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ANALYSIS

Effects of political institutions on air quality

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ABSTRACT

We empirically test existing theories on the provision of public goods, in particular air quality, using data on sulfur dioxide (SO_2) concentrations from the Global Environment Monitoring Projects for 107 cities in 42 countries from 1971 to 1996. The results are as follows: First, we provide additional support for the claim that the degree of democracy has an independent positive effect on air quality. Second, we find that among democracies, presidential systems are more conducive to air quality than parliamentary ones. Third, in testing competing claims about the effect of interest groups on public goods provision in democracies we establish that labor union strength contributes to lower environmental quality, whereas the strength of green parties has the opposite effect.

1. 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? What is the individual and net influence of political pressure groups with an environmental agenda?

The economics literature has thus far concentrated primarily on the effects of economic variables on environmental quality, notably, the level of income, the scale and type of economic activity, and trade openness. Political scientists, for their part, have only recently started to address quantitatively the implications of political variables for 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 underprovide 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 disproportionate influence on policymaking (Olson, 1965, 1982; Midlarsky, 1998). This implies that public goods (environmental quality) may be underprovided in the presence of strong special interest groups opposing environmental policies. The same may be true if elected politicians overweighed short-run benefits in the presence of long-term

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environmental degradation (Congleton, 1992). Yet other authors have advanced competing propositions with regard to the effects of various forms of democracies on public goods provision, most notably, presidential vs. parliamentary systems (Persson et al., 2000; Bueno de Mesquita et al., 2003).

In this paper we assess the effects of various political variables on air quality after having taken into account the effects of economic and other non-political variables. Computing the effects of political variables conditional on other important determinants of environmental quality, e.g., income, is essential because of very high correlations between some of these variables. In particular, we relate sulfur dioxide (SO_2) concentrations, an important indicator of air quality, from 1971 to 1996 in 107 cities in 42 countries to:

(1) the degree of democracy, defined in terms of institutional arrangements that affect political leaders' selection and their incentives to provide public goods in order to survive politically — i.e., the size of the winning electoral coalition relative to the electorate;
(2) the type of democratic government — i.e., parliamentary vs. presidential;
(3) interest group influence, defined as labor union strength, share of green parties in national parliaments, and civil liberties (which we interpret as a proxy for aggregate interest group influence).

The value added by this research is as follows. We examine the effects of a broader set of political variables than in similar research to date, including the degree of democracy, the form of democratic government, and interest group influence. In doing so we also test competing theoretical claims, notably those concerning the effects of political regimes, the form of democratic government and interest groups. Bueno de Mesquita et al. (2003) have argued that presidential systems are more likely to be associated with greater provision of public goods than parliamentary ones. Other authors (most notably, Persson et al., 2000) have proposed the opposite. While most environmental policy analysts agree that the existence of green parties has a positive effect on environmental quality, the effect of other interest groups, such as labor unions, remains unclear. More generally, Olson's (1982) argument about negative effects of civil liberties (freedom) and interest groups on public goods provision remains controversial. In assessing these competing claims we contribute to the broader literature on public goods provision.

Another improvement relative to the existing literature on the political determinants of air quality is that we use a more comprehensive set of economic determinants (Antweiler et al., 2001). The possibility that many important economic effects on the environment may be jointly determined with political variables requires that economic characteristics are included along side political determinants in order to avoid estimation bias. In contrast with most existing studies on the political determinants of environmental quality, we also include a set of geographical and climatic conditions that may account for the variation in pollution across cities and countries.

Studying the political determinants of environmental quality in such a comprehensive manner puts high demands on data availability and quality. It thus requires a rather narrow focus as regards to environmental quality indicators. We have chosen, as the first step, to focus on SO_2 concentrations, an important measure of air quality. In contrast to other environmental quality indicators, this data is available in relatively high quality for many countries over longer periods of time. Follow-up research could, to the extent that reliable data is available, concentrate on assessing the empirical relevance of the analytical framework developed in this paper in respect to other measures of environmental quality.

Our main findings are: First, we provide additional support for the claim that the degree of democracy has a positive effect on air quality. Second, we show that presidential systems are more conducive to air quality than parliamentary ones. This finding supports the public goods provision theory of Bueno de Mesquita et al. (2003) over competing theories. Third, we document that labor union strength contributes to lower air quality, whereas the strength of green parties has the opposite effect.

The following section discusses the theoretical arguments on democracy–environment linkages. We then state the hypotheses to be tested, define the variables and research design, and present the results of the empirical analysis.

2. Theoretical framework

In developing hypotheses about the impact of political variables on air quality, we draw on theories of public goods provision. For any given level of income (and other non-political control variables for that matter) this relationship seems theoretically ambiguous. In particular, the relevant literature offers both arguments stipulating positive and negative effects of democracy on public goods provision; it also offers contradictory arguments on the effects of particular forms of democratic governments.

2.1. *Positive effect of democracy on public goods provision*

Several 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 respective country to create personal wealth and to redistribute income from their populations towards themselves. If the costs of stricter environmental policies are born disproportionately by the elites (as it would be the case with restrictions on polluting industrial activities) while the benefits are uniformly dispersed throughout the population, then these elites would have little incentive to implement such policies. In contrast, in democracies the median voter, who decides on public policy, faces lower costs from environmental policies relative to the economic and political elite. This makes the adoption and implementation of stricter environmental policies more likely in democratic regimes.

Bueno de Mesquita et al. (2003) move beyond the simple classification of political systems as democratic or autocratic, which is mainly based on the competitiveness of political participation. They develop a model of how institutional

arrangements shape the selection of leaders as well as their incentives to provide public goods. They show that the institutional features of the selectorate (i.e., the group of people who can affect the choice of leaders and be the recipients of the benefits distributed by leaders) and the winning coalition (i.e., the subgroup of the selectorate maintaining incumbents in office in exchange for special privileges) determine whether governmental policies provide public or private goods. They argue that in autocracies, where the winning coalition is small and the selectorate is large, leaders have to provide the small number of their essential supporters with a relatively large amount of private goods if they wish to remain in power. Moreover, autocratic institutional structures promote loyalty to the incumbent leader among the privileged few of the winning coalition. This further enhances the provision of private goods. In contrast, in democracies, where the winning coalition is large relative to the selectorate, leaders lack sufficient resources to reward their supporters with high levels of private goods. In addition, the weak loyalty norm encourages defection from the incumbent leaders' winning coalition to opposing candidates. This forces leaders to adopt policies that provide a relatively high level of public goods (such as better environmental quality) to ensure their political survival.

2.2. *Negative effect of democracy on public goods provision*

Some authors have argued that elected governments may have shorter planning horizons than non-elected governments because of political myopia (Congleton, 1992). For example, many forms of environmental degradation develop slowly and over long periods of time (e.g., climate change, biodiversity, air and water pollution). Consequently, 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, if they want to, more costly decisions (stricter environmental policies) with longer-term benefits without fear of been punished by myopic voters.

Arguments on positive effects of democracy on public goods provision have also been challenged 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. By implication, this means that in mature democratic systems public goods provision could suffer from the existence of a relatively large number of special interest groups that have little or no incentive to make 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, public policy could fall short of improving environmental quality when distributional coalitions, including special interest groups, gain the upper hand. Midlarksy (1998) makes a similar argument, noting that democratic governments may be reluctant to mitigate environmental problems because some groups are expected to lose (or gain) more than others when environmental policies are implemented.

Finally, recent theoretical research has argued that in democratic political systems the form of government affects the provision of public goods. Persson et al. (2000) draw a *distinction between presidential and parliamentary systems*. They argue that legislative cohesion [2] (" the disciplined voting by members of a governing coalition" (p.1124)) in parliamentary regimes leads to policies aiming at pleasing the majority of voters and consequently increases spending on public goods.

In presidential systems, on the other hand, unstable legislative coalitions and the struggle among different minorities over different issues on the legislative agenda lead to inefficiently low spending on public goods. This also promotes the allocation of spending to powerful minorities, for example the constituencies of 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. They show, theoretically, that presidential systems, which necessitate a large winning coalition, 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 political variables employed are mainly the type of political system (democracy, autocracy, communist), and rarely institutional structures (corporatist and pluralist) and the quality of institutions that secure property rights and the efficient allocation of public goods (for example, the respect and enforcement of contracts, the efficacy of rule of law, and the extent of government corruption). The empirical evidence that democracy leads to better environmental quality is mixed. Midlarsky (1998) reports that democracies are associated with worse environmental performance than autocracies. Ward (2006) finds that the direct impact of democracy on a variety of environmental sustainability indicators is mixed. Grossman and Krueger (1995) find that communist countries tend to pollute more than non-communist countries, holding per capita income and other explanatory variables constant. Barrett and Graddy (2000) report that an increase in civil and political freedoms (based on the Freedom House indices) decreases certain types of pollution (e.g., air pollutants such as SO_2, smoke, and particles) but has no effect on other pollutants (e.g., pollutants affecting water quality). Gleditsch and Sverdrup (2003) report that an increase in democracy reduces CO_2 emissions per capital. Harbaugh et al. (2002) find that countries that are more democratic (based on Polity III data), ceteris paribus, tend to pollute less in terms of SO_2 than countries that are less democratic. Li and Reuveny (2006) report that democracy (based on Polity IV data) reduces five types of human-induced environmental degradation (CO_2 and NO_x emissions, deforestation, land degradation, and organic pollution in water). Torras and Boyce (1998) find that political rights and civil

[2] Diermeier and Feddersen (1998) show that the risk of losing valuable agenda-setting powers that are associated with participation in a majority coalition after a government crisis contributes to legislative cohesion.

liberties have in general a positive and significant effect on air and water quality, especially in low-income countries. Panayotou (1997) concludes that the quality of institutions (the respect and enforcement of contracts) significantly reduces ambient SO_2 levels in low-income level countries and speeds up improvements in higher-income countries. Finally, Janicke (1992), Crepaz (1995), Jahn (1998), and Scruggs (1999, 2001) study how institutional structures in industrialized democracies affect environmental quality. They find, for example, that corporatist institutions (consensual and encompassing forms of interest group representation) are associated with better environmental performance than their pluralist counterparts.[3]

Our contribution is complementary to this research. The main difference is that we examine a broader set of political variables to test some of the yet untested theoretical propositions on public goods provision discussed above. The effects of these variables are examined alongside the effects of economic and geophysical determinants of environmental quality. In empirically assessing competing theoretical claims associated with those political variables we also contribute to the literature on public goods provision.

3. Hypotheses on the political determinants of environmental quality

We begin by defining the measure of environmental quality to be used in this analysis. We then state the hypotheses to be tested and define the variables.

3.1. *Environmental quality: air pollution: SO_2*

There exist many pollutants that could serve as indicators of environmental quality. For the purposes of our study, which is to empirically test hypotheses derived from existing theories on the provision of public goods, a pollutant should fulfill the following requirements: 1) be produced by human activity; 2) be subject to regulations, if governments chose to, because of its harmful effects on humans, ecosystems, and the economy; 3) have available abatement technology(ies) for implementation of the regulations; and 4) for statistical purposes, have data available from a mix of democratic and non-democratic and developed and developing countries. Air pollution in particular sulfur dioxide (SO_2) concentrations fulfill the abovementioned requirements. First, air quality is widely regarded as one of the most important environmental indicators (Konisky, 1999). Moreover, SO_2 is one of the so-called criteria pollutants[4], and used by the World Bank, the OECD, and numerous other national and international authorities to describe air quality.

Second, SO_2 is perhaps the most prominent form of air pollution worldwide, since it has direct and visible effects on human health, ecosystems, and the economy. SO_2 has negative effects on the human body. It causes acid rain, which damages forests, lakes, buildings, cultural objects, and agricultural production. It also reduces visibility, from light mist to dense gray smog.

Third, SO_2 emissions can be controlled, if governments wish to, by altering the techniques of production. While some sulfur dioxide is also emitted by natural sources, such as volcanoes and decaying organic matter, it is primarily produced from the burning of fossil fuels, notably oil and coal. In industrialized countries SO_2 is produced mainly from electricity generation and the smelting of non-ferrous ores, whereas in developing countries it is primarily emitted from the burning of diesel fuel and home heating. This implies that SO_2 emissions can be curtailed, for example, by reducing consumption of fossil fuels (especially high-sulfur coal), by using smoke-scrubbing equipment in power plants and smokestacks, by reducing the sulfur content of fossil fuel, and by increasing energy efficiency. Although these emission reduction measures are readily available and effective they are quite costly. Many countries, however, around the world (e.g., USA, EU) and international organizations (e.g., WHO) have established standards and ambient concentration limits in order to protect public health and the environment.

Fourth, availability of data that is commensurable for a large number of countries and over long time periods is a major problem in this type of research. Data for SO_2 concentrations is more *reliable* than data for other forms of air pollution, and it is also available for a rather large number of countries since the 1970s. Data with similar properties is not available for most other environmental quality indicators, such as NOx, VOC, CO, PM, ozone, measures of water quality such as BOD and COD, indicators of soil degradation, deforestation, biodiversity loss, and the like. Also, we did not use composite environmental quality indices, such as the Environmental Sustainability Index or the various indices for anthropogenic ecological footprints (www.ciesin.org), because they are available only for very few (most recent) years and usually combine ecological and environmental policy components (whereas we seek to study the effects of political variables on ecological outcomes).[5] Moreover, although one could argue that emissions data should be used since emissions are more closely linked to economic activity than concentrations, we chose to focus on ambient pollution rather than emissions because a) it measures air quality more directly; b) it is what citizens have preferences over and demand to be restricted as their income increases; c) it is more appropriate for studies that examine the impact of pollution on human health and consequently voters preferences for better environmental quality (Stern et al., 1996); and d) the data itself is of greater quality and reliability since ambient pollution data come from international monitoring programs while data on emissions come largely from national sources and it is, thus, highly possible that emissions are biased

[3] Neumayer (2003), however, in his study of 21 OECD countries over the period 1980 or 1990–1999, finds that corporatism does not have a consistent systematic impact on air pollution levels.

[4] Carbon monoxide (CO), nitrogen oxide (NO_2), ozone (O_3), particulate matter (PM_{10} and $PM_{2.5}$), and lead (P_b) are other criteria pollutants.

[5] Some studies include several pollutants (e.g., Grossman and Krueger, 1995; Barrett and Graddy, 2000). However, the problem with this approach is that data for different pollutants is available for different sets of countries and years. This renders comparisons of results across pollutants very difficult.

downward. Nonetheless, we will attempt to judge the generality of our results for other important air pollutants by examining the cross sectional correlations between SO_2 and CO_2, N_2O, and NO_x emissions in the ETC-ACC emissions data set from the European Environment Agency (see below).

Our data for sulfur dioxide (SO_2) concentrations consists of annual observations for the years 1971–1996 from 291 observation sites located in 107 major cities in 42 countries[6]. This data has been collected through standardized procedures in the framework of the Global Environment Monitoring System (GEMS). GEMS was sponsored by the World Health Organization (WHO). The US Environmental Protection Agency (EPA) maintains this data in its Aerometric Information Retrieval System (AIRS) (see 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. (2001) point to a 1984 WHO report on the GEMS/AIR project which argues that concentrations are more suitably described by a log-normal distribution, for the distribution of concentrations is highly skewed towards zero when viewed on a linear scale.

3.2. *Political variables*

The above-mentioned general causal connections between politics and the provision of public goods (air quality) allow us to draw testable hypotheses on the effects of political variables on SO_2 concentrations. We posit the following hypotheses:

H1. The more democratic a country is, the lower its SO_2 concentrations.

3.2.1. *Democracy*

Technically, as it has already been argued, SO_2 can be controlled/curtailed by readily available and effective although costly methods. Whether this happens, however, depends mainly on the willingness of political leaders to do so. We use Bueno de Mesquita et al's (2003) winning coalition over the selectorate, *W/S*[7], variable (*WoverS*) to measure the degree of democracy. We believe that this variable connects more tightly to the theoretical arguments on public goods provision than conventional measures of democracy/autocracy, such as the Freedom House political liberties index and Polity IV data, which mainly focus on the competitiveness of political participation and of executive recruitment, and the constraints on the executive's power[8]. WoverS measures the strength of the loyalty norm. It accounts for the impact of institutional arrangements on political leaders' incentives to provide public goods in order to remain in power. As the size of the winning coalition increases relative to the selectorate, the loyalty of coalition members to the incumbent decreases and leader(s) must opt for policies that aim at providing more public goods (better environmental quality) in order to survive politically.

H2.1. The greater the strength of interest groups that tend to lose from more stringent environmental policies, the higher the SO_2 concentrations.

H2.2. The greater the strength of pro-environment groups, the lower the SO_2 concentrations.

H2.3. Civil liberties (a proxy for aggregate interest group influence) have a negative (positive) effect on SO_2 concentrations.

The political science and political economy literature does not offer any commonly accepted measure of special interest-group influence. We have chosen to use data on labor union strength, green party shares in national parliaments, and civil liberties to test hypotheses H3.1–H3.3.

3.2.2. *Labor union strength*

We assume that technological innovation and associated industrial restructuring tend to have pollution-reducing effects. We also assume that labor unions are, on average, interested in slowing down or preventing industrial restructuring. In many countries worldwide labor unions have in the past often been vocal opponents, for instance, of closures or modernization of pollution intensive traditional industries (e.g., steel production, pulp and paper production, mining, refineries, fossil fuel power plants, bulk chemicals production, and cement production). 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 opt for a measure that is available for a relatively large number of countries and captures the influence of labor unions on legislation, namely, the employment protection index[9] (*labor*). This index is taken from Nickell (1997). It

[6] Argentina, Australia, Austria, Belgium, Brazil, Canada, Chile, China, Czechoslovakia, Denmark, Egypt, Finland, France, Germany, Ghana, Great Britain, Greece, India, Indonesia, Iran, Iraq, Ireland, Israel, Italy, Japan, Kenya, Malaysia, Netherlands, New Zealand, Pakistan, Peru, Philippines, Poland, Portugal, South Korea, Spain, Sweden, Switzerland, Thailand, United States, and Venezuela.

[7] "W", the size of the winning coalition, is a composite index based on: (a) the variable REGTYPE (1 = civilian; 2 = military–civilian; 3 = military; 4 = other) taken from Banks' data set; and (b) the variables XRCOMP (competitiveness of executive recruitment), XROPEN (openness of executive recruitment), and PARCOMP (competitiveness of participation) from the POLITY IV data set. "S", the size of the selectorate, is the legislative selection (LEGSELEC) variable from the POLITY IV data set. LEGSELEC 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. According to Bueno de Mesquita et al. (2003), this variable measures "the breadth of the selectiveness of the members of each country's legislature" (pp.134). "W" and "S" are normalized to fall between 0 and 1. WoverS is, thus, W divided by (log(S + 1) 10) / 3 to avoid division by zero.

[8] Note that WoverS and Polity are correlated.91. We check the robustness of our results by substituting the Polity variable from the POLITY IV data set for the WoverS variable in all the regressions we run.

[9] Other variables that we could have used are collective bargaining coverage and union density. Unfortunately, yearly data on collective bargaining coverage is not available for the whole period of our study. We decided against union density because it may often provide a misleading picture of labor-union power. For instance, among all OECD countries union density is the lowest in France. This might be misleading because in France more than 70% 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).

measures the strength of the legal framework governing hiring and firing for the period 1989–1994. It ranges from 1 to 20, with 20 indicating the strictest regulation (the United States, with a value of 1, has the laxest regulation).

3.2.3. *Green party strength*

Neumayer (2003:205) states "the ecological orientation of green parties is beyond doubt. What is less clear, however, is whether their rise in Western democracies has had a significant impact on pollution levels. That is, …, their actual significance awaits to be tested empirically." We assume, thus, that green parties by and large represent the aggregate interests of pro-environment groups. To capture the strength of pro-environment interest groups we use the share of seats of green party(ies) in national parliaments (*sgreen*). The data is taken from the Armingeon et al. (2004) data set.

3.2.4. *Civil liberties*

Interest groups other than labor unions and pro-environment groups also influence environmental policies. We believe that the effect of such–empirically hard to identify–groups may be approximated by variable measuring civil liberties if this variable is included alongside the labor unions and green party variables. For this purpose we use the *civil liberties* (*civil*) component of the Freedom House index. The Freedom House organization rates all countries of the world on dimensions of political[10] and civil rights. The civil liberties part of the index measures constraints among other things on: association and organizational rights (freedom of assembly, demonstration, political or quasi-political organizations including ad hoc issue groups, and free trade unions and farmers 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). Instead of working with the original variable, we have chosen to transform it so that a higher value of the new variable means a higher level of civil liberties (hence, 7 now represents the highest level of civil liberties). This is an innocuous change that does not affect anything and is done for reasons of consistency with the other variables (where higher means more) and in order to eliminate a possible source of confusion in the reading of the tables. Since we view civil liberties at least in part as a *crude* proxy for the strength of special interest groups, we expect the effect of this variable on environmental quality to be ambiguous.

H3. For democracies, presidential systems experience lower SO_2 concentrations than parliamentary systems.

3.2.5. *Presidential vs. Parliamentary*

As argued above, the *form* of government (presidential vs. parliamentary) is likely to affect the provision of public goods. However, the sign of this relationship appears to be theoretically and empirically[11] ambiguous (Bueno de Mesquita et al., 2003 vs. Persson et al., 2000). We include in our analysis Bueno de Mesquita et al's *Parl-Pres*[12] variable to test for the effect 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.

3.3. *Control variables*

3.3.1. *Economic variables*

3.3.1.1. Income: lagged real GDP per capita. Although we are interested primarily in the impact of politics on environmental quality, we need to control for a number of other factors that have been identified, especially by economists, as important determinants of SO_2 concentrations. There is a large body of theoretical and empirical literature that focuses on the economic determinants of environmental quality. This literature has established that some forms of environmental degradation follow a Kuznets curve pattern[13] (e.g., Grossman and Krueger, 1995; Selden and Song, 1994; WTO, 1999). In other words, environmental quality 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).[14]

Following standard practice in the literature (see Grossman and Krueger, 1995, Antweiler et al., 2001), we use a *moving average of lagged income* (a three-year average of lagged real GDP per capita) in order to capture "permanent" income, which is the theoretically measure of income as far as the

[10] 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 with the consent of the electorate.

[11] For example, Bueno de Mesquita et al. find that presidential systems perform better than parliamentary systems 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] This variable was developed by Alvares et al. (1997), and Przeworski et al. (2000).

[13] Which ones and to what extent remain the subject of debate in the literature.

[14] For a critical review of the environmental Kuznets curve literature, see Stern (2004).

demand for the environment is concerned. But as Grossman and Krueger (1995) point out, lagged and current GDP per capita are highly correlated in practice, so including one or the other does not make much of a difference (we obtain similar results using current real GDP per capita instead).

3.3.1.2. Degree of trade openness: trade. Some authors have incorporated international trade in their analysis of economy–environment linkages (e.g., Frankel and Rose, 2002). They argue that trade affects the domestic economy and therefore also environmental behavior. The sign of this relationship, however, appears theoretically ambiguous due to offsetting forces (the pollution haven hypothesis, the positive effects of trade on income, and the effects of trade on the scale of production). Yet, Antweiler et al. (2001) establish that, at least for SO_2 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 a negative effect of trade on pollution.

3.3.2. Topographical and climatic conditions

Though geographical and climatic conditions (e.g., central or rural 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 some such variables to obtain more accurate estimates.

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

3.3.2.2. Climate: temperature, precipitation. We include the *average annual temperature* at each site to take into account seasonal influences on the demand for fuels that contribute to emissions of SO_2. We expect higher temperatures to lead to less pollution because the demand for fuel (notably, heating fuel) is lower.

We also include *variation of monthly precipitation* at each site. Precipitation can affect (wash out) SO_2 concentrations. But if precipitation is concentrated in one season, then SO_2 concentrations over the year are not reduced. Consequently, we expect a positive effect of variation of precipitation on SO_2 concentrations.

3.3.3. Time trend: year

Finally, we add a deterministic 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. Given the nature of the data set (unevenly spaced observations) it is not possible to test for the existence of a stochastic trend (unit root) as an alternative time specification for the SO_2 process.

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

Table 1 – Summary statistics

Variable	Observations	Mean	Standard deviation	Min	Max
SO_2	2555	−4.862	1.108	−6.908	−2.163
WoverS	2555	0.856	0.236	0.000	1.001
Civil	2515	2.240	1.879	1	7
Labor	1672	5.271	5.823	1.000	20.000
Parl_pres	2099	1.099	1.145	0.000	3.000
Sgreen	1700	0.086	0.628	0.000	8.500
Income	2555	2.614	2.242	0.012	6.944
Trade	2555	0.409	0.322	0.088	2.617

3.4. Statistical model

Combining the environmental, political, economic, and geophysical variables just discussed, we obtain the following statistical model:

$$SO_{2jikt} = \beta_0 + \beta_1 4\{\text{political variables}\} + \beta_2 4\{\text{economic variables}\} + \beta_3 4\{\text{other variables}\} + \beta_4 4\text{year} + e$$

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

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 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). Nonetheless, the Hausman test, which tests for correlation between the error and the regressors in order to compare the results produced by the two procedures, shows that the differences in the coefficients between the fixed and random effects estimations do not differ significantly. Consequently, we report only the random effects estimations.

4. Results

Table 1 reports relevant summary statistics. Table 2 shows correlation coefficients for the variables used in the analysis. As indicated by Table 2, the degree of democracy (WoverS) and civil liberties are highly, positively correlated 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

Table 2 – Correlations

	SO_2	WoverS	Civil	Labor	Parl_pres	Sgreen	Income	Trade
SO_2	1							
WoverS	−0.2282	1						
Civil	−0.2145	0.7812	1					
Labor	0.4626	−0.2323	−0.536	1				
Parl_pres	−0.2994	0.2796	0.2103	−0.3928	1			
Sgreen	−0.0238	0.0392	−0.1121	0.197	−0.0253	1		
Income	−0.3161	0.2019	0.332	−0.6155	0.4549	0.1594	1	
Trade	0.0135	0.1341	0.1493	0.3355	−0.2549	0.1374	−0.3525	1

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 concentrations on the explanatory variables described above. We have studied two sets of countries. The first set contains all the countries in the sample. In this sample we have examined the effect of the degree of democracy as well as that of the special interest groups on environment quality (along side the economic and geographical characteristics). The second sample contains only democracies. Within this sample, we have examined the role of the type of democracy (presidential vs parliamentary) along side the role of the other explanatory variables.

4.1. *Hypothesis 1: degree of democracy*

The results shown in column 1 of Table 3 indicate that the effect of the size of the winning coalition relative to the selectorate (WoverS) is to reduce pollution. A 1% increase in WoverS decreases SO_2 concentrations by 0.14%. This finding is consistent with the finding by some other authors[16] that the degree of democracy is good for the environment. Moreover, greater trade openness and higher temperature, as expected, contribute to lower pollution levels. The effect of income is imprecisely estimated, probably because of its strong positive covariation with the time variable.

4.2. *Hypothesis 2: interest groups*

What are the effects of special interest groups, as captured by organized labor and green parties? The results in Table 3 column 1 are consistent with the arguments advanced above. The quality of the environment is adversely affected by the strength of labor unions. That is, the greater the strength of labor unions, as measured by labor-friendly regulation, the higher the level of pollution. It is worth reporting that the labor-union variable has a substantial, negative, and statistically significant effect on air quality in all of the regressions that include it. On the other hand, environmental quality benefits from the presence of green parties. The coefficient is negative and statistically significant. This result is consistent with Neumayer's (2003) finding that the green parliamentary strength is associated with lower air pollution levels.

[16] Li and Reuveny (2006), Gleditsch and Sverdrup (2003), Harbaugh et al. (2002), Barrett and Graddy (2000), and Torras and Boyce (1998).

Environmental policy and, by implication, environmental quality are affected by many interest groups, ranging from business associations to homeowners to anti-globalization groups. We do not have specific quantitative information on such diverse groups that could help us determine the sign and size of their individual influence on environmental quality. We believe, though, that we can gain some information indirectly about the effect that these groups jointly have by examining the impact of civil liberties on environmental quality. As argued above, civil liberties allow even small groups to exert political influence. It is of interest to know which of these groups (pro-environment or other) have been able to make more effective use of the possibilities granted by liberal civil society.

As can be seen in column 1, civil liberties, do not have any effect beyond that present in the power of labor unions and environmental groups. The civil liberties variable is statistically insignificant. This suggests that these two special interest groups capture adequately any effects that civil liberties may have on the environment.

4.3. *Hypothesis 3: form of democratic government*

We now use the second sample, that containing democracies only, in order to examine the effect of the form of democratic

Table 3 – Degree (WoverS) and type (parl_pres) of democracy Random-effects GLS regressions

SO_2	All countries		Democracies	
WoverS	−0.836	(0.359)		
Parl_pres			−0.162	(0.073)
Labor	0.079	(0.013)	0.083	(0.015)
Sgreen	−0.076	(0.026)	−0.074	(0.030)
Civil	0.052	(0.061)	−0.059	(0.054)
Income	0.128	(0.092)	0.406	(0.122)
Income_square	−0.006	(0.008)	−0.032	(0.012)
Trade	−0.689	(0.233)	−0.901	(0.246)
Rural	−3.669	(1.499)	−4.850	(1.604)
Precipitation	7.091	(5.649)	1.516	(6.382)
Temperature	−0.032	(0.013)	−0.029	(0.015)
Year	−0.049	(0.007)	−0.055	(0.007)
Constant	93.64	(14.32)	104.1	(15.23)
Observations	1672		1297	
R-squared: overall	0.329		0.236	
Wald chi^2	404.9		243.48	
Prob>chi^2	0		0	

Standard errors in parentheses.
Significant at 1%, significant at 5%, and significant at 10%.

Table 3a – Degree of democracy (Policy)

Random-effects GLS regression	
SO_2	
Polity	−0.056 (0.021)
Labor	0.084 0.013
Sgreen	−0.077 (0.013)
Civil	0.119 (0.075)
Income	0.150 (0.093)
Income_sq	−0.008 (0.008)
Trade	−0.720 (0.234)
Rural	−3.676 (1.516)
Precipitation	7.353 (5.671)
Temperature	−0.033 (0.013)
Year	−0.050 (0.007)
Constant	94.72 (14.36)
Observations	1664
R-squared	0.326
Wald chi^2	399.09
Prob>chi^2	0.0000

Standard errors in parentheses.
Significant at 1%, significant at 5%, and significant at 10%.

is negative and statistically significant at the 5% confidence level. This indicates that presidential systems have an edge over parliamentary ones as far as the pursuit of environmental quality is concerned. This finding supports the theory of Bueno de Mesquita et al. (2003) that presidential systems are more likely to provide greater amounts of public goods because of their larger coalition requirements. It contradicts the opposite claim advanced by Persson et al. (2000). The effects of the other political variables are as in column 1 so there is no need to discuss them again.

How robust are these results to alternative empirical specifications? The relationships between SO_2 concentrations, the degree of democracy, the form of democratic government, labor union and green party strength, and civil liberties is quite robust. They are not affected by the inclusion or exclusion of the United States and communist regimes, by changes in the list of the explanatory variables, or by the use of different estimation techniques. For instance, we experimented with other measures of democracy such the Polity[17] variable from the POLITY IV data set without any effects on the results reported above (Table 3a).

Table 4 reports the results when within country variation has been eliminated by taking country averages for all the variables included in the regression. In this case, all countries receive the same "weight" independent of the number of observation sites they have, so that the political variables of the countries with a large number of sites (such as Canada and the US) do not exert a disproportionately greater influence on the results (recall that the political variables are common across sites within a single country). We correct for panel heteroskedasticity as suggested by Beck and Katz (1995: 645). The table reports Prais–Winstein coefficients with panel-corrected standard errors. As can be seen, the sign and the significance of the estimated coefficients of WoverS, labor and *sgreen* are not affected by this aggregation scheme. The estimated coefficient of the civil liberties variable, however, is positive and now becomes statistically significant at the 10% level. Note also that the pattern of the estimated coefficients on the quadratic specification of income is similar to that reported by Grossman and Krueger (1995) and consistent with an inverted U-shape Kuznets environmental curve.

Finally, we have examined the robustness of our results to inclusion of another "political" variable that is likely to matter for pollution. In particular, we have included participation in international arrangements such as membership in the Convention on Long Range Transboundary Air Pollution (LRTAP) and the European Union (EU). The addition of these two variables does not change the results at all. Interestingly, we find that membership in the LRTAP is associated with lower SO_2 concentrations but the estimated coefficient is statistically insignificant, while membership in the EU is associated with higher pollution.[18]

Do these results generalize to other pollutants or are they specific to SO_2? As discussed above, there exists no comparable information on other pollutants for the same years and same countries studied in this paper. Nevertheless, we can draw an indirect inference by examining the cross-country correlations between SO_2 and other important forms of air pollution (such as CO_2, N_2O and NO_x) in data sets that include all of these pollutants, such as the ETC-ACC air emissions data base from the European Environment Agency. The ETC-ACC data is available for the period 1990–2002, but for the European countries only. We have computed the cross country correlations for the period 1990–1996 (recall that the sample used in our empirical analysis ends in 1996) for all the countries in the ETC-ACC data set as well as for those countries that appear both in our and the ETC-ACC sample. These correlation coefficients are very high, indicating that the various important forms of air pollution behave similarly across countries. In particular, the correlation between SO_2 and CO_2 is 0.850 in the ETC-ACC data set (0.851 when we only look at the countries that appear in both data sets); between SO_2 and N_2O it is 0.66 in the ETC-ACC data set (0.63 for the overlapping sample); and between SO_2 and NO_x it is 0.87 in the ETC-ACC data set (0.85 for the overlapping sample). Hence, there are good reasons to believe that our results are also applicable to other forms of air pollution.

5. 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. Research to date also suggests that openness to international trade, in spite of theoretical ambiguities, tends to lower many forms of pollution.

The literature on political determinants of environmental quality is more limited and still developing. A consensus

[17] Polity ranges from 10 (most autocratic) to 10 (most democratic). See Marshall and Jaggers (2002).

[18] Results are not shown here.

Table 4 – Country averages, degree of democracy (WoverS) Prais–Winstein regression, heteroskedastic panels corrected standard errors

SO_2	Coefficient
Wovers	−1.607 (0.691)
Labor	0.082 (0.012)
Sgreen	−0.132 (0.030)
Civil	0.233 (0.127)
Income	0.343 (0.132)
Income_square	−0.063 (0.017)
Trade	−0.364 (0.196)
Rural	4.172 (1.414)
Precipitation	−8.21 (16.45)
Temperature	0.006 (0.016)
Constant	−5.55 (0.732)
Observations	259
R-squared	0.33
Wald chi^2	178.65
Prob$N$$chi^2$	0.0000

Robust standard errors in parentheses.
Significant at 1%, significant at 5%, and significant at 10%.

seems to be emerging that democracy contributes to higher environmental quality. But various components of this proposition remain controversial. Most notably, there is disagreement regarding which form of democratic government (e.g., presidential vs. parliamentary) is more conducive to environmental quality, and whether civil liberties (freedom) and associated interest group influence have positive or negative effects on the environment.

The results presented in this paper demonstrate, first, that the relationship between the degree of democracy (defined as the size of the winning coalition relative to the selectorate) and air quality, as measured by SO_2 concentrations, is positive and quite robust. Second, we find evidence in support of the proposition that presidential democracies provide a cleaner air than parliamentary democracies.

Third, we test competing claims about the effects of civil liberties and interest groups on public goods provision. It turns out that the relationship between pollution and labor union strength is robustly and significantly positive, whereas that between pollution and the strength of green parties is negative. The analysis also reveals that the effect of civil liberties operates mostly through these two interest groups. Further research should focus on testing the above model with regard to other forms of pollution—to the extent reliable data is available for a larger set of countries and several years. It should also focus on developing additional indicators of interest-group influence in order to test the interest group and civil liberties hypothesis more comprehensively.

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Appendix A. Description of the variables and data sources

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

SO_2 concentrations: log of the median of SO_2 concentrations at site j, city i, in country k, at time t. GEMS/AIR, US Environmental Protection Agency (US EPA) (http://www.epa.gov/airs/aexec.html)

WoverS: W divided by (log(S+1) 10)/3 to avoid division by zero. *The logic of Political Survival Data Source* (http://www.nyu.edu/gsas/dept/politics/data/)

Parl_Pres: dummy variable indicating whether a democratic country has a parliamentary (=0), mixed (=1), or presidential system (=2). *The logic of Political Survival Data Source*

Labor: an index ranging from1 to 20. *Nickell, Stephen (1997) in Journal of Economic Perspectives.*

Sgreen: the share of seats of green party(ies) in national parliaments. Armingeon et al. (2004), *Comparative Political Data Set 1960–2002.* (http://www.ipw.unibe.ch/mitarbeiter/ru_armingeon/CPD_Set_en.asp)

Civil liberties: an index ranging from 1 to 7. *Freedom House* (http://www.freedomhouse.org/rearch)

Income: three-year average of lagged GDP per capita. The *Penn World Tables*, NBER (ftp://ftp.nber.org/pwt56/), and International Monetary Fund, *International Financial Statistics*

Trade: the ratio of the sum of exports and imports to GDP. 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)

Rural: dummy variable indicating whether a measurement site is in a rural area. *GEMS/AIR.*

Temperature: average annual temperature. *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/)

Precipitation: coefficient of variation of monthly precipitation (the standard deviation of monthly precipitation in a given year divided by the monthly precipitation average in that year). *Global Historical Climatology Network (GHCN).*

SO_2, CO_2, N_2O and NOx emissions: annual total emissions. *European Environment Agency* (http://dataservice.eea.eu.int/dataservice/metadetails.asp?id=762)

LRTAP: membership in the Convention on Long Range Transboundary Air Pollution. (http://www.unece.org/env/lrtap/status/85s_st.htm)

REFERENCES

Alvares, Michael, Cheibub, Jose Antonio, Limongi, Fernando, Przeworski, Adam, 1997. Classifying political regimes. Studies in Comparative International Development 31, 3–36.

Antweiler, Werner, Copeland, Brian R., Taylor, M. Scott, 2001. Is free trade good for the environment? American Economic Review 91 (4), 877–908.

Armingeon, Klaus, Leimgruber, Philipp, Beyeler, Michelle, Menegale, Sarah, 2004. Comparative Political Data Set 1960–2002. Institute of Political Science, University of Berne, Switzerland.

Barrett, Scott, Graddy, Kathryn, 2000. Freedom, growth, and the environment. Environment and Development Economics 5 (4), 433–456.

Beck, Nathaniel, Katz, Jonathan N., 1995. What to do (and not to do) with time-series cross-section data. American Political Science Review 89 (3), 634–647.

Bueno de Mesquita, Bruce, Smith, Alastair, Siverson, Randolph M., Morrow, James D., 2003. The logic of political survival. The MIT Press, Cambridge, MA.

Congleton, Roger D., 1992. Political institutions and pollution control. Review of Economics and Statistics 74 (3), 412–421.

Crepaz, Markus L., 1995. Explaining national variations of air pollution levels: political institutions and their impact on environmental policy-making. Environmental Politics 4 (3), 391–414.

Deacon, Robert T. 1999. "The political economy of environment-development relationships: a preliminary framework," *mimeo*, Department of Economics, University of California, Santa Barbara.

Diermeier, Daniel, Feddersen, Timothy J., 1998. Cohesion in legislatures and the vote of confidence procedure. American Political Science Review 92 (3), 611–621.

Frankel, Jeffrey A., Rose, Andrew K., 2002. Is trade good or bad for the environment: sorting out the causality. Working Papers 9201. NBER.

Gleditsch, Nils P., Sverdrup, Bjorn O., 2003. Democracy and the environment. In: Paper, Edward, Redclift, Michael (Eds.), Human Security and the Environment: International Comparisons. Elgar, London.

Grossman, Gene M., Krueger, Alan B., 1995. Economic growth and the environment. Quarterly Journal of Economics 110 (2), 353–377.

Harbaugh, William, Levinson, Arik, Wilson, David, 2002. Reexamining the empirical evidence for an environmental Kuznets curve. Review of Economics and Statistics 84 (3), 541–551.

Jahn, Detlef, 1998. Environmental performance and policy regimes: explaining variations in 18 OECD-countries. Policy Sciences 31 (2), 107–131.

Janicke, M., 1992. Conditions for environmental policy success: an international comparison. The Environmentalist 12, 47–58.

Kennedy, Peter, 1992. A Guide to Econometrics. The MIT Press, Cambridge, MA.

Konisky, David M., 1999. Comparative risk projects: a methodology for cross-project analysis of human health risk rankings. Discussion Paper 99-46. Resources for the Future.

Lake, David, Baum, Matthew, 2001. The invisible hand of democracy: political control and the provision of public service. Comparative Political Studies 34 (6), 587–621.

Li, Quan, Reuveny, Rafael, 2006. Democracy and environmental degradation. International Studies Quarterly 50 (4), 935–956.

Marshall, Monty G., and Jaggers, Keith. 2002. Polity IV dataset. College Park, MD: Center for International Development and Conflict Management. University of Maryland, MD.

McGuire, Martin, Olson, Mancur, 1996. The economics of autocracy and majority rule: the invisible hand and the use of force. Journal of Economic Literature 34 (2), 72–96.

Midlarsky, Manus, 1998. Democracy and the environment: an empirical assessment. Journal of Peace Research 35 (3), 341–361.

Neumayer, Eric, 2003. Are left-wing party strength and corporatism good for the environment? evidence from panel analysis of air pollution in OECD countries. Ecological Economics 45 (2), 203–220.

Nickell, Stephen, 1997. Unemployment and labor market rigidities: Europe versus North America. Journal of Economic Perspectives 11 (3), 55–74.

Olson, Mancur, 1965. The Logic of Collective Action. Harvard University Press, Cambridge.

Olson, Mancur, 1982. The Rise and Decline of Nations. Yale University Press, New Haven.

Olson, Mancur, 1993. Dictatorship, democracy and development. American Political Science Review 87 (3), 567–576.

Panayotou, Theodore, 1997. Demystifying the environmental Kuznets curve: turning a black box into a policy tool. Environment and Development Economics 2 (4), 465–484.

Persson, Torsten, Roland, Gerard, Tabellini, Guido, 2000. Comparative politics and public finance. Journal of Political Economy 108 (6), 1121–1141.

Przeworski, Adam, Alvares, Michael, Cheibub, Jose Antonio, Limongi, Fernando, 2000. Democracy and Development: Political Institutions and Material Well-Being in the World, 1950–1990. Cambridge University Press, Cambridge.

Scruggs, Lyle, 1999. Institutions and environmental performance in seventeen western democracies. British Journal of Political Science 29 (1), 1–31.

Scruggs, Lyle, 2001. Is there really a link between neo-corporatism and environmental performance? Updated evidence and new data for the 1980s and 1990s. British Journal of Political Science 31 (4), 686–692.

Selden, Thomas M., Song, Daqing, 1994. Environmental quality and development: is there a Kuznets curve for air pollution emissions. Journal of Environmental Economics and Management 27 (2), 147–162.

Stern, David I., 2004. The rise and fall of the environmental Kuznets curve. World Development 32 (8), 1419–1439.

Stern, David I., Common, Michael S., Barbier, Edward B., 1996. Economic growth and environmental degradation: the environmental Kuznets curve and sustainable development. World Development 24 (7), 1151–1160.

Torras, Mariano, Boyce, James K., 1998. Income, inequality, and pollution: a reassessment of the environmental Kuznets curve. Ecological Economics 25 (2), 147–160.

Ward, Hugh, 2006. International linkages and international sustainability: the effects of the regime network. Journal of Peace Research 43 (2), 149–166.

WHO (World Health Organization), 1984. Urban Air Pollution: 1973–1980. Published under the joint sponsorship of United Nations Environment Program and the World Health Organization. Geneva, Switzerland.

WTO (World Trade Organization). 1999. Trade and the Environment. Geneva: WTO, Special Studies.