Environmentalism, Democracy, and Pollution Control

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Abstract

This paper makes two empirical contributions to the literature, based on predictions generated by a lobby group model. First, we investigate how environmental lobby groups affect the determination of environmental policy in rich and developing countries. Second, we explore the interaction between democratic participation and political (electoral) competition. The empirical findings suggest that environmental lobby groups tend to positively affect the stringency of environmental policy. Moreover, political competition tends to raise policy stringency, in particular where citizens' participation in the democratic process is widespread.

Keywords: Environmentalism, democracy, environmental regulations, policy.

1. Introduction

This paper investigates how environmental lobby groups, citizens' participation in the democratic process, and the degree of electoral competition affect the determination of environmental policy in rich and developing countries.

A prominent feature of the political landscape in the last few decades is the emergence of various environmental lobby groups (Wapner [61]). Their impact appears to be rising. On fishing, for example, Todd and Ritchie [57, p. 148] argue that "the tide is slowly turning in favour of the ENGOs on fisheries issues."[1] However, surprisingly little research has examined the impact of environmental lobby groups on environmental policy. Hillman and Ursprung [27], Fredriksson [19], Aidt [1], and Conconi [6,7] study the theoretical effects of environmental lobby groups on environmental policy outcomes.[2] The empirical literature includes Kalt and Zupan [32], Durden *et al*. [14], Fowler and Shaiko [18], Cropper *et al*. [9], VanGrasstek [59], and more recently, Riddel [54].[3] These empirical studies have focused on only one single country. No study exists of the effects of environmental lobbying on policy outcomes

[1] ENGO is here an acronym for environmental non-governmental organization.

[2] Smith [57] uses club theory to explain individuals' decision to join an environmental lobby group.

[3] Kalt and Zupan [32] and Durden *et al*. [14] examine the impact of environmental groups on coal strip-mining regulation. Fowler and Shaiko [18] investigate the role of grass-roots environmental lobbying efforts in the US Senate. Both Kalt and Zupan [32] and Fowler and Shaiko [18] report weak and inconsistent relationships between lobbying efforts of interest groups and roll call votes. Durden *et al*. [14] report that environmentalists had below average impact on coal strip-mining legislation. VanGrasstek [59] finds an effect of environmental lobby groups' political action during the NAFTA negotiations in the US Senate, Cropper *et al*. [9] finds that intervention by environmental advocacy groups raise the probability that the USEPA cancelled a pesticide registration, and Riddel [54] shows that the Sierra Club and the League of Conservation Voters have been successful in influencing US Senate election outcomes using campaign contributions (via political action committees). Note that Jackson and Kingdon [31] demonstrate that using an index of other roll call votes as a proxy for members' ideology produces inconsistent estimates of the coefficients (see also Smith [55]).

across countries. Moreover, no study examines the environmental policy impacts of environmental lobbying across different political regimes.

Our first main objective is to fill these gaps in the literature. One additional aim is to contribute to the ongoing policy debate on how to improve local and global environmental policymaking. Can foreign donors and international organizations expect to contribute to improved local and global environmental quality by supporting local environmental lobby groups (non-governmental organizations (NGOs)) in developing countries as currently done by the World Bank, among others?[4]

The second main objective of the paper is to contribute with a novel perspective to the small but growing literature on the relationship between democracy and environmental policy making (see, e.g., [8], [44], [13]).[5] We argue that an important interaction effect on environmental policy exists between

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[4] For example, the stated objectives of the Critical Ecosystem Partnership Fund (a joint initiative of Conservation International, the Global Environment Facility, the Government of Japan, the MacArthur Foundation, and the World Bank) are to serve as a catalyst to create strategic working alliances among diverse groups, to combine capacities and eliminating duplication of efforts for a comprehensive and coordinated approach to conservation challenges, to encourage local dialogue with extractive industries, and to strengthen indigenous organizations and facilitating partnerships. See www.cepf.net/xp/cepf/about_cepf/index.xml (visited May 5, 2003) for further details.

[5] In his theoretical work, Congleton [8] examines how environmental regulations are set to maximize the utility by (*i*) the median voter in a democratic system, and by (*ii*) an authoritarian ruler in a non-democratic system. Two forces drive Congleton's theoretical results (Deacon [13] provides related arguments). First, a shorter time horizon of the policy maker leads to less stringent environmental regulations, because of the long-term nature of many environmental problems. Arguing that authoritarian rulers tend to have a shorter time horizons, Congleton's model predicts that democracies have stricter environmental regulations than non-democracies due to this effect. Second, the authoritarian ruler appropriates a larger share of economy's income, which has an ambiguous effect on the strictness of environmental regulations. On the one hand, Congleton [8, p. 416] argues that for an autocrat, 'An increase in the fraction of national income going to the individual of interest increases the marginal cost of environmental standards faced by him, since he will now bear a larger fraction of associated reductions in national income' (see also [38]). On the other hand, appropriation of a larger share of the national income might also lead to stricter environmental standards if we assume that environmental quality is a normal, if not a

(i) the level of *democratic participation* by the general population, and (ii) the degree of *electoral competition*.[6,7]

We start by developing a theoretical model that provides guidance for our empirical work. First, the environmentalists organize their lobbying effort by forming lobby groups with identical environmental objectives. The number of environmental lobby groups that emerges depends on their collective action costs. We assume that the environmentalists face collective action costs that are increasing in group size, possibly due to their geographical dispersion or because of the administration and enforcement costs of large groups (see [49]). A single industry group with negligible collective action costs opposes their efforts.[8]

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luxury good. Congleton [8] finds that more democratic countries are more likely to sign or enact national legislation supporting the Montreal Protocol on chlorofluorocarbon (CFCs) emissions. Further empirical evidence is provided by Murdoch and Sandler [44] and Murdoch *et al*. [45], who show that more democratic countries cut back more on chlorofluorocarbon and sulphur oxide emissions. Deacon [13] reports that more democratic countries tend to provide greater levels of public goods (including greater access to safe water and sanitation). Democratic countries ratified faster the United Nations Framework on Climate Change (Fredriksson and Gaston [20]), the Convention on Biological Diversity and the Convention on International Trade in Endangered Species (Neumayer [47]). Neumayer [46] and Neumayer et al. [48] also find that more democratic countries put a higher percentage of land area under protection status and comply better with reporting requirements of multilateral environmental agreements. However, this existing empirical literature has ignored the level of democratic participation.

[6] The democratic participation variable is calculated as the percentage of the total population participating in elections. The electoral competition variable is calculated by subtracting the percentage of votes won by the largest party from 100.

[7] Mueller and Stratmann [43] find that high levels of democratic participation are associated with more equal income distribution, larger government sectors, and lower growth rates (see also [39] and [34]). The interaction between democratic participation and political competition is ignored in their paper.

[8] The industry owners are considerably fewer and more concentrated, and are therefore assumed to face relatively small collective action costs.

Each lobby group seeks to influence the same policymaker (in the same legislature) with the help of prospective campaign contributions (Grossman and Helpman [25]). The government values campaign contributions and aggregate social welfare. However, social welfare is taken into consideration only to the extent that (i) the average voter is expected to participate in the next election (implicitly modeled), and (ii) the next election is competitive.[9] Thus, the greater the number of disenfranchised citizens and the lower the level of political competition expected by the government, the greater is the relative weight that the government places on the political contributions from the environmental and industry lobby groups. Essentially, where the level of democratic participation (political competition) is expected to be relatively high, the policy maker's ability to deviate from the welfare maximizing policy is more restricted, given the degree of political competition (democratic participation rate).[10]

The predictions that emerge are that (i) an increase in the number of environmental lobby groups leads to a more stringent environmental policy, (ii) a greater degree of democratic participation leads to a more stringent environmental policy, (iii) greater political competition yields a stricter environmental policy, and (iv) the effect of democratic participation (political competition) is *conditional* on the level of political competition (democratic participation).

We test these predictions using cross-country data from 82 developing and 22 OECD countries on the regulation of lead content in gasoline. The empirical findings are largely consistent with the predictions of the model. First, we find evidence that an increase in the number of environmental lobby groups tends to lower the lead content of gasoline. This empirical result may have policy implications. The support of environmental lobby groups in developing countries may be a channel through which international donors can help improve local and global environmental policymaking. This may

[9] The democratic participation part of our model is reminiscent of Deacon's [13] model of an uncontested minority political elite, although in our model the franchise may range from close to the entire population to a small minority.

[10] In Baron [2] and Grossman and Helpman [25] campaign contributions may be used to enlighten voters about the positions of candidates, or purchase impressionable voters' support.

facilitate compliance with global international environmental agreements such as the Kyoto Protocol on CO_2 emissions.

Second, whereas citizens' democratic participation has no environmental policy effect by itself, greater political competition tends to lower lead content in gasoline, *in particular* where the level of political participation is high. However, democratic participation affects environmental policy stringency *only* in countries with sufficiently high degree of political competition. Thus, democratic participation has *no* effect in pure dictatorships. We believe these are new findings in the literature.

While these results are true in our full sample, the developing country results suggest that democratic participation has never any effect in this group of countries, possibly due to threshold effects or to different policy preferences among the very poor. In our view, compared with previous studies in the literature, the results suggest a more detailed channel through which various aspects of democracy (participation and competition) affect environmental policies.

The paper is organized as follows. Section 2 sets up the model, and Section 3 analyses the effects of the number of environmental lobby groups and democratic participation rates. Section 4 presents our empirical work. Section 5 concludes.

2. The Model

A small open economy has a "clean" sector producing a numeraire good *z*, and a polluting sector producing a good *x*. The economy has consumers and firms, where the population is normalized to 1. A share $\alpha^E < 1$ of the consumers derive disutility from pollution associated with the local production of good *z*, and become environmentalists. A consumer has utility given by[11]

$$U = c^z + u(c^x) - \delta^e X\theta, \tag{1}$$

[11] Corner solutions may result with quasi-linear preferences. Interior solutions are assumed.

where c^z and c^x are consumption of the numeraire good z and good x, with world and domestic prices equal to 1 and p^*, respectively.[12] $u(c^x)$ is a strictly concave and differentiable sub-utility function. Production of x by each of the $n \geq 1$ identical firms is given by x_i, where $nx_i = X$. δ^e is an indicator variable that takes a value of one if the consumer suffers disutility from pollution (i.e., if she is an environmentalist), and zero otherwise. θ is the per-unit damage from pollution, which depends on the amount h_i spent by the firm on pollution control per unit of output, where $\theta_h < 0$, and $\theta_{hh} > 0$. Thus, $X\theta$ represents aggregate emissions. The negative externality is regulated by the government which employs a pollution tax $t \in T$, $T \in$ R, on per unit of damage from production of good x.

Good z is produced with constant marginal cost equal to one. The cost of producing good x is given by $v(x_i, h_i)$, where we assume $v_x > 0$, $v_h > 0$, $v_{xx} > 0$, $v_{hh} > 0$, and that $v_{hx} > 0$, but "negligible". Given the pollution tax, the profit function of each firm is given by

$$\pi_i(t) = p^* x_i - v(x_i, h_i) - t\theta(h_i)x_i, \tag{2}$$

which yields the first-order conditions

$$\frac{\partial \pi_i}{\partial x_i} = p^* - v_x - t\theta = 0, \tag{3.1}$$

$$\frac{\partial \pi_i}{\partial h_i} = -v_h - t\theta_h x_i = 0. \tag{3.2}$$

Whereas equation (3.1) states that firm i will produce up to the point where the price is equal to the net-of-tax marginal cost, equation (3.2) equalizes the marginal cost of reducing pollution (by increasing pollution control costs) with the marginal gain (i.e., lower pollution taxes). Equations (3.1) and (3.2) implicitly define the equilibrium values of x_i and h_i as functions of t: $x(t)$ and $h(t)$. Applying the implicit function theorem to (3.1) and (3.2) yields $\partial x_i / \partial t < 0$ and $\partial h_i / \partial t > 0$; i.e., an increase in the pollution tax reduces output and increases pollution control expenditures.

[12] The world market price p^* is exogenously given as the country is a price taker.

Aggregate pollution tax revenues equal

$$\tau(t) = t\theta X(t), \tag{4}$$

where $X(t) = nx(t)$. We assume that tax revenues are distributed equally to all individuals (this assumption does not drive our results).[13]

The model defines a three-stage game. The timing assumptions are as follows.

Stage 1. The consumers with environmental concerns each join one of k environmental lobby groups. Similarly, the firms independently and simultaneously form their own lobby group.

Stage 2. The lobby groups offer the incumbent government a political contribution schedule each, denoted by Λ^i, $i=F,E^j$, $j=1,..., k$. A lobby's strategy consists of a continuous function $\Lambda^i(t):T \rightarrow \Re$; i.e., it offers a specific political contribution for selecting a policy t.

Stage 3. The government proceeds to set its optimal environmental policy, given the lobby groups' strategies and the expected levels of democratic participation and political competition in the next election (only implicitly modeled). The government collects the associated contribution from the lobbies. When the pollution tax has been set, the firms set output and pollution control levels.

The profits obtained by the n firms depend on the pollution tax rate. The n firms are sufficiently few that lobby group organization costs are negligible. They are assumed able to organize into one single lobby group $i=F$ that coordinates a prospective political contribution offer to the government. On the other hand, the environmentalists are many and dispersed. Thus, while the benefits of polluting are concentrated among a relatively small number of firms, the pollution costs are thinly and widely spread

[13] Let Y denote income of the representative consumer. Maximizing (1) subject to the budget constraint $Y = c^z + p^*c^x$ yields consumption functions $c^x = d(p^*) = u_c^{-1}$ and $c^z = Y - p^*d(p^*)$. The indirect utility function of a consumer can then be expressed as $V(p^*,t,Y) = Y + \delta(p^*) - \theta X$, where $\delta(p^*) = u[d(p^*)] - p^*d(p^*)$ is the consumer surplus derived from consumption of good x. Consumption of good z yields no consumer surplus.

across a larger number of individuals. Hence, as suggested by Olson [49], environmental groups are likely to face greater difficulties and costs in forming lobby groups.

To capture this we assume that each environmental lobby group j confronts organizational costs (e.g., negotiation, communication, collection, and monitoring costs) that are increasing in the number of members, N^j(we drop the lobby specific notation j where redundant).[14] For simplicity, we follow Moe [42] and assume convex lobby group collective action costs. As discussed by Potters and Sloof [52], a large number of potential participants to collective action is usually thought to raise the free riding problem, and thus collective action costs. For example, Miller [40] and Trefler [58] report negative effects of higher potential membership numbers on the degree of political influence. The collective action costs are assumed to take the form $C(N) = CN^2$. Individuals affected by pollution may each make voluntary contributions S to one single environmental lobby group, which organizes collective action. It offers the government political contributions in an attempt to obtain more stringent environmental controls.[15]

Let us consider a marginal consumer who suffers disutility from pollution. In particular, we focus on her problem of how much to contribute to an environmental lobby group (zero contribution implies no membership). Let t^{-e} be the pollution tax set in the absence of this single member's contribution to her environmental group. Define t as the tax set by the government when the member contributes to her environmental lobby. Analogously, define $D(t^{-e}) = -\theta(h(t^{-e}))X(t^{-e})$ and $D(t) = -\theta(h(t))X(t)$ as the levels of pollution damage suffered by each environmentalist with pollution tax policies t^{-e} and t,

[14] See Hamilton [26] for a study of communities' anticipated ability to undertake collective action and the siting of hazardous waste treatment facilities.

[15] It is important to note that all our results go through if environmental groups face higher lobbying costs than the firm lobby. To make the analysis transparent we consider the limiting case where the lobbying costs of the firms is normalized to zero.

respectively. Then the payoff to the individual e from joining an environmental lobby group j is given by

$$U^e = B(t) - S^e, \tag{5}$$

where $B(t) = D(t^{-e}) - D(t)$. Maximizing (5) with respect to S^e yields the first-order condition

$$\frac{\partial U^e}{\partial S^e} = -\frac{\partial D(t)}{\partial t}\frac{\partial t}{\partial S^e} - 1 = 0. \tag{6}$$

Observe that $\frac{\partial D(t)}{\partial t}$<0, hence an interior solution to (6) exists only if $\frac{\partial t}{\partial S^e}$>0. Thus, by the inverse function theorem, (6) can be rearranged into

$$-\frac{\partial D(t)}{\partial t} = \frac{\partial S^e}{\partial t}. \tag{7}$$

Equation (7) reveals that each individual pays contributions up to the point where the marginal benefits from a policy change (in the form of reduced pollution) equals the marginal cost (comprising the membership fee that is channeled into a greater potential political contribution to the government). Thus, political contributions are *locally truthful* in the sense that they reflect the benefits of a policy change.

Consider the group's optimal membership size (see also [56]). The contributions received by environmental lobby group j are used to cover the costs associated with organizing the group, CN^2, and to offer the government a contribution of size $\Lambda^{Ej} = \sum_{e=1}^{N} S^e - CN^2$. The optimal size N^* of each environmental group j is determined by maximizing the group's payoff:

$$\Omega^{Ej}(t) = N(B(t) - S^e) - CN^2. \tag{8}$$

Maximization of (8) yields the optimal size of each lobby group, defined by

$$N^* = \frac{B(t) - S^e}{2C}. \tag{9}$$

Assuming that the number of individuals affected by pollution equals α^E, the total number of organized environmental lobby groups equals $k = \frac{\alpha^E}{N^*} = \frac{2C\alpha^E}{B(t) - S^e}$. Thus, each group *j*'s membership size is uniform and equal to N^{*j}, where $\sum_{j=1}^{k} N^{*j} < 1$. We assume that no coordination takes place between the different environmental lobby groups in their organization or activities.[16]

Firm owners make up a negligible share of the population, and thus receive a negligible share of pollution tax revenues. The firm lobby's indirect utility (gross of the political contribution) is given by

$$\Omega^F(t) = n\pi(t), \tag{10}$$

where $n\pi(t)$ is the lobbying firms' aggregate profits, given the tax *t*. Once organized, environmental group *j* cares only about pollution and its gross utility function is given by

$$\Omega^{Ej}(t) = -N^{*j}\theta(h(t))X(t). \tag{11}$$

The government is concerned with political contributions and aggregate social welfare. Social welfare is given by

$$\Omega^A(t) \equiv n\pi(t) + \delta(p^*) + \tau(t) - \alpha^E\theta(h(t))X(t), \tag{12}$$

which is the sum of all profits, consumer surplus, pollution tax revenues, and aggregate disutility from pollution. The incumbent government's objective function is given by

$$G(t) \equiv \sum_{j=1}^{k} \Lambda^{Ej}(t) + \Lambda^F(t) + \gamma\mu\Omega^A(t), \tag{13}$$

which is a weighted sum of the political contributions and the level of aggregate social welfare. Whereas contributions can be used for campaign spending or incumbent politicians' personal consumption, we assume that increases in aggregate social welfare raise the probability that the

[16] Suppose instead that there was open access to each lobby group. From equation (8) then the size of each lobby group is given by $N^o = (B(t) - S^e)/C$ and all the subsequent qualitative results continue to hold.

government remains in power (not explicitly modeled).[17] The relative weight on aggregate social welfare in (13) adjusted by two factors: γ represents the (exogenous) expected democratic participation rate in the next (implicitly modeled) upcoming election, and μ is the (exogenous) expected degree of political competition in this election. We thus follow Dahl [10] and Vanhanen [60], who regard both political participation and political competition as necessary requirements for democracy.

Moreover, we take the view that only future levels of γ and μ are of importance to the incumbent, elections already passed are of little importance for the government's re-election efforts. Government politicians will therefore need to form expectations about future democratic participation and electoral competition levels. We assume that these expectations are correct.[18]

Note that a share $(1-\gamma)$ of the consumers is disenfranchised in the policy process. This is reminiscent of the formulation by Deacon [13] who studies the effects of democracy on the provision of public goods. Deacon captures democratic "inclusiveness" by using a measure of the size of the elite relative to the whole population. He argues that this variable measures "the degree to which government policy incorporates, or fails to incorporate, the interests of the entire population." (Deacon [13, p. 10]). Note that in our framework every citizen's welfare is indeed taken into consideration, but the relative weights are (possibly severely) distorted by campaign contributions and democratic participation rates below unity.

Note that γ is only a *partial* measure of the degree of democracy, because if all citizens are essentially forced (by an incumbent autocrat) to vote on only one available choice, policy makers are

[17] In the context of democratic societies this is perhaps obvious since it increases the probability that the median voter is made better off. In non-democratic systems higher welfare will also lower the expected benefits from a regime change.

[18] With regard to the application of rational expectations models to voting and elections, see MacKuen *et al*. [37] and Erikson *et al*. [16].

unlikely to put a large weight on social welfare. In this case the electoral process places no pressure on the incumbent politician to alter policies. Hence, the effect of democratic participation depends on the expected level of political competition, μ. High levels of political participation have little positive policy impact without effective choice, e.g. elections in single party dictatorships (Persson and Tabellini [51]). Nearly all studies of democracy include some notion of competition in their definition of democracy. Dahl's [10] definition of democracy, indeed, is expressed purely in terms of participation and electoral competition (or contestation).

The equilibrium in the common agency model by Bernheim and Whinston [3] maximizes the joint surplus of all parties, as discussed by Grossman and Helpman [25]. In order to conserve space, we do not derive the equilibrium condition here, but instead refer the reader to the earlier literature (see, for example, [25]). The policy outcome maximizes the joint welfare of each lobby and the government, given the other lobbies' strategies. In our set-up, the characterization of the equilibrium pollution tax, t^*, is given by

$$\sum_{j=1}^{k} \Omega_t^{Ej}(t^*) + \Omega_t^F(t^*) + \gamma\mu\Omega_t^A(t^*) = 0. \tag{14}$$

Differentiation of (10), (11), and (12) with respect to the pollution tax yields (using the envelope theorem):

$$\Omega_t^F(t) = -\theta(h(t))X(t), \tag{15}$$

$$\Omega_t^{Ej}(t) = -\alpha^E \left(\theta(h(t))\frac{\partial X}{\partial t} + X\frac{\partial \theta}{\partial h}\frac{\partial h}{\partial t} \right), \tag{16}$$

and

$$\Omega_t^A(t) = (t-1)\left(\theta(h(t))\frac{\partial X(t)}{\partial t} + X(t)\frac{\partial \theta(h(t))}{\partial h(t)}\frac{\partial h(t)}{\partial t} \right). \tag{17}$$

Note that the Pigouvian tax is found by setting equation (17) equal to zero. This yields $t = 1$, since the terms in brackets are all negative.

Note that with a uniform size of each environmental lobby, $\sum_{j=1}^{k} N^j = kN^j$. Summing (16) over all *j*, substituting the resulting expression together with (15) and (17) into equation (14), and rearranging, we find an expression for the equilibrium characterization given by

$$\underbrace{-\theta(h(t))X(t)}_{(-)} + \underbrace{\underbrace{\left(\gamma\mu(t^* - \alpha^E) - kN^j\right)}_{(-)}}_{A} \underbrace{\left(\theta(h(t))\frac{\partial X(t)}{\partial t} + X(t)\frac{\partial \theta(h(t))}{\partial h(t)}\frac{\partial h(t)}{\partial t}\right)}_{(-)} = 0. \tag{18}$$

We know that term *A* in (18) must be negative, because the remaining two terms in (18) are negative. However, the equilibrium tax rate is indeterminate in size relative to the Pigouvian tax, $t^* \gtreqless \alpha^E$. Two forces push the tax rate in opposite directions. The industry lobby pushes the tax down, whereas the *k* environmental groups all push it upwards. The industry group's pressure is captured by the first term in (18), and reflects the amount at stake (total pollution).

3. Environmental Lobbying, Participation, and Competition

In this section we analyze the effects of environmental lobby groups and the two components of democracy on environmental policy making. The aim is to derive testable hypotheses for our empirical work. We first investigate the effect of the number of environmental groups on environmental policy. Total differentiation of equation (18) with respect to *k* yields

$$\frac{\partial t^*}{\partial k} = \frac{N^j\left(\theta(h(t))\frac{\partial X(t)}{\partial t} + X(t)\frac{\partial \theta(h(t))}{\partial h(t)}\frac{\partial h(t)}{\partial t}\right)}{|D|} > 0, \tag{19}$$

where $|D| < 0$ represents the second-order condition of the government's maximization with respect to *t*, and can be derived from equation (11). $|D|$ is required to be negative for a maximum. Since the numerator is negative, equation (19) is positive. We find the following prediction.

Result 1: *In the political equilibrium, the pollution tax is increasing in the number of environmental lobby groups.*

Next, we investigate the effect of political participation on environmental policy. Differentiation of (18) with respect to γ yields

$$\frac{\partial t^*}{\partial \gamma} = \frac{\mu(\alpha^E - t^*)\overbrace{\left(\theta(h(t))\frac{\partial X(t)}{\partial t} + X(t)\frac{\partial \theta(h(t))}{\partial h(t)}\frac{\partial h(t)}{\partial t}\right)}^{(-)}}{|D|}, \qquad \forall \mu \neq 0. \qquad (20)$$

Since $|D| < 0$, Eqn. (20) is positive (negative) if $\alpha^E > (<) t^*$. Suppose environmental policy is inefficiently weak, such that $\alpha^E > t^*$. In this case, Eqn. (20) implies that the tax rate increases as the level of political participation rises. The intuition is that as the level of democratic participation rises, the government will increase its attention to social welfare relative to political contributions. This reduces the environmental policy distortion. In the case where environmental policy is inefficiently strict, such that $\alpha^E < t^*$, increased political participation alleviates the policy distortion by reducing the pollution tax. Finally, Eqn. (20) suggests that if $\alpha^E = t^*$, $\partial t^* / \partial \gamma = 0$.

Next, we find that the effect of political participation is conditional on the degree of political competition, μ. Differentiation of (20), and some rearrangements, yield

$$\frac{\partial^2 t^*}{\partial \gamma \partial \mu} = \frac{(t^* - \alpha^E)\left(\theta(h(t))\frac{\partial X(t)}{\partial t} + X(t)\frac{\partial \theta(h(t))}{\partial h(t)}\frac{\partial h(t)}{\partial t}\right)\left[\left(\theta(h(t))\frac{\partial X(t)}{\partial t} + X(t)\frac{\partial \theta(h(t))}{\partial h(t)}\frac{\partial h(t)}{\partial t}\right) + kN^j \psi\right]}{\left(|D|\right)^2}, \qquad (21)$$

where

$$\psi \equiv 2\frac{\partial X(t)}{\partial t}\frac{\partial \theta(h(t))}{\partial h(t)}\frac{\partial h(t)}{\partial t} + \theta(h(t))\frac{\partial^2 X(t)}{\partial t^2} + X(t)X(t)\frac{\partial^2 \theta(h(t))}{\left(\partial h(t)\right)^2}\left(\frac{\partial h(t)}{\partial t}\right)^2 + X(t)\frac{\partial \theta(h(t))}{\partial h(t)}\frac{\partial^2 h(t)}{\partial t^2} > 0.$$

Suppose $\alpha^E > t^*$. Eqn. (21) is positive (negative) for high (low) values of *k*, the number of environmental lobby groups, in particular when $k > (<) - \left(\theta(h(t)) \frac{\partial X(t)}{\partial t} + X(t) \frac{\partial \theta(h(t))}{\partial h(t)} \frac{\partial h(t)}{\partial t} \right) \Big/ N^j \psi$. If instead $\alpha^E < t^*$, Eqn. (21) is negative (positive) for high (low) values of *k*.

Expressions (20) and (21) yield the following prediction.

Result 2: *In the political equilibrium, if the pollution tax is inefficiently weak* (*strict*), *the pollution tax is increasing* (*decreasing*) *with the expected democratic participation rate. The effect increases* (*decreases*) *with the expected level of political competition, given that the number of environmental lobby groups is large* (*small*).

Result 2 shows that the effect of democratic participation depends on the equilibrium pollution tax relative to the efficient level. Result 2 also suggests that an interaction effect exists between the democratic participation rate and the degree of political competition. Since the number of environmental lobby groups provides a condition for the direction of the interaction effect, it may be expected to differ between rich and developing countries. We will return to this issue in our empirical work.

Next, we investigate the effect of the degree of political competition on environmental policy. Differentiation of (18) with respect to μ yields

$$\frac{\partial t^*}{\partial \mu} = \frac{\gamma(\alpha^E - t^*) \overbrace{\left(\theta(h(t)) \frac{\partial X(t)}{\partial t} + X(t) \frac{\partial \theta(h(t))}{\partial h(t)} \frac{\partial h(t)}{\partial t} \right)}^{(-)}}{|D|}, \qquad \forall \gamma \neq 0, \qquad (22)$$

which is positive (negative) if $\alpha^E > (<) t^*$. Political competition has no effect when $\alpha^E = t^*$. Finally, from (21) and Young's theorem, $\frac{\partial^2 t^*}{\partial \mu \partial \gamma} = \frac{\partial^2 t^*}{\partial \gamma \partial \mu}$, the following prediction follows.

Result 3: *In the political equilibrium, if the pollution tax is inefficiently weak* (*strict*), *the pollution tax is increasing* (*decreasing*) *with the expected degree of political competition*. *The effect increases* (*decreases*) *with the expected democratic participation rate, given that the number of environmental lobby groups is large* (*small*).

The direct effect of political competition depends on the equilibrium pollution tax relative to the efficient level. Again, since the number of environmental lobby groups provides the condition for the direction of the interaction effect, it may be expected to differ between rich and developing countries. We address this issue in our empirical work.

4. Empirical Research Design

Specification The simple model laid out above yields three testable implications for the relationship between the number of environmental lobby groups, the degree of democratic participation, and environmental policy outcomes, given by Results 1-3. First, an increase in the number of environmental lobby groups raises the stringency of environmental policy. Second, the effect of the democratic participation rate on environmental policy depends on the policy's initial degree of efficiency (whether sub-optimally weak or strong, or efficient), and the effect is conditional on the level of political competition and the number of environmental lobby groups. Third, the effect of political competition on environmental policy depends on the policy's degree of efficiency (whether sub-optimally weak or strong, or efficient), and the effect is conditional on the democratic participation rate and the number of environmental lobby groups. While the latter two implications of the theory are ambiguous (without further assumptions), they offer our empirical work the opportunity to bring some empirical clarity to the identified interaction effects.

We aim to test these implications using cross-country data on the lead content of gasoline, using (i) a data set from OECD and developing countries, and (ii) a developing country only sample.

The test can be formulated as follows,

$$t_i = \boldsymbol{x}'_i\boldsymbol{\beta}^x + \beta^k k_i + \beta^s s_i + \beta^c c_i + \beta^{sc} s_i c_i + \varepsilon_i, \tag{23}$$

where t_i is the environmental policy stringency in country i, $\boldsymbol{x_i}$ is a vector of controls, k_i is the number of environmental lobby groups in country i, s_i is the democratic participation rate, c_i is the degree of political competition, and ε_i is a zero mean error term. β^k, β^s, β^c, and β^{sc} are coefficient scalars, and $\boldsymbol{\beta}^x$ is a coefficient vector. Equation (23) allows the effect of the democratic participation rate (political competition) on environmental policy to be conditional on the degree of political competition (democratic participation rate).

The formulation in (23) does not condition the interaction effects on the number of environmental lobby groups, as specified in Results 2 and 3. However, we take this constraint into consideration by running our regressions for the developing country sample separately.[19] It is not a priori clear whether the simple linear specification in (23) is the appropriate functional form for testing our hypotheses. However, we tested for functional form misspecification with Ramsey's [53] Reset test and failed to reject the hypothesis that our linear specification is appropriate. In addition, we have tested whether any higher order terms of the explanatory variables assume statistical significance if added to the estimated model, but failed to find such evidence.

[19] In the full sample (104 obs.), the mean number of environmental lobby groups is 16.9 (std.dev. is 32.9), and in the developing country sample (82 obs.) the mean is 10.3 (std.dev. is 14.1) (data taken from the 2001 edition of Europa Publications [17]). See Table I for other years.

Dependent Variable. The stringency of environmental policy is measured by the lead content of gasoline in 1996, reported by Lovei [36]. *LEADCONTENT* measures the maximum allowed lead content in gasoline in grams per liter (see also Hilton and Levinson [28]; Deacon [13]). This is equal to zero in those countries that have completely banned leaded petrol. Unlike many other measures of the stringency of environmental policy, *LEADCONTENT* is a non-subjective indicator.[20] *LEADCONTENT* takes a value of zero grams in 15 of the countries in our sample, among them Argentina, Austria, Bolivia, and the United States. Spain and Kuwait have the highest values in the sample at 35.11 and 37.14 grams per liter, respectively. It should be noted that countries with identical lead content legislation may have implemented these pieces of legislation at widely different points in time.[21] While it is widely known that the US has been a frontrunner in reducing and eliminating lead from gasoline dating back to the 1970s, lead content policy changes in other countries are largely unknown, in particular in developing countries. Fortunately, our main (political) explanatory variables are strongly correlated over time (see Table I.C). Note also that our developing country models are likely to exclude early lead content reformers such as the U.S. and the timing of policy initiation should be of minor concern in these models.

[20] Damania *et al*. [11] provide evidence that this index is closely correlated with a number of other measures of environmental performance which are available for more restricted lists of countries.

[21] We thank a thoughtful referee for bringing this issue to our attention. However, we note that countries remain free to reverse their lead content legislation, i.e. most countries in our sample (except the ones having banned lead in gasoline) may alter their lead content in either direction at any point in time. With only cross-country data available, we feel justified to follow the previous cross-country empirical literature on the political economy of environmental policy. This literature appears to favor using political pressure variables from the same (or close) year as the dependent variable, abstracting from the year of policy reform (see, for example, [11] and the references therein). For similar (cross-sectional and cross-country) approaches on the empirical political economy of trade policy, see Goldberg and Maggi [22], Gawande and Bandyopadhyay [21], and Dutt and Mitra [15].

Independent variables. Turning to the independent variables, we use three sets of observations from three different years for several of our variables. *ENVIROGROUPSj*, *j*=1993, 1996, 2000, measures the number of environmental lobby groups in year *j*, as proxied by the number of non-governmental organizations (NGOs) with an environmental interest per country. This data is reported by the Environment Encyclopedia and Directory, and published by Europa Publications [17], respectively. The three existing editions differ in their coverage, with the later editions becoming increasingly comprehensive. *ENVIROGROUPS1996* is the primary year of observation. Moreover, *ENVIROGROUPS1993* is used to explore whether political pressure three years prior influenced the observed level of *LEADCONTENT* in 1996. For example (although not discussed in our theory), there may be lags involved with the implementation of policy reforms. *ENVIROGROUPS2000* (from Europa Publications [17]) is included because it (in our view) appears to have the most comprehensive coverage of environmental lobby groups, particularly for developing countries. However, some groups were founded *after* 1996. We therefore deleted all such groups from the 2000 data. In the 2000 data, the highest values in the sample are 65 (Poland), 190 (United Kingdom), and 250 (United States).[22] The number of environmental lobby groups equals zero in seven countries, among them Comoros, Malawi and Oman. Among the developing countries, 24 out of 82 countries have at least ten active environmental groups.

Our theory also contains political pressure from the industry group (see (18)). In a survey by Potters and Sloof [52], it is reported that the greater a lobby's stake, the greater its success. We use the number of passenger and commercial vehicle cars per capita in year *h*, *h*=1993, 1996 (reported by International Road Federation, various years), multiplied by the market share of leaded gasoline in 1996 (Lovei [36]) as a measure of industry lobby group pressure.[23] This resulted in the variable

[22] *ENVIROGROUPS* is not scaled by population, since we assume that lead regulation is determined by a central government influenced by all existing lobby groups.

[23] Unfortunately, to create *VEHICLES1993* we were forced to use the 1996 value of the market share of leaded gasoline,

VEHICLESh, *h*=1993, 1996, which is intended to account for the number of leaded vehicles normalized by population.[24]

Our theory highlights the roles of democratic participation and political competition in the determination of environmental policy. This makes Vanhanen's [60] index particularly useful for our purposes. Vanhanen's democracy index consists of two variables that are *not* based on expert evaluations: (*i*) a *PARTICIPATION* variable, calculated as the percentage of the total population participating in elections, and (*ii*) a *COMPETITION* variable, which is calculated by subtracting the percentage of votes won by the largest party from 100. The variable *PARTICIPATION**COMPETITION* captures the interaction discussed by our theory. Dictatorships that do not commonly hold elections such as Libya have *PARTICIPATION* and *COMPETITION* scores of 0. Most democracies have participation rates above 50. Autocracies that hold fake elections such as Cuba can also have high participation rates, but only democracies also have high competition rates, usually above 50.

In our theory, the government formulates its policy choice with a view of the next election, anticipating future rates of electoral participation and competition levels. We take the theory seriously and use for all three sets of (year-based) regressions the latest available data point for the two variables of concern, which is 1998.[25] We thus assume that politicians formulating lead content policies in 1996 were able to (reasonably) forecast the participation rate and the level of political competition.

As an additional control, the logarithm of per capita income for year *h*, *h*=1993, 1996, (*lnGDPPCh*) is included and can be expected to have a positive impact if environmental quality is a

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since the 1993 value is unavailable.

[24] We also tested (commercial vehicles per capita)*(market share of leaded gasoline). This indicator also produced statistically significant results.

[25] This *PARTICIPATION* and *COMPETITION* data will refer to elections held 1998 or the last election held before that year. In case of a coup d'etat after the last election, both *PARTICIPATION* and *COMPETITION* are coded zero.

normal good, as discussed by the literature on the environmental Kuznets curve (see, e.g., [28], [41]). Our GDP data for year *h*, *h*=1993, 1996, comes from World Bank [62]. As further proxy variables for industry group lobby strength we also tested whether car production and oil production as a share of GDP might impact upon our dependent variable. Both were highly insignificant throughout. To save degrees of freedom, these were not included in the estimation results reported below. In order to capture structural differences between groups of countries that might influence the stringency of environmental regulation (Congleton [8]; Murdoch and Sandler [44]), we estimate our model for a developing country only sample.

Data We have cross-country data from 82 developing countries and 22 OECD countries. Table I provides summary statistics together with bivariate correlation matrices for the full and developing country samples, respectively.

< Insert Table I about here >

Estimation Strategy In our main estimation we use OLS with heteroscedasticity robust standard errors due to the simple cross-national character of our sample. The dependent variable is zero for some observations. An estimation technique such as Tobit may therefore be appropriate, and we report Tobit estimation results for the full sample. However, we prefer the OLS estimator for three reasons. First, the share of zero values of the dependent variable is small (around 14 % in the full sample and 10 % in the developing country sample). Second, the Tobit estimator becomes inconsistent in the presence of heteroscedasticity and is generally more vulnerable to violations of the underlying distributional and functional specification assumptions than OLS (Greene [23]). Third, the small sample properties of maximum likelihood (ML) estimators such as Tobit are largely unknown. For example, Long and Freese [35] consider ML estimation in samples of less than 100 observations as 'risky' and recommend samples over 500 for use of ML, which is considerably above our sample size.

The endogeneity and measurement errors of *ENVIROGROUPSj* and *VEHICLESh* may potentially be a problem. We tested the consistency of the OLS estimations using the Durbin-Wu-Hausman

(DWH) test (Davidson and MacKinnon [12]), but failed to reject the null of consistent OLS estimates. However, for completeness we also include a set of IV results. As instruments, we use population size (World Bank [62]), the percentage of Muslims in the population (Parker [50]), a dummy variable for a country's legal origin (La Porta *et al.* [33]), as well as a dummy variable for countries with a Confucian tradition (Huntington [29]). Our instruments are partially correlated with *ENVIROGROUPSj* and *VEHICLESh* in the sense that the correlation persists after all other exogenous variables are controlled for. Since we have over-identifying restrictions, we can also test for the exogeneity of our instruments.[26] The tests suggest that our instruments are valid.

We tested whether different slope coefficients for our two lobby group variables, *ENVIROGROUPSj* and *VEHICLESh*, are warranted. To do so, we grouped countries into those with (i) high and low *PARTICIPATION*, (ii) high and low *COMPETITION*, and whether or not they are (iii) car producing, or (iv) oil producing countries. We found no evidence of statistically significant differences in the slope coefficients across any of these groups of countries. In addition, in our robustness analysis we explored whether our results are sensitive to a number of countries having zero or extremely low values (possibly due to measurement errors) for *ENVIROGROUPSj* by excluding all observations in the lowest quartile for this variables.

5. Results

Table II reports our empirical estimates for our various specifications, with *LEADCONTENT* as the dependent variable and explanatory variables from year 1996 (where applicable). Models 1 and 2 report full sample OLS and Tobit results, respectively. Model 3 reports OLS for the developing country sample only, and Model 4 shows the full sample 2SLS results. The Sargan test fails to reject the over-

[26] The test of over-identifying restrictions compares the IV estimation results for the just-identified to the over-identified equation.

identification restrictions, suggesting that our instruments are truly exogenous and therefore valid instruments.

< Insert Table II about here >

ENVIROGROUPS1996 is associated with lower lead content only in Model 1. This may be due to an incomplete (in our view) count of environmental lobby groups reported for year 1996. The results are mixed for the two variables measuring the two different aspects of democracy of interest. Whereas *PARTICIPATION* is insignificant in Models 1-4, *COMPETITION* is significant at least at the 5% level in these models. Moreover, consistent with our theory, an interaction exists between *PARTICIPATION* and *COMPETITION*. The significant negative coefficient for *PARTICIPATION**COMPETITION* in Models 1, 2 and 4 suggest that increased political competition raises the stringency of environmental policy, in particular where the level of democratic participation is high. Model 1 suggests that at the mean of *PARTICIPATION*, ∂*LEADCONTENT*/∂*COMPETITION* = -0.68 (= -0.368 - 0.009*34.85) grams, and at one standard deviation above the mean the effect equals -0.85 (= -0.368 - 0.009*(34.85 + 18.87)) grams. Moreover, although democratic participation has no independent effect on environmental policy stringency, *PARTICIPATION* does raise policy stringency *conditional* on the level of political competition being non-zero. Thus, in all pure dictatorships with a value of *COMPETITION* equal to zero (such as Iraq in the 1990s), *PARTICIPATION* has *no* effect on *LEADCONTENT*. Using the estimated coefficients in Model 1 we find that at the mean value for *COMPETITION*, ∂*LEADCONTENT*/∂*PARTICIPATION* = -0.37 (= -0.009*40.68) grams. We also find that vehicle owners form a powerful lobby opposing the environmental lobby groups. *VEHICLES* is positively associated with lead content in Models 1-4, lending further support to our theoretical model.[27] Moreover, *lnGDPPC1996* is highly significant in these models, with the expected negative sign.

[27] In additional analysis we broke the VEHICLES variable into its two components to see whether vehicles per capita or the

Models 5-7 present an outlier analysis. It would be of concern if a few observations drove our results. While Model 5 excludes the quartile of observations with the lowest values for *ENVIROGROUPS1996*, Models 6 and 7 exclude outliers from the full- and developing country samples, respectively. Belsley *et al*. [4] suggest that observations with both high residuals and a high leverage deserve special attention. We exclude an observation from the sample if its DFITS is greater in absolute terms than twice the square root of (k/n), where k is the number of independent variables and n the number of observations, and where DFITS is defined as the square root of ($h_i/(1-h_i)$), where h_i is an observation's leverage, multiplied by its studentized residual. In Models 5 and 6, *ENVIROGROUPS1996* is significant at the 5% level. This is consistent with the full sample OLS result in Model 1, which thus appears not to be merely driven by influential outliers. However, *ENVIROGROUPS1996* is insignificant in Model 7 in the developing country sample (as in Model 3), possibly due to insufficient variation. *VEHICLES1996* and *lnGDPPC1996* remain significant in Models 5-7.

Models 3 and 7 suggest that *PARTICIPATION* has no significant effect in developing countries. A reason for why the interaction effect differs in this group of countries is suggested by our theory, which conditions the interaction effect on the number on environmental lobby groups. Whereas in the full sample the number of groups (the level of environmentalism) appears sufficiently great to yield a negative interaction effect, this is not the case in the developing country sample, and the coefficient becomes insignificant (corresponding to (21) being approximately zero). A related issue is why *PARTICIPATION* has no direct effect on environmental policy in even the full sample, in contrast to, e.g., the results presented by Mueller and Stratmann [43] for income distribution? One reason may be that the very poor tend to be the most disenfranchised in developing countries. The very poor may put a

market share of unleaded gasoline exerts the main effect on the dependent variable. We found that the market share is more important than the extent of car ownership in a country.

low value on environmental quality (especially if lower lead content is associated with higher gasoline prices), and an increase in the democratic participation rate by the very poor may therefore reduce the average participant's preference for stricter environmental policy, blurring the overall results. There may also be threshold effects, over which *PARTICIPATION* has not reached in our sample of primarily developing countries.

Table III reports similar models as in Table II, but using *ENVIROGROUPS1993*, *VEHICLES1993*, and *lnGDPPC1993*, which seek to capture earlier (political) pressures that may affect *LEADCONTENT* in 1996.

<Insert Table III here >

Whereas *VEHICLES1993* and *lnGDPPC1993* remain significant in all models, *ENVIROGROUPS1993* affects 1996 lead content only in Models 1, 6 and 7. *COMPETITION* also preserves its significant negative sign in all models, but its interaction with *PARTICIPATION* is now significant only in the 2SLS regression (Model 4) and in two models that are part of the outlier analysis (Models 5 and 6). As before, *PARTICIPATION* is never significant.

Table IV reports results using *ENVIROGROUPS2000* (which we believe provides a superior coverage of the environmental lobby groups active in 1996, particularly for developing countries). This variable is now significant in five of the seven models. In particular, *ENVIROGROUPS2000* is significant in both models focussing exclusively on developing countries (Models 3 and 7), and the coefficient sizes are relatively large. This suggests that the support given by international donor organizations such as the World Bank to environmental advocacy groups in developing countries may have a measurable effect on environmental policy outcomes. *COMPETITION* is significant in all models, and its interaction with *PARTICIPATION* is significant in a majority of the models.[28] No major changes occur for *VEHICLES1996* or *lnGDPPC1996*.

[28] In Model 2, *PARTICIPATION* COMPETITION* is only marginally insignificant with a p-value equal to 0.103.

< Insert Table IV here >

6. Conclusion

This paper seeks to determine whether the number of environmental lobby groups, the democratic participation rate, and the degree of electoral competition have discernable impacts on environmental policymaking. In particular, we present a novel theory: the effect of democratic participation (electoral competition) is *conditional* on the level of electoral competition (democratic participation).

We find empirical support for the interaction effect suggested by our theory. Greater political competition raises the stringency of environmental policies, and this tends to be the case *particularly* in countries with a high level of democratic participation by citizens. However, democratic participation affects environmental policy stringency *only* in countries with sufficiently high degree of political competition. Thus, democratic participation has *no* environmental policy effect in pure dictatorships. We believe these are new findings in the literature.

Our empirical results also suggest that lobbying on environmental issues may have policy effects. In particular, we find some evidence that the *number* of environmental groups affect policy stringency.[29] It may therefore be worthwhile for international donor organizations to provide support for environmental non-governmental organizations worldwide. Such support may for example facilitate compliance with the Kyoto Protocol.

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[29] We cannot make any inferences about the importance of the (average) size of the environmental lobbies. However, the total number of environmentalists appears important, given the organization costs.

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Table 1.A
Descriptive statistics and bivariate correlation matrix: full sample

Variable	Obs	Mean	Std. Dev.	Min	Max
ENVIROGROUPS2000	104	16.93	32.92	0	250
ENVIROGROUPS1996	104	17.26	34.75	0	261
ENVIROGROUPS1993	104	14.99	34.69	0	272
lnGDPPC1996	104	7.96	1.66	4.70	10.72
lnGDPPC1993	104	8.51	1.11	6.17	10.28
LEADCONTENT	104	40.10	28.87	0	85
PARTICIPATION	104	34.85	18.87	0	67.9
COMPETITION	104	40.68	23.47	0	70
VEHICLES1996	104	7.30	9.51	0	40.84
VEHICLES1993	104	6.84	9.49	0	47.43

Table 1.B
Descriptive statistics and bivariate correlation matrix: developing countries

Variable	Obs	Mean	Std. Dev.	Min	Max
ENVIROGROUPS2000	82	10.34	14.10	0	65
ENVIROGROUPS1996	82	9.88	11.63	0	55
ENVIROGROUPS1993	82	7.87	10.15	0	50
lnGDPPC1996	82	7.37	1.35	4.70	10.12
lnGDPPC1993	82	8.15	1.11	6.17	10.28
LEADCONTENT	82	47.32	27.70	0	85
PARTICIPATION	82	29.66	17.26	0	67.9
COMPETITION	82	34.70	22.82	0	70
VEHICLES1996	82	6.45	8.67	0	40.84
VEHICLES1993	82	6.04	8.93	0	47.43

Table 1.C
Correlation matrix: full sample (N=104)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
(1) *ENVIROGROUPS2000*	1.00									
(2) *ENVIROGROUPS1996*	0.96	1.00								
(3) *ENVIROGROUPS1993*	0.94	0.99	1.00							
(4) *lnGDPPC1996*	0.31	0.31	0.30	1.00						
(5) *lnGDPPC1993*	0.33	0.32	0.30	0.98	1.00					
(6) *LEADCONTENT*	-0.33	-0.32	-0.30	-0.54	-0.57	1.00				
(7) *PARTICIPATION*	0.26	0.23	0.18	0.40	0.40	-0.35	1.00			
(8) *COMPETITION*	0.29	0.28	0.24	0.38	0.39	-0.47	0.67	1.00		
(9) *VEHICLES1996*	0.01	-0.02	-0.02	0.44	0.47	0.00	0.03	0.01	1.00	
(10) *VEHICLES1993*	0.00	-0.03	-0.02	0.44	0.47	-0.01	-0.02	-0.01	0.99	1.00

Table 2
Environmental Policy Stringency Equations

	(1) OLS Full sample	(2) TOBIT Full sample	(3) OLS Dev. countries	(4) 2SLS Full sample	(5) OLS Excl. lower quartile *ENVIROGROUPS1996*	(6) OLS Excl. outliers	(7) OLS Dev. Countries Excl. outliers
ENVIROGROUPS1996	-0.074**	-0.119	-0.346	-0.188	-0.067**	-0.068**	-0.216
	(0.032)	(0.089)	(0.307)	(0.118)	(0.029)	(0.029)	(0.250)
PARTICIPATION	0.021	0.020	0.086	0.013	0.215	0.138	0.075
	(0.156)	(0.189)	(0.222)	(0.154)	(0.181)	(0.146)	(0.213)
COMPETITION	-0.368***	-0.408***	-0.318**	-0.339**	-0.652***	-0.513***	-0.402**
	(0.134)	(0.140)	(0.160)	(0.133)	(0.139)	(0.151)	(0.173)
*PARTICIPATION**	-0.009*	-0.011*	-0.007	-0.010*	-0.012**	-0.013**	-0.009
COMPETITION	(0.005)	(0.006)	(0.006)	(0.005)	(0.005)	(0.005)	(0.006)
VEHICLES1996	0.794***	1.152***	0.819*	0.797***	0.652**	0.749***	1.123***
	(0.226)	(0.309)	(0.448)	(0.297)	(0.261)	(0.158)	(0.349)
lnGDPPC1996	-8.260***	-9.772***	-8.410***	-7.565***	-7.285***	-8.287***	-11.081***
	(1.603)	(2.069)	(2.839)	(1.431)	(1.954)	(1.518)	(2.376)
Constant	104.629***	112.997***	108.257***	101.255***	99.343***	107.597***	123.568***
	(11.647)	(14.759)	(17.600)	(10.753)	(15.034)	(10.848)	(15.136)
N	104	104	82	104	78	98	74
Adjusted R-squared	.44		.19		.45	.49	.31
Pseudo R-squared		.07					
Ramsey Reset test	.27		.99		.27	.08	.60
	(.8494)		(.4002)		(.8467)	(.9726)	(.6152)
DWH test	1.23		.50		2.85	1.70	.05
	(.5417)		(.7778)		(.2403)	(.4277)	(.9734)
Robust Sargan test				3.67			
				(.5986)			

Notes: Dependent variable is *LEADCONTENT*. Heteroscedasticity robust standard errors in parentheses. *, **, *** represents significance at the 10, 5, 1 % levels, respectively. Ramsey Reset test is asymptotically F distributed under the null of no omitted variables, with p-values reported in brackets. DWH test is asymptotically chi-sq distributed under the null of exogeneity, with p-values reported in brackets. Robust Sargan test is overidentification test of all instruments and is asymptotically chi-sq distributed under the null of exogeneity of instruments, with p-values reported in brackets.

Table 3
Environmental Policy Stringency Equations: Robustness Analysis I

	(1) OLS Full sample	(2) TOBIT Full sample	(3) OLS Developing countries	(4) 2SLS Full sample	(5) OLS Excl. lower quartile *ENVIROGROUPS1993*	(6) OLS Excl. outliers	(7) OLS Dev. Countries Excl. outliers
ENVIROGROUPS1993	-0.060*	-0.121	-0.368	-0.150	-0.047	-0.093*	-0.512*
	(0.032)	(0.092)	(0.322)	(0.115)	(0.029)	(0.056)	(0.265)
PARTICIPATION	0.086	0.104	0.184	0.086	0.176	0.137	0.254
	(0.153)	(0.185)	(0.218)	(0.153)	(0.162)	(0.124)	(0.202)
COMPETITION	-0.349***	-0.385***	-0.291*	-0.316**	-0.502***	-0.502***	-0.341**
	(0.131)	(0.137)	(0.152)	(0.128)	(0.130)	(0.115)	(0.141)
PARTICIPATION COMPETITION*	-0.007	-0.008	-0.004	-0.008*	-0.011**	-0.010**	-0.002
	(0.005)	(0.006)	(0.006)	(0.005)	(0.005)	(0.004)	(0.006)
VEHICLES1993	0.899***	1.233***	0.908**	1.164***	1.129***	0.825***	1.079***
	(0.198)	(0.307)	(0.364)	(0.331)	(0.263)	(0.181)	(0.344)
lnGDPPC1993	-14.636***	-16.848***	-14.581***	-14.879***	-15.023***	-13.197***	-16.248***
	(2.400)	(3.148)	(3.708)	(2.277)	(2.761)	(2.258)	(3.184)
Constant	161.942***	177.431***	164.009***	164.031***	165.391***	153.136***	177.100***
	(18.968)	(24.836)	(27.094)	(18.247)	(22.346)	(17.803)	(23.375)
N	104	104	82	104	80	98	79
Adjusted R-squared	.44		.24		.51	.48	.33
Pseudo R-squared		.08					
Ramsey Reset test	.69		1.88		.67	.07	.31
	(.5607)		(.1414)		(.5741)	(.9749)	(.8187)
DWH test	1.18		.02		1.21	1.29	.12
	(.5538)		(.9896)		(5452)	(.5246)	(.9399)
Robust Sargan test				4.449			
				(.4867)			

Notes: Dependent variable is *LEADCONTENT*. Heteroscedasticity robust standard errors in parentheses. *, **, *** represents significance at the 10, 5, 1 percent levels, respectively. Ramsey Reset test is asymptotically F distributed under the null of no omitted variables, with p-values reported in brackets. DWH test is asymptotically chi-sq distributed under the null of exogeneity, with p-values reported in brackets. Robust Sargan test is overidentification test of all instruments and is asymptotically chi-sq distributed under the null of exogeneity of instruments, with p-values reported in brackets.

Table 4
Environmental Policy Stringency Equations: Robustness Analysis II

	(1) OLS Full sample	(2) TOBIT Full sample	(3) OLS Dev. countries	(4) 2SLS Full sample	(5) OLS Excl. lower quartile *ENVIROGROUPS2000*	(6) OLS Excl. outliers	(7) OLS Dev. Countries Excl. outliers
ENVIROGROUPS2000	-0.095**	-0.159	-0.435*	-0.234*	-0.105**	-0.112	-0.371*
	(0.041)	(0.099)	(0.237)	(0.137)	(0.044)	(0.069)	(0.216)
PARTICIPATION	0.035	0.047	0.220	0.048	0.167	0.163	0.231
	(0.156)	(0.190)	(0.238)	(0.160)	(0.180)	(0.149)	(0.245)
COMPETITION	-0.367***	-0.403***	-0.311**	-0.332**	-0.518***	-0.507***	-0.451**
	(0.135)	(0.139)	(0.154)	(0.134)	(0.140)	(0.151)	(0.178)
*PARTICIPATION**	-0.009*	-0.010	-0.004	-0.009*	-0.013**	-0.012**	-0.007
COMPETITION	(0.005)	(0.006)	(0.007)	(0.005)	(0.005)	(0.005)	(0.007)
VEHICLES1996	0.798***	1.161***	0.872**	0.877***	0.799***	0.761***	0.959***
	(0.224)	(0.307)	(0.414)	(0.311)	(0.288)	(0.162)	(0.355)
lnGDPPC1996	-8.277***	-9.845***	-8.767***	-7.804***	-8.394***	-8.360***	-9.347***
	(1.594)	(2.035)	(2.678)	(1.501)	(1.739)	(1.522)	(2.658)
Constant	104.945***	113.867***	111.310***	103.105***	109.122***	108.496***	114.069***
	(11.608)	(14.615)	(16.993)	(11.358)	(12.916)	(11.005)	(16.862)
N	104	104	82	104	78	97	76
Adjusted R-squared	.41		.21		.49	.45	.27
Pseudo R-squared		.07					
Ramsey Reset test	.30		.38		.37	.06	.85
	(.8259)		(.7676)		(.7779)	(.9812)	(.4719)
DWH test	1.66		.49		5.59	1.41	.59
	(.4357)		(.7818)		(.0611)	(.4943)	(.7442)
Robust Sargan test				3.86			
				(.5694)			

Notes: Dependent variable is *LEADCONTENT*. Heteroscedasticity robust standard errors in parentheses. *, **, *** represents significance at the 10, 5, 1 percent levels, respectively. Ramsey Reset test is asymptotically F distributed under the null of no omitted variables, with p-values reported in brackets. DWH test is asymptotically chi-sq distributed under the null of exogeneity, with p-values reported in brackets. Robust Sargan test is overidentification test of all instruments and is asymptotically chi-sq distributed under the null of exogeneity of instruments, with p-values reported in brackets.