# SOCIAL CAPITAL AND NATIONAL ENVIRONMENTAL PERFORMANCE: A CROSS-SECTIONAL ANALYSIS

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**ABSTRACT**

Using cross-country data from a sample of low, middle and high-income countries, the paper provides the first empirical test of the empirical relationships between national measures of social capital (civic and public), social divergence and social capacity upon various indicators of national environmental performance. The results indicate a possible link between public social capital (democracy and corruption) and effective national environmental policies and the pivotal effects of economic and demographic determinants on national environmental performance. The policy implication is that improved national environmental performance may be best achieved by encouraging reductions in emissions and input intensities and improving the quality of public administration and democratic accountability.



**JEL classification:** Q20, C21

**Key words:** social capital, national environmental performance

## 1. Introduction

Increasingly governments recognize the importance of social capital and social networks to help achieve social and economic objectives. The appreciation of the value of social capital and collective action at a *local* level (Berkes, 1989; Bowles and Gintis 2002; Bromley *et al.*, 1992; Ostrom, 1990; Ostrom *et al.*, 1994), leaves a number of unanswered questions as to its importance on a *national* level in determining environmental outcomes. For example, to what extent do broad-based and national measures of *civic social capital* and *public social capital* affect national environmental performance? Are social barriers to communication across social groups, defined as *social divergence*, significant in affecting environmental performance across countries? Are proxies for poverty and measures of the ability of individuals to achieve their human potential, defined as *social capacity*, important in determining overall environmental outcomes at a national level?

Despite their potential significance, until now no paper has addressed all of these important policy questions. A key paper by Torras and Boyce (1998) examines whether unequal power distributions, as measured by income inequality, literacy and civil and political liberties, affect environmental degradation in a modified environmental Kuznets Curve (EKC) model. They conclude that widening the distribution of power within society can positively affect environmental quality. Scruggs (1998) has also addressed this issue with income inequality, but found it had no significant effect on environmental quality while Barrett and Graddy (2000) provide empirical support that civil and political liberties improve environmental quality.

Pretty and Ward (2001) provide numerous examples to show how social bonds and norms of behavior can manifest themselves in local collective action and groups to affect environmental performance, but do not test these relationships at a national level. López and Mitra (2000) develop a theoretical model that shows the importance of government institutions on environmental outcomes and that the potential exists for higher than optimal levels of pollution because of corruption and rent-seeking behavior. Damania (2002) has also developed a theoretical model to show how corruption may contribute to environmental degradation while Eriksson and Persson

(2003) have shown theoretically that, in a complete democracy, a more equal income distribution favours less pollution.

Despite the large literature, theoretical and empirical, to explain cross-country differences in environmental performance our paper is the first to actually test if a broad range of social determinants (social capital, social divergence and social capacity) have a significant effect on environmental quality. Using a comprehensive data set on environmental performance developed at Columbia and Yale Universities, we examine the effects of social determinants on six broad-based measures of environmental quality. After controlling for differences in income and population density, we test whether differences in civic social capital (trust, civic behaviour and participation in volunteer activities), public social capital (democracy and corruption), social divergence (ethnolinguistic fractionalisation, land inequality and religious homogeneity), and social capacity (calorie intake and human capital) explain cross-country differences in environmental performance.[1]

The empirical approach permits us to assess if social factors influence national environmental performance. Given that, hitherto, the effects of social determinants on national environmental performance have not been estimated before in such a comprehensive way, the paper provides an important first step in our understanding of the social-environment connections.

## 2. Defining the Society-Environment Relationships

Many definitions and measures exist for social capital, social divergence, social capacity and environmental performance or quality. Prior to estimating the cross-country relationships, we review the concepts, definitions and measures for the explanatory variables and environmental performance.

*Social Capital, Social Divergence and Social Capacity*

Putnam (1993, pp. 35-36) broadly defines social capital as "…the features of social organization…that facilitate coordination and cooperation for mutual benefit", which are embodied in networks and civic engagement.[2] Using this definition, social capital may be measured by such variables as trust, which has been used as a proxy for social capital in other contexts (Knack and Keefer 1997), or participation in voluntary associations.

A related concept is social divergence, which represents the social barriers to communication between individuals and groups (Grafton, Knowles and Owen, 2002). The greater the social divergence, the lower is the opportunity for collective action that may help address environmental concerns. Social divergence may be measured by such variables as religious and ethnic diversity and wealth inequality, which reflect broad social divisions and potential barriers to the exchange of ideas across social groups.

Social capacity is the potential for individuals to achieve their human potential and may be measured by a number of commonly used and available development indices. For instance, poor health or nutrition status or low levels of education are development indices that proxy lower levels of social capacity and may reduce the ability of a society to resolve its environmental problems.

*Environmental Performance*

No single set of measures can adequately describe the multifaceted nature of the environment. Commonly collected proxies of primary environmental quality include such measures as air quality, water quality, use of natural resources and land use change. For air and water quality, ambient levels of different pollutants are often recorded, as are total levels of emissions for some pollutants. In terms of air quality, pollutants whose ambient levels are commonly recorded include sulphur dioxides, nitrogen oxides, volatile organic compounds, carbon monoxide and total suspended particulates, among others. Ambient measures of water quality commonly recorded include faecal coliform, dissolved oxygen and phosphorous, among others.

Single ambient measures of environmental quality are obtained for a specific site and at a particular time, thus they are not necessarily representative of the state of nature in a country as a whole. Land use measures include a variety of proxies of natural resource use such as water withdrawals as a proportion of available water resources, changes in land cover or measures of soil erosion.

In addition to primary measures of environmental quality, indirect measures of environmental performance also exist. For example, the number of species at risk is an indirect measure of environmental quality as it is a function of both the classification and the resources spent in wildlife research as well as environmental factors, such as habitat degradation. Other indirect measures may include the performance of governments or national institutions in committing themselves to achieving defined environmental targets or agreements such as the Framework Conventions on Climate Change, The Montreal Protocol (on substances that Deplete the Ozone Layer) or the Convention on Biological Diversity.[3]

## 3. A Model of Social Capital-Environment Relationships

Social capital, social divergence and social capacity may interact to affect environmental performance in many different ways. These effects are a sub-component of how human activities influence the state of nature. We posit that the main drivers of environmental performance are population (or population density), the level of income and a variety of institutional and social determinants. The simplest structural model that encompasses this representation is given below,

$$E_{it} = \forall_0 + \sum \forall_i D_{it} + \exists_1 pd_{it} + \exists_2 y_{it} + \varepsilon_{it} \qquad (1),$$

Where $E_{it}$ is a measure of environmental performance of country i in period t, $D_{it}$ i=1,2,…n are measures of a set of social determinants in country i and period t, $pd_{it}$ is population density in country i in period t, $y_{it}$ is per capita GDP in country i period t, and $\varepsilon_{it}$ is an error term assumed to be independently and normally distributed.

To overcome both data availability and a lack of variation in social determinants over time, we estimate reduced-form equations of (1) using cross-sectional data from poor, middle-income and rich countries. Estimates of (1), combined with diagnostics, permit us to estimate the overall effects of social capital, social divergence and social capacity on environmental performance across countries.

## 4. Measuring Social Factors and Environmental Performance

An insufficient number of observations exist for the application of a comprehensive general-to-specific modelling approach commencing from a general unrestricted model that includes all the potential regressors. Thus, we separately estimate coefficients for civic social capital, public social capital, social divergence and social capacity. This separate equation approach has the advantage that it enables us to use, as much a possible, the available information from the sample.

In each of the estimated equations we control for the population per square kilometre for 1998 (POP) and gross domestic product per capita converted to international dollars using purchasing parity rates for 1998 (GDPPC). The regressands and regressors in each of the reduced-form models are described below under the headings environmental performance, social capital (civic and public), social divergence and social capacity. Summary statistics of the data are provided in Table 1.

*Environmental Performance*

The six measures of national environmental performance come from a new and important data set compiled by the Global Leaders of Tomorrow Environment Task Force (GLTETF) with the collaboration of the Yale Center for Environmental Law and Policy and the Center for International Earth Science Information Network at Columbia University. Collectively, the measures provide an indication of national environmental quality that is comparable across countries.

The national environmental performance variables used in the study include, one, an overall environmental sustainability index (ESI) based on 22 core indicators in 2001; two, a measure of the state of environmental systems comprised of air quality, water quality and quantity, biodiversity and terrestrial system variables (SYS); three, an air quality index (SYSA); four, a water quality index (SYSW); five, urban concentrations of sulphur dioxide for the period 1990-1996 (SO2), and, six, urban concentrations of total suspended particulate matter for the period 1990-1996 (TSP).[4]

For the measures ESI, SYS, SYSA and SYSW higher values represent better levels of environmental performance while for SO2 and TSP the reverse is true (GLTETF 2000). Sample correlations between the six measures of environmental performance are provided in Table 2. The correlations indicate, as we would expect, collinear relationships among several of the measures of environmental performance.

*Social Capital*

In cross-country studies, social capital variables are typically obtained from the World Values Survey (WVS). The survey asks a variety of questions of a sample of individuals in a population so as to quantify their values and ethics for comparative purposes across countries (Inglehart *et al.* 2000). The WVS sample includes 24 countries for 1981, 45 countries for 1990-1991 and 55 countries for 1995-97.

Three variables are used from the WVS to test for a relationship between aggregate measures of social capital and national environmental performance. These regressors are from the 1995-97 survey and include the percentage of respondents who agreed with the statement that "most people can be trusted", after deleting "don't know" responses (TRUST). The second variable (CIVIC) is an index where respondents were asked to give a 1 to 10 response where 1 indicated the behaviour was never justified and 10 indicated the behaviour was always justified. The five behaviours include one, claiming a government benefit to which you are not entitled; two; avoiding paying for public transport; three, cheating on taxes if you have the chance; four, buying something that you knew was stolen and, five, accepting a bribe in the course of one's duties. In our analysis the reported values of CIVIC were transformed such that the raw score was subtracted from 50 so that a value of 45 indicates the *highest* possible level of social capital and a score of 0 indicates the *lowest* level. A third variable (ASSOC) is the sum of the proportion of people who were active members in any of the four types of voluntary organizations (church or religious; sports or recreation; arts, music or educational organization; and charitable organization).

Although there is a precedence in the literature (Knack and Keefer 1997, Zak and Knack, 2001) for using TRUST, CIVIC and ASSOC as proxies for social capital, it is important to acknowledge some potential problems with these measures of social capital. In particular, the coverage of the World Values Survey differs significantly from country to country and the sample in some countries is not representative of the population as a whole.

With respect to TRUST, Gleaser *et al.* (2000) show that peoples' answers to the trust question from the World Values Survey are not correlated with how trusting they are of others in economic experiments. However, there is evidence of a positive correlation between TRUST with how *trustworthy* is the individual. Thus it may be more appropriate to interpret TRUST as a measure of trustworthiness, rather than how trusting individuals are of others. The validity of TRUST as a measure of trustworthiness is supported by an experiment conducted by the *Reader's Digest*. In the test, a number of wallets were "dropped" in various countries around the world to see how many would be returned. The proportion of wallets returned may be interpreted as a measure of trustworthiness. The correlation between TRUST (from the World Values Survey) with the *Reader's Digest* trustworthiness measure was 0.67 (Knack and Keefer, 1997). Finally, a potential weakness of the ASSOC variable is that it only takes into account the number of associations an individual belongs to, rather than taking into account the strength of membership. For example, active membership in a volunteer fire brigade is treated as equivalent to occasional church attendance.

In addition to civic measures of social capital, public measures are also used in the analysis. These variables are described in detail in the International Country Risk Guide and were obtained for June 1999 (Sealy, 1999). The two variables used from the International Country Risk Guide (ICRG) include a six-point scale measure of democratic accountability (DEMO) that indicates how responsive a government is to its people and a six-point scale measure of corruption (CORRUP) within the political system. For the DEMO variable, a higher score indicates more democratic institutions and for the CORRUP variable, a higher score indicates *lower* levels of corruption.

*Social Divergence*

Social divergence, or the social barriers to communication across groups of individuals, can be measured in a number of different ways. For this analysis, we use three variables, the first of which is the ethnolinguistic fractionalisation index (ELF), which measures the probability of two randomly selected individuals in a country belonging to a different ethnic or linguistic group. The data are only available for 1960 and are described in Mauro (1995). The second variable is a measure of wealth inequality, proxied by a land inequality Gini coefficient (LANDINEQ) scaled from 0 to 100, obtained from the United Nations Food and Agriculture censuses in the early and mid 1980s and is available in Jazairy *et al.* (1992).[5] The third proxy of social divergence is a measure of religious homogeneity that represents the probability that two randomly selected individuals have the same religious affiliation (RELHOM) for 1980, and is obtained from Barrett (1982).[6]

*Social Capacity*

A large number of variables can be used to measure social capacity, or the ability of individuals to meet their human potential. The first variable chosen is daily per capita calorie supply as a percentage of total requirements (CAL) and is obtained from Annex 6 of the GLTETF for the period 1988-1990. This measure is a proxy of the ability of individuals to engage in social action to address environmental challenges. The second variable used in the analysis is the average years of schooling of the population aged 25 years or older (AYS) for the year 2000. AYS is obtained from Barro and Lee (2001) and is included as a measure of human capital.[7]

## 5. Empirical Results

The empirical results are presented separately for social capital (civic and public), social divergence and social capacity.

*Civic Social Capital*

Table 3 provides the sample correlations for the measures of civic social capital and auxiliary regressions. Of the ten possible pairings across the five variables, only TRUST and GDPPC have a correlation that exceeds |0.5| and none of the R-squared from the auxiliary regressions exceed 0.60, which suggests that multicollinearity is not a major problem.

Table 4 gives the ordinary least squares (OLS) results of the regressions of interest.[8] The results provide little support for the hypothesis that national measures of civic social capital have a positive impact on national environmental performance. In the SYSW and SO2 models we fail to reject the null hypothesis that the coefficients of the regressors, with the exception of the intercept, are all equal to zero. Further, in the SYS equation we reject the null hypothesis that the coefficients of the regressors of three alternative model specifications are all equal to zero, which implies possible model misspecification. Only in the TSP model is the TRUST coefficient different from zero at the ten percent level of significance, but the positive sign on the estimated coefficient implies that higher levels of TRUST *increase* TSP. The CIVIC coefficient is not significantly different from zero at the ten percent level of significance in any of the models. The ASSOC coefficient is significantly different from zero in the ESI, SYSA and TSP models, but in each case the results imply increases in membership of associations *reduces* the national measures of environmental performance.

*Public Social Capital*

The two measures of public social capital represent risk ratings that assess the political stability, responsiveness and effectiveness of governments developed by the ICRG system. Table 5 provides the simple correlations and auxiliary regressions for the explanatory variables. None of the R-squared for auxiliary regressions exceed 0.60, which indicates that collinear relationships among the explanatory variables are not a major concern.

The results for the models with social capital (public) as the explanatory variables are given in Table 6. The results indicate that improvement in DEMO reduces urban concentrations of sulphur dioxides and that a reduction in corruption, as measured by an increase in CORRUP, may contribute to an improvement in national environmental performance, as measured by ESI. The significant result for the coefficient on the measure of corruption provides empirical support for the theoretical result of López and Mitra (2000) that higher levels of corruption lead to more than optimal levels of pollution.[9]

For the SYSW model we fail to reject the null hypothesis that all the coefficients, except the intercept, are equal to zero. In the case where ESI, SYS and SYSW are the regressands, all the RESET tests indicate that we reject the null hypothesis that the coefficients of three alternative specifications of the model are equal to zero, which suggests possible model misspecification.

For the ESI and SO2 models, the Breusch-Pagan-Godfrey (BPG) test for homoskedasticity indicates, at the five percent level of significance, that a heteroskedastic error structure may be a problem. If heteroskedasticity does exist, the statistical tests of significance will be invalid. However, re-estimating the three models with White's correction for an unknown form of heteroskedasticity gives similar levels of significance to those given in Table 6. In the re-estimated ESI model, the DEMO coefficient is not statistically different from zero, but the CORRUP coefficient becomes significant at the five percent level. In the SO2 model, there is virtually no difference in the significance level of either the DEMO or CORRUP coefficients.

In summary, the results do not indicate a broad-based relationship between public social capital and national environmental performance. However, the coefficient for DEMO is significant where SO2 is the regressand, and the coefficient for CORRUP is significant where ESI is the regressand.

*Social Divergence*

The correlations between social divergence variables and auxiliary regressions are provided in Table 7. The correlations do not indicate a problem of collinear relationships among the explanatory variables and this is supported with the low R-squared in the auxiliary regressions.

Table 8 provides the results of the regressions with the social divergence regressors. None of the three coefficients for the proxies for social divergence are significantly different from zero at the ten percent level in any of the regressions. To test the influence of the choice of the regressors on the results, the models were re-estimated using alternative proxies of social divergence from the ICRG, while controlling for population density and per capita income. These alternative social divergence measures include a six-point measure of religious tensions and a six-point measure of ethnic tensions for June 1999. The coefficient for the measure of religious tension is significantly different from zero at the ten percent level in the ESI and SO2 models, but has the opposite to expected sign in the SO2 model. The coefficient of the proxy for ethnic tension is significantly different from zero at the ten percent level in only the SO2 model, but has the opposite sign to that expected.[10]

Overall, the results provide little evidence that the chosen measures of social divergence affect national measures of environmental performance.

*Social Capacity*

The sample correlations and auxiliary regressions between the explanatory variables are given in Table 9. The results of the regressions that model the effect of social capacity on national environmental performance are provided in Table 10. The AYS coefficient is not significantly different from zero in any of the models, but the CAL coefficient is significant where ESI, SYS, SYSA and SYSW are the regressands. In all these four models, an increase in calorie intake *reduces* measures of national environmental performance. However, only in the SYSA model do we reject the null hypothesis that all the coefficients in alternative specifications of the model are all equal to zero, but in this case we reject the null hypothesis that the errors are normally distributed. For the SO2 model, the BPG statistic indicates the possibility of heteroskedasticity. Using White's correction for an unknown form of heteroskedastic variances the AYS coefficient remains insignificant.[11]

Overall, the results provide evidence that increases in calorie intake may significantly influence broad measures of environmental performance as proxied by ESI, SYS, SYSA and SYSW. In all four models, however, the sign of the coefficient is negative, rather than the expected positive sign, suggesting that the collinear relationship (0.605) between CAL and GDPPC may be contributing to a scale effect that would tend to reduce national environmental performance. Further investigation using alternative measures of social capacity is required before any firm conclusion can be drawn as to the effect of social capacity on environmental performance.

*Per Capita Income and Population Density*

Measures of per capita income and population density are control variables that are expected to affect national measures of environmental performance.[12] The intention is not to focus on the impacts that the control variables have on environmental quality that has been addressed in many different studies (especially per capita income), but to control for their effects so as to assess the influence of social determinants on environmental performance.

Selden and Song (1994) have shown that emissions per capita are decreasing as a function of population density although total emissions may rise with population density. Scruggs (1998) has hypothesized that higher density can *reduce* environmental degradation as it accentuates its impacts and provides an impetus to address problems of pollution. An alternative perspective, consistent with Selden and Song's results, is that higher density may be associated with a reduced assimilative environmental capacity and, thus, poorer ambient measures of environmental performance. The results support the latter hypothesis and indicate that the POP coefficient is statistically different from zero with a negative sign in the ESI, SYS and SYSW models for all four different sets of explanatory variables.

The results presented in Tables 4, 6, 8 and 10 show that the GDPPC coefficient is significantly different from zero and positive in the ESI and SYSA models for all four sets of explanatory variables. The GDPPC coefficient is also significantly different from zero and negative in all four TSP models and three of out of four of the SO2 models.  These findings, however, should *not* be interpreted as suggesting that countries can grow out of their environmental problems as detailed testing of the relationship between per capita income and environmental performance is best accomplished using time series or panel data. Moreover, our study is not intended to be a detailed analysis of the existence, or otherwise, of an EKC, but an examination of the effects of social determinants on environmental performance.[13]

## 6. Social Capital and Policy Issues

The results provide only weak support that the chosen national measures of civic social capital, social divergence and social capacity positively affect national measures of environmental quality. The implications of the results are reviewed below.

*Civic versus Public Social Capital*

The results suggest that the impact of social capital on national environmental performance is likely to be more important in terms of its effects at the public or institutional level, rather than in terms of its effect at the civic or individual level. This interpretation is supported, in part, by evidence that the only social determinants that have a positive effect on national environmental performance---democracy with urban concentrations of sulphur dioxides[14] and corruption with an overall environmental sustainability---are measures of public social capital. This effect may also be accentuated at higher levels of income given the positive correlations between GDPPC and the measures of public social capital. If this is the case, it may imply a “middle-class consensus” (Easterly 2001) whereby improved institutions complement increases in per capita income to accentuate any positive effects on environmental quality. Such a result is also consistent with a mean voter explanation for why income inequality and pollution may be positively related in a complete democracy (Eriksson and Persson 2003).

*The Structure of Social Capital*

The extent to which aggregate measures of social capital, social divergence and social capacity play a role in determining national environmental performance is also likely to be dependent on *how* societies are structured. For instance, Putnam (2000) distinguishes between bridging social capital that links across groups and aids information diffusion, and bonding social capital that helps to reinforce existing and more exclusive identities and groupings. Thus if measures of social capital, such as association membership, reflect merely bonding social capital this may not necessarily have any positive impact on the national levels of environmental performance.

*The Use of Social Capital*

The importance of social capital may also be related to how it is used. For example, Ostrom (2000, p. 198) emphasizes that the benefits that accrue from social capital at a *local* level arise from self-organized resource governance systems. In other words, social capital directed towards stewardship (Carr, 2002) may be more important in affecting environmental performance than social capital directed toward advocacy.[15] Further, evidence that social capital may improve environmental performance at the local level does not necessarily imply that the federation of such networks on a national level (Pretty and Ward, 2001) will be successful, or that the requirements for effective collective action will exist at a national level.[16]

Another issue of importance is that many aspects of social capital do not directly focus on the improvement of national environmental performance. Thus a country might, for example, be characterized by a high-level of trust and church attendance, but this may not translate itself into a better state of the environment. Indeed, given the time constraints on all individuals, the greater the time spent in one particular set of activities or networks the less time, *ceteris paribus*, that can be devoted to competing activities. Moreover, an increase in membership of social organisations that focus on the environment does not necessarily imply a rise in civic engagement focused on the environment (Putnam, 2000 p. 53).

*Economic and Demographic Factors*

A possible explanation for the lack of a significant relationship between aggregate measures of civic social capital, social divergence and social capacity and national environmental performance is that environmental quality (or degradation) is dominated by economic and demographic factors. Such a finding is consistent with the results of several authors. In particular, Xepapadeas and Amri (1998) find that the probability of having acceptable environmental quality changes with the level of economic development. It would seem, therefore, that population density and factors associated with per capita income, such as input intensities and emissions per unit of output and per unit of input, may account for much of the variation in national environmental performance across countries.

*Policy Issues*

Overall, the study finds that factors other than social determinants play an important role in explaining environmental quality. An implication, supported by the work of Bruvoll and Medin (2003), is that technical factors represented by emissions intensities and input intensities are dominant factors that affect environmental degradation. If correct, this suggests that policies directed to reducing emissions and input intensities and technical innovation are critical instruments in environmental policy.

The pivotal role of technical innovation in determining national environmental performance does not necessarily imply that social factors have no role to play in reducing environmental degradation. Based on our findings, which support the existing theory (López and Mitra 2000; Eriksson and Persson 2003), it would seem that the primary importance of social determinants on the environment is in terms of the level of corruption and democratic accountability.

## 7. Concluding Remarks

Using cross-sectional data from a sample of low, middle and high-income countries, the paper provides the first empirical test as to whether a range of national measures of civic and public social capital, social divergence and social capacity influence national environmental performance. The findings suggest that, with the exception of measures of corruption and democracy, higher levels of social capital and related variables are not necessarily associated with better levels of national environmental performance.

The results imply that the mere existence of social capital is not a sufficient condition for improved national environmental outcomes. This may be because it is the type of social capital, how it is applied and whether it is directed to environmental stewardship that determines its overall effect on national environmental performance. The policy implications from our study are that improved national environmental performance may be best accomplished by focusing policy efforts at reducing emission and input intensities, and by raising the overall quality of public administration and democratic accountability.

## Table 1. Summary Statistics of the 53 Country Sample Data

| Variable | Mean | SD | Max. No. of Obs. | Source | Period | Impact |
|---|---|---|---|---|---|---|
| **Environmental Performance** | | | | | | |
| **ESI** | 55.883 | 11.967 | 52 | GLTETF | 2001 | + |
| **SYS** | 53.475 | 17.554 | 52 | GLTETF | 2001 | + |
| **SYSA** | 0.209 | 0.831 | 52 | GLTETF | 2001 | + |
| **SYSW** | 0.103 | 0.761 | 52 | GLTETF | 2001 | + |
| **SO2** | 28.383 | 27.398 | 36 | GLTETF | 1990-1996 | - |
| **TSP** | 87.220 | 79.333 | 34 | GLTETF | 1990-1996 | - |
| **Social Capital (civic)** | | | | | | |
| **TRUST** | 26.467 | 13.879 | 42 | Inglehart *et al.* | 1995-1997 | + |
| **CIVIC** | 38.676 | 2.628 | 38 | Inglehart *et al.* | 1995-1997 | + |
| **ASSOC** | 0.462 | 0.335 | 38 | Inglehart *et al.* | 1995-1997 | + |
| **Social Capital (public)** | | | | | | |
| **DEMO** | 4.679 | 1.341 | 53 | Sealy | June 1999 | + |
| **CORRUP** | 3.491 | 1.409 | 53 | Sealy | June 1999 | + |
| **Social Divergence** | | | | | | |
| **ELF** | 30.526 | 28.472 | 38 | Mauro | 1960 | + |
| **LANDIN** | 57.828 | 16.257 | 32 | Jazairy *et al.* | 1980-1985 | + |
| **RELHOM** | 0.769 | 0.206 | 38 | Barrett | 1980 | - |
| **Social Capacity** | | | | | | |
| **CAL** | 119.92 | 18.181 | 39 | GLTETF | 1988-90 | + |
| **AYS** | 8.058 | 2.396 | 48 | Barro & Lee | 2000 | + |
| **Controls** | | | | | | |
| **GDPPC** | 12105 | 8827 | 52 | World Bank | 1998 | NA |
| **POP** | 130.69 | 163.38 | 51 | World Bank | 1998 | NA |

Notes:

1. Impact = +(-) indicates a positive (negative) relationship between an increase in the particular variable and its influence on its group category provided under the headings environmental performance, social capital (civic), social capital (public), social divergence and social capacity.
2. GLTETF = Global Leaders of Tomorrow Environment Task Force.
3. ESI and SYS are component scores given as a standard normal percentile and range from a theoretical low of 0 to a high of 100 and are calculated for 2001 using data from earlier periods. ESI is a composite measure of environmental sustainability based on 22 separate environmental indicators. SYS is a composite measure based on indicators of air quality, water quantity, water quality, biodiversity and terrestrial systems
4. SYSA and SYSW are given as Z scores with a zero indicating the mean for the 122 countries in the GLTETF and a value of +1 (-1) representing one standard deviation above or below the mean. Values are calculated for 2001 using data from earlier periods. SYSA is an indicator based on measures of urban SO2, NO2 and TSP concentrations. SYSW is an indicator based on measures of dissolved oxygen, phosphorous concentration, suspended solids and electrical conductivity.
5. SO2 is urban concentration of sulphur dioxide in thousands of metric tons and TSP is urban total suspended particulate concentration in thousands of metric tons as given in Annex 6 of the GLTETF. Within each country the values were normalized by city population for the year 1995 and summed across cities to obtain a total country concentration.
6. CAL is daily per calorie intake as a percentage of total requirements as given in Annex 6 of the GLTETF.

### Table 2. Simple Correlations between the Measures of Environmental Performance

| Variable | ESI | SYS | SYSA | SYSW | SO2 | TSP |
|---|---|---|---|---|---|---|
| **ESI** | 1 | 0.878 | 0.710 | 0.388 | -0.631 | -0.711 |
| **SYS** | | 1 | 0.700 | 0.671 | -0.493 | -0.726 |
| **SYSA** | | | 1 | 0.165 | -0.729 | -0.812 |
| **SYSW** | | | | 1 | -0.042 | -0.252 |
| **SO2** | | | | | 1 | 0.536 |
| **TSP** | | | | | | 1 |

Notes:
1. The sample correlation coefficients were calculated using 30 observations, which represent the total number of countries with observations for all 6 variables.

## Table 3. Simple Correlations between the Measures of Civic Social Capital and $R^2$ of Auxiliary Regressions

| Variable | TRUST | CIVIC | ASSOC | GDPPC | POP | Aux. $R^2$ |
|---|---|---|---|---|---|---|
| **TRUST** | 1 | 0.356 | 0.056 | 0.670 | -0.018 | 0.501 |
| **CIVIC** | | 1 | 0.414 | 0.398 | 0.319 | 0.407 |
| **ASSOC** | | | 1 | 0.307 | 0.026 | 0.257 |
| **GDPPC** | | | | 1 | -0.172 | 0.567 |
| **POP** | | | | | 1 | 0.216 |

Notes:
1. The correlation coefficients were calculated using 35 observations, which represent the total number of countries with observations for all 5 variables.
2. Each auxiliary regression has the identified explanatory variable as the regressand and all other explanatory variables as the regressors. The $R^2$ from each auxiliary regression is provided in the column Aux. $R^2$.

## Table 4. Estimates of the Effects of Civic Social Capital on Environmental Performance

| Variable | ESI | SYS | SYSA | SYSW | SO2 | TSP |
|---|---|---|---|---|---|---|
| **TRUST** | .056E-3 | -0.189 | -0.27E-2 | -0.016 | -0.021 | 2.026[a] |
| | (0.052) | (-0.776) | (-0.209) | (-1.234) | (-0.040) | (1.915) |
| **CIVIC** | 0.584 | 1.711 | 0.040 | 0.103 | -2.846 | 2.176 |
| | (1.142) | (1.483) | (0.658) | (1.698) | (-1.097) | (0.442) |
| **ASSOC** | -7.991[b] | -12.481 | -0.734[a] | -0.436 | 6.823 | 128.42[c] |
| | (-2.251) | (-1.557) | (-1.739) | (-1.037) | (0.339) | (2.877) |
| **GDPPC** | 0.001[c] | 0.001[b] | 0.64E-4[c] | -0.49E-5 | -0.13E-2 | -0.11E-2[c] |
| | (6.071) | (2.512) | (2.821) | (-0.219) | (-1.248) | (-5.268) |
| **POP** | -0.019[b] | -0.039[b] | 0.36E-3 | -0.21E-2[b] | -0.017 | 0.282[b] |
| | (-2.721) | (-2.544) | (0.443) | (-2.594) | (-0.323) | (2.758) |
| **CONSTANT** | 27.210 | -7.464 | -1.612 | -2.822 | 154.18 | 8.621 |
| | (1.504) | (-0.183) | (-0.749) | (-1.315) | (1.631) | (0.049) |
| **Adj. $R^2$** | 0.744 | 0.349 | 0.267 | 0.113 | 0.150 | 0.641 |
| **No. Obs.** | 35 | 35 | 35 | 35 | 21 | 21 |
| **F stat.[k-1,n-k df]** | 20.77* | 4.65* | 3.48* | 1.87 | 1.70 | 8.13* |
| *Heteroskedasticity* | | | | | | |
| **BPG stat. [k-1df]** | 2.871 | 6.861 | 1.830 | 3.639 | 6.981 | 6.022 |
| *Specification* | | | | | | |
| **RESET(2)[1,n-k-1 df]** | 0.054 | 5.971* | 1.840 | 21.096* | 2.156 | 0.14E-5 |
| **RESET(3)[2,n-k-2 df]** | 2.509 | 7.714* | 2.099 | 10.519* | 1.271 | 2.033 |
| **RESET(4)[3,n-k-3 df]** | 2.086 | 5.021* | 1.351 | 7.547* | 0.864 | 2.675 |
| *Normality* | | | | | | |
| **Jarque-Bera stat. [2 df]** | 1.443 | 1.559 | 35.90* | 0.817 | 3.540 | 0.005 |

Notes:

1. k= number of regressors, n= number of observations and df=degrees of freedom.
2. T-ratios are given in brackets. The estimated coefficients from a two-tailed t-test that are significant at 10 or 5 or 1 percent levels are denoted respectively by the superscripts [a] , [b], and [c].
3. Test statistics that indicate we should *reject* the null hypothesis at the 5 percent level of significance are denoted by *.
4. The F-test statistic is for the null hypothesis that the coefficients of all the regressors, except the constant term, are equal to zero.
5. The BPG test statistic is for the null hypothesis of homoskedasticity and converges to a chi-square distribution if the null is true.
6. The RESET tests are for the null hypothesis that the coefficients of the regressors in alternative model specifications are *all* zero and has an F distribution if the null is true. The alternative models have the same regressand, but included in the regressors is the regressand squared (2), squared and cubed (3), squared, cubed and to the power of 4 (4).
7. The Jarque-Bera test statistic is for the null hypothesis that the errors are normally distributed and converges to a chi-square distribution if the null is true.
8. E-i denotes that the coefficient is multiplied by $10^{-i}$.

## Table 5. Simple Correlations between the Measures of Public Social Capital and $R^2$ of Auxiliary Regressions

| Variable | DEMO | CORRUP | GDPPC | POP | Aux. $R^2$ |
|---|---|---|---|---|---|
| **DEMO** | 1 | 0.639 | 0.636 | 0.1667 | 0.544 |
| **CORRUP** | | 1 | 0.612 | -0.047 | 0.491 |
| **GDPPC** | | | 1 | -0.033 | 0.484 |
| **POP** | | | | 1 | 0.081 |

Notes:

1. The correlation coefficients were calculated using 51 observations, which represent the total number of countries with observations for all 4 variables.
2. Each auxiliary regression has the identified explanatory variable as the regressand and all other explanatory variables as the regressors. The $R^2$ from each auxiliary regression is provided in the column Aux. $R^2$.

## Table 6. Estimates of Effects of Public Social Capital on Environmental Performance

| Variable | ESI | SYS | SYSA | SYSW | SO2 | TSP |
|---|---|---|---|---|---|---|
| **DEMO** | 0.396 | -0.580 | 0.090 | -0.031 | -8.064$^{b}$ | 1.410 |
| | (0.392) | (-0.259) | (0.820) | (-0.277) | (-2.047) | (0.110) |
| **CORRUP** | 1.842$^{a}$ | 1.576 | 0.110 | 0.024 | -3.182 | -1.106 |
| | (1.996) | (0.772) | (1.096) | (0.233) | (-0.973) | (-0.093) |
| **GDPPC** | 0.83E-3$^{c}$ | 0.79E-3$^{b}$ | 0.32E-4$^{a}$ | -0.54E-5 | -0.16E-2$^{b}$ | -0.63E-2$^{c}$ |
| | (5.688) | (2.435) | (2.002) | (-0.328) | (-2.276) | (-3.570) |
| **POP** | -0.023$^{c}$ | -0.041$^{c}$ | -0.15E-3 | -0.18E-2$^{b}$ | 0.017 | 0.145 |
| | (-3.943) | (-3.155) | (-0.235) | (-2.692) | (0.634) | (1.636) |
| **CONSTANT** | 40.63$^{c}$ | 46.223$^{c}$ | -0.961$^{b}$ | 0.446 | 96.942$^{c}$ | 155.65$^{c}$ |
| | (11.58) | (5.956) | (-2.523) | (1.13) | (6.768) | (3.803) |
| **Adj. $R^2$** | 0.708 | 0.319 | 0.281 | 0.085 | 0.495 | 0.377 |
| **No. Obs.** | 51 | 51 | 51 | 51 | 35 | 33 |
| **F stat.[k-1,n-k df]** | 31.28* | 6.85* | 5.89* | 2.16 | 9.315* | 5.832* |
| *Heteroskedasticity* | | | | | | |
| **BPG stat.[k-1 df]** | 12.687* | 7.725 | 2.527 | 3.025 | 17.821* | 6.864 |
| *Specification* | | | | | | |
| **RESET(2)[1,n-k-1 df]** | 6.285* | 13.639* | 0.553 | 25.757* | 5.554* | 5.183* |
| **RESET(3)[2,n-k-2 df]** | 7.335* | 7.370* | 0.367 | 19.108* | 2.683 | 3.089 |
| **RESET(4)[3,n-k-3 df]** | 4.783* | 4.855* | 3.233* | 12.601* | 1.730 | 2.081 |
| *Normality* | | | | | | |
| **Jarque-Bera stat.[2 df]** | 0.928 | 0.695 | 55.342* | 3.626 | 0.283 | 6.624* |

Notes:
1. k= number of regressors, n= number of observations and df=degrees of freedom.
2. T-ratios are in brackets. Estimated coefficients from a two-tailed t-test that are significant at 10 or 5 or 1 percent levels are denoted respectively by the superscripts $^{a}$ , $^{b}$, and $^{c}$.
3. Test statistics that indicate we should *reject* the null hypothesis at the 5 percent level of significance are denoted by *.
4. The F-test statistic is for the null hypothesis that the coefficients of all the regressors, except the constant term, are equal to zero.
5. The BPG test statistic is for the null hypothesis of homoskedasticity and converges to a chi-square distribution if the null is true.
6. The RESET tests are for the null hypothesis that the coefficients of the regressors in alternative model specifications are *all* zero and has an F distribution if the null is true. The alternative models have the same regressand, but included in the regressors is the regressand squared (2), squared and cubed (3), squared, cubed and to the power of 4 (4).
7. The Jarque-Bera test statistic is for the null hypothesis that the errors are normally distributed and converges to a chi-square distribution if the null is true.
8. E-i denotes that the coefficient is multiplied by $10^{-i}$.

### Table 7. Simple Correlations between the Measures of Social Divergence and $R^2$ of Auxiliary Regressions

| Variable | ELF | LANDIN | RELHOM | GDPPC | POP | Aux. $R^2$ |
|---|---|---|---|---|---|---|
| **ELF** | 1 | -0.154 | -0.138 | -0.299 | 0.039 | 0.130 |
| **LANDIN** | | 1 | 0.245 | -0.105 | -0.283 | 0.137 |
| **RELHOM** | | | 1 | 0.077 | -0.425 | 0.215 |
| **GDPPC** | | | | 1 | 0.055 | 0.220 |
| **POP** | | | | | 1 | 0.401 |

Notes:
1. The correlation coefficients were calculated using 31 observations, which represent the total number of countries with observations for all 5 variables.
2. Each auxiliary regression has the identified explanatory variable as the regressand and all other explanatory variables as the regressors. The $R^2$ from each auxiliary regression is provided in the column Aux. $R^2$.

## Table 8. Estimates of Effects of Social Divergence on Environmental Performance

| Variable | ESI | SYS | SYSA | SYSW | SO2 | TSP |
|---|---|---|---|---|---|---|
| **ELF** | -0.061 | -0.093 | 0.26E-2 | -0.28E-2 | -0.110 | 0.754 |
| | (-1.256) | (-0.999) | (0.542) | (-0.545) | (-0.735) | (1.622) |
| **LANDIN** | -0.067 | -0.136 | -0.16E-2 | 0.22E-2 | -0.071 | -0.118 |
| | (-0.796) | (-0.854) | (-0.192) | (0.250) | (-0.304) | (-0.157) |
| **RELHOM** | -1.910 | -15.609 | -0.226 | 0.020 | -0.016 | 43.599 |
| | (-0.267) | (-1.152) | (-0.326) | (-0.026) | (-0.001) | (0.622) |
| **GDPPC** | 0.11E-2$^{c}$ | 0.87E-3$^{c}$ | 0.59E-4$^{c}$ | -0.12E-4 | -0.21E-2$^{c}$ | -0.53E-2$^{c}$ |
| | (7.060) | (3.041) | (4.022) | (-0.758) | (-4.289) | (-3.497) |
| **POP** | -0.045$^{c}$ | -0.100$^{c}$ | -0.98E-3 | -0.40E-2$^{c}$ | -0.40E-2 | 0.125 |
| | (-4.173) | (-4.908) | (-0.938) | (-3.490) | (-0.119) | (1.261) |
| **CONSTANT** | 55.451$^{c}$ | 78.757$^{c}$ | -0.310 | 0.777 | 68.774$^{b}$ | 100.17 |
| | (6.485) | (4.866) | (-0.373) | (0.852) | (2.273) | (1.223) |
| **Adj. $R^2$** | 0.718 | 0.512 | 0.296 | 0.298 | 0.366 | 0.452 |
| **No. Obs.** | 31 | 31 | 31 | 31 | 25 | 23 |
| **F stat.[k-1,n-k df]** | 16.31* | 7.30* | 3.53* | 3.54* | 3.77* | 4.62* |
| *Heteroskedasticity* | | | | | | |
| **BPG stat.[k-1 df]** | 11.341* | 3.751 | 1.512 | 3.231 | 11.799* | 4.817 |
| *Specification* | | | | | | |
| **RESET(2)[1,n-k-1 df]** | 0.011 | 0.518 | 0.126 | 28.217* | 5.528* | 1.332 |
| **RESET(3)[2,n-k-2 df]** | 1.092 | 0.328 | 2.185 | 13.862* | 2.718 | 0.795 |
| **RESET(4)[3,n-k-3 df]** | 0.927 | 0.209 | 1.574 | 8.871* | 2.268 | 0.561 |
| *Normality* | | | | | | |
| **Jarque-Bera stat.[2 df]** | 0.598 | 0.028 | 69.472* | 1.806 | 1.717 | 13.264* |

Notes:
1. k= number of regressors, n= number of observations and df=degrees of freedom.
2. T-ratios are in brackets. Estimated coefficients from a two-tailed t-test that are significant at 10 or 5 or 1 percent levels are denoted respectively by the superscripts $^{a}$ , $^{b}$, and $^{c}$.
3. Test statistics that indicate we should *reject* the null hypothesis at the 5 percent level of significance are denoted by *.
4. The F-test statistic is for the null hypothesis that the coefficients of all the regressors, except the constant term, are equal to zero.
5. The BPG test statistic is for the null hypothesis of homoskedasticity and converges to a chi-square distribution if the null is true.
6. The RESET tests are for the null hypothesis that the coefficients of the regressors in alternative model specifications are *all* zero and has an F distribution if the null is true. The alternative models have the same regressand, but included in the regressors is the regressand squared (2), squared and cubed (3), squared, cubed and to the power of 4 (4).
7. The Jarque-Bera test statistic is for the null hypothesis that the errors are normally distributed and converges to a chi-square distribution if the null is true.
8. E-i denotes that the coefficient is multiplied by $10^{-i}$.

## Table 9. Simple Correlations between the Measures of Social Capacity and $R^2$ of Auxiliary Regressions

| Variable | CAL | AYS | GDPPC | POP | Aux. $R^2$ |
|---|---|---|---|---|---|
| **CAL** | 1 | 0.490 | 0.605 | -0.204 | 0.382 |
| **AYS** | | 1 | 0.779 | -0.255 | 0.632 |
| **GDPPC** | | | 1 | -0.127 | 0.682 |
| **POP** | | | | 1 | 0.101 |

Notes:
1. The correlation coefficients were calculated using 38 observations, which represent the total number of countries with observations for all 4 variables.
2. Each auxiliary regression has the identified explanatory variable as the regressand and all other explanatory variables as the regressors. The $R^2$ from each auxiliary regression is provided in the column Aux. $R^2$.

## Table 10. Estimates of the Effects of Social Capacity on Environmental Performance

| Variable | ESI | SYS | SYSA | SYSW | SO2 | TSP |
|---|---|---|---|---|---|---|
| **CAL** | -0.271[c] | -0.709[c] | -0.021[b] | -0.024[b] | 0.258 | 0.821 |
| | (-3.866) | (-4.929) | (-2.526) | (-2.697) | (0.959) | (0.904) |
| **AYS** | -0.160 | -1.112 | -0.086 | -0.23E-2 | -0.184 | 7.630 |
| | (-0.257) | (-0.868) | (-1.177) | (-0.029) | (-0.080) | (0.988) |
| **GDPPC** | 0.14E-2[c] | 0.002[c] | 0.11E-3[c] | 0.17E-4 | -0.23E-2[c] | –0.95E-2[c] |
| | (7.080) | (5.079) | (4.601) | (0.688) | (-3.501) | (-4.048) |
| **POP** | -0.026[c] | -0.050[c] | -0.18E-3 | -0.21E-2[c] | 0.012 | 0.118 |
| | (-4.555) | (-4.319) | (-0.272) | (-3.012) | (0.462) | (1.341) |
| **CONSTANT** | 75.723[c] | 126.68[c] | 1.914[a] | 3.027[c] | 31.868 | 55.855 |
| | (9.038) | (7.373) | (1.96) | (2.880) | (0.879) | (0.493) |
| **Adj. $R^2$** | 0.771 | 0.598 | 0.417 | 0.226 | 0.421 | 0.486 |
| **No. Obs.** | 38 | 38 | 38 | 38 | 31 | 27 |
| **F stat.[k-1,n-k df]** | 32.20* | 14.77* | 7.61* | 3.70* | 6.45* | 7.16* |
| *Heteroskedasticity* | | | | | | |
| **BPG stat.[k-1df]** | 8.448 | 6.274 | 5.293 | 4.229 | 14.021* | 6.890 |
| *Specification* | | | | | | |
| **RESET(2)[1,n-k-1 df]** | 3.002 | 4.742* | 1.806 | 17.566 | 2.563 | 4.524* |
| **RESET(3)[2,n-k-2 df]** | 10.550* | 3.500* | 0.942 | 9.485* | 1.615 | 2.154 |
| **RESET(4)[3,n-k-3 df]** | 6.910* | 3.160* | 0.660 | 6.143* | 3.046* | 2.569* |
| *Normality* | | | | | | |
| **Jarque-Bera stat.[2 df]** | 0.990 | 0.659 | 12.077* | 2.749 | 0.895 | 1.788 |

Notes:
1. k= number of regressors, n= number of observations and df=degrees of freedom.
2. T-ratios are in brackets. Estimated coefficients from a two-tailed t-test that are significant at 10 or 5 or 1 percent levels are denoted respectively by the superscripts [a] , [b], and [c].
3. Test statistics that indicate we should *reject* the null hypothesis at the 5 percent level of significance are denoted by *.
4. The F-test statistic is for the null hypothesis that the coefficients of all the regressors, except the constant term, are equal to zero.
5. The BPG test statistic is for the null hypothesis of homoskedasticity and converges to a chi-square distribution if the null is true.
6. The RESET tests are for the null hypothesis that the coefficients of the regressors in alternative model specifications are *all* zero and has an F distribution if the null is true. The alternative models have the same regressand, but included in the regressors is the regressand squared (2), squared and cubed (3), squared, cubed and to the power of 4 (4).
7. The Jarque-Bera test statistic is for the null hypothesis that the errors are normally distributed and converges to a chi-square distribution if the null is true.
8. E-i denotes that the coefficient is multiplied by $10^{-i}$.

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## End Notes

[1] A full data appendix that gives all observations per country is available upon request. The 53 nations in the sample include: Argentina, Armenia, Australia, Austria, Azerbaijan, Bangladesh, Belarus, Belgium, Brazil, Bulgaria, Canada, Chile, China, Colombia, Croatia, Denmark, Dominican Republic, Estonia, Finland, France, Germany, Ghana, Iceland, India, Ireland, Italy, Japan, Korea, Latvia, Lithuania, Mexico, Moldova, Netherlands, Nigeria, Norway, Pakistan, Peru, Philippines, Poland, Portugal, Russia, Slovenia, South Africa, Spain, Sweden, Switzerland, Taiwan, Turkey, Ukraine, United Kingdom, USA, Uruguay and Venezuela.

[2] Several other similar, but different, definitions of social capital also exist. See the edited volume by Dasgupta and Serageldin (2000) for alternative perspectives.

[3] For descriptions of various international environmental agreements consult Grafton, Pendleton and Nelson (2001).

[4] Further details about the variables are provided in Table 1. A detailed description of the indicators and data sources is given in GLTETF (2001) and the associated annexes.

[5] Measures of income inequality are problematic due to the limited number of countries for which data are available that are of “high quality”, “reliable” and comparable. See Knowles (2001) for further details.

[6] For a detailed discussion on social divergence and the variables used to measure it, consult Grafton, Knowles and Owen (2002).

[7] We view the average years of schooling (AYS) as a superior measure to a basic literacy rate. AYS provides a measure of *degree* of human capital that a measure of proportion of the population that are literate does not, and also provides a measure with a greater dispersion.

[8] A possibility exists that the errors in the six estimated equations might be correlated in that the error term in one equation for a particular observation or country may be correlated in another equation for the same country. In other words, the influence of omitted factors in one equation for a particular country may be similar to their influence in another of the six equations for the same country. Seemingly unrelated regression (SUR) is an alternative estimation procedure to OLS that uses information on the correlation across error terms for the same observation or country to obtain more precise estimates. In our study all the explanatory variables are identical for every country and in every equation. In this situation, the SUR and OLS procedures will yield identical estimates of the coefficients, even if errors across equations are correlated.

[9] Several potential reasons exist for the result that reduced corruption can improve national environmental performance. Shleifer and Vishny (1993, p. 615) observe "…countries would rather spend their limited resources on infrastructure projects and defence, where corruption opportunities are abundant, than on education and health, where there are much more limited." López and Mitra (2000) emphasize that bribery and rent-seeking behaviour may prevent the implementation or enforcement of pollution control measures.

[10] These results are available on request from the authors.

[11] Torras and Boyce (1998) find that increased literacy in low-income countries improved a number of ambient air and water quality measures. However, for high-income countries they find contradictory results with literacy improving measures of heavy particles and dissolved oxygen, but increasing ambient measures of smoke and faecal coliform (see their Table 3, p. 156).

[12] Results with $GDP^2$ as a regressor and also separate regressions with the data split between low and high-income countries are available on request from the authors. The inclusion of the additional explanatory variable does not change the overall findings provided in Tables 4, 6, 8 and 10.

[13] See de Bruyn, Dasgupta *et al.* (2002), Harbaugh *et al.* (2002) and Stern (1998) for examinations of the empirical evidence for an environmental Kuznets curve.

[14] This result is also consistent with the findings of Harbaugh *et al.* (2002).

[15] Pretty and Ward (2001, p. 213) also emphasize the importance of distinguishing between social capital embedded in social and church groups and social capital embodied in groups focused on natural resources.

[16] Ostrom, Gardner and Walker (1994, p. 328) observe, “Efforts to establish one set of rules to cover large territories, which include significantly different types of local environments, are as problematic as the presumption that those involved may find adequate solutions entirely on their own.”