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Governance, institutions and the environment-income relationship: a cross-country study

Kuheli Dutt

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Abstract This paper examines the environment-income relationship in the context of the Environmental Kuznets Curve (EKC), and explores the possible role that factors like governance, political institutions, socioeconomic conditions, and education play in influencing this relationship. The results suggest that the EKC exists for carbon dioxide emissions for cross-country data over the period 1984–2002. However, there is nothing automatic about this relationship; policies designed to protect the environment may be responsible for this phenomenon. Two other significant findings are: one, countries with better quality of governance, stronger political institutions, better socioeconomic conditions and greater investment in education have lower emissions; and two, only around 15% of the countries in the dataset have reached income levels high enough to be associated with an unambiguous decline in emissions. The implications of these results are discussed within the context of the international environmental policy arena and the Kyoto Protocol. One of the main objectives of this paper is to bridge the gap between studies conducted on the EKC and developments in the international environmental policy arena. As a final note this paper emphasizes that one needs to connect the body of knowledge on the EKC hypothesis to the international environmental policy arena, despite the apparent difficulty of doing so. One hopes that future studies will further build on this line of thought.

Keywords Climate change · Sustainable development · Kyoto Protocol · Environmental Kuznets Curve · International environmental law and policy

1 Introduction

Since the early 1990s there have been several studies conducted on the possible existence of a significant relationship between environmental quality and economic growth, with a

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K. Dutt (✉)
Northeastern University, Boston, MA 02115, USA
e-mail: kuhelidutt@gmail.com

view to giving policymakers insights into the development process. In this context a widely discussed concept is that of the Environmental Kuznets Curve (EKC), which shows that as per capita income increases, environmental quality initially worsens, but with continued increases in income, environmental quality starts improving, giving rise to an inverted U shaped curve.

Many reasons have been suggested for this. One, at low levels of economic development, environmental degradation is limited to the effects of subsistence economic activity. As industrialization takes place, pollution increases, and as the economy develops further and moves into the service sectors, environmental quality improves again (Panayotou 1993). Another reason is that as economic development progresses, there tends to be a parallel progression in environmental regulation; and one goes from little or no regulation at low levels of development, to strong environmental regulation at high levels of development, highlighting the role of institutional development and property rights (Yandle et al. 2004).

The earliest empirical study on the environment-income relationship was conducted by Grossman and Krueger (1991). They analyzed the EKC relationship within the framework of the NAFTA agreement and proposed that free trade would lead to increasing incomes, which would lead to stricter environmental control. Their findings provided statistical evidence for the existence of an EKC relationship between income and pollution. Following closely after that, Shafik and Bandyopadhyay (1992) estimated the relationship between economic growth and environmental quality using 20 different indicators, of which 10 were environmental indicators. Their study was a particularly influential one, with their results being used in the 1992 World Development Report published by the World Bank. They found that certain environmental indicators followed the EKC pattern while others did not.

These studies paved the way for several new studies. The results were mixed with some studies finding evidence of the EKC and others finding no evidence of it. Connections were made between the narrower picture of the environment-income relationship and the broader picture of environmental policy and economic development. The Earth Summit[1] at Rio de Janeiro (1992) marked the emergence of sustainable development as a development policy paradigm. Defined by the Brundtland Commission (1987) as "*…development that meets the needs of the present without compromising the ability of future generations to meet their own needs*" the concept of sustainable development focuses on the goal of promoting economic and social development that is environmentally sustainable.

2 Brief literature review

Following the Grossman and Krueger and Shafik and Bandyopadhyay studies, several studies found evidence of the EKC (Panayotou 1993; Selden and Song 1994; Shafik 1994; Grossman and Krueger 1995; Cole et al. 1997; De Bruyn et al.1998). Researchers also explored various economic, social, and political factors in the context of the environment-income relationship. Panayotou (1997) looks at the role that policies and institutions play in influencing environmental quality and finds that better governance and policies can make a significant improvement in environmental quality. Jalal (1993) looks at the human dimension of the environment-income relationship for developing countries and points out that development processes are essentially resource-driven, and depend on how well a

[1] The first major global event focusing on sustainable development was the United Nations Conference for Environment and Development (also called the Earth Summit) at Rio de Janeiro in 1992.

society manages its resources. Dasgupta et al. (1995) highlight the importance of institutional development and environmental regulation. De Bruyn (1997) investigates the roles of structural change and environmental policy in explaining the EKC hypothesis and finds that the downward sloping part of the EKC (i.e. the part representing better environmental quality with increased income) is better explained by environmental policy than by structural change. He concludes that international co-operation may play an important role in providing encouragement to countries that have not yet reached their turning point on the hypothesized EKC. De Bruyn et al. (1998) look at emissions for the UK, USA, Netherlands, and West Germany for various time intervals between 1960 and 1993. They find that the effect of economic growth on emissions is positive and significant in most cases, and their findings indicate the existence of an inverted U-shaped curve. Borghesi (2000) looks at the impact of income inequality on environmental degradation and finds that depending on the econometric framework used, one gets different results. With the OLS model he finds that greater inequality reduces emissions, while the Fixed Effects models show that inequality always has a statistically non-significant impact on CO_2 emissions. Borghesi concludes that further research is needed in this area. Looking at corruption, Cole (2007) analyzes the linkages between corruption and pollution and finds that the total effect of corruption on emissions is negative for most countries except the highest income countries. Harbaugh et al. (2002) look for the existence of the EKC using data from cities worldwide and find little or no evidence of an inverted U-shaped relationship between pollution and income.

Addressing the question of whether the EKC pattern is inevitable, Stern et al. (1996) assert that the existence of an EKC relationship does not guarantee that global environmental degradation would decline automatically with time and increased income; policies to achieve sustainable development must incorporate explicit incentives to reduce environmental degradation. Stern (2004) goes on to assert that the EKC is not a complete model of emissions or concentrations and the true form of the environment-income relationship is most likely a mix between several scenarios. Looking at the role of social factors, Barros et al. (2002) assert that improvement of income, education and other forms of social capital can lower the turning point of the EKC, thereby avoiding the hypothesized increase in environmental damage before the environmental quality begins to improve. Deacon and Norman (2004) assert that it is not necessarily the increase in income that causes a reduction in pollution. Factors such as better information and education would have the same effect. Deacon (2005) states than when a country is much richer, then in most cases political institutions are more democratic and more closely reflect the preferences of the public, which could explain the improvement in environmental quality at higher levels of income. Constantini and Martini (2006) find that once they account for human development and sustainability, the turning point of the EKC actually occurs at lower levels of income, and conclude that an increase in human well-being is necessary to provide a sustainability path.

Looking at the broader picture of transboundary issues, Kolstad (2006) states that one of the difficulties of interpreting the EKC in the context of greenhouse gas emissions is the weak link between demand for higher environmental quality to prevent damage from climate change and the environmental regulations that limit emissions at the country level. He points out that the weak link between regulatory actions at a global levels and benefits to citizens in an individual country is part of the reason why it is so difficult to implement international agreements on greenhouse gases.

The literature indicates that there is no single relationship that fits all environmental indicators across all countries. There is still a debate going on about whether or not the

EKC hypothesis is a convincing one. Scholars are divided on the issue—on the one hand there are studies like Stern (2004) stating that the EKC hypothesis is based on weak econometric framework and is therefore not a suitable approach to the environment-income relationship; on the other there are studies like Constantini and Martini (2006) that find evidence of the EKC even after using various robust econometric techniques. Overall, however, there is a general agreement that higher incomes are associated with better environmental quality. The debate lies over the process by which this higher income is converted into better environmental quality.

One limitation with many EKC studies is the excessive focus on the shape of the curve, rather than the underlying issues that give rise to such a relationship in the first place. Being able to determine whether or not the inverted U-shaped relationship exists is not enough to gain a fundamental insight into the relationship between economic development and the environment. Institutional, social, and political factors need to be explored in greater detail. However, these are often difficult to model and have limited data availability. Another limitation is that there have not been many attempts to connect the results of the EKC studies to the bigger picture of current developments in the international environmental arena, and in order to gain a deeper insight into the policy implications of the environment-income relationship, this connection needs to be made.

This paper extends the previous analysis on the environment-income relationship in two ways. First, it explores the possible role played by factors like governance, political institutions, socioeconomic factors, and education in the context of this relationship. Second, it attempts to connect the results of the EKC study to the bigger picture of the current international environmental policy arena in the context of global warming and the Kyoto Protocol.

3 Empirical modeling

Data for CO_2 emissions are examined in order to explore whether an EKC exists, and whether factors like governance, political institutions, education, government expenditure on education, and socioeconomic factors are related to emissions. The choice of CO_2 as an environmental indicator was based on several factors such as data availability, relevance to both developed and developing countries, and relevance in the international environmental policy arena. At the domestic level, while CO_2 by itself does not pose any immediate health hazard to human beings, it is usually a by-product of increased industrial activity, which, in the absence of stringent regulation, is a source of toxic emissions and particulates that pose environmental concerns. At the global level, CO_2 is an immediate cause for concern in itself since it is a key greenhouse gas, responsible for global warming and climate change. Examining CO_2 emissions in a cross-country setting will facilitate discussion in the context of the international environmental policymaking process.

One interesting point to note is that the early studies on the EKC as reflected in the literature do not find any evidence of it (e.g., Shafik and Bandyopadhyay); however later studies do find evidence of it (e.g., Panayotou), raising questions as to why this might happen, making it a potentially interesting indicator to focus on.

The final selection is a set of 124 countries,[2] spanning the time period from 1984 to 2002, and collectively accounting for about 97% of all global anthropogenic CO_2.[3] The

[2] The complete list of countries can be made available upon request.

[3] United Nations Statistics Division, 2002.

data sources used are: the World Bank,[4] Freedom House,[5] the Political Risk Services (PRS) Group,[6] and the Education Policy & Data Center (EPDC).[7] The regression models take the form:

Environmental quality = Function (Income, Population density, Governance, Political institutions, Government expenditure on education, Years of schooling, Socio-economic factors)

The expected signs of all the variables are shown in the following table (Table 1).

Robust Ordinary Least Squares (OLS) model and Fixed-Effects (FE) model[8] specifications (FE Year and FE Country) are examined. Two models are used. The first model tests for the EKC as well as any significant relationship with institutional variables such as governance and political institutions. The second model uses the same set of variables but also includes factors like government expenditure on education, average years of schooling, and socioeconomic conditions. The reason these variables are estimated separately instead of with the first model is that the data coverage for the education and socioeconomic variables is over a lesser time span (available only for 94 countries spanning the time period 1985–2000).

3.1 Description of variables

Carbon dioxide (CO_2) emissions (dependent variable): This is measured in metric tons per capita, calculated based on fossil fuel consumption data and world cement manufacturing data.

Income: This is measured in Gross Domestic Product per capita in constant 2000 international dollars, adjusted for Purchasing Power Parity (PPP). For evidence of the EKC the coefficient on the quadratic term GDP squared should be significant and negative.

Population density: This is measured as the number of people per square kilometer.

Quality of governance: This is a composite index of "Quality of Bureaucracy", "Corruption in Government", and "Democratic Accountability" and ranges in value from 0 to 16, with higher numbers implying better quality of governance.

Socioeconomic conditions: This is a composite index of unemployment, consumer confidence, and poverty and ranges in value from 0 to 12, with higher numbers representing better conditions.

Political institutions: This is a composite index measuring civil liberties and political rights, ranging from 2 to 14 with higher numbers representing stronger political institutions. The original ordering was not consistent with the interpretation of the other indicators used in this study, so the numbers were reversed in order to be compatible with the ordering of all the other variables.

[4] Data for CO_2 emissions, per capita income, and population density have been taken from the World Development Indicators, published by the Data & Research Group of the World Bank, Washington D.C.

[5] Data on political institutions have been taken from Freedom in the World rankings by Freedom House.

[6] Data on quality of governance, and socioeconomic conditions have been taken from the International Country Risk Guide, published by the Political Risk Services (PRS) Group, New York.

[7] Data on government expenditure on education have been taken from EPDC, Washington D.C.

[8] A preliminary investigation showed that the Fixed Effects Model was superior to the Random Effects Model, based on the Hausman test which tests whether a Random Effects estimator is as consistent and efficient as a Fixed Effects estimator.

Table 1 Expected relationship of explanatory variables with carbon-dioxide

Explanatory variable	Description	Expected relationship
GDP	Gross Domestic Product per capita	Positive
GDP squared	Quadratic term to test for inverted U-shaped curve	No prediction
Quality of governance	Composite index measuring quality of bureaucracy, corruption in government, and democratic accountability	Negative
Political institutions	Composite index measuring political rights and civil liberties	Negative
Socioeconomic conditions	Composite index measuring unemployment, poverty, and consumer confidence	Negative
Population density	Number of people per square kilometer	Positive
Education	Average years of schooling in the adult population	Negative
Education expenditure	Expenditure on education as a percentage of GDP	Negative
Governance and political (Interaction)	Interaction term between governance and political institutions	No prediction
Education expenditure and schooling (Interaction)	Interaction term between education expenditure and years of schooling	No prediction
Time trend	Indicator of exogenous time dependent variables	No prediction

Mean years of schooling: This measures the average years of schooling in the population above the age of 25. These data were measured in 5-year intervals, so linear interpolation was used to fill in missing data. The data for this variable have been taken from the Barro-Lee (2000) dataset, available from the World Bank.

Government expenditure on education: This is measured as a percentage of total GDP.

In addition to the above variables, a *time trend* was added to adjust for temporal effects, and *two interaction terms* were added—one for political institutions and governance, and another one for average years of schooling and education expenditure. The existence of an interaction term implies that the impact of one explanatory variable on the dependent variable is dependent on the magnitude of another explanatory variable. There might be reason to believe that incremental improvements in political institutions are associated with lower emissions for countries with better governmental quality than for countries with poor governmental quality. Also, it is possible that the impact of education (as measured by average years of schooling) on emissions will depend on the government's expenditure on education.

The rationale behind choosing all of the specified variables is based on intuitive reasoning. Governance and political institutions determine the policymaking process and the effectiveness of policies designed to improve environmental quality. Also, environmental quality is a public good that is typically provided by the government and consumed by the public, so the nature of the interaction between the public and the government is important. Education is also an important indicator because one can expect that greater awareness among the public about environmental hazards will lead to better choices, thus influencing environmental quality. Similarly, better socioeconomic conditions can be expected to be associated with better environmental quality. It should be noted however, that cross-country comparisons have certain data limitations. For example, government expenditure on education could be a lower percentage in one country but be of a higher quality than in

another country that spends a higher percentage on education. This is one of the reasons why cross-country studies should be supplemented with single-country studies so as to get a clearer picture overall. Table 1 shows the expected signs for each of the variables.

A preliminary exploration of the data revealed heteroskedasticity and serial correlation, something that is not surprising for panel data of this nature. Accordingly, heteroskedasticity-robust standard errors were computed for all models. Also wherever relevant, the observations were clustered by country and adjusted for serial correlation.

4 Results and discussion

In all of the specifications examined (Robust OLS, FE Year, or FE Country) there is evidence of the EKC with turning points ranging from $27,000 to $30,000, as shown in the Tables 2 and 3. This study finds all turning points to be well within the range of the given dataset. Early studies found lower turning points and later studies found very high turning points, sometimes well outside the range of the relevant dataset.[9] Possible reasons for this are discussed in a later section.

A noteworthy point is that unlike the very early studies done on CO_2 that do not find evidence of an EKC, the results of this study are similar to the later studies done on CO_2 where there is evidence of the EKC. One reason for this could be that environmental regulations were imposed in developed countries starting from the 1970s to 1980s, and given that it could take at least a decade if not more to actually observe the effects of this regulation in terms of improved environmental quality, the earlier studies were not able to capture that effect. It has now been approximately three decades since the imposition of environmental regulations—a time period large enough to be able to observe some impacts of regulation. Even though there were no policies specifically designed to curb CO_2 emissions, it is quite possible that on the whole, CO_2 emissions decreased after the imposition of environmental regulations. This could explain why later studies found evidence of the EKC for CO_2 but earlier studies did not.

To further explore this line of thought, data on income and CO_2 emissions were examined for the same set of countries over the period 1960–1980. There was no observed evidence of the EKC. Figure 1a and b illustrate this. Figure 1a shows us that over 1960–1980 there is no evidence of the EKC for CO_2. In fact, increases in income seem to be consistently associated with increases in emissions. On the other hand, in the second figure we observe a clear inverted U-shaped curve, consistent with the EKC hypothesis. A closer look also reveals that the highest observed emissions over 1960–1980 was in the range of 80 metric tons, while for 1984–2002 it was in the range of 35 metric tons. (Note: the absolute figures of GDP are higher over the period 1960–1980 which seems odd; however the income data for this period are in nominal terms and have not been adjusted for PPP unlike the dataset for 1984–2002. While PPP adjusted data allow for a more realistic analysis, in this case the purpose of comparing the two time periods was to identify any differing trends in CO_2 emissions).

These observations allow for speculation that policies specifically designed and enforced to protect the environment were ultimately responsible for the decline in emissions. It is interesting to note that in developed countries, where environmental regulations

[9] Yandle et al. (2004) states that the turning point for CO_2 emissions as observed in the literature occurs within the income range of $37,000–$57,000. Earlier studies found turning points within the range of $5,000–$8,000.

Table 2 Model I: Factors influencing CO_2 emissions[a]

Explanatory variable	Robust OLS model	Fixed Effects model	
		Country effects	Year effects
GDP	1.178E−03 (5.50)*	8.231E−04 (5.35)*	1.186E−03 (20.27)*
GDP squared	−2.02E−08 (−3.29)*	−1.38E−08 (−4.26)*	−2.064E−08 (−11.91)*
Population density			5.332E−04 (3.53)*
Quality of governance	2.706E−01 (2.03)		2.545E−01 (4.69)
Political institutions	1.038E−01 (0.51)	−1.0878E−01 (−2.96)*	−8.653E−02 (−1.31)
Interaction (Govt*Pol)	−4.932E-02 (−2.01)**		−4.765E−02 (−5.86)*
Time trend			2.621E−04 (2.08)**
Intercept			−1.812 (−3.69)*
R^2 Overall	0.6308	0.5169	0.6308
R^2 Within	–	0.2865	0.6305
R^2 Between	–	0.5158	0.7555
Estimated turning point	$29,450	$29,822	$29,650
No. of observations	2,062	2,062	2,062

[a] Only significant results reported. Figures in parentheses indicate absolute *t*-values significant at 1% or 5% as indicated by the *P* values. *Note*: Overall *F*-statistics are significant at 1% levels for all models

Significant at $*P < 0.01$, $**P < 0.05$

Table 3 Model II: Factors influencing CO_2 emissions[a]

Explanatory variable	Robust OLS model	Fixed Effects model	
		Country effects	Year effects
GDP	1.122E−03 (3.14)*	8.587E−04 (5.44)*	1.112E−03 (9.87)*
GDP squared	−2.03E−08 (−2.22)**	−1.45E-08 (−4.85)*	−1.99E−08 (−6.52)*
Population density	1.3E−03 (1.84)***		1.313E−03 (4.29)*
Quality of governance	3.776E−01 (2.59)		3.837E−01 (5.61)
Political institutions	1.43E−01 (0.61)	−8.269E−02 (−2.47)**	1.546E−01 (1.70)
Education expenditure			1.307E−01 (2.67)*
Years of schooling			
Interaction term (Govt*Pol)	−5.311E−02 (−2.04)**		−5.373E−02 (−5.14)*
Socio-economic conditions			
Time trend		−4.172E−02 (−2.05)**	
Intercept		46.406 (2.03)**	−3.2038 (−4.31)
R^2 Overall	0.6107	0.0493	0.6107
R^2 Within	–	0.3662	0.6103
R^2 Between	–	0.0367	0.5366
Estimated turning point	$27,640	$29,029	$27,939
No. of observations	1,072	1,072	1,072

[a] Only significant results reported. Figures in parentheses indicate absolute *t*-values significant at 1%, 5%, or 10% as indicated by the *P* values. *Note*: Overall *F*-statistics are significant at 1% levels for all models

Significant at $*P < 0.01$, $**P < 0.05$, $***P < 0.10$

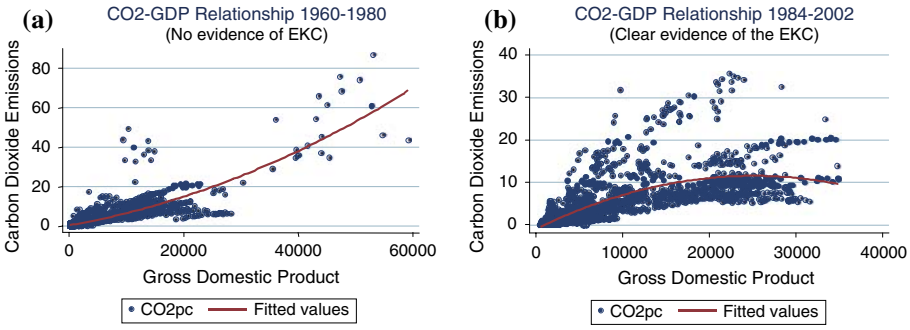

Fig. 1 Carbon dioxide (CO_2) emissions 1960–1980, and 1984–2002

were imposed, emissions ultimately declined; however in developing countries where there haven't been strong environmental regulations, these emissions have been steadily rising over time. The policy implications of this trend are discussed in a later section.

As mentioned earlier, unlike some studies that find turning points to be outside the range of the relevant dataset, this study finds all the turning points to be within the bounds of the dataset, implying that some countries in the dataset have already reached those levels of income beyond which further increases in income will result in an unambiguous decline in per capita CO_2 emissions. Technically, a turning point outside the range of the relevant dataset means that while the data display a trend that is consistent with emissions being reduced after a certain income has been reached, that reduction is not yet significantly observable within the given data. It could be the case that prior to environmental regulations the decrease in emissions is slower, but the imposition of environmental regulations speeds up the process of reducing emissions, and the result is that the turning point income occurs well within the observed bounds of the given dataset.

In Model I, there is evidence of the EKC for all three types of model specifications, i.e. Robust OLS, FE Year, and FE Country.[10] Population density is not significant in the Robust OLS model or the FE Country model, but significant in the FE Year model. This is not surprising since one would expect population density to change very slowly over time. For governance and political institutions, one finds that countries with better governance and political institutions have lower CO_2 emissions than those that don't. This model was estimated twice, once without the interaction term and once with the interaction term. Both yielded similar implications, i.e. better political institutions and better governance are associated with lower CO_2 emissions.[11] The OLS and the FE Year specifications show a significantly negative interaction term between political institutions and governance.

What this means is that a given improvement in political institutions is associated with lower CO_2 emissions if it takes place in a country with a better level of governance than in a country with a worse level of governance. The results show that at the average level of governance, an incremental improvement in political institutions is associated with a reduction of 0.34 (or approximately one third) of a standard deviation from the mean CO_2 emissions. At higher levels of governance, an incremental improvement in political institutions is associated with a decrease of CO_2 emissions by 0.64 (or about two thirds) of

[10] Higher order relationships were tested, such as GDP^3 and GDP^4 but the results for the different models were either not significant or were inconsistent with each other. Accordingly, the focus was only on GDP and GDP^2

[11] The results of the model without the interaction term can be made available upon request.

a standard deviation from the mean CO_2 emissions. In comparison, at low levels of governance the impact of an incremental improvement in political institutions is associated with a decrease of only about 0.09 (or about one tenth) of a standard deviation from the mean CO_2 emissions.

The important thing to note here is that while the actual number may vary with the sort of model specification that one chooses, the underlying pattern in all of the models that show a significant interaction term reveal the same trend, i.e. better political institutions are associated with lower CO_2 emissions in countries with better governance. These results have profound implications for policy, implying that better governance could be a potential policy focus and countries with weak governance structures could be advised to focus on improving the quality of governance.

In Model II, in addition to political institutions and quality of governance, the relationship between CO_2 emissions and government expenditure on education, average years of schooling, and socioeconomic factors is explored. Neither of the education indicators is statistically significant in either the OLS model or the FE Country model, and they are barely significant in the FE Year model. This does not change even when an interaction term is included between education expenditure and average years of schooling. Accordingly, the interaction term was dropped and the model was re-estimated without it.

This result seems surprising, given that one would expect that higher expenditures on education would translate into better environmental choices made by the population, which would be expected to translate into lower CO_2 emissions. However closer examination of the education data reveals that education is so closely correlated with income, that once the explanatory power of income has been accounted for, education provides very little additional explanatory power. Another seemingly surprising result is that socioeconomic conditions are not significant. However, again one finds that socioeconomic factors are closely correlated with income and so once we account for income, they provide little additional explanation.

An important point to note is that this does not mean that education indicators or socioeconomic conditions are not important overall. While in this specific case they do not provide any additional explanatory power once income has been taken into account, it is interesting to note that the countries with highest incomes are also the ones with the highest education and best socioeconomic conditions. In fact the high degree of correlation between education expenditure and income shows that education expenditure could easily serve as a proxy for income, right down to the inverted U-shaped curve (all the other variables were tested and education expenditure was found to have the strongest correlation with income). In other words, as expenditure on education reaches higher and higher levels, ultimately CO_2 emissions begin to decline. This suggests that larger investments in education could have a similar impact on CO_2 emissions as increasing per capita income. In other words, investing in education might be able to speed up the improvement of environmental quality.

4.1 Limitations of the model

One limitation is that this study uses only CO_2 emissions per capita. However, there may be other relevant measures of CO_2 such as total CO_2 emissions or CO_2 emissions per unit of landmass. For the purposes of this study, many of the countries with high per capita emissions were also the same ones with high total emissions.[12] In recent years however,

[12] More information on individual emissions from each country can be made available upon request.

emissions from developing countries have rapidly increased, and using per capita emissions may provide a different picture from using total emissions.

A second limitation is that in a cross-country study, one cannot go into great detail about any single country. Rather, one looks at the broad picture overall to see if any dominant patterns emerge. However, there is a well-known trade-off between the "depth" of single country studies, and the "breadth" of cross-country studies. Each has its own merits and limitations, and for this reason it is best to consider them complements rather than substitutes.

A third limitation is that the results show association, not causation between different variables and CO_2 emissions. Ultimately, one is left with the task of finding suitable explanations for such associations. One such possible explanation is that reduced emissions are a result of specific policies designed to protect the environment, combined with strong institutional capacity and the means to effectively implement these policies. Related to the above limitation is the fact that while the Fixed Effects models confirm the existence of unobserved effects, they don't specify what those unobserved effects are, leaving this part open to speculation.

A fourth limitation is to do with the data used. First, the CO_2 data represent industrial activity and not activities related to biomass burning or livestock grazing which, if included, could change the CO_2 values for each country. However, it is difficult to obtain such data. Besides, one also needs to acknowledge spillover effects between neighboring countries, which is most likely occurring in reality. Second, it is difficult to quantify factors such as quality of governance or institutions. A common practice is to use rankings and composite indexes, but it is highly simplistic to assume that a change in any of the components of the composite index can be measured equally on the ranking scale. However, on the other hand, if one were to separate out these components and use them as individual variables one would run into a problem of severe multicollinearity, given that many of these factors tend to be closely related. This trade-off poses dilemmas and there is no single right approach to this problem.

Given all these limitations the current practice is to work with what is available, and to try to work around these limitations. Obviously these need to be factored in when considering policy implications. Having said that however, one must also point out that despite these limitations, the results of the model are significant and have some valid implications for policy, all of which are discussed in Sect. 5.

A few notes of caution are relevant here. While there is evidence of the EKC in this particular study, one needs to be cognizant of the fact that it is by no means the only possible relationship between environmental quality and income. This model is applicable only to the dependent variable that has been specified, i.e. per capita emissions of CO_2. One cannot generalize these results to other environmental indicators. Studies in this field have shown that there are various types of relationships between different environmental indicators and income, and the EKC is just one of them.

How does one relate these results to the bigger picture of global environmental governance and international environmental negotiations? As has been mentioned earlier, there is growing worldwide concern about CO_2 emissions. Given that it is one of the key greenhouse gases leading to global warming, currently there are intense global negotiations in progress addressing this issue.

Before one can consider the implications of the model for international environmental policy, one needs to first understand how the international environmental policymaking process works. After that one will be in a position to integrate the results of the preceding section into the bigger picture of international environmental policy.

4.2 An overview of the international environmental regime

By international environmental regime we mean a set of mechanisms and institutions that govern environmental outcomes at the international level. The international law making system is not as well developed as the typical domestic law making systems in individual countries, and involves a complex interplay of both domestic and international forces. There is no global "supra-national" form of legislature or some central authority with the power to create and enforce laws for the whole world. Moreover, no country can be forced to follow any international law regime without its prior consent. Therefore, one of the major challenges of protecting the global environment essentially boils down to an issue of effective governance at the global level. The key players in this regime are[13]: International Governmental Organizations (IGOs) such as the United Nations System; Specialized intergovernmental agencies such as USAID, IISD, IUCN; Governments and governmental organizations such as national governments and governmental agencies; and Civil Society, i.e. the private and non-profit sectors, and non-governmental and scientific and research organizations.

According to Article 38 Section I of the statute of the International Court of Justice (the judicial branch of the United Nations) there are four sources of international law.[14] These are: international conventions and treaties, international customs, general principles of the law, and judicial decisions and teachings. These form the basis of international environmental law and can broadly be classified into two categories: hard law and soft law. Hard law refers to treaties (either bilateral or multilateral) and formal binding agreements that have been ratified[15] by different governments (i.e. converted into domestic law), while soft law refers to non-binding guidelines which lack formal enforcement methods and usually urge actors and institutions to behave in a certain way. Examples of hard law are the Kyoto Protocol and the Montreal Protocol, while examples of soft law are the Rio Declaration and Agenda 21.

4.3 Major milestones in the international environmental arena

The first international expression of global concern regarding the state of the environment was the United Nations Conference on the Human Environment, Stockholm, 1972. It focused on the interplay of environment and economic development. A significant legacy of this conference was the creation of the United Nations Environment Program (UNEP). The next significant conference was the UN Conference on Environment and Development (Earth Summit), Rio de Janeiro, 1992. At this conference the United Nations Framework Convention on Climate Change (UNFCCC) was drawn up, and entered into force in March 1994 following ratification by 50 countries.

The Earth Summit can be thought of as the beginning of a global movement to protect the environment along with integrating developmental goals into environmental considerations. The notion of sustainable development first emerged in the 1980s, but it was only after the Earth Summit that this notion gained global prominence. The Brundtland

[13] Speth and Haas (2006)

[14] Rogers et al. (2006)

[15] In international law there is a distinction between signing a treaty and ratifying a treaty. Signing implies providing preliminary support but does not pose any binding obligations. For example, the U.S. has signed the Kyoto Protocol but not ratified it.

Commission, chaired by Norwegian Prime Minister Gro Harlem Brundtland published its report "Our Common Future" in 1987, and advocated the view that environmental degradation and poverty alleviation needed to be tackled together. The two main highlights that emerged were the Rio Declaration, a set of 27 principles that followed the spirit of the Stockholm Declaration of committing to international co-operation to solve environmental concerns, and Agenda 21, a landmark document that served as a blueprint for putting the concept of sustainable development into practice for the 21st century. The next major global summit was the World Summit on Sustainable Development (WSSD), Johannesburg, 2002. This summit focused on the need to integrate economy, environment, and society and acknowledged that these issues needed to be worked on collaboratively and collectively.

The decade after the Rio Summit saw major developments in the international environmental regime. Several new treaties were drawn up and global environmental governance gained greater impetus. One of the most controversial of these treaties, the Kyoto Protocol, was drafted and signed in 1997 in Kyoto, Japan, at the UNFCCC Conference of Parties (COP). This treaty incorporates various principles of international environmental law, some of which seem to contradict each other. Before one goes into greater detail about this Protocol, a brief review of the principles that govern international environmental law is in order.

4.4 Governing principles of international environmental law

At present, the United Nations Framework Convention on Climate Change (UNFCCC) of 1992 provides the legal basis for international environmental agreements pertaining to the reduction of greenhouse gas emissions. It sets out the guidelines for co-operation, imposes penalties, and distinguishes between developed and developing countries. The principles that the UNFCCC operates on are based on some commonly observed principles for shaping international environmental law and policy.[16] In the context of the Kyoto Protocol and climate change, some of the relevant principles are: *Common But Differentiated Responsibilities, State Sovereignty, State Responsibility, Sustainable Development, Intergenerational Equity, Right to Development, Polluter Pays, Precautionary Principle*, *Common Heritage of Humankind*, and *the Common Concern of Humankind.* Historically, the concept of *State Sovereignty* has been a sort of "default", so to speak, implying that countries have the autonomy to do whatever they want within their own areas of jurisdiction. However, for transboundary and global environmental concerns, there is now an increasing importance placed on principles like *State Responsibility*, *Common Concern for Humankind* and *Common Heritage of Mankind*, which highlight the notion that the atmosphere is a "global common" that no country can claim individually. This has diluted the previous emphasis that was placed on *State Sovereignty.*

The principle of *Common But Differentiated Responsibilities* is very controversial—it implies that developed countries should shoulder the primary burden of reducing greenhouse gases. While developing countries are encouraged to reduce their emissions, they are not subject to any rigorous or binding requirements. This has been hotly contested by countries such as the United States. Similarly, the *Polluter and User Pays Principle* places the burden of responsibility on the original polluters, i.e. today's developed countries. This principle is often cited as the rebuttal to the controversy caused by the principle of

[16] These principles are further elaborated in Hunter et al. (2002).

Common But Differentiated Responsibilities. In addition to the above-mentioned principles pertinent to the Kyoto Protocol, the *Precautionary Principle*, the *Duty to Assess Environmental Impacts* principle, and the *Sustainable Development* principle have been galvanizing factors. According to these principles, uncertainties regarding the scientific knowledge pertaining to global warming and climate change do not constitute grounds for inaction, and states are responsible for assessing environmental impacts.

4.4.1 Emergence of the Kyoto Protocol

After 8 years of furious and intense debates, the Kyoto Protocol finally came into force in February 2005. The Protocol assigns the main responsibility of reducing climate change to the developed nations, recognizing the fact that poor countries have the right to economic development, while at the same time allowing for flexibility in how emissions reductions can be achieved by developed countries. This is done through the adoption of three flexibility mechanisms: Joint Implementation (Annex I countries may jointly implement projects that reduce emissions); Emissions Trading (Countries can engage in trading allowances for emissions); Clean Development Mechanism (Annex I countries can implement sustainable development project activities that reduce emissions in non-Annex I countries). However, these are not without their problems and loopholes, some of which include the danger of artificially inflated baselines, fictitious credits resulting from trading emissions rather than reducing them, and the problem of being able to gauge the commitment of developing countries to reducing emissions when there are no legally binding targets for them.

4.4.2 The international environmental policymaking process

There are various stages in the international environmental lawmaking process. The main stages, like most policy issues, include: Problem identification and Agenda setting; Negotiations on proposed actions; Adoption of policy; and Monitoring and evaluation.

Problem identification and Agenda setting: Whenever there emerges an issue for which collective action is needed, one of the first steps is usually to initiate some form of soft law, (e.g., Agenda 21 and Rio Declaration). This is usually followed by a precursor to the adoption of legally binding agreements. For climate change, this was the creation of the Berlin Mandate (1995). Before any international climate change treaty can actually be drawn up, there is a need for reliable scientific information. In the case of climate change, this is provided by the UN Intergovernmental Panel on Climate Change (IPCC).

Negotiations on proposed actions: The next step is to initiate the treaty-making process. In this stage certain key factors are identified, such as the needs that the treaty will meet, the optimal form of the treaty, the means of monitoring and enforcement, the likelihood that it will be adopted by enough countries, the expected costs of adopting it, and the timeline of the proposed treaty. Once a preliminary draft is drawn up the key actors sign the treaty as a show of preliminary support.

Adoption of policy: Once the treaty is formally drawn up, each country is expected to ratify it, i.e. accept the obligation to reduce its emissions by converting the requirements of the treaty into domestic law. Each treaty has its own set of requirements that need to be fulfilled before it can come into effect. For the Kyoto Protocol it was that it had to be ratified by at least 55 Annex I countries accounting for at least 55% of total CO_2 emissions

based on 1990 levels. Once this was met, the treaty became binding. The treaty came into force in February 2005 once this requirement was met. As of June 2007, 174 countries have ratified the Kyoto Protocol, accounting for almost 62% of global CO_2 emissions.[17] Pertinent to note here is that even for the countries that have ratified a treaty, they are not bound by its terms until it officially enters into force, in this case over the period 2008–2012.

Monitoring and evaluation: The UNFCCC facilitates the whole process and monitors the progress made by each country. Current reporting practices include the submission of national communications by Annex I countries, along with proving demonstrable progress in achieving its emissions reduction commitments. It is still too early to be able to arrive at a definite conclusion about its efficacy in meeting its stated objective since the enforcement period starts only in the year 2008 and continues till the year 2012.

4.4.3 Emerging trends in the global environmental regime

One trend that has emerged as a result of various global negotiations has been the division of the world into a global "North" or richer nations who have successfully industrialized and achieved high levels of economic development (i.e. developed countries), and a global "South" or poorer, developing nations who are still trying to catch up with the developed nations and view industrialization as the means to achieve economic development. Obviously, the needs and aspirations of these two groups of countries are very different, giving rise to fierce "North versus South" debates on how to tackle common environmental challenges. Developing countries are not willing to cut down on industrialization as it would compromise their developmental goals, and yet emissions from developing countries are expected to increase significantly over the coming decades. Using the business-as-usual scenario, carbon emissions from the developing world are expected to surpass the emissions from developed countries by the year 2018.[18] A challenge facing the global environmental actors is how to reconcile the conflicting objectives of environmental protection and economic development.

5 Policy implications

We are now in a position to discuss the policy implications of the econometric model against the background of the current international environmental arena. The dataset shows that higher levels of income are consistently associated with better governance, better political institutions, higher levels of education, greater investments in education, and better socioeconomic conditions. The results show that higher incomes are associated with lower CO_2 emissions. One finds that for countries with a per capita income within or above the range of $27,000–$30,000, further increases in income lead to unambiguous reductions in CO_2 emissions.

A very relevant point to note here is that only about 15% of the countries in the dataset have income levels high enough to indicate an unambiguous decline in CO_2 emissions with continued increases in income. The rest of the countries are still at the stage where

[17] UNFCCC—The Kyoto Protocol. http://unfccc.int/kyoto_protocol/items/2830.php.

[18] Energy Information Administration (EIA) "Greenhouse Gases, Climate Change, and Energy" http://www.eia.doe.gov/oiaf/1605/ggccebro/chapter1.html Accessed May 30, 2007.

Table 4 Comparison of mean values

	Quality of governance	Political institutions	Education expenditure	Years of Schooling
High-income	13.06	12.02	5.23	8.3
Middle-income	8.61	9.12	3.98	4.6
Low-income	6.36	5.97	2.91	2.5

increases in income are associated with increases in CO_2 emissions, i.e. on the upward portion of the EKC. In other words, approximately 85% of the countries in the study are at the point where further economic development would actually increase emissions. This raises concerns about the extent to which countries can pollute unchecked if climate negotiations are expected to have a fruitful outcome, given that emissions from developing countries are expected to rapidly increase over the next few years. While these countries need to industrialize in order to achieve economic development, a potential concern is that the increased emissions from developing countries might more than offset the emissions reductions from developed countries, defeating global efforts to combat climate change. So the question now is: For countries that are on the upward portion of the EKC, how does one ensure that their developmental goals will not interfere with the process of combating climate change?

One implication that seems to emerge is that policymakers need to find ways to strengthen the quality of governance and institutions in developing countries, which in turn could facilitate lower emissions. The results of the model when one includes political institutions and quality of governance show an unambiguous decline in emissions in countries with better governance and political institutions. While improvements in governance and political institutions are not specifically targeted at reducing emissions, the persistent and significant association of better governance and political institutions with lower emissions allows one to speculate that improving governance and institutions could ultimately lead to reduced emissions. Also, the association of higher incomes with lower emissions seems to beg the question whether increases in income will automatically result in lower emissions. Based on all the findings so far, this does not seem to be the case. The explanations for the observed associations are open to speculation and could be explained by a variety of factors. Policies, combined with better institutions and public awareness could have helped reduce emissions, and in this study these happen to be associated with high-income countries.

The dataset also show that expenditure on education is closely related to per capita income. Given the close association between income and investment in education, and the negative association of income with emissions, this raises the question of whether investing in education could promote activities that could lead to a decline in emissions. At this point it is interesting to note that Agenda 21, the blueprint for sustainable development action in the 21st century has an entire chapter dedicated to the role of education in achieving sustainable development.[19]

It is interesting to note that the countries that have the best quality of governance, the strongest political institutions, the highest investments in education, and the maximum years of schooling are also the same countries with the lowest emissions. This is illustrated in Table 4 which shows how mean governance, political institutions, and education statistics differ between countries.

[19] Agenda 21, Chapter 36 "Education".

A note of caution is relevant here. While the dataset used in this particular study show that there is a direct relationship between income levels and the quality of governance, this may not always be the case. A study of Asian countries by Quibria (2006) found that contrary to the widely believed notion that the state of governance and economic growth are directly related, many countries in the study that exhibited better governance also displayed lower levels of average economic growth. The state of governance was measured by the KKZ (Kaufman, Kraay, and Zoido-Lobotan) index which included data for: voice and accountability, government effectiveness, political stability, regulatory quality, rule of law, and control of corruption. It is interesting to note that some of the components that have been used to make that composite index are similar to the ones used in this study as well (i.e. democratic accountability, corruption in government, and quality of bureaucracy). This gives rise to the question of what should be included as a component of good governance. There is no single answer to that—it would entail examining the unique circumstances surrounding each country. While for the purposes of this present paper, the results show a direct correlation between quality of governance and economic development, it is pertinent to note that this may not always be the case.

In addition to the specific points above, a couple of general points are in order. Global efforts should be made to broaden the jurisdiction of the Kyoto Protocol in terms of the number of countries bound by it as well as the requirements for developing countries. Currently the Protocol accounts for almost 62% of all global CO_2 emissions. If the United States (accounting for almost a quarter of the world's CO_2 emissions[20]) were to ratify it, the Protocol would cover close to 90% of all global CO_2 emissions. Also, if certain restrictions were imposed for developing countries, this could allow the Protocol to better meet its ultimate objective.

From all of the above it is clear that there is no quick-fix solution to these issues. As is obvious with the fiercely contested Kyoto Protocol, for any international environmental agreement to work as well in reality as it does in principle, it needs to be politically acceptable and economically feasible. The important thing is to be able to come up with a set of incentives or disincentives that will prompt nations to act in a way that they perceive to be most beneficial for them while at the same time maintaining the objective of protecting the environment.

6 Concluding comments

This paper offers qualified support for the EKC hypothesis. While higher income countries are associated with lower CO_2 emissions, one does not find evidence that there is anything automatic about higher incomes decreasing environmental degradation, a sentiment expressed by some other researchers as well. High income economies are also those economies that are associated with better socioeconomic conditions, greater awareness about environmental risks, and a greater demand for improved environmental quality, which when combined with better institutions and better governance could translate into a better level of environmental quality.

Given the current scenario, it is possible that Kyoto may not meet its emissions reduction targets. However, this is not necessarily a cause for pessimism. Twenty years ago few would believe that such a treaty could even be possible. When the stakeholders are so diverse with such different priorities, it goes to the credit of policymakers to have come

[20] United Nations Statistics Division, 2002.

even this far. In this context, the Kyoto Protocol can be viewed as a landmark piece of environmental negotiation that can pave the way for improved environmental treaties in the future.

As a final note this paper emphasizes that while it is extremely difficult to connect the EKC hypothesis to developments in the international environmental policy arena in the absence of more information about the factors determining environmental quality (a point that has been mentioned by other researchers in this field), it is still very important to make that connection. There needs to be a way to connect the empirical results to the current international environmental regime. One of the main objectives of this paper is to bridge the gap between studies conducted on the EKC and developments in the international environmental policy arena. However, there need to be more studies attempting to link these two bodies of literature before we can better understand the environment-income relationship in the context of the international environmental policy arena. One hopes that future studies will build on this line of thought.

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