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On the Political Determinants of Environmental Quality

Paper prepared for presentation at the Annual Convention of the American Political Science Association in Chicago, September 2-5, 2004.

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Introduction

Does the degree and form of democracy affect the level of environmental quality enjoyed by a country independently of that country's income, production and trade structure? Are civil and political freedoms good or bad for the environment?

The economics literature has thus far concentrated primarily on the effects of economic variables on environmental quality, notably, level of income, the scale and type of economic activity, and trade openness. Political scientists, for their part, have not yet systematically addressed the implications of political variables on environmental performance. Theories of public goods provision offer a useful starting point for such research. In particular, it has been argued that non-democratic countries are likely to under-provide public goods (Olson, 1993; McGuire and Olson 1996; Deacon, 1999; Lake and Baum, 2001; Bueno de Mesquita et al, 2003). Hence we should expect a positive relationship between democracy and environmental quality. Some authors have claimed, however, that in democratic countries special interest groups enjoy a disproportionate influence on policymaking (Olson, 1965, 1982). This implies that public goods (environmental quality) may be underprovided in the presence of strong special interest groups opposing environmental policies. The same would be true if elected politician overweighed short run factors (Congelton, 1992).

In this paper we assess the effect of various political variables, such as the type of political system, the type of democratic government, civil liberties, and labor union strength on environmental quality after having taken into account the effects of economic variables. Computing the effects of these political variables conditional on important economic determinants of the environment, such as income, is essential because of the very high correlation between these variables. In particular, we relate sulfur dioxide (SO_2) concentrations from 1971 to 1996 in 107 cities located in 42 countries to: the degree to which different institutions of government are democratic (i.e., whether political participation is competitive, executive recruitment is opened, and the chief executive is constrained); civil liberties (i.e., constraints, among other things, on the rights of individuals to debate, demonstrate, and to form organizations, including political parties and political pressure groups); the type of democratic government (parliamentarian vs. presidential); and the size of the winning electoral coalitions.

The value added of this research is as follows. First, as recommended by Antweiler[1], Copeland and Taylor (2001) we use a more comprehensive set of economic determinants of the environmental quality. Second, we examine the effects of a broader set of political

1 We are grateful indeed to Werner Antweiler for giving us their data set.

variables than in similar research to date, including democracy, civil liberties, and the type of democratic government. In our view, while the first type of political variables is more likely to capture factors that are conducive to the provision of public goods (environmental quality) and the second one may capture the influence of special interest groups to slow down or prevent more ambitious environmental policies, the last type's impact, however, seems to be both theoretically and empirically ambiguous. And third, we investigate the likelihood that the effect of certain political variables –such as civil liberties- on environment may not be monotonic (non-linearities). That is, we examine the hypothesis that too much or too little civil liberties may not be good for the environment. Too much may mean that special interest groups opposed to stricter environmental policies become more effective. We elaborate on this hypothesis by examining the effect of labor union power on environmental quality.

Our main findings are as follows: First, we provide additional support for the claim that the degree of democracy has a positive effect on environmental quality. Second, we show that civil freedom has an ambiguous effect. While more civil liberties in less liberal countries translate into a cleaner environment, more civil liberties in relatively free countries do not contribute to higher environmental quality. This finding may be related to disproportionate influence of special interest groups opposing stricter environmental policies in countries with developed civil liberties. In this context, we find that in democratic countries the quality of the environment is adversely affected by the strength of labor unions. Third, we find that presidential democracies enjoy a better environmental quality than parliamentarian democracies. The same holds true for countries with a larger winning electoral coalition, a finding that is consistent with theories of public good provision.

The following section discusses the state of the art in research on economic growth-democracy- environment linkages. We then define the variables and the research design, and present the results of the empirical analysis.

State of the Art and Theoretical Propositions

A large body of theoretical and empirical literature focuses on the economic determinants of environmental quality. It has established two important empirical patterns (e.g., Grossman and Kruger, 1995; Selden and Song, 1994; WTO 1999). First, there seems to exist a so-called environmental Kuznets curve. That is, pollution first deteriorates and then improves as income per capita increases. The standard interpretation of this finding is that environmental quality is a luxury good in the initial stages of economic development. Poor countries facing a trade off between protecting the environment and improving material living standards opt for the latter. Once significant gains have been made in living standards, the opportunity cost

of stricter environmental policies becomes smaller and voters are prepared to accept lower economic growth in order to enjoy less pollution (the environment becomes a normal good).

The second empirical pattern concerns the implications of international trade for the environment. While the sign of this relationship is theoretically ambiguous because of offsetting forces (the pollution haven hypothesis, the positive effects of trade on income, and the effect of trade on the scale of production), Antweiler et al (2001) establish that, at least for sulfur dioxide emissions, the net effect of trade is to reduce pollution levels.

While political variables have received relatively less attention, the last few years have witnessed a number of studies examining the relationship between political freedom and democracy and various measures of environmental quality. Theories of public goods provision can serve as a useful starting point for more systematic empirical research. For any given level of income, this relationship seems theoretically ambiguous. One the one hand, many authors (Olson, 1993; McGuire and Olson, 1996; Deacon 1999) have argued that non-democratic regimes are likely to underprovide public goods, including environmental quality. The logic is as follows. Non-democratic regimes are typically ruled by small elites that use the resources of their country to create personal wealth and to redistribute income from the rest of their populations towards themselves (rent seeking). Stricter environmental policies retard income creation (economic growth) and thus have a disproportionately negative effect on the main beneficiaries of the status quo (the elite) – policies that improve environmental conditions would have more uniform benefits across the whole population. Consequently, for rent seeking elites in non-democratic countries the marginal cost of public good (clean environment) provision is high relative to the marginal benefit. This discourages stricter environmental policies. In contrast, income distribution tends to be less unequal in democratic countries. This implies that the marginal cost of stricter environmental policies (and, by implication, the retardation of economic growth) is spread over a larger number of individuals and results in a lower marginal cost for each voter. A lower marginal cost (given the marginal benefit schedule) increases the likelihood of pollution reducing policies in democratic countries.

Bueno de Mesquita, Smith, Siverson and Morrow (2003) have developed a model of political competition and political survival of leaders that produces results similar to Olson (1993) and McGuire and Olson (1996). They show how the institutional features of the selectorate (i.e., the group of people that can affect the choice of leaders and be the recipient of the benefits distributed by leaders) and the winning coalition (i.e., the subgroup of the selectorate which in exchange of special privileges maintain incumbents in office) determine whether governmental policies provide public or private goods. They argue that when the winning coalition is large relative to the selectorate, as tends to be the case in democracies, leaders do not have sufficient resources to reward their supporters with high levels of private goods. Thus, they have to adopt policies that provide a relatively high level of public goods if they wish to survive. In contrast, when the winning coalition is small and the selectorate is

large, as is the case in autocracies, leaders have to provide the small number of their essential supporters with a relatively large amount of private goods if they wish to survive.

However, democracy may be associated with countervailing forces. It has been argued that elected governments may have shorter planning horizons than non-elected governments because of political myopia (Congelton, 1992). Many forms of environmental degradation develop slowly and over long periods of time (e.g. climate change, biodiversity, air and water pollution). Thus, the social costs of current economic behavior and political choices often materialize over the long term and burden future generations and future politicians. Democracies may, as a result, undersupply environmental public goods relative to non-democratic regimes where political leaders do not face frequent (re-)election and can take more costly decisions (stricter environmental policies) with longer term benefits without fear of been punished by myopic voters.

The positive effects of democracy on environmental quality may also be subject to challenge by another line of reasoning. As democratic societies become more advanced and stable, their institutions become more complex; and, at some point, stability may turn into rigidity. Olson (1982) claims that the influence of special interest groups is in part responsible for institutional *sclerosis* in mature democracies. As he puts it "the larger the number of individuals or firms that would benefit from a collective good, the smaller the share of the gains from action in the group interest that will accrue to the individual or firm that undertakes the action. Thus, in the absence of selective incentives, the incentive for group action diminishes as group size increases, so that large groups are less able to act in their common interest than small ones" (Olson, 1982).

In other words, in mature democratic systems public goods provision is likely to suffer from the existence of a relatively large number of small special interest groups that have little or no incentive to make any significant sacrifices in the interest of society as a whole. These groups compete over access to and control over legislative and administrative processes in an attempt to appropriate larger shares of a society's production. Consequently, environmental policies are likely to fall short of substantially improving environmental quality when 'distributional coalitions', such as special interest groups (e.g., business associations or labor unions), gain the upper hand. Except in cases where interest groups can achieve protectionist benefits through stricter environmental policies (which is rather rare in practice, see Murphy 2004) they are likely to oppose higher environmental standards because of (perceived) higher costs (relative to benefits). Moreover, because of superior organizational capabilities they are better able than public interest oriented groups to shape political decision-making processes.

Recent theoretical research has moved beyond propositions on the implications for public goods provision of democracy or autocracy per se. It shows that in democratic political systems the form of government affects the provision of public goods, and predicts

that parliamentary regimes are associated with more public goods than presidential regimes.[2] Persson, Roland and Tabellini (2000) make a distinction between presidential and parliamentary regimes and argue that legislative cohesion in parliamentary regimes leads to higher spending on public goods. In presidential regimes, on the other hand, unstable legislative coalitions and the fight among different minorities over different issues on the legislative agenda lead not only to inefficiently low spending on public goods but the allocation of spending targets powerful minorities such as the constituencies of the heads of congressional committees. In contrast, Bueno de Mesquita et al (2003), relying on selectorate theory, argue that different forms of democracy produce substantially different winning coalition sizes, and that presidential systems with their large winning coalition requirements provide more public goods than parliamentary systems, which require a smaller winning coalition.

In the extant empirical literature on the determinants of environmental quality, the main political variables are either a measure of democracy, as reported in the Polity dataset, or a measure of political freedom based on the Freedom House indices of political and civil freedoms (see next section for a description of variables and datasets). Barrett and Graddy (2000) find that an increase in civil and political freedoms (measured by two dummy variables based on Freedom House indices) decreases certain types of pollution (e.g., air pollutants such as SO_2, smoke, and heavy particles) but has no effect on other pollutants (e.g., pollutants affecting water quality). Carlsson and Lundstrom (2001) find a negative effect of political freedom (measured by the political and civil freedom indices from Freedom House) on CO_2 emissions. Deacon (1999) finds a negative effect of democracy (based on Polity III data) on lead levels. Finally, Crepaz (1995) and other authors[3], in studying how institutional structures in industrialized democracies affect environmental quality, finds that corporatist[4] forms of interest representation are more effective than the pluralist ones in reducing air pollutants such as CO_2, NO_x, and SO_x.

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2 The type of the electoral system also affects the provision of public goods. For example, Lizzeri and Persico (2001), in a formal model on how electoral rules influence the composition of government spending, argue that proportional elections tilt the composition of public spending towards programs benefiting large groups in the population, such as public goods (environmental quality) because with proportional elections, not only legislators are elected in large districts, which gives parties strong incentives to seek support from broad coalitions in the population, but also the 50 percent requirement of the national vote to win elections forces politicians to internalize the policy benefits for larger segments of the population and thus they need to emphasize broad programs.

3 E.g. Jahn (1998), Scruggs (1999, 2003), Wälti (2004). Similarly, positive effects of fiscal decentralization and multi-level governance in OECD countries have been observed, though the effects of these variables remain contested.

4 Corporatism is defined as a system of "interest representation in which a small number of strategic actors (usually representatives of capital and labor), organized in peak associations, represent large parts of the population in an encompassing fashion" (Crepaz, 1995:391-392).

Our paper is complementary to this research on the political determinants of environmental quality. The main differences are the following. First, we use a more comprehensive set of economic determinants of pollution levels than the studies just mentioned. These studies condition mostly on income, a reflection of their interest in the environmental Kuznets curve. The possibility that many important economic effects on the environment may be jointly determined with political institutions requires that several economic characteristics are included along side political variables to avoid estimation bias. In contrast to extant studies on the political determinants of environmental quality, we also include a set of geographical and climatic conditions that may account for variation in pollution across cities and countries.

Second, we include a larger set of political variables to test some of the yet untested theoretical propositions on public goods provision discussed above. Political variables included in the analysis are: the type of political regime (democracy, autocracy), the size of winning coalitions, the type of democratic political system, the extent of civil liberties, and the power of special interest groups (the strength of labor). The advantage of using alternative political variables is that they may help shed light on the influence of special interest groups. This could be the case if one of the variables was more likely to have a higher correlation with the ability of special interest groups to influence policymaking. Third, we investigate non-linear effects. That is, the likelihood that the relationship between political development and environmental quality is subject to a Kuznets type effect too. In particular, we are interested in finding out whether too little and too much freedom (or democracy) may be bad for the environment. Too little freedom may lead to environmental degradation because the interests of the ruling oligarchy are not compatible with stricter environmental policies. Too much freedom may lead to environmental degradation because of the disproportionate influence "non-green" special interest groups exert on policy-making.

Empirical Analysis

We begin by defining the variables and method to be used and then proceed to a discussion of empirical results.

Description of the variables

Environmental quality: air pollution SO_2

Our dependent variable is air pollution, and sulfur dioxide (SO_2) concentrations in particular. The reasons are as follows. First, air pollution is widely regarded as one of the most important environmental problems worldwide and most forms of air pollution have direct implications for human health, ecosystems, and economies as such (Konisky, 1999). Particles (smoke and soot), sulfur dioxide (SO_2), ozone (O_3), lead, Nitrogen oxides (NO, and NO_2, together NOx), and carbon monoxide (CO) constitute the so-called criteria pollutants. These measures are used by the World Bank, the OECD, and numerous other national and international authorities to describe air quality. Moreover, many countries around the world (USA, EU) and international organizations (WHO) have established standards and limits for these forms of air pollution.

Second, availability of data that is commensurable for a larger number of countries and over longer time periods is a major problem in this type of research. For practical reasons, we have chosen SO_2 concentrations. Data for this pollutant is more reliable than data for other forms of air pollution and is available for a rather large number of countries since the 1970s. Moreover, *SO_2* is perhaps the most prominent form of air pollution because it has direct effects on human health, ecosystems, and the economy.

And thirdly, SO_2 emissions can be controlled, if governments wish to, by altering the techniques of production. Sulfur dioxide although is emitted by natural sources like volcanoes, decaying organic matter and sea spray, it is primarily produced from the burning of fossil fuels such as oil, natural gas, and coal. In developed countries SO_2 is produced mainly from electricity generation and the smelting of non-ferrous ores, while in developing countries is primarily emitted from the burning of diesel fuel and home heating. SO_2 emissions can be curtailed by reducing consumption of fossil fuels, especially high-sulfur

coal, using smoke scrubbing equipment on power plant smokestacks, and increasing energy efficiency[5]. However, these techniques are expensive.

Our data for sulfur dioxide (SO_2) concentrations consists of annual observations for the years 1971-1996 from 291 observations sites located in 107 major cities in 42 countries (2555 observations). This data has been collected through standardized procedures in the framework of the Global Environment Monitoring System (GEMS), sponsored by the World Health Organization (WHO). The US Environmental Protection Agency (EPA) maintains this data in its Aerometric Information Retrieval System (AIRS) (see the appendix for the sources of data).

Following Antweiler et al. (2001) we use the logarithmic transformation of the median SO_2 concentration. The unit of measurement is micrograms per m^3. Antweiler et al point to a 1984 WHO report about the GEMS/AIR project which argues that concentrations are more suitable described by a log-normal distribution, because the distribution of concentrations is highly-skewed towards zero when viewed on a liner scale.

Economic variables

Almost all studies on the environment-economy relationship use income (GDP) as the measure of economic activity. That is, they employ income as a surrogate for a number of underlying economic factors whose individual influences on environmental quality are difficult to discern. In this paper, we decompose economic activity into scale, composition, and technique effects to account for the different effects that income (economic development) may have on environmental quality.

Scale effect: Intensity of economic activity: **activity**

The larger the scale of economic activity per unit is, the higher the level of environmental degradation (i.e., pollution) is likely to be – increased economic activity tends to result in more SO_2 emissions and thus higher levels of ambient SO_2 concentration. Since income is an indicator of economic activity, we expect a positive relationship between environmental degradation and income, controlling for all other income related effects. We measure the scale of economic activity by *GDP per square kilometer* for each city and each year in our sample. This measure is an approximation of the intensity of economic activity in a city relative to its size, and it is constructed by multiplying a country's per-capita GDP by each city's population density.

5 In the US and the European Union SO2 emissions have been on the decrease since the mid 1970s and are expected to decline even further, to a total reduction of 26 percent, and of more than 75 percent respectively by 2010.

Composition effect: Capital intensity of production: **capital**

The composition of economic activity also influences environmental quality because the different sectors of the economy affect environmental quality differently. For example industry and especially manufacturing tends to be more pollution intensive than either agriculture or services. We represent economic structure by a nation's *capital to labor ratio* and expect a positive relationship with pollution.

Technique effect: **income**

At lower income levels people tend to be more concerned with food, shelter, and other material needs and less concerned with environmental quality. They are also less likely to be able to afford costly environmental clean-up measures. At higher income levels, people usually demand higher levels of environmental quality, and they can afford higher environmental clean up costs. We expect the relationship between per capita income and pollution to be negative since increasing economic prosperity leads to high public demand for pollution abatement and provides the necessary resources to achieve it. To account for the assumption that pollution policy is flexible and responsive to changes in the economy but it takes time for income increases to affect policy we proxy the technique effect by a moving average of lagged income (*a three-year average of lagged GDP per capita).*

Degree of trade openness: **trade**

Some authors have incorporated international trade in their analysis of growth-environment linkages arguing that trade affects the domestic economy and therefore also environmental behavior. While the sign of this relationship is theoretically ambiguous because of offsetting forces (the pollution haven hypothesis, the positive effects of trade on income, and the effect on the scale of production), Antweiler et al (2001) establish that, at least for SO2 emissions, the net effect of trade is to reduce pollution levels. In this analysis we measure a country's trade openness by *the ratio of the sum of exports and imports to GDP*. We expect the relationship between pollution and trade to be negative.

Political variables

Political system: Democracy vs. autocracy: ***democracy***

Our measure of political system is an index of the extent of democratic participation in government, *Democracy*, from the POLITY IV[6] data set. Democracy's composite index includes the following elements: the presence of competitive political participation, the guarantee of openness and competitiveness of executive recruitment, and the existence of

[6] The POLITY IV data set is described in Marshall and Jaggers (2000).

institutionalized constraints on the exercise of executive power[7]. The democracy indicator is an additive eleven-point scale (0-10). We expect a positive relationship between democracy and environmental quality for the reasons stated in the previous section.

Political system: Winning coalition: ***WoverS***

We use Bueno de Mesquita et al's *W/S* variable, which measures the strength of the loyalty norm, as an alternative measure of the political system. "*W*", the size of the winning coalition, is a composite index based on variables taken from Banks's data[8], and from the POLITY IV data[9]. *"W"* is normalized to vary between 0 and 1. "*S*", the size of the selectorate, is the legislative selection (LEGSELEC)[10] variable from the POLITY IV data. "*S*" is also normalized to fall between 0 and 1. As the size of the winning coalition increases relative to the selectorate, leaders opt for policies that aim at providing more public goods in order to survive. Thus we expect a positive relationship between the size of the winning coalition relative to selectorate and environmental quality.

Democratic system: parliamentary vs. presidential system: **Parl_Pres**

As argued further above, the form of government is likely to affect the provision of public goods. However, the sign of this relationship appears to be theoretically and empirically[11] ambiguous. We include in our analysis Bueno de Mesquita et al's Parl-Pres[12] variable to test for the impact of the form of democratic government on environmental quality. Parl-Pres is a trichotomous variable that takes the value of 1 for parliamentary democracies, 2 for mixed parliamentary-presidential systems, and 3 for presidential systems when the democracy variable is at its maximum score of 10. If not, it takes the value of 0. Parl-Pres is also normalized to vary between 0 and 1.

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7 Note that although the authors of the POLITY data set accept that civil liberties are an essential element of any institutionalized democracy the POLITY data set does not include data on civil liberties.

8 REGTYPE (1=civilian; 2=military-civilian; 3=military; 4=other)

9 XRCOMP (competitiveness of executive recruitment), XROPEN (openness of executive recruitment), and PARCOMP (competitiveness of participation)

10 This variable measures the breadth of the selectiveness of the members of each country's legislature. It is a trichotomous variable that takes the value of 0 when there is no legislature, 1 when the legislature is chosen by either heredity, ascription or the executive, and 2 when members of the legislature are directly or indirectly selected by popular election.

11 For example, Bueno de Mesquita et al. find that presidential systems perform better than parliamentary system in providing core public goods (prosperity, peace, transparency, political rights, and civil liberties), but with regard to other public goods (such as education, health care, social security, and foreign policy) the results are mixed.

12 Bueno de Mesquita et al note that their Parl-Pres indicator cannot distinguish between parliamentary systems with proportional representation or multi-member districts and those with single-member districts and first-past-the-post electoral systems, although their coalition-size requirements vary.

Civil liberties: **civil**

Dahl (1971) argues that without the freedom to obtain information and to try and influence others the ability of citizens to make representative democracy effective is very doubtful. A free and critical press, the ability to move about and engage in political and economic activity, and freedom from arbitrary judicial action are all characteristics intimately related to a well functioning democracy.

We proxy the influence of special interest groups with the *civil liberties* component of the Freedom House index. The Freedom House organization rates all countries of the world on dimensions of political[13] and civil rights. The civil liberties part of the index measures constraints on: the freedom of expression and belief (freedom of press and religious institutions); association and organizational rights (freedom of assembly, demonstration, political or quasi-political organizations including ad hoc issue groups, and free trade unions and peasant organizations); the rule of law and human rights (existence of an independent judiciary, and freedom from extreme government indifference and corruption); and personal autonomy and economic rights (secured property rights, personal social freedoms, and equality of opportunity including freedom from exploitation by or dependency on employers, union leaders or bureaucrats). Freedom House rates countries on a 1 to 7 scale. In countries with a rating of 1 law is unshaken and there is freedom of expression, assembly, and association. Increasing numbers indicate that laws and traditions impinge increasingly on such freedoms until, in states ranked as 7, citizens have no rights vis-à-vis the state and "…an overwhelming and justified fear of repression characterizes these societies" (Freedom in the World 1999-2000). Because we view civil liberties at least in part as a proxy for the influence of special interest groups (see previous section) we expect the relationship between civil liberties and environmental quality to be negative.

Influence of labor: **labor**

Because civil liberties constitute only a crude, and perhaps questionable, indicator for the influence of special interest groups we use an additional indicator that may proxy for special interest group influence, namely, labor union strength. Note that there exists no commonly accepted measure for special interest group influence in the political science and political economy literature. Although several measures of labor union strength are available in the literature, they are unfortunately available only for a subset of OECD countries. Thus we opted for a variable that is available for a relatively large number of countries and may capture the influence of labor on legislation, namely, the employment protection index[14].

13 The political rights dimension, which is very close to the POLITY IV measure of democracy, captures mainly the fairness and freedom of elections, that is, whether a government came to power by election or by gun; whether elections, if any, are free and fair; and whether an opposition exists and has the opportunity to take power at the consent of the electorate.

14 Another variable that we could have used is union density. We decided against because union density may often provide a misleading picture of labor union power. For instance, among all OECD countries union

This index is taken from Nickell (1997) and measures the strength of the legal framework governing hiring and firing for the period 1989-94. It ranges from 1 to 20, with 20 indicating the strictest regulation (the US, with a value of 1, has the laxest regulation). To the extent that this variable proxies for special interest group influence we expect the relationship between labor union power and environmental quality to be negative.

Other variables

Though geographical and ecological conditions (e.g., central or suburban location, temperature, precipitation) are unlikely to be strongly correlated with our political variables, several authors have noted their influence on environmental quality[15]. We thus include these variables to obtain more accurate estimates.

Topographical conditions: **central, suburban, or rural**

Since the GEMS/Air measurement stations are not all located in metropolitan areas, we include a dummy variable indicating whether a station is located in a *suburban* area. We expect suburban areas to be less polluted than city centers (the default location is the city center).

Weather conditions: **temperature, precipitation**

We include the *average annual temperature* at each site in order to capture seasonal influences on the demand for fuels that contribute to emissions of SO_2. We expect high temperature to lead to less pollution because the demand for fuel (heating fuel) is lower.

We also include *variation in precipitation* at each site because precipitation can affect (wash out) SO_2 concentrations. However, if precipitation is concentrated in one season then its ability to wash out SO_2 concentrations over the year is reduced, and thus we expect the relationship between SO_2 concentrations and precipitation to be positive.

Time trend: **year**

Finally, we include a time trend in our regression analysis to capture time effects, and in particular the general trend for higher environmental quality observed during the sample period that is due to the existence of a trend in income, capital intensity, and intensity of economic activity.

density is the lowest in France. This might be misleading because in France more than 70 percent of the workforce is covered by union bargaining whether or not workers belong to unions. The same holds true for other countries (e.g. Spain). In other cases, we observe the opposite pattern (large union density but small union coverage).

15 Some authors have also included other site-specific influences such as proximity to oceans (Grossman and Krueger, 1995; Torras and Boyce, 1998).

Statistical Model

Combining the environmental, economic, political, and site-specific components just discussed we obtain the following statistical model:

$SO_{2jikt} = \beta_0 + \beta_1$ *{economic variables}+ β_2*{political variables} + β_3*{other variables} + β_4*year + e

where SO_2 is the log of the median of SO_2 concentrations at site j, city i, in country k, at time t. β_i =1,2,3 are vectors of coefficients.

The following economic variables are used: $activity_{ikt}$ is measured by real GDP/km^2; $capital_{kt}$ is measured by the capital to labor ratio; $income_{kt}$ is one period lagged three year moving average of GDP per capita; $trade_{kt}$ is measured by the ratio of the sum of exports and imports to GDP.

The political variables used are: $democracy_{kt}$, measured on a scale of 0 to 10; $WoverS_{kt}$ is W divided by (log(S+1)*10)/3 to avoid division by zero; $parl\_pres_{kt}$ is a dummy variable indicating whether a democratic country has a parliamentary, mixed, or presidential system; $civil_{kt}$ is measured on a scale of 1 to 7; $labor_{kt}$ is measured on a scale from 1 to 20. Because of strong collinearities between some of the political variables (see table 2) we often include only a subset of these variables. Moreover, the data set that includes labor union power is considerably different from the one without this variable (the data set including labor union power contains only around 50% of the countries in the full sample, essentially high income OECD countries). We have thus run some of the regressions twice, with and without the labor union power variable.

The other variables are: $suburban_{jik}$ is a dummy variable indicating whether a measurement site is in a suburban location; $precipitation_{ikt}$ is the variation in precipitation in a city in a given year; $temperature_{ikt}$ is the average temperature in a city in a given year. The variable year captures the time trend; and e is the error term.

We have used both fixed and random effects estimations. The fixed effects approach is more appropriate when the data exhaust the population, that is, when the model is viewed as applying only to the countries or observation sites in the sample, but not to additional countries or observation sites outside the sample. The random effects approach is more appropriate when the countries or observation sites in the data set are randomly drawn from a larger population. Although the random effects procedure has the advantage of saving a lot of degrees of freedom, it suffers from a major drawback. It assumes that the random error associated with each cross-sectional unit is uncorrelated with the other regressors. Its coefficient estimates can thus be biased (Kennedy 1992). We use (and report) the Hausman test, which test for correlation between the error and the regressors, to compare the results produced by the two procedures.

Results

Table 1 reports relevant summary statistics. Table 2 shows correlation coefficients for the variables used in the analysis.

Table 1
Summary Statistics

Variable		Obs	Mean	Std.Dev	Min	Max
SO_2		2555	-4.86225	1.108498	-6.90776	-2.16282
income		2555	2.614146	2.242493	0.012347	6.943756
activity		2555	7.904903	8.77529	0.103134	59.33626
capital		2555	5.612229	2.49684	0.829223	17.18889
trade		2555	0.408813	0.322309	0.0884	2.6174
democracy		2532	7.651264	3.949357	0	10
civil		2515	2.240557	1.87894	1	7
labor		1672	5.270933	5.822646	1	20
parl_pres		2099	1.098618	1.144595	0	3
WoverS		2555	0.855848	0.236062	0	1.001425

Table 2

Pairwise Correlations

(Simple pairwise coefficients, followed by the p-value for statistical significance and the number of observations.)

	enviro	incom	activit	capita	trade	demo	civil	labor	parl-pres	w/s
SO_2	1									
	2555									
incom	-0.34	1								
	0									
	2555	2555								
activit	0.18	0.35	1							
	0	0								
	2555	2555	2555							
capita	0	0.39	0.26	1						
	0.81	0	0							
	2555	2555	2555	2555						
trade	0	-0.25	-0.17	0.11	1					
	0.71	0	0	0						
	2555	2555	2555	2555	2555					
demo	-0.24	0.64	0.35	0.51	0.09	1				
	0	0	0	0	0					
	2532	2532	2532	2532	2532	2532				
civil	0.25	-0.68	-0.36	-0.48	-0.06	-0.95	1			
	0	0	0	0	0	0				
	2515	2515	2515	2515	2515	2492	2515			
labor	0.44	-0.74	-0.06	0.5	0.58	-0.24	0.54			
	0	0	0.01	0	0	0	0			
	1672	1672	1672	1672	1672	1664	1672	1672		
parl-pres	-0.19	0.88	0.31	0.22	-0.19	0.61	-0.63	-0.63	1	
	0	0	0	0	0	0	0	0		
	2099	2099	2099	2099	2099	2099	2059	1297	2099	
w/s	-0.21	0.65	0.35	0.45	0.08	0.93	-0.89	-0.28	0.63	
	0	0	0	0	0	0	0	0	0	
	2555	2555	2555	2555	2555	2532	2515	1672	2099	2555

As indicated by Table 2, income and democracy, and income and civil liberties are highly positively correlated. The same holds true for democracy and civil liberties, even though some countries score lower on civil rights than on political rights. This indicates a democratically oriented electoral system with some isolated civil liberties violations (for example, Italy, Argentina and Colombia). Other countries score higher on civil liberties than

political rights, which indicates a relatively authoritarian system with some civil liberties (for example, Peru and Brazil).

Table 3 reports the results from the regression of SO_2 concentration on the explanatory variables described above.

Table 3

	Fixed Effects					Random Effects			
SO_2	Coef.	Std. Err.	t	P>|t|		Coef.	Std.Err.	t	P>|t|
income	-0.24	0.03	7.81	0.00		-0.26	0.02	11.19	0.00
activity	0.03	0.01	2.76	0.01		0.03	0.01	5.42	0.00
capital	-0.03	0.03	0.94	0.35		0.00	0.02	0.10	0.92
trade	-1.30	0.23	5.67	0.00		-1.00	0.16	6.07	0.00
democracy	-0.10	0.02	5.83	0.00		-0.08	0.01	5.10	0.00
civil	-0.03	0.04	0.73	0.47		-0.04	0.03	1.14	0.26
suburban						-1.02	0.31	3.31	0.00
precipit	7.88	4.21	1.87	0.06		4.89	3.94	1.24	0.22
temperature	-0.05	0.02	1.82	0.07		-0.08	0.01	9.58	0.00
_cons	-2.39	0.43	5.62	0.00		-2.33	0.26	9.01	0.00
	Number of obs = 2492					Number of obs = 2492			
	Number of groups = 281					Number of groups = 281			
	R-sq overall = 0.1928					R-sq overall = 0.3025			
	F(8,2203) = 7.29					Wald chi2(9) = 393.24			
	Prob > F = 0.0000					Prob > chi2 = 0.0000			

Hausman specification test

	(b)	(B)	(b-B)
	Fixed	Random	Difference
income	-0.24	-0.26	0.01
activity	0.03	0.03	-0.01
capital	-0.03	0.00	-0.03
trade	-1.30	-1.00	-0.30
democracy	-0.10	-0.08	-0.02
civil	-0.03	-0.04	0.01
precipit	7.88	4.89	2.99
temperature	-0.05	-0.08	0.04

Test: Ho: difference in coefficients not systematic
chi2(8) = 46.70 Prob>chi2 = 0.0000

These results indicate that higher income, higher intensity of economic activity, and greater trade openness contribute to lower pollution levels. The effect of democracy is also pollution reducing. Civil liberties, on the other hand, do not have a statistically significantly effect on pollution. These findings are robust to excluding the United States, which accounts for a large share of the observations in the sample. Weather also has a significant effect on SO_2 concentrations. An increase in average temperature reduces concentrations, and an increase in yearly precipitation raises concentrations.[16] Finally, locations in suburban areas experience less pollution than city centers. The Hausman specification test shows (Table 3) that differences in coefficients between the fixed and random effects estimations are not significant.

One may argue that the statistical insignificance of the civil liberties variable reflects a multicollinearity problem, in particular the very high correlation of democracy and civil liberties. This argument may not be completely satisfactory, however, because in all variations of the basic regression we ran, the democracy variable was always statistically significant while the civil liberties variable was never significant. Another reason for this pattern may be that the relationship between civil liberties and pollution is non-linear. That is, while restricting the power of non-democratic oligarchies may contribute to lower pollution levels, giving too much political power to special interest groups that oppose environmental regulation (such as labor unions) could lead to lower environmental quality. Such an explanation would be consistent with Olson's theory of special interest groups as it implies that the relationship between public goods provision and civil freedoms may not be monotonic.

16 As noted above, these effects can be interpreted in the sense that higher temperatures lower the demand for fuel and, therefore, SO2 emissions; and that more precipitation is often concentrated in one season, which reduces the "washing out" of SO2 concentration over the year.

To investigate this possibility we partition the sample according to the mean value of the civil liberties index (2.24). Table 4 reports the results for countries with high civil liberties (< 2.24) and Table 5 for the less liberal countries (>2.24).

Table 4
Fixed-effects regression: civil<2.24

SO_2	Coef.	Std. Err.	t	P>|t|
income	-0.20	0.04	5.54	0.00
activity	0.04	0.01	3.75	0.00
capital	-0.10	0.04	2.39	0.02
trade	-1.61	0.31	5.15	0.00
civil	-0.19	0.09	2.08	0.04
suburban				
precipit	10.78	5.67	1.90	0.06
temperature	-0.02	0.03	0.88	0.38
_cons	-2.96	0.41	7.14	0.00

Number of obs = 1786
Number of groups = 197
R-sq overall = 0.076
F(8,2203) = 14.24
Prob > F = 0.0000

Table 5
Fixed-effects regression: civil>2.24

SO_2	Coef.	Std. Err.	t	P>|t|
income	-0.78	0.55	1.42	0.16
activity	-0.04	0.08	0.43	0.67
capital	0.21	0.06	3.67	0.00
trade	-1.46	0.48	3.05	0.00
civil	0.12	0.05	2.40	0.02
suburban				
precipit	10.10	6.75	1.50	0.14
temperature	-0.16	0.06	2.93	0.00
_cons	-2.32	1.04	2.22	0.03

Number of obs = 729
Number of groups = 113
R-sq overall = 0.129
F(8,2203) = 6.84
Prob > F = 0.0000

Tables 4 and 5 reveal an interesting pattern. While increasing civil liberties in already highly free countries increases pollution, increasing civil liberties in countries with low levels

of freedom contributes to lower pollution levels[17]. (Note that a higher value on the civil liberties index means *less* liberty). Hence the statistical insignificance of the civil liberties variable in the full sample does not simply reflect the lack of a relationship between civil liberties and the environment but rather reflects the fact that this relationship changes sign as the level of repression changes.

With some caution, we may interpret this result as an indication that in highly free countries the demand for cleaner environment by some special interest groups, such as environmental NGOs, is more than counterbalanced by the support for polluting activities by other special interest groups (e.g. business associations and labor unions in the manufacturing sector). The sign of the estimated coefficient indicates that the relative influence on policymaking of the former groups increases with the degree of liberty (so too much freedom in already very free countries is bad for the environment).

As noted above, the political science literature does not offer any indicators for the political influence of "non-green" or "anti-green" special interest groups. However, to examine the special interest group hypothesis somewhat more thoroughly we repeat the analysis using labor protection as a proxy for the political influence of special interest groups. We assume that strong labor unions may slow down "green" industrial restructuring, for example by preventing the closure or modernization of pollution intensive traditional industries (e.g. steel production, pulp and paper production, mining, refineries, fossil fuel power plants, bulk chemicals production, cement production). The empirical results shown in Table 6 provide support for this hypothesis.

17 Torras and Boyce (1998) obtain a somewhat similar result in showing that increasing civil liberties in poorer countries reduces environmental degradation.

Table 6
Random-effects regression with "labor"

SO_2	Coef.	Std. Err.	z	P>|z|
income	-0.20	0.03	6.77	0.00
activity	0.04	0.01	6.46	0.00
capital	-0.09	0.03	3.50	0.00
trade	-1.17	0.21	5.45	0.00
democracy	-0.14	0.04	3.76	0.00
civil	-0.15	0.08	1.97	0.05
labor	0.07	0.01	4.77	0.00
suburban	-0.97	0.39	2.48	0.01
precipit	7.65	5.53	1.38	0.17
temperature	-0.06	0.01	4.23	0.00
_cons	-1.67	0.46	3.62	0.00

Number of obs = 1664
Number of groups = 167
R-sq overall = 0.406
Wald chi2(9) = 389.5
Prob > chi2 = 0.0000

The higher the influence of labor unions, as measured by labor friendly labor regulation, the higher is pollution. It is worth reporting that the labor variable always has a substantial, negative, statistically significant effect on pollution in all of the regressions that include it.

We have also run similar regressions without the civil liberties variable and with a partition of the sample based on the level of democracy instead. Unlike in the case of civil liberties, no non-linear relationship between democracy and environmental quality emerged in this case.

How robust are these results to alternative empirical specifications? The negative, statistically significant relationship between democracy and SO_2 emissions is very robust. For instance, it is not affected by changes in the list of the explanatory variables and by the use of fixed or random effects estimation techniques. Similarly, dropping the observation site-specific information and using country averages for each year of observation does not make any difference (Table 7). Note that some of the economic variables and all of the political variables are country rather than observation site-specific. Using country averages instead of observation site information may be appropriate if one wishes to focus exclusively on the effect of the political variables.

Table 7
OLS regression with robust standard errors, with country averages for each year of observation

SO_2	Coef.	Std. Err.	t	P>|t|
income	-0.17	0.02	7.03	0.00
activity	0.05	0.01	10.14	0.00
capital	0.08	0.01	6.56	0.00
trade	-0.23	0.10	2.18	0.03
democracy	-0.05	0.01	3.42	0.00
year	-0.05	0.01	6.98	0.00
_cons	97.26	14.61	6.66	0.00

Number of observations = 463
F(6, 466) = 50.58
Prob > F = 0.0000
R-squared = 0.3009
Root MSE = .8209

Finally, we have examined the effects of other political variables that have been suggested in the literature as influencing the provision of public goods: the size of the winning coalition and the size of the selectorate; and parliamentarian vs. presidential democratic political systems. Table 8 reports the results.

Table 8
Fixed-effects regression: other political variables

SO_2	Coef.	Std. Err.	t	P>|t|
income	-0.04	0.06	0.70	0.48
activity	0.09	0.01	7.75	0.00
capital	-0.13	0.04	3.23	0.00
trade	-0.76	0.22	3.42	0.00
parl_pres	-0.27	0.12	2.18	0.03
WoverS	-0.53	0.26	2.02	0.04
year	-0.04	0.01	6.22	0.00
_cons	67.68	11.29	5.99	0.00

Number of obs = 2099
Number of groups = 279
R-sq overall = 0.131
F(8,2203) = 27.27
Prob > F = 0.0000

The provision of public goods increases (less pollution) with the size of the winning electoral coalition. Moreover, presidential democracies tend to provide more public goods (a

cleaner environment) than parliamentarian democracies. The first result is consistent with the selectorate theory. The second result supports Bueno de Mesquita et al.'s argument that presidential systems tend to provide more public goods than the parliamentarian ones.

Conclusions

Research on the determinants of environmental quality has thus far focused largely on economic factors. It has shown that many (but not all) forms of environmental degradation tend to decrease with increases in income, and that some forms of pollution first increase and then decrease with growing income (environmental Kuznets curve). Research to date also suggests that openness to international trade, in spite of theoretical ambiguities, tends to lower pollution. The literature on political determinants of environmental quality is more limited and still developing. However, a consensus seems to be emerging that both democracy and freedom contribute to higher environmental quality.

The research results presented in this paper demonstrate that the relationship between democracy and environmental quality, as measured by SO_2 concentrations is positive and quite robust. The relationship between freedom and the environment, though, is more complex. In countries with few civil liberties, enhancing liberties contributes to lower levels of pollution. But in countries that already enjoy a high level of civil liberties, further increases in liberties seems to translate into higher levels of pollution. This result suggests that in highly free countries the demand by some special interest groups, such as environmental NGOs, for cleaner environment may be more than counterbalanced by the support for polluting activities by other special interest groups (e.g. business associations and labor unions in the manufacturing sector). This interpretation receives support from the finding that the greater the influence of labor on legislation (as captured by the degree of employment protection) is, the lower is the quality of the environment.

We also found evidence in support of the proposition that presidential democracies provide more public goods (a cleaner environment) than parliamentarian democracies. The same holds for the proposition that the provision of public goods increases with the size of the winning electoral coalition.

Further research should focus on testing the above model in regard to other forms of pollution – to the extent data is available for a larger set of countries and several years. It should also focus on developing more sophisticated indicators of interest group influence in order to test the civil liberties and interest group hypothesis more thoroughly.

Finally, environmental quality is affected by all sorts of economic and political structures and processes. While most political scientists have focused largely on qualitative

analysis of domestic and international political processes to explain variation in environmental quality (across countries, time, or environmental problems), economists have concentrated predominantly on easy-to-measure economic determinants. More extensive quantitative analysis of political determinants of environmental quality that takes economic determinants seriously can contribute to building mutually rewarding bridges between the two research efforts.

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Appendix

Countries in the sample (number of observation stations)

Argentina (15)
Australia (4)
Austria (3)
Belgium (4)
Brazil (7)
Canada (21)
Chile (3)
China (21)
Colombia (9)
Czechoslovakia (3)
Denmark (3)
Egypt (4)
Finland (3)
France (7)
Germany (4)
Ghana (3)
Great Britain (6)
Greece (5)
India (12)
Indonesia (3)
Iran (3)
Iraq (3)
Ireland (3)
Israel (7)
Italy (5)
Japan (7)
Kenya (2)
Malaysia (4)
Netherlands (3)
New Zealand (7)
Pakistan (2)
Peru (3)
Phillipines (5)
Poland (6)
Portugal (3)
South Korea (6)
Spain (5)
Sweden (8)
Switzerland (1)
Thailand (4)
United States (53)
Venezuela 3

Data Sources

The data set was constructed with data taken from the following sources:

SO_2 concentrations**:** *GEMS/AIR,* US Environmental Protection Agency (US EPA) (http://www.epa.gov/airs/aexec.html)

GDP: The *Penn World Tables*, NBER (ftp://ftp.nber.org/pwt56/), and International Monetary Fund, *International Financial Statistics*

Capital: The *Penn World Tables*

Trade: The *Penn World Tables*

Population: *Global Population Distribution Database*, The Consortium for International Earth Science Information Network (CIESIN) (http://grid2.cr.usgs.gov/globalpop/1-degree/description.html)

Suburban and **Rural**: *GEMS/AIR*

Temperature and **Precipitation**: *Global Historical Climatology Network (GHCN),* National Climatic Data Center of the US National Oceanic and Atmospheric Administration (ftp://ftp.ncdc.noaa.gov/pub/data/ghcn/v1/)

Civil liberties: *Freedom House* (http://www.freedomhouse.org/rearch)

Democracy: *Polity IV* (http://www.cidcm.umd.edu/inscr/polity)

WoverS: *The logic of Political Survival Data Source* (http://www.nyu.edu/gsas/dept/politics/data/>

Parl_Pres: *The logic of Political Survival Data Source* (http://www.nyu.edu/gsas/dept/politics/data/>

Labor: *Nickell, Stephen (1997) in Journal of Economic Perspectives.*

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