49)	(-2.72)	(0.13)	(-0.36)
Lagged Corruption	No	No	Yes	Yes
Time Fixed Effects	No	Yes	No	Yes
	F(9,396)=6.54	(p=0.00)	F(6,219)=5.20	(p=0.00)
State Fixed Effects	Yes	Yes	Yes	Yes
Observations	465		288	

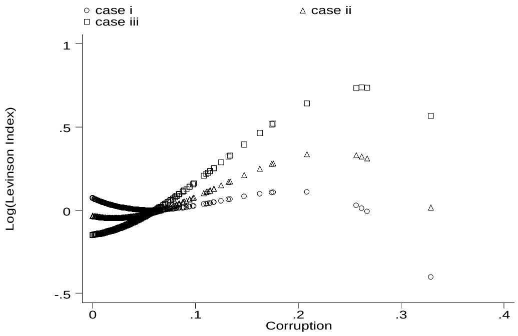
NOTES:

1. Government GSP excludes military GSP.

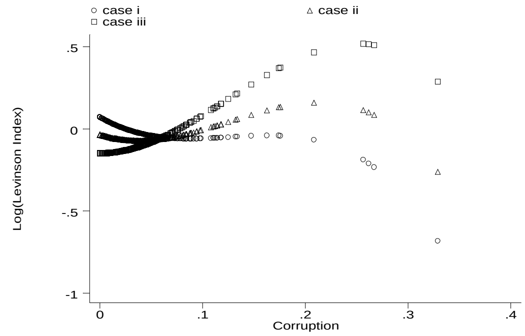
2. Other regressors included in each model: share of GSP in legal services, relative government (excluding military) wages, per capita income, per capita income squared, and population.

3. Lagged corruption is includes the average over the prior three years as well as the average squared and cubed.

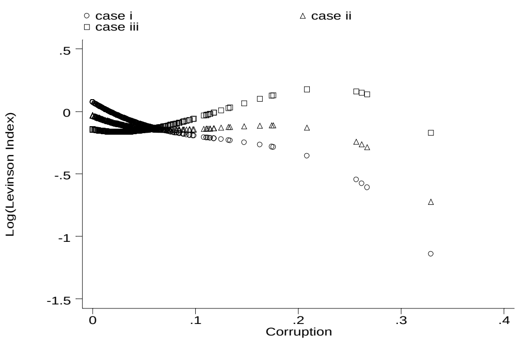
4. Robust t-statistics in parenthesis. †significant at the 5% level. ‡significant at the 10% level.



Panel A



Panel B



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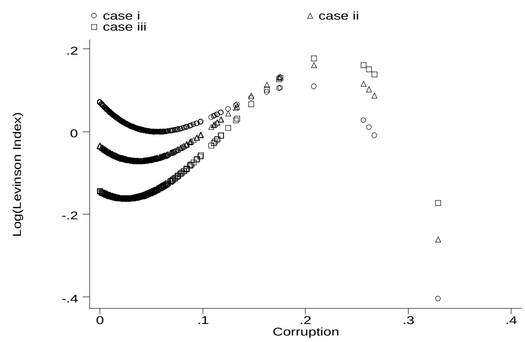
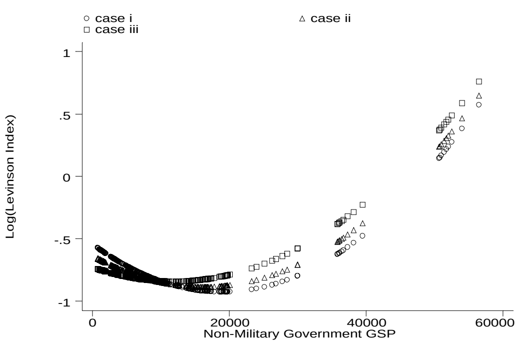


Panel D



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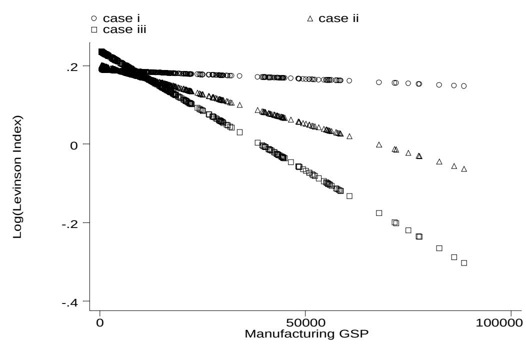


Panel F

Figure 1. Corruption and the Levinson Index of Environmental Compliance Costs.

NOTES:

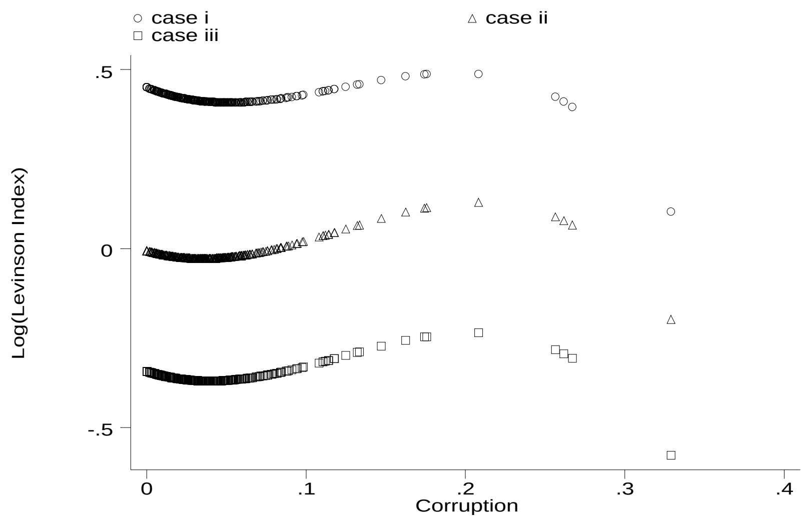
1. Corruption is measured as the number of public officials convicted of corruption-related activities one year ahead.

2. Panel A fixes manufacturing GSP at the 25^{th} percentile; panel B at the 50^{th} percentile; panel C at the 75^{th} percentile.

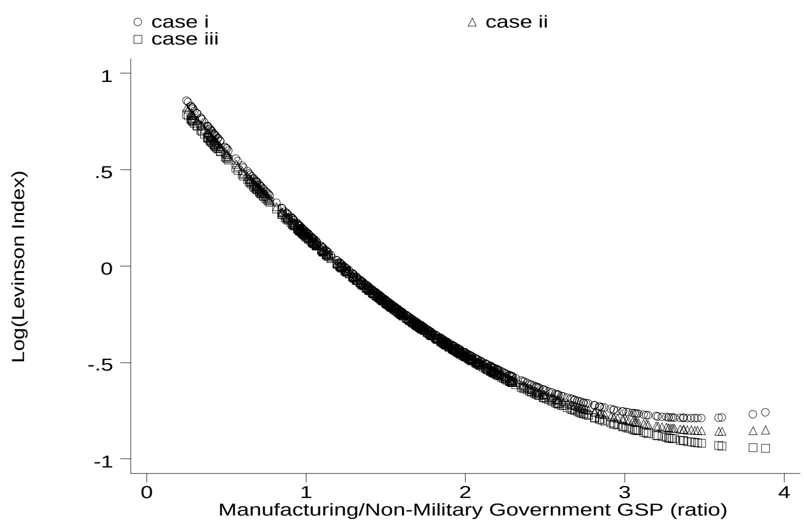
3. In Panels A - C, case i fixes non-military government GSP at the 25^{th} percentile; case ii at the 50^{th} percentile; case iii at the 75^{th} percentile.

4. In Panel D, case i fixes both manufacturing and non-military government GSP at the 25^{th} percentile; case ii fixes both at the 50^{th} percentile; case iii fixes both at the 75^{th} percentile.

5. Panel E fixes manufacturing GSP at its mean. Panel F fixes non-military government GSP at its mean. In both panels, case i fixes corruption at the 25^{th} percentile; case ii at the 50^{th} percentile; case iii at the 75^{th} percentile.



Panel A



Panel B

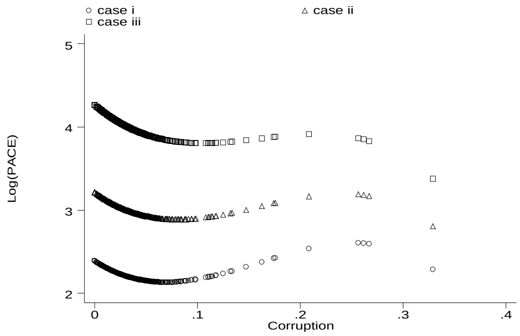
Figure 2. Corruption and Environmental Regulation.

NOTES:

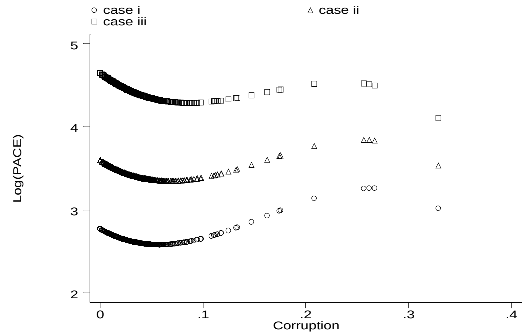
1. Corruption is measured as the number of public officials convicted of corruption-related activities one year ahead.

2. In panel A, case i fixes the ratio of manufacturing to non-military government GSP at the 25^{th} percentile; case ii at the 50^{th} percentile; case iii at the 75^{th} percentile.

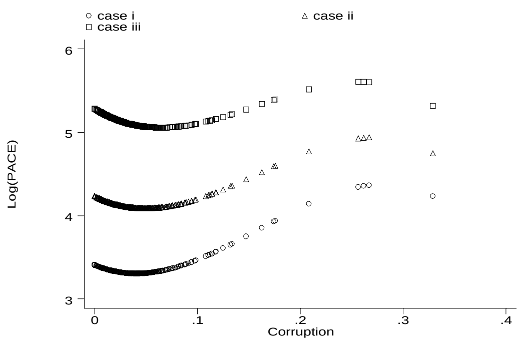
3. Panel B fixes the ratio of manufacturing to non-military government GSP at its mean. Case i fixes corruption at the 25^{th} percentile; case ii at the 50^{th} percentile; case iii at the 75^{th} percentile.



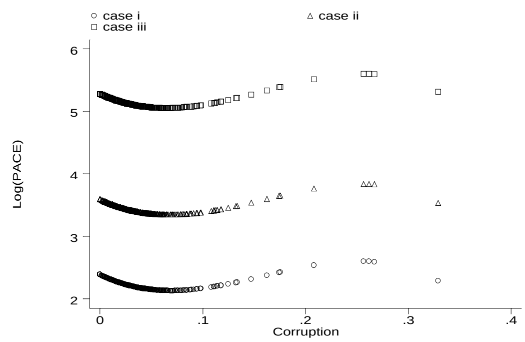
Panel A



Panel B



Panel C



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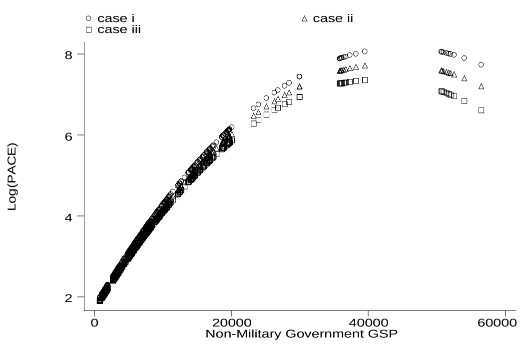
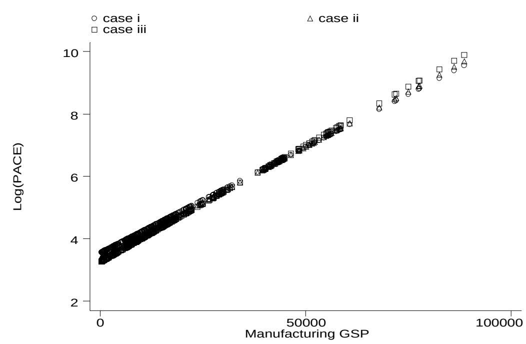


Panel E



Panel F

Figure 3. Corruption and Aggregate State PACE.

NOTES:

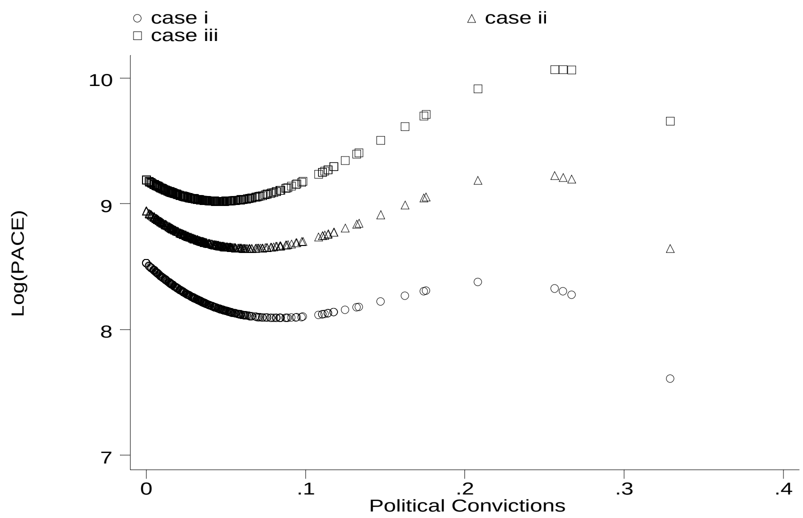
1. Corruption is measured as the number of public officials convicted of corruption-related activities one year ahead.

2. Panel A fixes manufacturing GSP at the 25^{th} percentile; panel B at the 50^{th} percentile; panel C at the 75^{th} percentile.

3. In Panels A - C, case i fixes non-military government GSP at the 25^{th} percentile; case ii at the 50^{th} percentile; case iii at the 75^{th} percentile.

4. In Panel D, case i fixes both manufacturing and non-military government GSP at the 25^{th} percentile; case ii fixes both at the 50^{th} percentile; case iii fixes both at the 75^{th} percentile.

5. Panel E fixes manufacturing GSP at its mean. Panel F fixes non-military government GSP at its mean. In both panels, case i fixes corruption at the 25^{th} percentile; case ii at the 50^{th} percentile; case iii at the 75^{th} percentile.



Panel A

Panel B

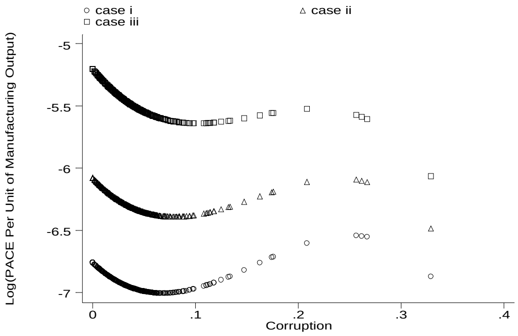
Figure 4. Corruption and Aggregate State PACE.

NOTES:

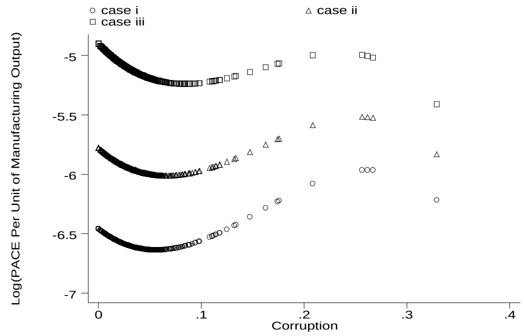
1. Corruption is measured as the number of public officials convicted of corruption-related activities one year ahead.

2. In panel A, case i fixes the ratio of manufacturing to non-military government GSP at the 25^{th} percentile; case ii at the 50^{th} percentile; case iii at the 75^{th} percentile.

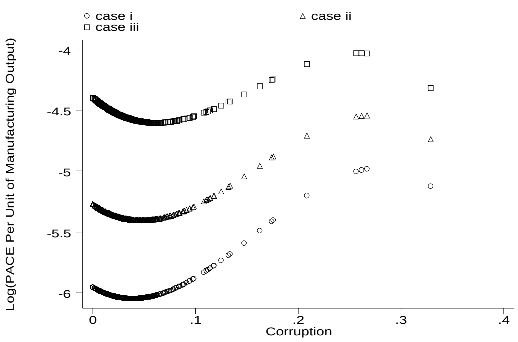
3. Panel B fixes the ratio of manufacturing to non-military government GSP at its mean. Case i fixes corruption at the 25^{th} percentile; case ii at the 50^{th} percentile; case iii at the 75^{th} percentile.



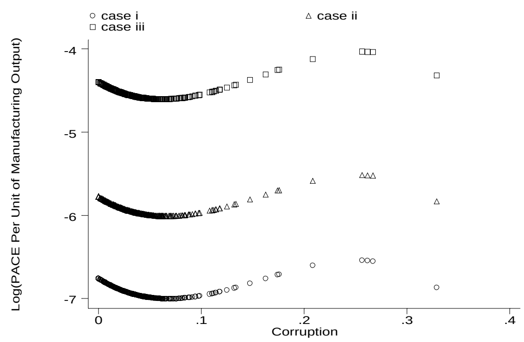
Panel A



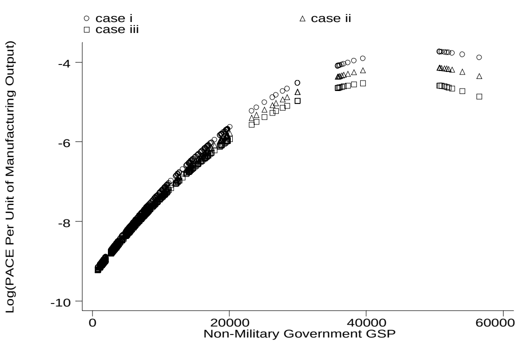
Panel B



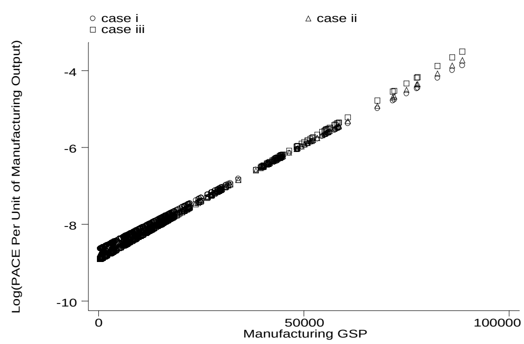
Panel C



Panel D



Panel E



Panel F

Figure 5. Corruption and PACE Per Dollar of Manufacturing Output.

NOTES:

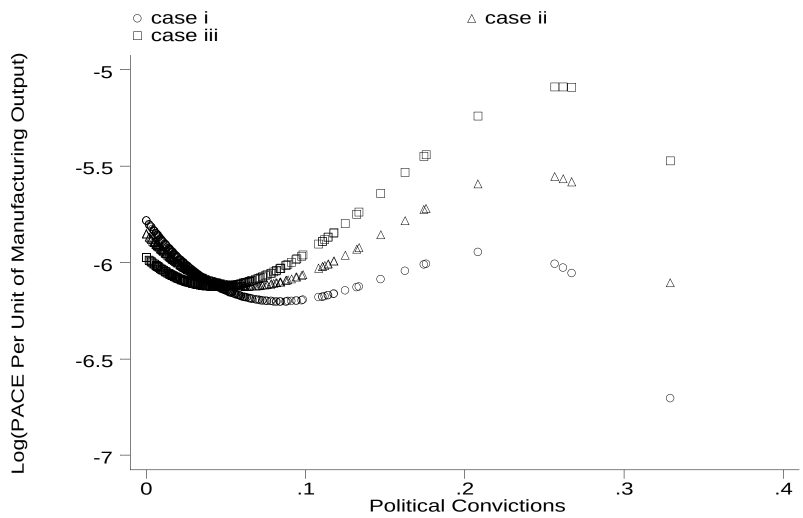
1. Corruption is measured as the number of public officials convicted of corruption-related activities one year ahead.

2. Panel A fixes manufacturing GSP at the 25^{th} percentile; panel B at the 50^{th} percentile; panel C at the 75^{th} percentile.

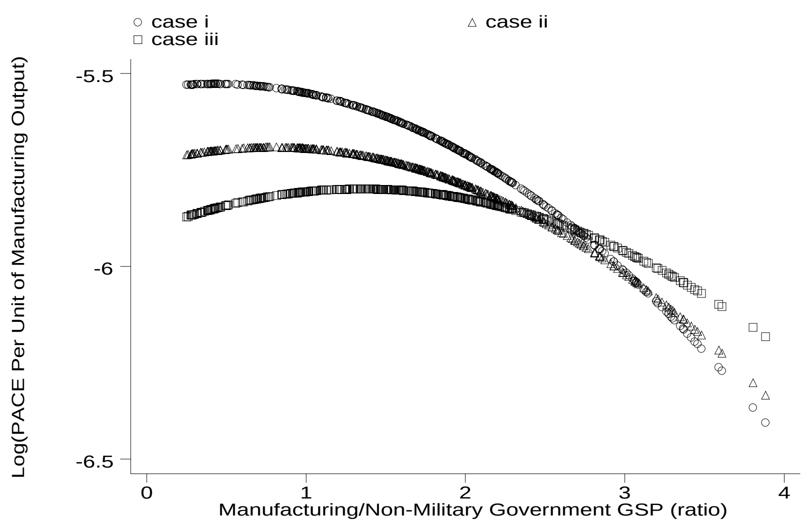
3. In Panels A - C, case i fixes non-military government GSP at the 25^{th} percentile; case ii at the 50^{th} percentile; case iii at the 75^{th} percentile.

4. In Panel D, case i fixes both manufacturing and non-military government GSP at the 25^{th} percentile; case ii fixes both at the 50^{th} percentile; case iii fixes both at the 75^{th} percentile.

5. Panel E fixes manufacturing GSP at its mean. Panel F fixes non-military government GSP at its mean. In both panels, case i fixes corruption at the 25^{th} percentile; case ii at the 50^{th} percentile; case iii at the 75^{th} percentile.



Panel A



Panel B

Figure 6. Corruption and PACE Per Dollar of Manufacturing Output.

NOTES:

1. Corruption is measured as the number of public officials convicted of corruption-related activities one year ahead.

2. In panel A, case i fixes the ratio of manufacturing to non-military government GSP at the 25^{th} percentile; case ii at the 50^{th} percentile; case iii at the 75^{th} percentile.

3. Panel B fixes the ratio of manufacturing to non-military government GSP at its mean. Case i fixes corruption at the 25^{th} percentile; case ii at the 50^{th} percentile; case iii at the 75^{th} percentile.