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An Empirical Analysis

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Abstract. There is an established theoretical and empirical case-study literature arguing that environmental pressure groups have a real impact on pollution levels. Our original contribution to this literature is to provide the first systematic quantitative test of the strength of environmental non-governmental organizations (ENGOs) on air pollution levels. We find that ENGO strength exerts a statistically significant impact on sulfur dioxide, smoke and heavy particulates concentration levels in a cross-country time-series regression analysis. This result holds true both for ordinary least squares and random-effects estimation. It is robust to controlling for the potential endogeneity of ENGO strength with the help of instrumental variables. The effect is also substantively important. Strengthening ENGOs represents an important strategy by which aid donors, foundations, international organizations and other stakeholders can try to achieve lower pollution levels around the world.

***Keywords*:** civil society, non-governmental organizations, environmental groups, lobbying, environmental policy.

1. Introduction

The high-profile exploits of environmental non-government organizations (ENGOs) such as Greenpeace and the Chipko movement are well known. Anecdotal evidence of ENGOs meeting with success in preventing environmentally harmful projects or persuading legislators and policymakers to promulgate protective laws and regulations abounds. Certainly, there is a widespread belief in the effectiveness of ENGOs; their members are a testament to this notion. In the words of Carter (2001, p. 131): ‘There is little doubt that environmental groups have been the most effective force for progressive environmental change.’ Little doubt, yes, but also little systematic empirical evidence. Do ENGOs, on the whole, actually have a discernable impact on environmental degradation?

Some economists assert that environmental quality is a simple function of income. Worrying about environmental policies should take a backseat to a focus on growth, which will lead quasi-automatically to an improved environment (Beckerman, 1992). Empirical studies have found an inverse U-shaped relationship between per capita income and numerous indicators of environmental degradation (Selden and Song, 1992; Holtz-Eakin and Selden, 1995; Grossman and Krueger, 1995; Cole et al., 1997; Cole and Neumayer 2004), which supporters of the quasi-automatic relationship hypothesis often cite as evidence. However, even the economists that have found the so-called Environmental Kuznets curve (EKC) caution that their results should not be interpreted to mean that growth automatically leads to higher environmental quality. Indeed, Grossman and Krueger (1996, p. 120) suggest that policy, driven by ‘vigilance and advocacy’, plays an important mediating role in the observed relationship. ENGOs are the primary vehicle for vigilance and advocacy. Selden, Forest and Lockhart (1999), for example, find that emission reductions in the United States were largely directly linked to the Clean Air Act and ENGOs played a vital role in the passing and enforcement of the act (Melnick 1983).

This paper makes a contribution to the empirical case for the influence of ENGOs on levels of environmental degradation in demonstrating that ENGO strength is associated with lower air pollution levels even after controlling for variation in income, democracy, business lobby strength, literacy and income inequality. Section 2 of the paper reviews and assesses the relevant literature on the way in which ENGO strength influences environmental degradation. Section 3 describes the research design, section 4 presents results, and section 5 concludes.

2. ENGO strength and environmental pollution: a review of the literature

Two types of literature are highly relevant to this paper: studies concerning the (anthropogenic) determinants of environmental quality and studies concerning the political economy of environmental interest group influence. This paper is informed by, and seeks to contribute to, both sets of literature. We give more space to the second set of literature since the EKC literature is more widely known already.

2.1 The Environmental Kuznets Curve (EKC)

Most of the empirical literature that analyses the determinants of environmental outcomes focuses on per capita income and, to a lesser extent, democracy, literacy and income inequality (Selden and Song, 1994; Grossman and Krueger, 1995; Panayotou, 1997; Cole et al., 1997; Torras and Boyce, 1998; Barrett and Graddy, 2001; Neumayer, 2002a, 2002b; Neumayer, Gates and Gleditsch, 2002). The literature generally consists of reduced form analysis of cross-country time-series data. Studies that utilize reduced form equations to analyze the effect of income on pollution capture the overall effect of national income (usually expressed as GDP per capita) on concentration levels or emission rates of certain pollutants (Grossman and Krueger 1995). Their results reveal little about the particular pathways through which income affects pollution ‘since income level is used as a catch-all surrogate variable for all the changes that take place with economic development' (Panayotou, 1997, p. 466).[1]

Several recent studies focus on the economic and non-economic factors that may have significant explanatory power over environmental outcomes via policy (see Neumayer (2003) for an overview). Torras and Boyce (1998) hypothesize that the distribution of power within a country significantly affects policy choices and, therefore, environmental policy outcomes. Using reduced form regression analysis, they find in some regressions that the distribution of power has a statistically significant influence on some measures of air and water pollution that often exhibit an EKC relationship with income. In particular, they find that literacy, political rights and civil liberties (all factors that affect the distribution of power) have negative effects on pollution levels. The opposite is the case for income inequality as measured by the Gini coefficient. However, the effects are not consistent across various aspects of pollution and do not hold in all model specifications. Barrett and Graddy (2000) also find that the extent of political and civil liberties have a significant effect on air and water pollution outcomes in some, but not all model specifications.

2.2 The role of environmental NGOs: theory

All of the aforementioned studies imply a significant role for policy, but none deals with the particular element at the center of the policy nexus that links pure income effects and socio-political variables to pollution outcomes, namely ENGOs. Environmental degradation occurs when individuals do not internalize fully the costs of their resource exploitation or pollution. ENGOs have neither the authority needed to prevent individuals and corporations from taking environmentally harmful actions, nor, generally speaking, the financial wherewithal to restore

[1] For a thorough analysis of income and demand for environmental quality see McConnell (1997).

quality at anything but the most local level, if at all. However, ENGOs may have a significant indirect impact on environmental quality.

ENGOs achieve an indirect effect through their influence on policymakers, who seek to maximize their own political welfare. Stigler (1971) posits that policymakers attempt to maximize a political support function calculated by giving fixed weights to the welfare of interest group members and the deadweight loss to society that would result from the group's favored policy.[2] Recent work by Grossman and Helpman (2001) supports this theory. They find that elected policy-makers respond to a weighted sum of the aggregate welfares of informed voters and members of interest groups. ENGOs use their influence to convince policymakers that increasing provision of the environmental good will translate into greater political support from their members and the public.

The political economy literature suggests a strong role for ENGOs in determining environmental policy. Much of the theoretical and empirical literature on the influence of ENGOs focuses on the effectiveness of the environmental lobby. The models of ENGO influence are based largely on the traditional public choice literature, in which politically and economically self-interested policymakers choose the policy option that maximizes their own utility (Aidt, 1998). Aidt shows that competition between environmental and industry lobbies over environmental policy drives the internalization of externalities. Fredriksson (1997) shows that when environmental and industrial lobbies compete, the equilibrium pollution tax increases with environmental lobby group membership. Similarly, Damania et al. (2003) demonstrate in a formal model that the pollution tax is increasing in the number of environmental lobby groups.

[2] Stigler considered the costs of standard economic regulations, which generally imply a deadweight loss to society. However, in the case of the publicly provided environmental good, increased provision may lead to social welfare gains when the original supply does not meet demand.

Indeed, ENGOs engage in various activities meant to change (or threaten to change) policymakers' perceived political support. Smith and Connelly (1999, p. 78) identify 10 types of ENGO activity: informal, discreet lobbying; formal lobbying; collecting and sending letters or petitions from the public; producing scientific research and reports; taking legal action; organizing demonstrations and marches; staging media stunts; promoting consumer boycotts; engaging in non-violent direct action; engaging in violent direct action. To this list, one might add giving campaign contributions or endorsements to environmentally friendly candidates (Grossman and Helpman, 1994, 1999).

Most of the above activities ultimately affect the calculus of policymakers' political support functions.[3] Formal and informal lobbying serves as an important vehicle for the transfer of information to policymakers (Ainsworth and Sened, 1993; Austen-Smith, 1993). It communicates ENGO members' demand for the provision of the environmental good and the potential political support they will give or take away for a particular policy choice. It also communicates the potential welfare gain to society that would result from a particular policy (as perceived by the ENGO). This information about the public's and ENGO members' welfare shapes the calculus of the political support function.

Encouraging members and the public to send letters and petitions to policymakers and holding rallies and demonstrations bolsters lobbyists' message with 'grass-roots' support, while scientific research augments the credibility of the message. Demonstrations, direct action and media stunts can affect the political support calculus, given coverage by the media. Through the media, these ENGO activities make policymakers more aware of public opinion on the environmental issue. Moreover, information relayed to the public by an ENGO through mass media can increase participation in, and change or form attitudes about, a particular

[3] Court action does not necessarily affect policymakers' political support functions, but like the other activities, increases the probability that the government will increase provision of the environmental good.

environmental policy debate (Lemert, 1981). ENGOs can also attempt to set the policy agenda and frame policy debates through the media (Lippman, 1992; McCombs, Einsiedel and Weaver, 1991). Finally, campaign contributions and endorsements most directly affect political support, and can change the weight given to ENGOs in the political calculus.

Thus, ENGO activity potentially influences policymakers' support functions. None of the activities is guaranteed to translate into policy success, but the output of ENGOs can be thought of as raising the probability that the government increases provision of the environmental good (Smith, 1985). This conception is particularly fitting since it implies an expected value, which reflects the reality that in many cases the government will increase provision by a value between zero and the amount desired. The probability that policymakers increase provision of the public good depends on the strength of the ENGO community. As modeled by the theoretical literature and borne out by the empirical literature, this strength derives from the number of members (e.g. Kau and Rubin, 1982) and the level of financial support (e.g. Riddel, 2003) that ENGOs have.

Since, theoretically, the activities of ENGOs primarily affect environmental quality through their influence on policymakers, it follows that ENGOs should primarily have an effect on types of degradation that carry direct costs to the current generation and over which governments can exert substantial influence in the short term, i.e. a given political cycle (Damania et al. 2003). In the case of pollutants like CO_2, the costs of which are to a large extent externalized beyond national borders and/or beyond the current generation, there may be little incentive for governments to take action. Not only will the general public be less willing to accept the costs associated with reducing emissions if they suffer very little from the pollution, but fewer environmentalists may feel compelled to act. Thus, policymakers weighing the support to be gained from ENGO members against the support to be lost from the general public will likely decide against policies meant to mitigate the problem. The three air pollutants addressed in this study – sulfur dioxide, smoke and particulate matter – are ideally suited for analyzing the impact of ENGO strength on pollution levels since the environmental damage affects the current generation and mainly the emitting country (the latter does not necessarily hold true for sulfur dioxide for all countries, however).

2.3 The role of environmental NGOs: empirical evidence

The empirical literature on ENGO influence focuses primarily on the U.S. and analyses the effect of ENGOs on particular policy issues (Kau and Rubin, 1982; Kalt and Zupan, 1984; Fowler and Shaiko, 1987; Durden, Shogren and Silberman, 1991; Cropper et al., 1992; and Riddel, 2003). Kau and Rubin (1982) show that the public-interest group Common Cause had a statistically significant effect on voting in the U.S. Congress for a bill amendment to tax energy-inefficient automobiles. Kalt and Zupan (1984) and Durden, Shogren and Silberman (1991) show that ENGO lobbying had a significant impact on votes for strip-mining legislation. However, Kalt and Zupan find only weak evidence, and Durden, Shogren and Silberman (1991) find that the influence of ENGOs is below average relative to the influence of other groups. Fowler and Shaiko (1987) find that ENGOs' grass-roots lobbying efforts have met with moderate success in the U.S. Senate.

Greater evidence of ENGO influence is found by Cropper et al. (1992) and Riddel (2003). Cropper et al. show that ENGO lobbying had a significant effect on the probability that the U.S. Environmental Protection Agency (EPA) cancelled a harmful pesticide registration. Riddel focuses on a different aspect of ENGOs' influence in analyzing their role in election outcomes and finds that the Sierra Club and the League of Conservation Voters had a significant effect on U.S. Senate election outcomes by leveraging campaign contributions channeled through political action committees.

While the ENGO literature provides substantial theoretical support for the influence of ENGOs on environmental policy, the empirical literature only shows success for particular cases and does not extend the analysis to actual environmental outcomes. The existing literature therefore does not truly show whether ENGOs are effective in achieving what they really want: a higher level of environmental quality.

Only one study currently links the EKC and ENGO literature (Damiana et al. 2005). They tackle the issue by taking a cross-country, outcome-oriented approach to the analysis. They model ENGO impact within the framework of interest group participation and influence and find that the number of environmental advocacy groups in a country has a statistically significant negative effect on lead content levels in gasoline.

This paper attempts to further bridge the gaps between the standard EKC literature and the literature that analyses the influence of ENGOs. In comparison to Damania et al. (2003), it adds a time dimension to the analysis. Furthermore, it estimates the determinants of three different air pollutants not covered in Damania et al. (2003) and uses some of the same dependent variables and data that have been used in the standard EKC literature. To our knowledge, this is the first empirical analysis of the effects of ENGOs on actual pollution levels using a panel of cross-country time-series data.

3. Research Design

3.1 The dependent and explanatory variables

This paper tests three indicators of air pollution: SO_2, smoke and heavy particulates, all measured in the form of concentration levels. Data for the three pollution indicators come from Torras and Boyce (1998), who use the same data as Grossman and Krueger (1995). These data stem originally from the United Nations' Global Environmental Monitoring System (GEMS). They cover the period 1977 to 1988.

The indicator for the strength of ENGOs is the number of ENGOs per capita. Taking account of the theoretical and empirical literature, one expects that the strength of ENGOs in a given country depends primarily on their financial resources and membership base. However, data is not readily available for the budget and membership numbers of many ENGOs, and attempting to collect this information for a cross-country study is prohibitively difficult. Consequently, this study uses the number of ENGOs per capita to proxy for financial and membership support.

Information regarding the number of ENGOs in each country for each year of concern (1977-1988) comes primarily from the World Environment Encyclopedia and Directory (Europa Publications 2001), whilst population data are taken from World Bank (2001). For cases in which the Directory listed no founding date, this information came from the groups themselves. Unfortunately, the Directory is not comprehensive. It omits a number of ENGOs in several countries and does not include ENGOs that may have been active in the time period of concern but ceased to exist before publication of the Directory. In the search for founding dates for ENGOs, some of these groups were discovered and added to the list as appropriate. By virtue of this supplementary research, the data is fairly comprehensive, with the continued exception of groups that have ceased to exist. In a few cases, it was not possible to find a founding date for a group. Groups for which a year of establishment could not be determined have been excluded. The consequence of this is that the ENGO variable is likely to be subject to measurement error, a point to which we will come back later on in the estimations.

Since we expect ENGOs to have a negative effect on pollution levels by way of their influence on policy, we also account for the countervailing policy influence of the business lobby. While the specific motivations and mechanisms of business lobbying exceed the scope of this article, we accept the premise that industry groups often perceive benefits from lax environmental regulations and are therefore likely to oppose stricter pollution control;

therefore, we include a control variable for the business lobby. There is no commonly agreed upon proxy variable for business lobby strength. We choose to employ commercial energy use per capita in kilograms of oil equivalent as our variable (COMEN p.c.) because all the three air pollutants analyzed are related to commercial energy use. Data are taken from World Bank (2001).

As additional control variables, we use per capita income, democracy and literacy. Per capita income is the main variable of the EKC-literature and needs no further justification for its inclusion here. As concerns democracy, Congleton (1992) and Neumayer et al. (2002) note that there is no clear-cut *a priori* expectation as to the effect that democracy has on the environment. However, a number of empirical studies have found evidence for a positive effect of democracy on environmental commitment or outcomes. Neumayer (2002a, 2002b) and Neumayer et al. (2002) find that higher levels of democracy translate into higher levels of government commitment to multilateral environmental agreements and other aspects of environmental protection. Torras and Boyce (1998) find a similar effect in some estimations on air and water pollution levels. They also find some weak evidence for a negative effect of education as proxied by adult literacy rates for both men and women on pollution.

Boyce (1994, 2003) argues that power inequality is also a cause of environmental degradation. This is because the more powerful people are likely to benefit from environmental degradation. Power inequality comes in many forms and is difficult to measure directly, but the one most commonly looked at is income inequality as measured by the Gini coefficient. Note that income inequality will have an increasing effect on pollution even if we assume that demand for environmental quality is a normal good, as long as the increasing effect due to power inequality dominates the decreasing effect due to higher environmental valuation (Boyce 2003). Unfortunately, the quality of income inequality data at the cross-country cross-time setting is very poor (Atkinson and Brandolini 2001). The Gini coefficient is also not available for all countries and all years, such that its inclusion would further reduce the sample size. Nevertheless, we add the Gini coefficient to supplementary estimations and find that all our main results are robust to its inclusion.

Per capita income in purchasing power parity and prices of 1985, literacy rates and Gini coefficient data are taken from Torras and Boyce (1998). However, their Freedom House (FH) indicator for democracy and civil rights is not used in this study. The FH indicator is not ideally suited for time-series analysis because changes in a country's rating over time may have to do with changes in the global context rather than institutional changes within the country itself (Neumayer et al. 2002). Instead, the Polity IV indicator from Marshall and Jaggers (2000) is used in the empirical analysis. The Polity data are based on expert judgement on aspects of institutionalized democracy and autocracy within a country, both measured on an additive 0 to 10 scale. The autocracy score is deducted from the democracy score to create a variable that runs from –10 to 10.

Finally, like Grossman and Krueger (1995) and Torras and Boyce (1998) we also include a number of site-specific control variables. These include whether the monitoring station is close to a coast line, whether it is located in an industrial, residential or commercial area, whether it is in the center of the city or suburban, and the city's population density. We also include year-specific time dummies to control for any global changes in pollution due to, for example, technical progress. Since neither the site-specific control variables nor the time dummies are of substantive interest to our analysis their estimated coefficients are not shown in the tables below even though they are included in the estimations.

Poor availability of data for the dependent variables means that the sample of countries included is not particularly large, covering 35 countries at most in the estimations with SO_2 concentration levels as the dependent variable (see the appendix). The good thing is that the countries are from both the developed and developing world and include the most populous ones for the case of SO_2 and heavy particulates. Note that the pollution data come from several monitoring stations in each country. Table 1 reports summary descriptive information of the dependent variables, the ENGO strength, business lobby, income, democracy, literacy and income inequality variables.

< Insert Table 1 about here >

Estimation technique and the model to be estimated

We employ two estimators, one used by Torras and Boyce (1998), the other used by Grossman and Krueger (1995). The first one is ordinary least squares (OLS) with standard errors that are robust towards arbitrary heteroscedasticity and autocorrelation. The second one is a panel estimator, where following Grossman and Krueger (1995) we use a random-effects (RE) rather than fixed-effects estimator to account for the unbalanced nature of the panel. We take the natural log of all the dependent variables to render their distributions less skewed, thus mitigating potential problems with heteroscedasticity. With respect to the explanatory variables, we take the natural log of all cardinal variables, namely income, ENGO and business lobby strength, literacy, population density and the Gini coefficient, to allow an easy to understand elasticity interpretation. An estimated coefficient of .5, for example, is interpreted as meaning that a ten per cent increase in the relevant explanatory variable increases the dependent variable by five per cent. In addition, a log-linear form is also commonly used in the EKC literature and exhibited a better fit with the data at hand. As concerns the income variable, given the results from the EKC literature suggesting non-linear effects on pollution, we included income squared in the model to be estimated. If both the linear and the squared term are insignificant, this is typical a sign that the relationship is more complex and a cubed income term was added to the estimations. Theory does not predict non-linear effects of the other explanatory variables, which is why they all enter the estimations in linear form only.

4. Results

Columns 1 and 2 of table 2 report OLS and RE estimation results for SO_2 concentration levels, respectively. ENGO strength has a negative impact on pollution and the relevant coefficient is highly statistically significant. Business lobby strength as approximated by commercial energy use per capita raises pollution levels, but the effect is not statistically significant in column 2. Income has the expected non-linear relationship with pollution as predicted by the EKC literature: the concentration level first rises and then falls with higher income. Democracy is negatively associated with pollution, but the effect is only statistically significant in OLS estimation. Literacy is not a significant determinant.

< Insert Table 2 about here >

Next, column 3 reports OLS estimation results for smoke concentration levels as the dependent variable (the RE results are identical since the RE estimator 'degenerated' to pooled OLS). The results are qualitatively rather similar to the ones for SO_2. The coefficient of the ENGO variable is estimated with a negative sign and is clearly statistically significantly different from zero. Greater business lobby strength is associated with higher pollution, as indicated by the positive and statistically significant coefficient sign of the commercial energy use variable. Income follows the non-linear path predicted by the EKC literature. Democracy is negatively associated with pollution.

For heavy particulates, which is analyzed in columns 4 and 5, there is also a negative effect of ENGO strength on concentration levels clearly discernible. The relationship with income is slightly more complicated in OLS estimation as we find an S-shaped relationship due to a second turning point at higher income levels.[4] No such second turning point is estimated with the random-effects estimator, where the income-pollution relationship is the traditional EKC one (the squared income term is only very marginally insignificant with a p-value of 0.115). Both democracy and literacy are negatively associated with pollution, but for democracy the effect is statistically significant only in OLS estimation. A higher commercial energy use per capita is not significant in OLS estimation and marginally significant, but wrongly signed in RE estimation. We will see below that this strange result disappears in instrumental variable estimations and when the Gini coefficient is included. It might therefore simply be down to chance.

Next, we address the potential problems of endogeneity and measurement error of the ENGO strength variable. That measurement error is likely to exist has already been explained above. With respect to endogeneity, of all the explanatory variables, ENGO strength is the most susceptible to being a function of pollution itself. Pollution and resource depletion can lead to changes in the basic conditions of life that would produce discontent and prompt collective action to increase environmental quality. If deterioration in environmental quality deprives people of their livelihoods, significantly increases the risk of negative health effects, or poses some other great inconvenience, people are likely to take action to reverse or mitigate the damage and prevent future degradation. On the other hand, if pollution levels are low and people do not feel threatened by pollution, they are less likely to organize. Thus, pollution and resource depletion are likely to be important factors driving collective action for the environment.

[4] The potential existence of a second turning point is an issue discussed in more detail by De Bruyn, van den Bergh and Opschoor (1998).

A consequence of measurement error in the ENGO variable and its potential endogeneity is that it will be correlated with the error term and OLS or random-effects estimation will be inconsistent, that is, the estimated coefficients and the standard errors might be invalid. Dealing with this problem calls for the use of instrumental variable (IV) estimation techniques. Contrary to OLS, IV estimation is consistent in case an explanatory variable is correlated with the error term.

What instruments to use? Instrumental variables need to fulfil two conditions (Wooldridge 2002, pp. 84-6): First, they need to be partially correlated with the endogenous variables in the sense that the correlation persists after all other exogenous variables are controlled for. The stronger the correlation the better. This is easy to test and the instruments we use, which are described later on, fulfil this requirement. Second, they must not be correlated with the error term since otherwise they would suffer from the very same problem they are supposed to remedy. This condition can in principle be tested since we have what is called over-identifying restrictions, that is we have more instruments than variables to be instrumented. The test of over-identifying restrictions works in comparing the IV estimation results for the just identified to the over-identified equation. If the two estimations do not systematically differ then we can have some statistical confidence that our instruments are truly exogenous.

As instruments for the number of ENGOs per capita we use variables measuring the strength of civil society in general. General civil society strength should be correlated with ENGO strength, but should not be endogenous to air pollution since the vast majority of NGO groups pursue issues other than environmental protection. We use two variables to proxy for general civil society strength. One is the number of international NGOs per capita, that is NGOs active in at least three different countries. The other is the membership density of international NGOs as measured by the number of memberships per capita.[5] The first variable is taken from Wiik (2002), the second from Anheier, Glasius and Kaldor (2002). However, both sources originally derive their data from the Union of International Association's Yearbook of International Organizations. In the estimation for heavy particulates we had to replace the count of international NGOs, which failed to pass the test of over-identification, with the number of ENGOs per capita in 1972. We feel justified in using this variable since it stems from well before the start year of our study period (1977). We note, however, that the instruments pass the test of over-identification only at the 5, but not at the 10 per cent level.

Columns 1 to 6 of table 3 report the IV estimation results. We report over-identification test results only for the OLS-IV estimations since there is no routine available in Stata, the econometrics package used throughout this paper, to test for over-identification for the random effects estimator with instrumental variables. Columns 1 and 2 start with SO_2. The IV results are very similar to the non-IV results reported in table 3 above. In particular, the negative association between ENGO strength and SO_2 and the non-linear relationship between income and concentration levels are maintained. The main difference is that democracy is no longer statistically significant in OLS-IV estimation. The instruments pass the test of over-identification, which suggests that they can be regarded as exogenous.

< Insert Table 3 about here >

In column 3 smoke is the dependent variable. IV estimation results are again very similar to their non-IV estimation counterpart. ENGO strength has a negative impact on smoke concentration levels, commercial energy use per capita a positive impact, whereas income has

[5] Ideally, we would have liked to include a variable that measures national rather than international NGOs, but no such measure is available.

the non-linear effect predicted by the EKC literature. Democracy has the expected negative coefficient sign as before. We fail to reject the hypothesis of exogenous instruments.

Finally, IV estimation results for heavy particulates are reported in columns 4 and 5. They are also rather similar to the results reported in table 2. In addition, the business lobby strength variable is now correctly positively signed and statistically significant. We now find a cubic relationship between income and heavy particulate concentration in both OLS-IV and RE-IV. However, democracy is no longer statistically significant in OLS-IV. We fail to reject the hypothesis of exogenous instruments at the 5 per cent significance level, but not at the 10 per cent level.

So far, we have not included the Gini coefficient as a further control variable due to doubts about the quality of data and due to the loss of observations following its inclusion. In table 4, we report results with this variable included. For reasons of space, we merely report results without instrumental variables.[6] ENGO strength always has a negative impact on pollution levels. Business lobby strength and income inequality are associated with higher pollution levels in two and three out of four regressions, respectively. We always find evidence for a cubic relationship between income and pollution concentration levels. Democracy is always negatively associated with pollution. Literacy rates do not have a consistent effect.

< Insert Table 4 about here >

[6] For smoke and heavy particulates the RE estimator 'degenerated' to pooled OLS so that only the OLS results are reported.

5. Conclusion

The results of this study are consistent with the hypothesis that ENGOs have a statistically significant impact on air pollution levels. ENGO strength can thus help ‘tunneling the Kuznets curve’ (Munasinghe, 1999). Foundations, aid donors, international organizations and other stakeholders concerned with air pollution can make an effective contribution by facilitating and strengthening ENGOs. This buttresses the case for a strategy recently embraced by the World Bank and other international organizations to support local environmental lobbying groups.[7]

How substantively important is the effect of ENGO strength? Given that the estimated coefficient of the variable can be interpreted as an elasticity, our non-IV results suggest that a 10 per cent increase in such strength lowers SO_2 levels by between 5.1 and 9.3 per cent, smoke levels by 5.7 per cent and levels of heavy particulates by between .8 and 1.5 per cent. Clearly, ENGO strength is not only statistically significant, but also substantively important. For SO_2 and heavy particulates concentration levels the elasticities derived from IV-estimations are somewhat higher with the exception of smoke where there is little difference. This suggests an even greater impact of ENGO strength once the potential endogeneity and measurement error of the variable is accounted for.

The results for the other explanatory variables are in line with the established literature. Like Torras and Boyce (1998) we find some weak evidence that a greater extent of democracy and literacy is associated at times with lower pollution levels. More importantly, we find the EKC result of an inverse U relationship between income and concentration levels for all pollutants (in the case of heavy particulates only for random-effects estimation). Interestingly, in almost all regressions we find that the estimated turning point of income is

[7] See, for example, the Critical Ecosystem Partnership Fund (CEPF) initiative at http://www.cepf.net/xp/cepf/about_cepf/index.xml.

lower if ENGO strength is not included in the model (results not shown). What this suggests is that ENGO strength is part of the reason why the EKC literature often finds modestly low turning points.

This paper's main result is that ENGO strength is effective in reducing air pollution levels in the form of SO_2, smoke and heavy particulates. However, the results cannot be generalized to claim that ENGOs have an impact on all aspects of environmental quality. Further research might focus on the influence of ENGOs on other types of environmental degradation. Particularly valuable would be a study of ENGO effects on resource-side aspects of environmental quality, such as deforestation, erosion, and biodiversity loss, since many ENGOs focus their efforts on these issues.

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Table 1. Descriptive variable information

Variable	Obs.	Mean	Std. Dev.	Min	Max
ln Smoke	479	3.31	1.02	0.00	5.74
ln Heavy particulates	915	4.65	0.85	2.20	6.57
ln SO_2	1297	1.17	4.38	-6.91	5.75
ln ENGO p.c.	1253	-1.37	2.15	-9.21	1.47
ln COMEN p.c.	1297	7.60	1.00	5.68	9.04
ln Gini	1188	-1.03	0.20	-1.30	-0.46
ln GDP	1297	8.63	0.91	6.43	9.76
$(\ln GDP)^2$	1297	75.28	15.04	41.32	95.17
$(\ln GDP)^3$	1297	663.19	188.75	265.61	928.46
Democracy	1263	4.99	7.28	-10.00	10.00
ln Literacy	1297	4.48	0.19	3.59	4.60

Table 2. Estimation results without instrumental variables

	(1)	(2)	(3)	(4)	(5)
	SO_2	SO_2	Smoke	Heavy particulates	Heavy particulates
	OLS	RE	OLS	OLS	RE
ln ENGO p.c.	-0.511	-0.933	-0.569	-0.078	-0.152
	(4.62)***	(2.41)**	(6.64)***	(2.82)***	(1.92)*
ln COMEN p.c.	1.009	1.544	0.824	0.068	-0.323
	(1.63)*	(1.36)	(3.18)***	(0.77)	(1.81)*
ln GDP p.c.	13.818	23.774	7.385	34.299	2.009
	(3.74)***	(2.91)***	(2.59)**	(3.82)***	(2.02)**
$(\ln \text{GDP p.c.})^2$	-0.887	-1.469	-0.466	-4.286	-0.100
	(3.54)***	(2.89)***	(2.87)***	(3.90)***	(1.58)
$(\ln \text{GDP p.c.})^3$				0.176	
				(3.96)***	
Democracy	-0.051	-0.057	-0.030	-0.051	-0.014
	(1.96)**	(0.80)	(2.06)**	(2.91)***	(0.49)
ln Literacy	-0.372	-1.183	0.644	-1.079	-1.988
	(0.40)	(0.40)	(1.05)	(6.39)***	(3.84)***
R^2	0.17		0.53	0.71	
R^2 (overall)		0.14			0.64
Observations	1203	1203	427	862	862
Countries	35	35	17	25	25

Note: Ordinary least squares (OLS) and random effects (RE) estimation. Absolute t-statistics and z-statistics in parentheses. All variables except Democracy in natural log form. Site-specific control variables and year-specific time dummies included, but their estimated coefficients not reported.

* significant at p < .1; ** at p < .05; *** at p < .01.

Table 3. Instrumental variables estimation results

	(1)	(2)	(3)	(4)	(5)
	SO_2	SO_2	Smoke	Heavy particulates	Heavy particulates
	OLS	RE	OLS	OLS	RE
ln ENGO p.c.	-1.005	-1.262	-0.525	-0.121	-0.120
	(7.35)***	(2.16)**	(4.27)***	(3.91)***	(4.61)***
ln COMEN p.c.	1.489	1.829	0.774	0.306	0.286
	(2.41)**	(1.50)	(2.81)***	(2.08)**	(2.48)**
ln GDP p.c.	18.851	25.214	8.055	43.831	38.259
	(4.98)***	(2.98)***	(2.72)***	(4.00)***	(4.58)***
$(\ln GDP p.c.)^2$	-1.185	-1.553	-0.503	-5.378	-4.703
	(4.63)***	(2.95)***	(3.02)***	(4.06)***	(4.64)***
$(\ln GDP p.c.)^3$				0.216	0.189
				(4.10)***	(4.67)***
Democracy	0.002	-0.044	-0.032	-0.019	-0.027
	(0.07)	(0.57)	(2.19)**	(0.82)	(1.54)
ln Literacy	-1.021	-1.074	0.501	-1.298	-1.247
	(1.12)	(0.33)	(0.76)	(6.44)***	(6.84)***
R^2	0.15		0.53	0.71	
R^2 (overall)		0.13			0.71
Test over-identification	0.169		0.056	3.594	
	(0.681)		(0.813)	(0.058)	
Observations	1203	1203	427	850	850
Countries	35	35	17	24	24

Note: Ordinary least squares (OLS) and random effects (RE) estimation. Absolute t-statistics and z-statistics in parentheses. All variables except Democracy in natural log form. Site-specific control variables and year-specific time dummies included, but their estimated coefficients not reported. Over-identification test is asymptotically chi-sq distributed under the null of exogeneity of instruments, with p-values reported in brackets.

* significant at p < .1; ** at p < .05; *** at p < .01.

Table 4. Estimation results with Gini included (without instrumental variables).

	(1)	(2)	(3)	(4)
	SO_2	SO_2	Smoke	Heavy particulates
	OLS	RE	OLS	OLS
ln ENGO p.c.	-0.926	-1.285	-0.833	-0.104
	(7.41)***	(4.12)***	(8.92)***	(3.69)***
ln COMEN p.c.	1.061	1.323	0.589	0.270
	(1.54)	(1.19)	(1.72)*	(3.36)***
ln Gini	5.573	5.290	-0.765	0.701
	(7.52)***	(2.75)***	(1.39)	(3.64)***
ln GDP p.c.	-291.994	-241.457	-195.403	14.741
	(4.91)***	(2.12)**	(2.71)***	(1.62)*
$(\ln GDP\ p.c.)^2$	35.798	30.298	23.181	-1.997
	(4.96)***	(2.18)**	(2.72)***	(1.82)*
$(\ln GDP\ p.c.)^3$	-1.446	-1.247	-0.915	0.088
	(4.98)***	(2.22)**	(2.71)***	(1.99)**
Democracy	-0.218	-0.179	-0.066	-0.106
	(5.26)***	(2.33)**	(4.32)***	(5.35)***
ln Literacy	1.049	-2.367	3.896	-1.451
	(0.57)	(0.82)	(3.10)***	(6.12)***
R^2	0.21		0.58	0.75
R^2 (overall)		0.20		
Observations	1094	1094	348	800
Countries	31	31	13	22

Note: Ordinary least squares (OLS) and random effects (RE) estimation. Absolute t-statistics and z-statistics in parentheses. All variables except Democracy and Gini in natural log form. Site-specific control variables and year-specific time dummies included, but their estimated coefficients not reported.

* significant at $p < .1$; ** at $p < .05$; *** at $p < .01$.

Appendix.

List of countries in SO_2 sample.

Argentina, Australia, Belgium, Brazil, Canada, Chile, China, Colombia, Denmark, Egypt, Finland, France, Germany, Greece, India, Ireland, Iran, Israel, Italy, Japan, Kenya, Netherlands, New Zealand, Pakistan, Peru, Philippines, Portugal, South Korea, Spain, Sweden, Switzerland, Thailand, United Kingdom, United States, Venezuela.

List of countries in heavy particulates sample.

Argentina, Australia, Belgium, Brazil, Canada, China, Colombia, Denmark, Finland, Germany, Greece, India, Indonesia, Iran, Iraq, Israel, Japan, Kenya, New Zealand, Pakistan, Philippines, Portugal, Thailand, United States, Venezuela.

List of countries in smoke sample.

Argentina, Belgium, Brazil, Chile, Colombia, Denmark, Egypt, France, Greece, Ireland, Iran, New Zealand, Peru, Portugal, Spain, United Kingdom, Venezuela.