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Corruption and Energy Efficiency in OECD Countries: Theory and Evidence

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Abstract

We investigate the effect of corruption and industry sector size on energy policy outcomes. The main predictions of our theory are that: (i) greater corruptibility of policy makers reduces energy policy stringency; (ii) greater lobby group coordination costs (increased industry sector size) results in more stringent energy policy; and (iii) workers' and capital owners' lobbying efforts on energy policy are negatively related. These predictions are tested using a unique panel data set on the energy intensity of 11 sectors in 14 OECD countries for years 1982-1996. The evidence generally supports the predictions.

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Abstract

We investigate the effect of corruption and industry sector size on energy policy outcomes. The main predictions of our theory are that: (i) greater corruptibility of policy makers reduces energy policy stringency; (ii) greater lobby group coordination costs (increased industry sector size) results in more stringent energy policy; and (iii) workers' and capital owners' lobbying efforts on energy policy are negatively related. These predictions are tested using a unique panel data set on the energy intensity of 11 sectors in 14 OECD countries for years 1982-1996. The evidence generally supports the predictions.

I. INTRODUCTION

This paper investigates how the corruptibility of policy makers, as well as the incentives of worker and capitalist interest groups, affect the determination of energy policy in industrialized countries.[1]

Recent evidence suggests that government corruption is an important determinant of growth, investment, and environmental policy (see, for example, Mauro (1995), Ades and Di Tella (1999), Wei (2000), and Fredriksson and Svensson (2002)).[2] However, although energy policy is of great environmental and geopolitical importance, the effect of policymakers' corruptibility on energy policy has been ignored. In this paper, we seek to fill this gap in the literature.[3]

Moreover, we contribute to the literature on the role of industry size (lobby group size) in the policy formation process, in particular on energy policy. In his seminal work, Olson (1965) argues that coordination costs and free-riding problems will reduce the influence of large political groups. The effect of lobby group size on the ability of special interests to influence policy is however still an unresolved issue in the empirical literature, and the literature on energy policy is no exception.[4] In our

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[1] Some observers may associate corruption mainly with developing countries. However, recent high-level corruption scandals in for example France and Germany (embroiling, for example, President Chirac and former Prime Minister Kohl) indicate that the OECD countries are not immune to this phenomenon. In the United States, the recent collapse of the major energy firm Enron has focused the attention on (energy) firms' open and hidden political activities. See Oates and Portney (2001) for a nice survey of the literature on the political economy of environmental policy, and Graichen *et al*. (2001) for a case study.

[2] Mauro (1995) and Wei (2000) show a negative effect of corruption on growth and foreign direct investment, respectively, Ades and Di Tella (1999) study the relationship between corruption, industrial policy, and competition, López and Mitra (2000) develops a theory of the effects of corruption on the environmental Kuznets curve, Damania *et al*. (2002) find a negative direct effect of corruption, as well as an interaction effect between trade openness and corruption, on the standard for lead content in gasoline, and Fredriksson and Svensson (2002) study the interaction effect between corruption and political instability on agricultural sector environmental policies.

[3] Our focus on OECD countries also appears unique in the literature on corruption.

[4] See Rodrik (1995). Potters and Sloof (1996, pp. 417-8) point out that "Most scholars indeed find an increased scope for political influence with higher degrees of concentration, but there are many that find no effect or even a negative effect."… and "there seems to be relatively little direct empirical support for the Olson (1965) influential theoretical study on collective action." Marvel and Ray (1983), Walter and Pugel (1985), Gardner (1987), Trefler (1993), Gawande (1997), and Gawande and Bandyopadhyay (2000), found a positive effect of industry concentration on political influence, whereas Salamon and Siegfried (1977), Finger *et al*. (1982), and Baldwin (1985) found negative, ambiguous, or insignificant effects. Grier *et al*. (1991) document an inverted-u relationship between an industry's prevalence of Political Action Committees and both industry concentration and industry sales.

view, this literature suffers from a deficiency: it has, to our knowledge, ignored the interrelationship between lobby groups with similar interests in policy decision-making.[5]

Finally, we merge the two literatures discussed above by exploring an interaction effect of government corruptibility and lobby group size on energy policy. Is the effect of lobby group size conditional on corruptibility?

We begin the analysis by developing a simple model of bribery, which serves as guidance for our empirical work. The model builds on the menu auction model originating with Bernheim and Whinston (1986), which has been applied by Grossman and Helpman (1994) to trade policy and by, e.g., Aidt (1998) and Damania (2001) to environmental policy. The government is assumed to care about aggregate social welfare and bribes. It takes bribes from both worker and capital owner lobby groups, in return for energy policy that permits greater energy use in production, and thus greater emissions of pollutants.[6] The willingness of government politicians to deviate from optimal policy making here reflects the level of corruptibility (see Schulze and Ursprung (2001) and Fredriksson and Svensson (2002)). As in Laffont and Tirole (1991), bribery is assumed costly to coordinate due to transactions costs (see also Eerola (2002)). These transactions costs (coordination costs) are assumed to be increasing in the size of the industry sector, as argued by Olson (1965). Our theory separates lobbies' (i) incentives to offer a bribe (the amount at stake) and (ii) its ability to coordinate bribery (coordination costs), from (iii) the government's willingness to be bribed (degree of corruptibility). These three factors together contribute to a special interest group's success in the energy policy process.

Three main predictions emerge from the model. First, greater corruptibility reduces the stringency of energy policy. Intuitively, an increase in corruptibility shifts the government's relative

[5] Oates and Portney (2001) state that "It seems to us that approaches that explicitly recognize this interaction of different interest groups are the most promising for an understanding of environmental policy." (2001, p. 5).

weighting away from welfare and towards bribes, facilitating the purchase of influence by making it cheaper. Second, increasing costs of coordinating bribery causes energy policy to become more stringent (in general), consistent with Olson (1965). This is because an increase in coordination costs reduces the lobby groups' bribe offers to the government. Third, the *distribution* of the worker and capital-owner lobbies' political pressures depends on how energy policy affects the lobby group members' income. In turn, the effects of increasing coordination costs on lobbying efforts are distributed in a similar fashion: when the effect of coordination costs on worker lobbying is high (low), the effect on capital owner lobbying is low (high). An additional implication of the model is that the effect of lobby group size depends on the level of government corruptibility.

We test these predictions using dynamic panel data on sector energy intensity (energy use per unit of value added) in OECD countries for the years 1982-1996. As measures of size of the capital owner and worker lobby groups, we use an industry's shares of aggregate (i) contributions to value added and (ii) employment, respectively.[7] The empirical findings support several of the model's predictions.

First, higher corruptibility strongly correlates with lower energy efficiency in OECD countries. To our knowledge, this is the first empirical evidence on the (detrimental) effects of corruption (corruptibility) on energy policy outcomes, and more generally on the effects of corruption using cross-country data exclusively from OECD countries.

Second, an increase in coordination costs appears to *reduce* the influence of the capital owner lobby, consistent with our theory. However, for the worker lobby the same result holds only above a certain threshold industry size.[8]

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[6] Energy policy determines the maximum allowed energy use, and thus restricts the productivity of labor and capital. However, greater energy intensity of production implies that the unorganized consumers suffer greater environmental damage.

[7] Salamon and Siegfried (1977) and Grier *et al*. (1991) have previously used industry size as the unit of analysis in studies with a focus on the U.S.

[8] The relationship between coordination costs and political success is stronger in less corrupt countries.

Third, the effects of coordination costs on the capital and worker lobby groups' policy success are indeed related, as predicted by our theory. Focussing exclusively on energy intensive sectors, we find that the relationship between the capital owner lobby's coordination costs and its policy success is u-shaped. However, for the worker lobby the same relationship exhibits an inverted-u shape.[9] Thus, coordination costs have opposite effects on the policy influence of the two lobbies. Finally, we find that these relationships are conditional on the level of corruptibility. To our knowledge, these are novel empirical findings in the literature, which rarely separates worker and capital owner lobbying and never has considered the interaction with policy maker corruptibility. The results may account for some of the ambiguities reported.

Since energy policy is an important focus of the current debate (for example, in the negotiations on global warming), we believe our findings may have policy implications. Reforms aimed at reducing corruption (corruptibility) would have the indirect benefit of improving energy efficiency in industrialized economies. We also believe our results may have more general applicability to other environmental policies, as well as to for example health and safety standards.

The paper is organized as follows. Section II sets up the model, derives the equilibrium energy policy, and generates the predictions of the model. Section III describes the empirical model and the data. Section IV reports the empirical results, and Section V provides a brief conclusion.

II. THE MODEL

In this section, we develop a simple model of corruptibility and the endogenous formation of energy policy in a small open economy.[10] Each country contains firms that produce a private good, Q, for a perfectly competitive international market; price equals unity. Production requires inputs of capital, K, labor, L, and energy, θ. The capital stock and the labor supply are immobile internationally,

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[9] Our findings may be related to Grier *et al*. (1991) who argue that PAC formation and average industry sales exhibit an inverted-u shaped relationship. They argue that firms in concentrated industries may have a lower need for government intervention since they are already enjoying greater profits, ceteris paribus.

[10] The model partially builds on Oates and Schwab (1988) and Fredriksson and Gaston (2000).

while energy can be imported free of import duties at price *p*. Energy use is assumed polluting and the damage confined to the country using energy in production. The production technology exhibits constant returns to scale, is concave and increasing in all inputs, and twice continuously differentiable. It is given by $Q = F(K, L, \theta)$, which by linear homogeneity can be rewritten as

$$Q = Kf(l, \alpha), \tag{1}$$

where $l = L/K$ is the labor-capital ratio (the inverted capital-labor ratio) and $\alpha = \theta / K$, $\alpha \in \mathrm{A}$, $\mathrm{A} \subset \Re_+$ is the energy-capital ratio. The energy-capital ratio is the environmental policy set by the government.[11]

Because the amount of capital is fixed in each country, this implies that α determines aggregate energy use. Implicitly, it also specifies the energy-intensity of production. Suppressing arguments and using subscripts to denote partial derivatives, the marginal products of capital, energy, and labor are given by $(f - lf_l - \alpha f_\alpha)$, f_α, and f_l. The marginal products are diminishing, i.e., $f_{\alpha\alpha} < 0$, $f_{ll} < 0$, and we assume that $f_{l\alpha} > 0$, i.e., an increase in α raises the marginal product of labor. With constant returns to scale, the size of each firm is indeterminate. The aggregate profit function of the country's firms equals

$$\pi = Kf(l, \alpha) - Kr - Lw - \theta p, \tag{2}$$

where *r* is the cost of capital and *w* denotes the wage rate. Assuming many small firms, such that *r* and *w* are taken as given, the FOC of (2) with respect to energy use, θ, yields $f_\alpha = p$. We assume

[11] This specification resembles for example the Corporate Average Fuel Economy (CAFE) standards that have been a recent focus of the energy policy debate in the U.S., although first mandated in 1975 (see Portney (2002) and Sterner (2003, p. 249)). CAFE standards specify fuel use for all new light-duty vehicles sold in the U.S. (note that the Transport Sector (ISIC Code 71) is the most energy intensive sector in our sample (see Table 1 below)). Since CO_2 emissions are proportional to energy use, another example is the U.K. cap-and-trade system with a fixed total of carbon emissions that are tradable, the Emissions Trading Scheme (Sterner (2003, p. 92)) (since we have identical firms with constant returns to scale, permit trade is not applicable). Finally, our specification does not drive our results. Since we assume that damage from pollution equals total energy use (see below), the specification is equivalent to an environmental policy that sets an emissions cap.

that the government's regulation of energy use is binding, such that energy use by firms is restricted to a quantity lower than implied by the FOC.

There are three types of individuals in this economy: workers, consumers, and capital owners. Normalizing the population in each country to 1, let $\beta^W = L, \beta^S$, and β^K represent the proportion of the population that are workers, consumers, and capital owners, respectively. All individuals gain utility from consuming the good, but consumers in addition suffer damage, D, from the pollution stemming from the energy input. The damage suffered by each consumer is, for simplicity, directly proportional to the energy used (and thus the environmental policy set by the government), i.e. $D = \theta$. Individuals are assumed to have additively separable utility functions of the following form:

$$U^j = c^j - \lambda^S D, \tag{3}$$

where $j = W, S$, and K index workers, consumers, and capital owners, respectively, and $\lambda^S = 1$ for consumers (0 otherwise).

The income Y^S of each consumer is exogenously determined, e.g. earned from employment in white-collar jobs unaffected by environmental policy. Workers supply one unit of labor each and the wage equals the gain from employing an additional worker. The marginal product of capital equals the sum of the marginal product of capital given permitted energy use, *plus* the additional output arising from the increase in the permitted energy use (which is rationed in the model through the energy-capital ratio) associated with an increase in the capital stock, αf_α (see also Oates and Schwab (1988)). Hence, the returns to capital is given by $f - lf_l$.

Capital owners and workers are able to overcome free-rider problems and form two separate lobby groups, where all capital owners and workers are members, respectively. Let both the organized and unorganized population groups be denoted by a superscript *i*, *i*=*W*,*K*,*S*. The organized worker and capital owner lobby groups are assumed to offer the government a bribe schedule each, $C^i(\alpha)$, $i = W, K$. The bribe schedule offered by each lobby relates a prospective bribe to the equilibrium energy policy chosen by the government. We follow Laffont and Tirole (1991) by assuming that corrupt activities involve coordination (organizational) costs, such that the total cost to lobby *i* of bribery equals $(1+\lambda^i)C^i(\alpha)$, where we assume that the larger the coordination problems of lobby group *i*, the greater the coordination costs (transactions costs), λ^i (see also Eerola (2002)). The total coordination costs may be viewed as reflecting the variable costs directly related to lobby group size .[12] The coordination costs only affect the bribery activity level, not participation, and the greater the size of the industry sector, the greater the coordination costs. On the other hand, the consumers face sufficiently large such costs that they are unable to overcome the problems associated with collective action (see Olson (1965)).

The net (indirect) utility functions of the worker and capital owner lobby groups are given by

$$V^W(\alpha) \equiv Lf_l - (1+\lambda^W)C^W(\alpha), \tag{4}$$

and

$$V^K(\alpha) \equiv K(f - lf_l) - (1+\lambda^K)C^K(\alpha), \tag{5}$$

respectively. Both these groups prefer weaker restrictions on energy use. We express the aggregate utility of the consumers (although not organized in a lobby group) as

$$V^S(\alpha) \equiv \beta^S(Y^S - D) = \beta^S(Y^S - K\alpha). \tag{6}$$

The government derives utility from a weighed sum of aggregate social welfare and bribes, and thus its utility function is given by

$$V^G(\alpha) \equiv \sum_{i=W,K,S} aV^i(\alpha) + \sum_{i=W,K} C^i(\alpha), \tag{7}$$

where $a \geq 0$ represents the exogenous weight that the government places on social welfare relative to bribes, and $\sum_{i=W,K,S} V^i(\alpha)$ represents aggregate social welfare. We interpret the weight *a* as the level

[12] See, e.g., Mitra (1999) for a discussion of fixed lobbying costs.

of corruptibility (corruption) of the regime. The greater the level of corruptibility (the smaller is *a*), the greater the influence of lobbying activities relative to social welfare.

Clearly, in some countries, even democratic OECD countries, the transfer of funds to politicians is legal. In our view this represents a form of corruption, and clearly other authors share this perspective. Shleifer and Vishny (1993) and Bardhan (1997) define governmental corruption as the propensity to sell policies for personal gains in the form of monetary transfers. Moreover, Schulze and Ursprung (2001) and Fredriksson and Svensson (2002) view the interaction between lobby groups and the government in the model by Grossman and Helpman (1994) as closely describing corruption. The monetary transfers (bribes) are aimed at influencing government policy and not elections. The level of corruptibility in our model is, in essence, reflected by the government's willingness to allow lobby groups to distort energy policy.[13]

The equilibrium energy policy is determined as the outcome of a two-stage, non-cooperative game. In stage one the lobby groups offer the government a bribe schedule $C^i(\alpha)$, $i=W,K$. The strategy of each lobby is a differentiable function $C^i : \mathrm{A} \rightarrow \Re_+$; and each lobby offers the government a monetary reward for selecting policy α. In stage two, the government selects an energy policy and collects the associated bribe from each lobby. The lobbies are assumed not to renege on their promises in the second stage. The lobbies receive payoffs described by $V^i : \mathrm{A} \rightarrow \Re_+$.

The equilibrium in the common agency model by Bernheim and Whinston (1986) maximizes the joint surplus of all parties and is formally equivalent to the Nash bargaining solution (see also Grossman and Helpman (1994) and Dixit *et al*. (1997)).[14] The characterization of the equilibrium

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[13] Coate and Morris (1999) also view the monetary transfer in this type of model as a bribe. See also López and Mitra (2000) and Damania *et al*. (2002) for similar formulations.

[14] The subgame perfect Nash equilibrium is defined as a feasible bribe schedule C^{i^*} and an energy policy α^* such that the energy policy maximizes the government's welfare $V^G(\alpha)$, taking the bribe schedule as given; and given the government's and lobby *i*'s strategies, lobby *j* does not have a feasible strategy that results in a net payoff greater than the equilibrium net payoff.

energy-capital standard, α^*, can be derived from the following two necessary conditions (see Eerola (2002) for a complete proof):

$$\alpha^* \in \arg\max_{\alpha} V^G(\alpha); \tag{C1}$$

$$\alpha^* \in \arg\max_{\alpha} \{[V^i(\alpha) - (1+\lambda^i)C^i(\alpha)] + V^G(\alpha)\}, \ \forall i. \tag{C2}$$

The derivation of the equilibrium characteristics is standard in the literature, and we therefore omit it. The FOC of condition (C2) implies $V_\alpha^i(\alpha) = (1+\lambda^i)C_\alpha^i(\alpha)$, which can be substituted into the FOC of (C1) to yield the characterization of the equilibrium energy policy:

$$\sum_{i=W,K,S} aV_\alpha^i(\alpha) + \sum_{i=W,K} \left(\frac{1}{1+\lambda^i}\right) V_\alpha^i(\alpha) = 0. \tag{8}$$

The failure of the consumers to participate in political bribery gives rise to a political distortion. From (8) it follows that their interests are not represented to the same degree as the workers' and capital owners' interests. Whereas these latter two groups receive a weight of $[1/(1+\lambda^i)+a]$, the consumers receive a weight of only a. However, as $\lambda^i \to \infty$, the weight of group i converges to a. Moreover, note that the greater the organizational costs involved with bribery, the lower the influence of the organized special interest groups.

To find an explicit expression for the equilibrium energy policy (corresponding to (8)), we need to find the effects of a change in the energy policy on the *gross* welfare of the groups. The effect of energy policy on the workers', capital owners', and consumers' welfare is given by

$$V_\alpha^W(\alpha) = Lf_{l\alpha}, \tag{9}$$

$$V_\alpha^K(\alpha) = K(f_\alpha - lf_{l\alpha}), \tag{10}$$

and

$$V_\alpha^S(\alpha) = -\beta^S K, \tag{11}$$

respectively. Notice that the effect of energy policy on the welfare of the worker and capital owner lobby groups are closely related. If the wage effect in (9) is relatively large (small), the effect on the returns to capital in (10) is relatively small (large).[15] Below, we will see that the effect on income determines the equilibrium lobbying efforts of the two lobbies.

Substituting (9), (10) and (11) into (8) yields an equilibrium condition for the energy policy equal to

$$\underbrace{\left(\frac{1}{1+\lambda^{W}}+a\right)lf_{l\alpha}}_{A}+\underbrace{\left(\frac{1}{1+\lambda^{K}}+a\right)(f_{\alpha}-lf_{l\alpha})}_{B}-\underbrace{a\beta^{S}}_{C}=0. \tag{12}$$

Equation (12) shows the forces on energy policy, in equilibrium. Term *A* captures the influence of the worker lobby group, term *B* mirrors the influence of the capital owner lobby group, and term *C* reflects the government's consideration of consumers' welfare (due to changes in emissions). All terms multiplied by *a* are included in social welfare, and terms containing λ^{i} reflect the bribery effort of lobby *i*. Note that simple rearrangements of (12) imply that in equilibrium, $\beta^{S} > f_{\alpha}$, i.e. the marginal disutility from energy related pollution is greater than the marginal productivity of energy. This is due to the lack of participation by the consumers in bribery activities.

The previous literature has made a distinction between interest group activity and conditions for political success (see the survey by Potters and Sloof (1996)). Let us discuss this in terms of our framework, using the worker lobby as an example. In our theory the aggregate influence of the worker lobby depends on three factors, in equilibrium. First, the worker lobby's *incentive* to offer a bribe depends on the amount at "stake" (reflected by $lf_{l\alpha}$).[16] Second, the *ability* to offer a bribe is affected by coordination costs (reflected by $1/(1+\lambda^{W})$). The lobby's incentive and ability combines into an "activity" level. Third, the degree of government corruptibility (reflected by *a*) is the

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[15] Expression (10) is positive, given that a weaker energy policy raises the productivity of capital. The equation reflects the share of the income increase (due to weaker energy policy) not claimed by labor (see (9)).

willingness of the government to sell policy favors (i.e. to distort policy). The level of a lobby's s*uccess* in influence-seeking is consequently the combination of all three factors, as seen in (12).

Predictions

To examine the effect of corruptibility on energy policy, we assume for simplicity that all third-order conditions are approximately zero (as do Laffont and Tirole (1998, p. 66)). Differentiation of (12) yields

$$\frac{\partial \alpha}{\partial a} = \frac{\beta^S - f_\alpha}{\left(\frac{1}{1+\lambda^K} + a\right) f_{\alpha\alpha}}, \tag{13}$$

which is negative, since from (12), $\beta^S > f_\alpha$. An increase in corruptibility (a lower *a*) raises the distortion in energy policy. This is simply because the government's willingness to sell policy favors rises. We summarize our first testable prediction as:

Prediction 1: *Greater corruptibility reduces the stringency of energy policy.*

Next, we find that the effects of capital owners' and workers' coordination costs equals:

$$\frac{\partial \alpha}{\partial \lambda^K} = \frac{1}{\left(1+\lambda^K\right)^2} \frac{\left(f_\alpha - l f_{l\alpha}\right)}{\left(\frac{1}{1+\lambda^K} + a\right) f_{\alpha\alpha}} < 0, \tag{14}$$

and

$$\frac{\partial \alpha}{\partial \lambda^W} = \frac{1}{\left(1+\lambda^W\right)^2} \frac{l f_{l\alpha}}{\left(\frac{1}{1+\lambda^W} + a\right) f_{\alpha\alpha}} < 0. \tag{15}$$

Rising lobby group coordination costs cause energy policy to become more stringent, because the bribe offers are scaled back. Each lobby group member gains less by contributing to the lobby, on

[16] Energy sector restrictions hurt energy-intensive sectors more, and therefore more is at stake for both the worker and the

the margin (the lobby group size is given). This yields a form of free-riding by the lobby group members, causing lower bribe offers. The prediction that emerges is:

Prediction 2: *Greater lobby group coordination costs cause energy policy to become more stringent.*

Note also that the effect of coordination costs: (i) depends on the level of corruptibility; (ii) is non-linear since λ^i appears on the right hand side and thus depends on its own value, and $\partial\alpha/\partial\lambda^i \to 0$ as $\lambda^i \to \infty$. Coordination costs have little marginal effect where these costs are very high. These observations will be explored further in our empirical analysis.

Finally, (14) and (15) also reveal that the effects of the two groups' coordination costs are inter-related. They are proportional to the lobbying incentives, which are reflected in the numerators of (14) and (15). Ceteris paribus, when the wage effect of energy policy, $lf_{l\alpha}$, is large (in the numerator of (14)), the effect on energy policy stringency of increased worker coordination costs is high, and the effect of capital owner coordination costs is low. The crucial determinant of the distribution of the burden is thus the *allocation* of the effect on factor rewards of energy policy. If a particular lobby carries a relatively large burden from stricter energy policy, coordination costs have a relatively greater marginal effect on its lobbying effort. There is consequently a negative interdependence between the lobby groups in their response to greater coordination costs. In sum, we have the following prediction:

Prediction 3: *In equilibrium, when the wage effect of energy policy is large* (*small*), *the effect on energy policy stringency of worker coordination costs is large* (*small*), *and the effect on energy policy stringency of capital owner coordination costs is small* (*large*), *ceteris paribus*.

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capital owner lobby in these sectors, ceteris paribus.

III. EMPIRICAL STRATEGY

Our theoretical framework yields three main predictions, which we test empirically in this section: (i) Greater corruptibility reduces the stringency of energy policy; (ii) Lobby group coordination costs cause energy policy to become more stringent; (iii) Worker and capital owner bribery efforts are negatively related.

Econometric Model

To test the main predictions of the model we analyze variations in energy policy stringency at the sector level within and between countries. We fit the following model:

$$Y_{ijt} = c_{ij} + \beta_i t + \gamma \mathbf{Z}_{ijt} + \delta \mathbf{X}_{ijt} + \varepsilon_{ijt}, \qquad (16)$$

where Y_{ijt} is the sector specific energy policy stringency measure for sector *i* in country *j* at time *t*, c_{ij} are time-invariant country-specific sector fixed effects, $\beta_i t$ are sector specific time trends, $\mathbf{Z}_{ijt}$ represents the matrix of explanatory variables, $\mathbf{X}_{ijt}$ is the matrix of sector or country specific control variables, and ε_{ijt} is the normally distributed error term corrected for cross-sectional heteroskedasticity (with $\varepsilon_{ijt} \sim N(0, \boldsymbol{\sigma_{ij}})$). Vector γ is the set of parameters of interest and δ the vector of control parameters.

In order to test whether the explanatory variables differ significantly from zero, we start from the presumption that sectors are non-homogeneous. The variation in variances across different sectors across countries is considerable. Therefore, we employ a Generalized Least Square (GLS) specification to correct for the presence of cross-section heteroskedasticity.[17] The sample variance-covariance matrix is obtained from a first-stage OLS regression and is iterated until convergence.

[17] The Breusch-Pagan test statistic is 262 and clearly rejects the homoskedasticity assumption. Furthermore, there is little reason to employ an error component or random effects model as the number of statistical units is large and sector data are not drawn from a random set as the sample is closed (see Matyas and Sevestre (1996)). Testing for the equality of variances across the different sectors clearly rejects the assumption of homogeneity employed by the ordinary OLS estimator. Due to the relative short time dimension we estimated the model using a deterministic trend. Sensitiveness for estimation in first differences, however, is very limited.

Finally, we perform several robustness tests. Below, we discuss our data, its sources and limitations, and next we address the links between theory and our estimation equation.

Data Sources and Measurement Issues

We have panel data set on the energy use in 11 sectors in 14 OECD countries for years 1982-1996.[18] Energy consumption, in particular the consumption of fossil fuels, has been a major focus in environmental policy over the last decades. As our dependent variable, we use sector level energy efficiency defined as physical energy units per unit of value added (*ENERGYINTENSITY*). This measure has the advantage that: (i) it reflects the combined regulatory strategies used by OECD countries (physical energy constraints, efficiency standards, and energy taxes); (ii) it is potentially influenced by corruption;[19] (iii) it is available as a large panel data set; (iv) it exhibits sufficient industry, country, and time variation to help us control for important unobservable factors that may influence our main regressors.[20] By restricting energy use (per unit of output), firms internalize several air pollution externalities that are directly related to the combustion of fossil fuels, including smog, acid rain (SO_2 and NO_x), and climate change (CO_2). Energy use per unit of output is the ultimate outcome of policies that seek to constrain energy use for environmental reasons.

Our unbalanced panel combines OECD sectoral energy use data and economic data from the Intersectoral Data Base (ISDB) (see the Appendix for details). Compared to the earlier literature, our data set is particularly large (and focused). Table 1 specifies the sectors and their levels of energy use per unit of output.[21] [TABLE 1 HERE]

[18] This focus reduces the number of unobservables related to institutional differences between high- and low-income countries.

[19] According to Leveque *et al*. (1996), the evaluation of available technologies for energy efficiency improvements on the basis of Best Available Technologies Not Entailing Excessive Costs (BATNEEC) at the plant level leaves much room for regulatory capture.

[20] Moreover, by looking at the variation in energy intensity measured by the *physical* amount of energy use (tons of oil equivalent) per unit of value added for each sector, our measure is not obstructed by changes in the sector's energy price composite.

[21] The ten countries are: Belgium, Canada, Denmark, Finland, France, Italy, Japan, Netherlands, Norway, Sweden, the UK and the US. As seen in Table 1, the level of energy efficiency is particularly high in the transport sector, the basic

Explanatory variables

Corruptibility is difficult to measure. The widely used Transparency Index (*CORRUPT*) from Transparency International (2000) is however a good and widely used proxy for corruptibility (corruption) (see, for example, Persson *et al*. (2000)). The index shows enough variability across rich countries (important for our purposes) and over time (to some degree). The *CORRUPT* data show that Denmark, Finland, Norway and Sweden have become less corrupt over the time period 1982-1996, whereas Belgium, France, Japan and the USA have become more corrupt. In order to construct a smooth estimate of the long-term trend in corruptibility we interpolated the available data points using the Hodrick-Prescott filter.[22]

In order to measure the coordination costs of the worker and capital owner lobbies we focus on sector size, following Olson (1965) and our theory. As a measure of the capital owner lobby's coordination costs, we use an industry sector's contribution to total value added (*VALUEADDED%*). Larger sectors represent a greater number of firms and greater coordination problems, given firm size.[23] As a measure of worker coordination costs, we use the share of all workers employed in a particular sector (*EMPLOYMENT%*).[24] Moreover, in order to capture non-linearities (discussed by the theory), we include the squared terms $VALUEADDED\%^2$ and $EMPLOYMENT\%^2$.

Our theory predicts that the effect of sector size on bribery efforts depends on the marginal effect of energy policy on lobby group income, i.e. the amount at stake. A small change in energy policy has a greater impact on the returns to labor and capital when more energy is used, thus the

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metal industry, the non-metallic mineral products industry, and the paper industry, whereas the commercial service sector and construction have the lowest levels. The intra-sectoral variation is considerable.

22 The Hodrick-Prescott filter is normally used to smooth macro-economic time series to obtain a smooth estimate of the underlying long-term trend. The smoothing process minimizes the variance of the series around the smoothed series using a penalty parameter on the second difference of the smoothed series. In contrast, our objective is to maximize the variance in the corruption series given the observed data points. Therefore, we choose very low values for this parameter to create a trend as close as possible to the given data points.

23 To verify that *VALUEADDED%* is positively correlated with the number of firms in an industry we used the 4-digit data available from OECD (2003) which covers a subset of our data (2121 observations). The correlations (t-statistics within brackets) were 0.82 [30.4] for the Netherlands (69 sectors; years 1992-98), 0.84 [29.4] for Norway (166; 1997-2000), 0.63 [18.9] for Portugal (179; 1996-98), 0.21 [6.0] for Spain (132; 1993-98), and 0.62 [36.4] for the full sample.

economic stakes in the policy outcome are greater for sectors that use relatively more energy. Interest groups will likely engage more intensively in bribery if they have higher stakes in the energy policy outcome.[25] To capture differences in stakes between sectors, we create the interaction variables *VALUEADDED%*ENERGY%* and *EMPLOYMENT%*ENERGY%*, where *ENERGY%* is the share of total energy used by a sector.

Control variables

Assuming that environmental quality is a normal good, demand will increase with income. Our measure is income per capita (*GDPPC*). Following Antweiler *et al*. (2001), we assume that energy policy is likely to respond slowly to pollution problems, and we therefore use the average GDP per capita of the previous 3 years.

The intensity of energy use at the sector level is affected by (adaptive) firm behavior. Indeed, differences in the structure of energy production across countries, as well as shifts in production structure through price or technological effects, are likely to affect energy intensity. We address this problem by explicit and implicit controls. In order to capture structural changes in energy prices in the observed period, and the association between domestic energy resources and lower local energy prices (OECD (1999)), we include domestic energy prices for heavy fuel oil (*OILPRICE*) and electricity (*ELECTRICITYPRICE*). *OILPRICE* should capture common trends in both the oil and natural gas markets, while electricity prices usually reflect country specific circumstances.[26] Furthermore, we add factor prices such as mean hourly wage of production workers (*WAGES*) and cost of capital (*CAPITALPRICE*). Changing (relative) input prices might induce substitution between production factors. Antweiler *et al*. (2001) find that capital is complementary to energy, and we

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[24] Workers in larger sectors may have greater influence at the voting booth (see Stigler (1971)). While workers' voting power likely plays a role, we need to keep in mind that our theory ignores voting issues.

[25] Lobby group size is often used to measure both a lobby's stake in the policy outcome and the lobby's political strength, and therefore ambiguous results are common in the literature. Given that energy and capital are usually complements (see Antweiler *et al*. (2001)), restrictions on energy use are likely to hit capital owners harder in capital-intensive industries.

therefore expect substitution between a capital/energy composite and labor. Whereas we expect *OILPRICE* and *ELECTRICITYPRICE* to take negative signs (higher energy prices should lead to substitution away from energy as a factor of production), we expect *WAGES* and *CAPITALPRICE* to have the opposite effects on *ENERGYINTENSITY*.

Finally, we use sector specific fixed effects (c_{ij}) to allow for uncontrolled variables such as excluded economic determinants or technological differences between sectors.[27] For example, the production process in a sector may differ between countries.[28] We take these parameters as fixed over time. In order to account for time related unobservables, we add sector specific time trends ($\beta_i t$). The pattern of energy intensity shows a clear trend for most sectors. This may reflect a gradual shift over time towards new techniques in response to the oil price shock in the 1970s. Given our focus on sectors as our basic estimation unit, allowing for time related variation between sectors appears preferable, compared to introducing heterogeneous time dummies that are homogenous for all sectors. Table 2 provides descriptive statistics. [TABLE 2 HERE].

IV. RESULTS

Basic findings

Table 3 presents the main results from our estimations. [TABLE 3 HERE] In Models 1-3, we include the variables of interest, but not all interactions are included in each model. This enables us to better understand the effect of the interactions discussed in our theory. *CORRUPT* has the expected positive sign in all models and is significant at the 1% level, implying that greater corruptibility increases energy intensity. Moreover, consistent with our theory, *VALUEADDED%* has a significant

[26] We also experimented with indices reflecting indigenous energy production variables, measured as the share of total energy use coming from domestic fossil fuels, nuclear power, and green sources (biomass, hydro, wind, and sun). None of these are important. Results are available upon request.

[27] We extensively tested our model with and without country-specific, as well as sector-specific fixed effects, in particular because variation of *CORRUPT* is fairly limited. These results indicate that country-specific sector fixed effects are to be preferred (F-test). Moreover, our main results do not depend on this specification. Results are available upon request.

negative sign, indicating that capital owner lobby groups encounter increasing coordination costs as sector size rises. *VALUEADDED%*^{2} is mostly insignificant suggesting a linear effect. However, *EMPLOYMENT%* has a positive and significant sign, but the marginal effect of worker lobby coordination costs is rising as *EMPLOYMENT%*^{2} has a (small) negative coefficient. This implies that workers in large sectors receive less strict energy policies, but the effect declines as industry employment rises.

In Model 2, *CORRUPT*VALUEADDED%* is significant and positive as expected, suggesting that the capital owners' coordination costs have less impact where policy makers are more corruptible. Second, *CORRUPT*EMPLOYMENT%* has a significant and negative coefficient, indicating the opposite relationship for workers (compared to capital owners). Note that the estimated coefficient on *EMPLOYMENT%* roughly doubles from Model 1 to 2. The effect is lower in countries with more corruptible policy makers, however. Third, the importance of including the interaction terms is also reflected by the fact that the significance of the *CORRUPT* coefficient rises strongly as we move from Model 1 to 2. In Model 3, the interactions with *ENERGY%* capture the stakes involved in energy policy. *ENERGY%*VALUEADDED%* is significant, indicating that capital owners suffer less from coordination costs if a sector uses a larger share of total energy consumption and thus has more at stake.

In Model 4 all interactions are included. This is our preferred model, as it captures the direct and indirect effects discussed by our theoretical model. Most coefficients are significant at the 1% level. *CORRUPT* lowers the stringency of energy policy, consistent with our theory. This is particularly the case in sectors with high *VALUEADDED%* and low *EMPLOYMENT%*.[29]

[28] The paper industry in Finland uses raw pulp, which is more energy intensive than the recycled fibers used by the Dutch paper industry, for example.
[29] Model 4 suggest that a unit increase in *CORRUPT* (evaluated at the mean) increases the value of *ENERGYINTENSITY* by 1.87 (= 2.56 +0.35*5.0–0.53*4.6).

In Fig. 1 we plot the relationship between *CORRUPT* and *ENERGYINTENSITY* at the sample means of all significant variables. [FIG. 1 HERE] Higher corruptibility clearly correlates with greater energy intensity, which lends support for our first hypothesis. A unit increase in *CORRUPT* increases *ENERGYINTENSITY* (at the mean) by 0.86 units (= 2.56 + 0.35*2.1 – 0.53*4.6). The effect of government corruptibility, however, also depends on coordination costs of the lobby groups (the indirect effect). This sensitivity is illustrated for a rise of both *VALUEADDED%* and *EMPLOYMENT%* by 1 std. dev. above the means. At this higher value for *VALUEADDED%*, the level of *ENERGYINTENSITY* is below average for all values of corruptibility, confirming the hypothesis that capital owners in larger sectors face greater coordination costs. However, the marginal effect of *CORRUPT* is stronger in this case (the slope being greater). In contrast, the evidence for sectors with large employment shares (1 std. dev. above the mean) is mixed. Large worker lobbies face lower-than-average coordination problems at low levels of corruptibility, but higher-than-average problems at high corruptibility values. Greater corruptibility thus raises coordination costs for worker lobbies. The results suggest that the effects of energy policy bribery activities are sensitive to lobby groups' coordination costs.

With respect to the capital owner lobby, the (significant) coefficients imply that a unit increase in *VALUEADDED%* (evaluated at the sample means) causes a *decline* in energy use per unit of output (a reduction of the value of *ENERGYINTENSITY*) by 2.53 units (=-4.35 + 0.35*2.1 + 0.23*4.7). This lends support to both Olson's and our theory. Fig. 2 plots the relationship between *VALUEADDED%* and *ENERGYINTENSITY*, conditional on three different levels of *CORRUPT*. [FIG. 2 HERE] The negative (linear) relationship suggests that capital owners in larger sectors are less successful in influence activities. However, their organizational problems are less problematic in more corrupt countries.[30]

[30] For capital owners, increased corruptibility increases the ability to gain influence on energy policy. At a *CORRUPT* level two std. dev. above the mean, the effect of an increase in *VALUEADDED%* falls somewhat (in absolute value), to –

Model 4 also implies that the predictions of our theory regarding worker coordination costs hold only for sectors employing a sufficiently large share of workers: we detect an inverted-u shaped relationship between employment numbers and the effects of coordination costs. Evaluated at the mean, a unit increase in *EMPLOYMENT%* causes an *increase* in *ENERGYINTENSITY* by 1.23 units (=3.42 – 2*0.02*4.6 – 0.53*2.1 – 0.19*4.7). The effect of *EMPLOYMENT%* is less pronounced in countries with greater corruptibility, however.[31] As illustrated by Fig. 3, for sufficiently high values of *EMPLOYMENT%* a unit increase indeed *reduces* energy intensity.[32] [FIG. 3 HERE] Moreover, at high values of *EMPLOYMENT%*, the impact of a further increase in employment share is greater the lower the level of corruptibility.[33] The generally opposite effects of increases in *VALUEADDED%* and *EMPLOYMENT%* lend a measure of support to our Prediction 3. In situations where capital owner coordination costs have a relatively large (small) effect on the policy outcome, the effect of the worker lobby's coordination costs are small (large). Model 4 suggests that corruptibility, as well as energy share differences between sectors, have the opposite effects on the two lobby groups' coordination problems (both variables reduce the capital owner lobby's coordination problems, but increase the worker lobby's).

In Table 3 we also present some alternative specifications that bring out the differences between relatively energy intensive (Model 5) and energy extensive (Model 6) sectors.[34] Since the economic stakes may differ considerably between these types of sectors, bribery behavior on energy

1.62. While our theoretical model correctly predicts the interaction between capital owner coordination costs and corruptibility, it fails to predict the direction of this conditionality.

[31] Evaluated at one std. deviation above the sample means for *CORRUPT*, the marginal effect declines to 0.54 (= 3.42 – 0.02*4.6*2 – 0.53*3.4 – 0.19*4.7) and becomes negative at two std. deviations.

[32] At one std. dev. above the mean for *EMPLOYMENT%*, the marginal effect is 0.88 (=3.42-0.02*13.4*2-0.53*2.1-0.19*4.7), whereas at the maximum level it equals –0.84. The peak occurs at *EMPLOYMENT%*=24.9, with 7% of all observations to the right of the peak.

[33] The interactions with *ENERGY%* (again) indicate that workers and capital owners have opposite policy effects as sector energy use rises, although some sign shifts occur. One explanation may be that the correlation between *ENERGY%*VALUEADDED%* and *ENERGY% *EMPLOYMENT%* is quite strong for some sectors.

[34] See Table 1 for these categories. Note that an energy-intensive sector does not necessarily also have a high share of energy consumption within a country. For instance, the relatively energy intensive BMI industry in Denmark has a value of 1590 for *ENERGYINTENSITY*, but uses only 1.3% of total energy.

policy may potentially also differ noticeably. The results for the energy intensive sectors (Model 5) yield coefficient sizes substantially larger than in Models 1-4 and 6. Moreover, the variables of importance remain significant with identical signs as in Model 4, and $VALUEADDED\%^2$ becomes significant. Capital owner coordination costs and energy intensity display a u-shaped relationship for energy intensive sectors. Fig. 4 shows a similar pattern as in Fig. 1 between *CORRUPT* and *ENERGYINTENSITY*, but the effects are now much stronger (notice the differences in scale on the axis). [FIG. 4 HERE] An increase in *CORRUPT* by one std. dev. implies a 4% increase in *ENERGYINTENSITY* in energy intensive sectors, whereas this effect is 0.4% for the full sample. The result can be expected, since the stakes in energy policy outcomes are significantly greater in energy intensive industries. In general, energy restrictions tend to hurt incomes more in energy intensive sectors, given the larger amount of energy (per unit of output) used in these sectors. Therefore the lobbies' stakes are greater (see (12)). Fig. 4 also indicates that lobby group coordination costs in large energy intensive sectors have similar effects as in the full sample (Fig. 1). This again suggests that the effect of corruptibility depends on lobby group coordination costs.

Fig. 5 and 6 explicitly plot the separate effects of the two lobby groups in energy intensive sectors. The relationship between *ENERGYINTENSITY* and *VALUEADDED%* for the energy intensive sectors (conditional on *CORRUPT*) is non-linear.[35] [FIG. 5 HERE] It appears that when the stakes are high, capital owners are able to overcome coordination problems once the sector's size is sufficiently large.[36] Fig. 6 shows the relationship between *ENERGYINTENSITY* and *EMPLOYMENT%* for energy intensive sectors (conditional on *CORRUPT*).[37] [FIG. 6 HERE] In energy-intensive sectors, the peak of the inverted-u occurs substantially earlier than in the full sample

[35] This finding is consistent with Guttman (1978) who finds that the effect of the number of producers on political influence on agricultural policy is more likely positive when a state has a relatively large number of farmers.

[36] An alternative explanation could be that large sectors benefit from various subsidies that reduce the net energy price. This is a topic for future research that is outside the scope of this paper.

[37] The peak for *ENERGYINTENSITY* and *EMPLOYMENT%* occurs at 3.7% with 22% of the observations to the right of the peak. These figures for *ENERGYINTENSITY* and *VALUEADDED%* are 5.1% and 9%, respectively.

(Model 4). The non-linear effects are strong in these sectors, suggesting that the worker lobby's coordination problems emerge at substantially lower levels of sector employment. This may be explained by the fact that according to Antweiler *et al*. (2001), energy intensive sectors are relatively capital-intensive. Thus, the workers' stakes are relatively lower in energy intensive sectors. For energy extensive sectors (Model 6), most of the (relevant) coefficients are similar to Model 4. Thus, the energy extensive sectors appear to drive the results in the full sample (Model 4), but sector energy intensity is important for the effect of corruptibility and coordination costs.

Turning to the control variables in Table 3, *GDPPC* has a significant positive sign in some models, implying that richer countries may permit greater energy use per unit of output. *ELECTRICITYPRICE* is significant with a positive sign in most models. *CAPITALPRICE* is also significant in most models with the expected (positive) sign, while *WAGES* is never significant. The explicit controls reflecting factor prices thus appear less robust than our main variables, indicating that political variables are relatively important for energy efficiency.

Discussion of Results

Why does *EMPLOYMENT%* tend to raise *ENERGYINTENSITY* for part of the sample range (especially in energy intensive sectors)? We can provide several explanations that together contribute to this empirical result, relying both on our theoretical framework and on the previous literature: (i) Prediction 3 suggests that when the effect of coordination costs on capital owner lobbying is great, the effect is small on worker lobbying. In particular, when $lf_{l\alpha}$ in the numerator of (15) is small, the numerator of (14) is large (thus, for small values of $lf_{l\alpha}$, $\partial\alpha/\partial\lambda^W \rightarrow 0$). Fig. 2 and 3 (partially) reflect such a relationship. Whereas capital owners suffer severely from coordination costs, the effect on workers is minor for a large part of the sample range. (ii) Moreover, expressions (14) and (15) also imply that coordination costs have little impact when these costs are high. If coordination costs (λ^W) are high in the average sector even for small worker groups (possibly due to fixed costs), a further increase in the worker lobby group size has a minor impact on energy intensity, according to (15). This may explain the relatively flat curve for the worker lobby in Fig. 3.

The reasons for why Fig. 6 (Model 5) shows that greater employment more strongly raises energy intensity in energy intensive sectors for small worker lobby group sizes include: (iii) the energy intensive sectors may have too few employees for coordination costs to emerge as a major problem (Olson (1965)) (see Table 2 for descriptive statistics, in particular the relatively small mean sector size). Instead, when a sector employs a relatively small percentage of all workers, lobby group size may have a positive effect on lobbying success, as reported by Miller (1991). Miller argues that a greater number of farmers has a positive impact on their political influence in developed countries, but a negative effect in developing countries. This is consistent with our findings for workers in energy intensive sectors, since farmers are fewer in rich countries. Moreover, as discussed by Grossman and Helpman (1994), the equilibrium bribe given by each lobby *i* must compensate the government and the remaining lobby groups for the welfare losses experienced as a result of the participation of lobby *i* in the bribery activities. Since the welfare effects of energy policy changes may differ depending on sector size (both on capital and labor income, as well as the environmental effects), the required bribe from the worker group would vary accordingly. Raising the necessary funds will be easier when the environmental effects are small, for example (the required amount is smaller). This is more likely in small sectors. (iv) Worker groups having greater electoral resources may exert greater political pressure, as discussed by, e.g., Stigler (1971).

(v) Unionization (which is easier in small sectors see Farber (2001)) may help overcome collective-action problems (see Bloch (1993)).[38] (vi) As suggested by Schonhardt-Bailey (1991), geographically dispersed industries (dispersion is likely to be increasing with size) have leverage on a

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[38] As pointed out by a referee, trade unions may partly exist to overcome coordination problems. Since each worker has a limited income from which to contribute to the political fight, a larger work force may raise greater funds that help cover fixed costs and which also can be used to offer bribes. We are grateful to the referee for this explanation, the details of which however are left for future research.

larger group of local representatives and consequently a wide political support base. This effect may be at work in small sectors.

As shown in Fig. 3 and 6, at some size of the worker group, coordination costs dominate the political forces discussed above, and a further increase in sector size is associated with lower energy intensity. In sum, many factors influence the relationship between (potential) lobby group size and political influence, and the relationship between sector employment and energy policy outcomes appears intricate. As argued by Potters and Sloof (1996, p. 418), “Probably the relationship between numbers and influence is not a linear one, and perhaps not even a monotonic one.”

Robustness analysis

We extensively tested whether the results are driven by any particular features of our data, or the econometric specification. To test whether the use of the Hodrick-Prescott filter biases our main results, we estimated Model 4 with an arbitrary interpolation based on a linear approach. This yields results similar to earlier findings.[39] Table 4 presents a robustness analysis which builds on our preferred Model 4 from Table 3 [TABLE 4 HERE]. Italy is a probable outlier, in our view. Throughout the sample period, Italy has the highest level of *CORRUPT* in the data set. The remaining countries’ *CORRUPT* values show variation only at the end of our sample period (some gradually approaching Italy). The main effect of excluding Italy from the sample (Model 7) is that the direct effect of *CORRUPT* is significant only at the 10% level. This finding suggests that Italy might drive our results for *CORRUPT*.

However, further testing with shorter subsamples (of later date) shows that Italy by itself is not responsible for our basic findings, but confirms (perhaps not surprisingly) that enough variation in *CORRUPT* is important. The smallest sample for which iteration is still possible is from 1987-1996. Here the presence of Italy makes no difference (see Models 8 and 9). Moreover, for 1992-96 we find

[39] In general, while the coefficients for the direct and indirect effect are similar for Models 1-3 as well, the test statistics are worse (as one might expect). Results are available on request.

no further evidence that Italy drives our results for *CORRUPT* (see Models 10-11).[40] On the contrary, excluding Italy improves our results for *CORRUPT* and its interactions. The larger variance in *CORRUPT* towards the end of the sample period appears responsible for its effect in Model 4. Note also that *GDPPC*, *OILPRICE* and *ELECTRICITYPRICE* have the expected negative sign in Models 9 and 11 (Italy excluded).

Another issue is our normalization of sector size across countries. *VALUEADDED%* and *EMPLOYMENT%* do not account for differences in sector sizes between countries. The organization problems in larger sectors might be more severe in larger countries. However, further testing with the logarithm of the absolute number of sector size yields similar results for all models presented in Table 3, except for the direct effect of *CORRUPT* and the interaction effects with *CORRUPT* in Model 4. The results for energy-intensive sectors are more robust (Model 5), with only the interaction *CORRUPT*VALUEADDED* no longer significant. Moreover, reestimating Model 4 using the most recent data for which iteration is possible (1985-1996) yields results similar to Model 8, (again) indicating insufficient variation in *CORRUPT* in the early part of the sample period.[41] We therefore have little reason to believe that absolute sector size differences across countries make a difference, and prefer the model with relative measures.

Given the absence of intra-sector variation in the *CORRUPT* variable, we also investigated whether our results are sensitive to the inclusion of particular sectors. Our results appear insensitive to the choice of sectors. For instance, estimating Model 4 without the Commercial Service sector (with the largest values for both *VALUEADDED%* and *EMPLOYMENT%*), does not influence our basic results. The same holds for the exclusion of other sectors. Even with subsamples of several sectors, like in the case of energy-extensive and energy-intensive sectors, the results are robust (compare

[40] Because iteration is no longer possible for these subsamples, these estimates are based on a one-step weighing matrix.
[41] This problem is likely to be aggravated by the much larger spread in the logarithm of the absolute measures for the energy-extensive subsample compared with the energy-intensive subsample. This also contributes to the weak

Models 6 and 7, Table 3). A final issue is endogeneity.[42] However, we consider it is unlikely that corruptibility (corruption) is affected by energy intensity or energy policy. La Porta *et al*. (1999), e.g., argue that corruption depends on cultural and historical factors.

V. CONCLUSION

This paper seeks to explain the effect of corruptibility and lobby group size on policy outcomes. Our theory separates lobbies' (i) incentives to offer a bribe (the amount at stake) and (ii) its ability to coordinate bribery (coordination costs), from (iii) the government's willingness to be bribed (degree of corruptibility). These three factors together contribute to a special interest group's success in the policy process. The theory predicts that greater corruptibility of policy makers and greater lobby group coordination costs reduce the stringency of energy policy. Moreover, the effects of coordination cost on bribery by the worker and capital owner groups are inter-related. If the effect of energy policy on the wage rate is small (large), coordination costs have little (a large) impact on worker bribery. On the other hand, the effect on capital owner bribery is great (small) in this case.

We find general empirical support for the model's predictions. Our corruptibility measure strongly correlates with the energy intensity of production. Lobby group coordination costs also affect energy policy (energy intensity), and the effect of lobby group size is conditional on the level of corruptibility. Finally, we find evidence of an inter-relationship between the impacts on energy policy outcomes of a sector's worker lobby group and its capital owner lobby group. The worker lobby appears relatively influential in precisely those sectors in which the capital owners have a relatively minor impact, and vice versa.

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performance of Model 4 with the absolute measures given the dominance of the energy-extensive subsample in generating the overall results of Model 4.

[42] Using legal origin to instrument for corruptibility (often used in the literature) is not particularly helpful in our case as legal origin is time invariant. Note that most papers on corruption are based on cross-sectional estimations and lack a reliable corruption measure over time.

Our results may have policy implications. For example, compliance with the Kyoto Protocol may be facilitated by reforms aimed at reducing corruption and corruptibility in OECD countries.

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Table 1. Sample ISIC Industries

ISIC Code	Industry	*Mean ENERGY-INTENSITY*
Manufacturing industries		
31	Food, Beverages and Tobacco	166
32	Textiles, Apparel and Leather	107
33	Wood, Products and Furniture	178
34	Paper and Paper Products, Printing and Publishing	468#
36	Non-Metallic Industry	650#
37	Basic Metal Industry	859#
384	Transport Equipment	54
Other industries		
50	Construction	27
71	Transport	1385#
11-13	Agriculture, Forestry and Fishing	183
61+62+63+72+81+82+83+ 91+92+93+94+95+96	Commercial Services	58

Notes: # Denotes sectors classified as Energy Intensive.

Table 2. Descriptive Statistics

	Mean	Std. Dev.	Maximum	Minimum
ENERGYINTENSITY	380.1	489.9	3190.4	2.2
ENERGYINTENSITY#	806.2	560.5	3190.4	75.8
CORRUPT	2.1	1.3	6.6	0.8
VALUEADDED%	5.0	9.9	55.6	0.2
VALUEADDED%#	2.1	1.7	8.0	0.2
EMPLOYMENT%	4.6	8.8	56.4	0.2
EMPLOYMENT%#	2.1	1.6	5.5	0.2
GDPPC	16.7	2.1	23.0	12.8
*CORRUPT*EMPLOYMENT%*	8.9	15.3	128.0	0.2
*CORRUPT*VALUEADDED%*	9.2	16.8	124.2	0.2
ENERGY%	4.7	7.3	39.2	0.0
ENERGY%#	8.6	9.9	39.2	0.5
*ENERGY%*EMPLOYMENT%*	36.3	103.9	699.3	0.0
*ENERGY%*VALUEADDED%*	40.7	119.0	926.3	0.0
OILPRICE	0.16	0.07	0.36	0.07
ELECTICITYPRICE	0.06	0.03	0.13	0.02
CAPITALPRICE	0.06	0.02	0.14	0.02
WAGES	0.02	0.01	0.07	0.00

Notes: # Denotes the descriptive statistics for sectors classified as Energy Intensive only.

Table 3. Results

Model:	(1)	(2)	(3)	(4)	(5)	(6)
		All sectors			Energy Intensive Sectors	Energy Extensive Sectors
CORRUPT	1.04***	3.13***	1.21***	2.56***	29.97***	2.46***
	(0.35)	(0.41)	(0.33)	(0.39)	(5.77)	(0.40)
VALUEADDED%	-3.58***	-5.01***	-3.19***	-4.35***	-322.43***	-3.77***
	(0.43)	(0.66)	(0.41)	(0.47)	(22.05)	(0.47)
VALUEADDED%^{2}	0.02***	0.01	0.00	0.00	56.54***	-0.01*
	(0.01)	(0.01)	(0.01)	(0.01)	(3.86)	(0.01)
EMPLOYMENT%	1.95***	4.49***	1.70***	3.42***	358.70***	2.93***
	(0.37)	(0.70)	(0.33)	(0.41)	(36.53)	(0.40)
EMPLOYMENT%^{2}	-0.06***	-0.04***	-0.04***	-0.02***	-97.75***	-0.01***
	(0.01)	(0.01)	(0.01)	(0.00)	(6.11)	(0.00)
*CORRUPT*VALUEADDED%*		0.37***		0.35***	12.88**	0.45***
		(0.14)		(0.07)	(5.50)	(0.08)
*CORRUPT*EMPLOYMENT%*		-0.68***		-0.53***	-21.05***	-0.64***
		(0.14)		(0.08)	(5.78)	(0.09)
*ENERGY%*VALUEADDED%*			0.14***	0.23***	-17.94***	0.24***
			(0.04)	(0.03)	(1.19)	(0.03)
*ENERGY%*EMPLOYMENT%*			-0.06	-0.19***	27.14***	-0.20***
			(0.06)	(0.04)	(1.41)	(0.04)
GDPPC	0.36*	0.63**	0.23	0.45**	7.72***	0.36
	(0.22)	(0.26)	(0.21)	(0.23)	(2.57)	(0.23)
OILPRICE	1.99	0.31	1.90	1.21	-9.27	1.85
	(1.57)	(1.74)	(1.47)	(1.55)	(20.26)	(1.65)
ELECTRICITYPRICE	13.73	34.72**	10.67	27.70**	333.06**	45.80***
	(11.59)	(13.89)	(11.18)	(12.53)	(160.57)	(13.54)
CAPITALPRICE	8.61*	6.03	9.98**	9.64**	142.67**	13.14***
	(4.49)	(5.01)	(4.27)	(4.47)	(68.48)	(4.45)
WAGES	-2.72	34.58	11.69	26.08	-82.90	-14.15
	(37.05)	(42.96)	(34.97)	(37.48)	(364.49)	(35.92)
Adjusted R^2	.99	.99	.99	.99	.99	.99
Observations	1506	1506	1506	1506	581	912
Groups	116	116	116	116	44	71

Notes: Generalized LS regressions (cross section weights with iteration); dependent variable is *ENERGYINTENSITY*; Standard errors in parenthesis. ***[**](*) denotes significance at the 1[5](10) percent level. All estimations use sector specific fixed effects as well as sector specific trends. Model (5) presents results for energy-intensive sectors and Model (6) for energy-extensive sectors only.

Table 4. Robustness Analysis

Model:	(7)	(8)	(9)	(10)	(11)
	1982-1996	1987-1996		1992-1996	
	Excl. Italy	Incl. Italy	Excl. Italy	Incl. Italy	Excl. Italy
CORRUPT	0.88*	4.15***	3.78***	42.06**	84.34***
	(0.54)	(0.65)	(1.24)	(19.78)	(18.65)
VALUEADDED%	-5.12***	-8.89***	-7.89***	-124.61***	-105.90***
	(0.49)	(0.81)	(0.59)	(31.94)	(17.43)
VALUEADDED%^{2}	0.00	0.02**	0.01	0.86	0.39
	(0.01)	(0.01)	(0.01)	(0.61)	(0.35)
EMPLOYMENT%	2.81***	6.25***	6.70***	81.28**	79.08***
	(0.44)	(0.70)	(0.64)	(36.50)	(20.95)
EMPLOYMENT%^{2}	-0.01**	-0.03***	-0.04***	-0.46	-0.27
	(0.00)	(0.01)	(0.01)	(0.53)	(0.29)
*CORRUPT*VALUEADDED%*	0.56***	1.20***	1.59***	12.49	17.02**
	(0.10)	(0.16)	(0.17)	(10.17)	(7.70)
*CORRUPT*EMPLOYMENT%*	-0.71***	-1.39***	-1.79***	-15.00	-21.85**
	(0.11)	(0.19)	(0.21)	(12.19)	(9.06)
*ENERGY%*VALUEADDED%*	0.24***	0.26***	0.23***	1.34	1.46
	(0.03)	(0.03)	(0.03)	(2.56)	(1.35)
*ENERGY%*EMPLOYMENT%*	-0.19***	-0.12***	-0.09*	-0.39	-0.47
	(0.04)	(0.04)	(0.04)	(3.10)	(1.64)
GDPPC	0.57**	-0.07	-0.85***	-7.71	-0.75
	(0.28)	(0.21)	(0.26)	(10.39)	(6.16)
OILPRICE	0.27	5.65**	-14.04***	-154.14	-106.06*
	(2.13)	(2.56)	(3.87)	(101.28)	(53.84)
ELECTRICITYPRICE	9.11	6.94	-46.89***	-582.78	-648.75**
	(17.58)	(12.77)	(17.56)	(328.43)	(282.21)
CAPITALPRICE	14.17*	7.03	25.65***	206.38	-178.43*
	(7.56)	(4.35)	(7.81)	(225.02)	(95.41)
WAGES	-9.05	-75.75*	41.94	-457.58	-1711.6***
	(42.55)	(42.27)	(37.88)	(882.52)	(506.21)
Adjusted R^2	.99	.99	.99	.99	.99
Observations	1360	937	841	367	321
Groups	106	116	106	106	96

Notes: All models are Generalized LS regressions using cross section weights; Models (7)-(9) are with and Models (11) and (12) without iteration; dependent variable is *ENERGYINTENSITY*; Standard errors in parenthesis. ***[**](*) denotes significance at the 1[5](10) percent level. All estimations use sector specific fixed effects as well as sector specific trends.

Figure 1. Energy Intensity and Corruptibility

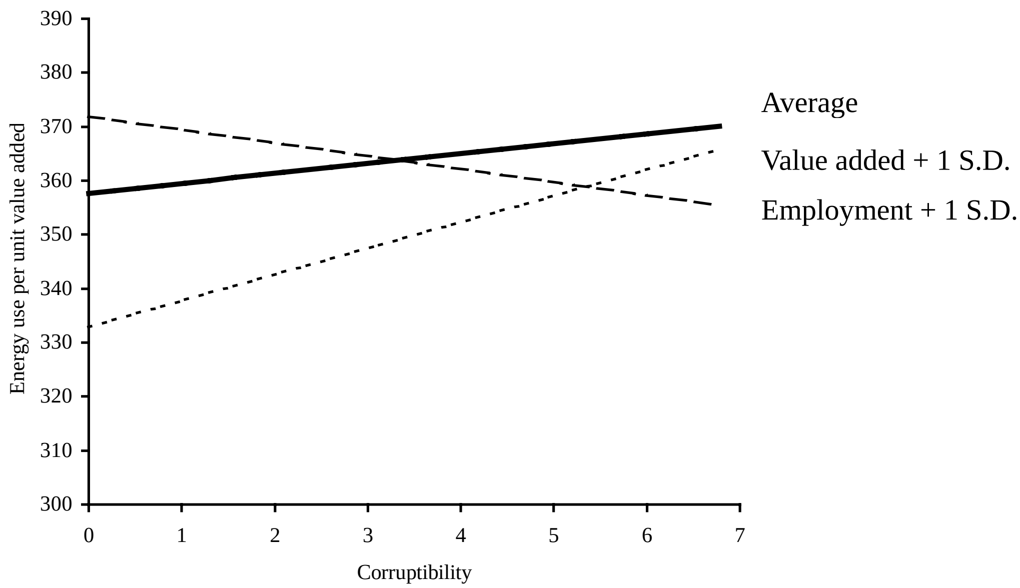
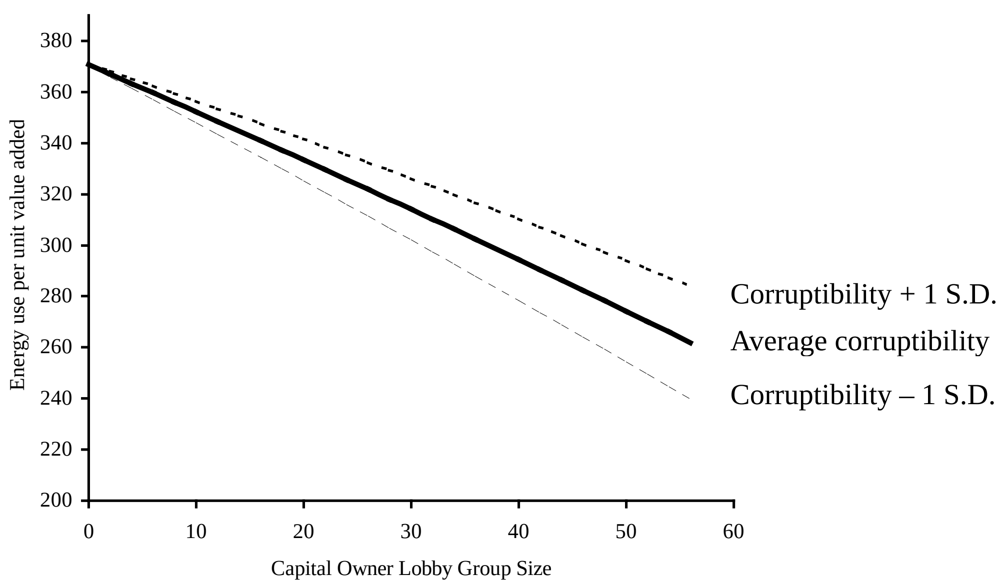
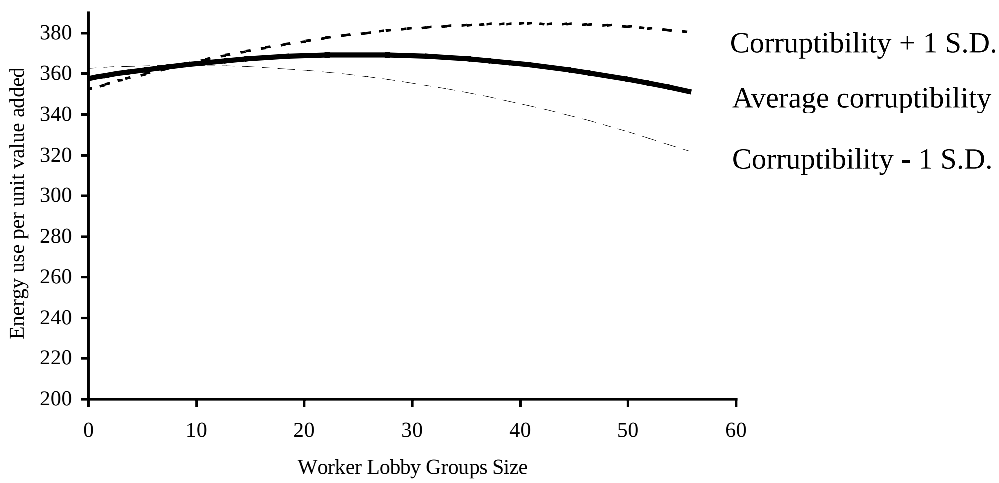


Figure 2. Energy Intensity, Capital Owner Lobby Group Size, and Corruptibility



Notes: Capital owner lobby group size is measured by the sector's share of total value added (%).

Figure 3. Energy Intensity, Worker Lobby Group Size, and Corruptibility



Notes: Worker lobby group size is measured by the sector's share of total employment (%).

Figure 4. Energy Intensity and Corruptibility: Energy Intensive Sectors

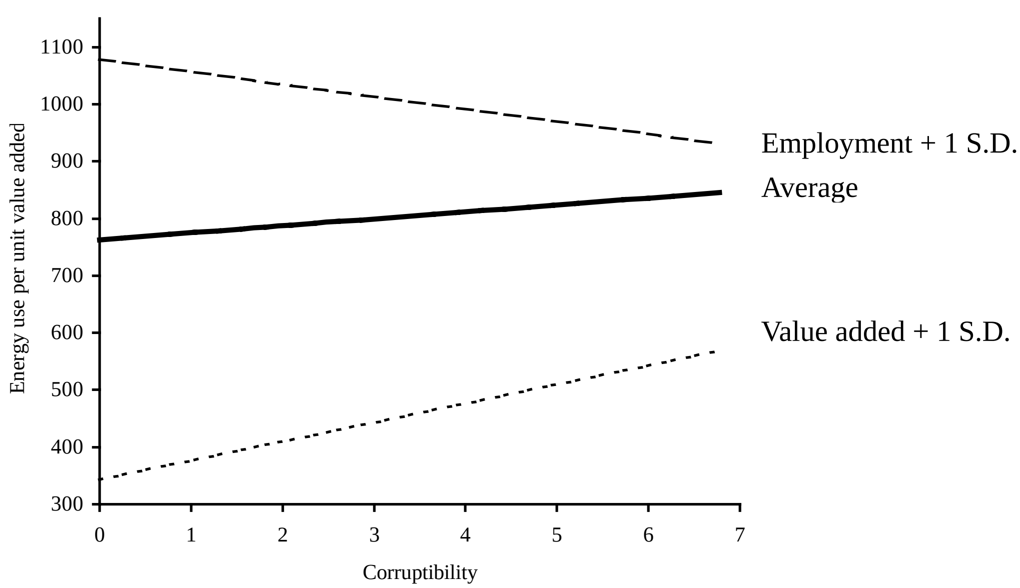
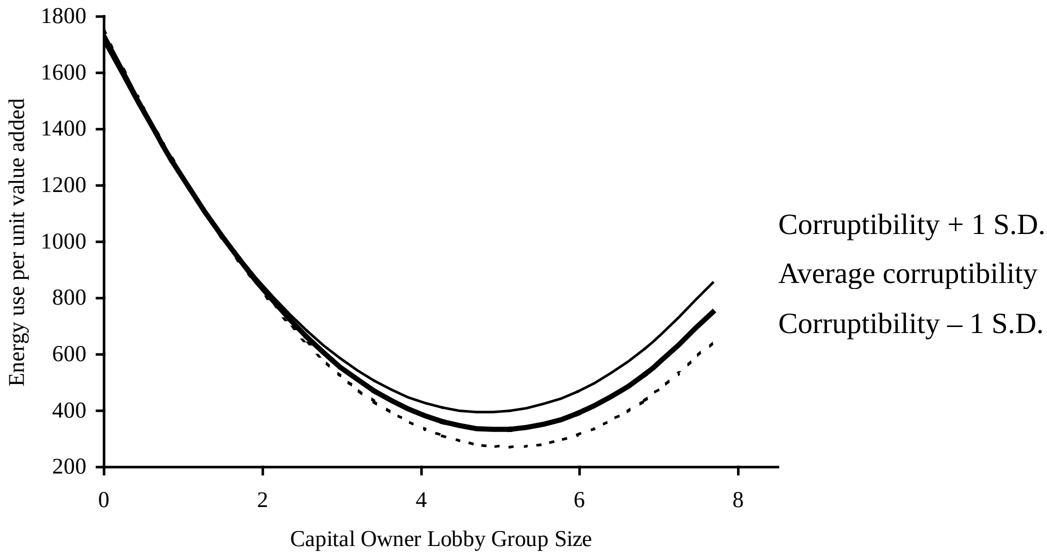
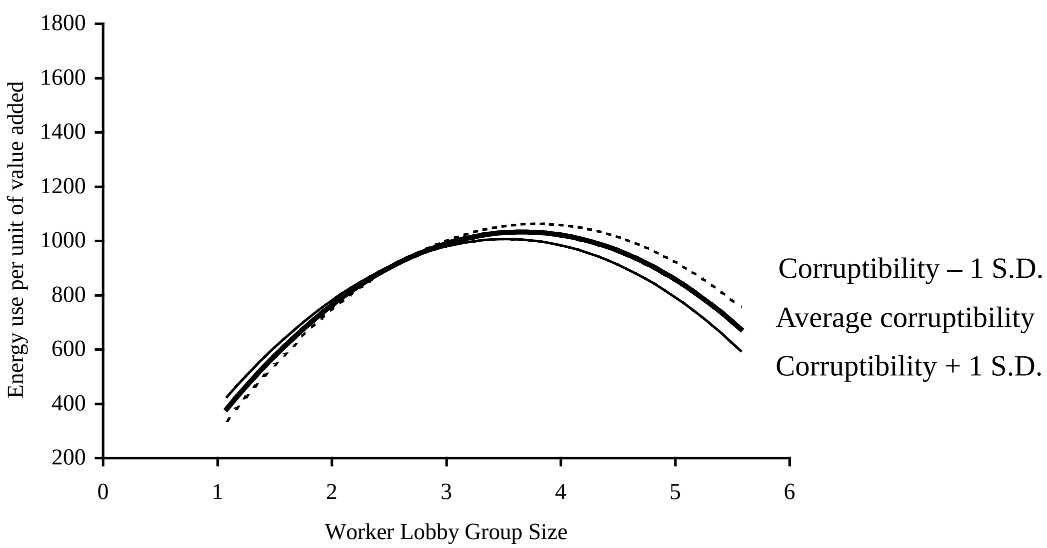


Figure 5. Energy Intensity, Capital Owner Lobby Group Size, and Corruptibility: Energy Intensive Sectors



Notes: Capital owner lobby group size is measured by the sector's share of Value Added (%).

Figure 6. Energy Intensity Worker Lobby Group Size, and Corruptibility: Energy Intensive Sectors



Notes: Worker lobby group size is measured by the sector's share of total employment (%).

Appendix
Sources and Variable Construction

ENERGYINTENSITY
Source: OECD/IEA Energy Balances and IDSB/STAN
Energy use of sector *i* in country *j* relative to its own value added (constant 1990$ against PPP)

CORRUPT
Source: Transparency International (http://www.transparency.de/documents/cpi/2000)
Transformation: values in this paper = 10 – original values; we interpolated the scores for 1986 and 1987 and 1993-1995 from the data for the periods 1980-1985 and 1988-1992 and the figure for 1996. Interpolation based on the Hodrick-Prescott filter.

EMPLOYMENT%
Source: ISDB/STAN
Percentage of employees of a particular sector *i* relative to total number of employees in country *j*

VALUEADDED%
Source: ISDB/STAN
Percentage value added of a particular sector *i* relative to total value added of all sectors in country *j*

GDPPC
Source: OECD Statistical Compendium 2000/1, OECD/IEA, Paris
GDP data per capita are GDP at market prices (constant 1990 US $ against PPP) divided by population for each country in each year. Our GDP measure is based on the average GDP in the previous three years.

ENERGY%
Source: OECD/IEA Energy Balances
Percentage energy use of sector *i* in total final energy consumption (TFC) in country *j* (including feedstock)

OILPRICE
Source: OECD/IEA Energy Prices and Taxes
Price of High Fuel Oil Industry (constant 1990 US $ against PPP per Ton)

ELECTRICITYPRICE
Source: OECD/IEA Energy Prices and Taxes
Industrial electricity price (constant 1990 US $ against PPP per kWh)

WAGES
Source: ISDB/STAN
Sector specific wages constructed from the compensation of employees (constant 1990 US $ against PPP) divided by the number of employees in sector *i*

CAPITALPRICE
Source: IMF Statistics
Country specific real interest rates (GDP deflated) in percentages.