The Environmental Kuznets Curve – An Environmental Performance Based Approach

Daniel Lachmann

FUB-Discussion Paper
FUB 17-01
July 2017
The Environmental Kuznets Curve – An Environmental Performance Based Approach

Daniel Lachmann

Abstract:
The present article is a first venture into investigating the Environmental Kuznets Curve (EKC) hypothesis from a performance based perspective. Using the Environmental Performance Index (EPI) as the dependent variable and the Human Development Index (HDI) as the independent variable, this paper shows that the relationship between HDI and EPI varies depending on the specific area of environmental performance. In general the performance is better in developed countries for local indicators with an impact on human health. In contrast, indicators concerning environmental vitality are barely related to a country’s development. The environmental performance regarding global indicators (e.g. climate change) is worse the higher the human development.

Key words: Environmental performance index, environmental Kuznets curve, sustainability, human development index
Introduction

There is substantive policy interest in knowing the relationship between a country’s state of development and its impact on the environment. Consequently, this issue drew the attention of many scientists. In particular the relationship between economic performance and growth (usually GDP or GNI per capita) and its impact on the environment was in the center of interest. Various measures of environmental pressures, such as emissions of CO₂, SO₂, the Ecological Footprint (EF) and many more have been employed, and their relation to economic activity and human well-being investigated to aid finding a path to a sustainable social and economic development.

When sustainability means “the sustaining of human well-being into the indefinite future by minimizing humanity’s impact on the natural environment upon which that well-being ultimately depends” (Knight and Rosa 2011, p. 931) it is obvious that a society’s socio-economic development and its impact on the environment is a key topic of investigation. Most research, however, thus far is restricted to the economic development. Integration of other social aspects, such as education and health, is necessary. “Developing human well-being while sustaining the biosphere” (Dietz et al. 2009: 115; italics in original) requires robust insights into human development - environment relationship from various perspectives that go beyond economic ones.

While most of the research either stresses the impact of economic development and the pressures exerted on the environment or the environmental efficiency or intensity of human well-being, the present study applies a policy and performance oriented perspective. How well do nation-states perform regarding environmental protection in relation to their state of development? This article adds to the existing literature on this relationship by applying a performance based measure, the Environmental Performance Index (EPI) and its relationship to the United Nations’ Human Development Index (HDI) which thus far has been used much less frequently than, for instance, GDP per capita within this framework.

This article is structured in the following way. First, basic theoretical assumptions about the connection between development and environmental degradation, the Environmental Kuznets Curve (EKC), will be presented. These theoretical basics are followed by an overview of the state of research on the EKC and the derived hypothesis to be tested. A description of the data and measures applied precedes an introduction to the methods applied. In the next step the results are discussed and finally, the article closes with concluding remarks.
Affluence, well-being and environmental degradation: Environmental Kuznets Curve

In 1955 Simon Kuznets analyzed the relationship between a nation’s economic wealth (measured in GDP per capita) and income inequality. “Does inequality in the distribution of income increase or decrease in the course of a country's economic growth?” (Kuznets 1955: 1) was one central question of his paper. The basic implication is that low income countries increase their income inequality as their economy grows. When a certain point of wealth is reached, income inequality declines with a further growing GDP. The hypothesis of the Environmental Kuznets Curve (EKC) is based on quite similar assumptions (Dinda 2004, 2005). At first, in economically little developed regions the environmental impact is low and economic growth increases the impact when agriculture is replaced by industry and its population grows. When a tipping point is reached additional economic growth entails a decrease in the environmental impact, for instance due to the development of cleaner technologies or a shift toward a service economy (Israel and Levinson 2004). Representing the path of the original Kuznets Curve and the EKC graphically would show an inverted U-shape curve (e.g. Dietz et al. 2012; Dinda 2004, 2005; Kijima et al. 2010; Stern 2004). The basic question, if this inverted U-shape is indeed true, is: “can economic growth be part of the solution rather than the cause of environmental problems?” (Dinda 2004: 432). In the theoretical development of the EKC argument the author later points out that environmental quality improvement via economic growth is only possible “when a sufficient investment takes place in the abatement sector” (Dinda 2005: 409).¹ So, the positive effect of growth on the environment does not occur automatically and complementary environmental policy is necessary (Grossmann and Krueger 1996: 120); economic development rather opens possibilities to deal with environmental issues that it might have caused. This argument already implies that measures of economic development are not sufficient but other social aspects need consideration as well. Rosa and Dietz (2012: 582) ask the more suitable question whether changes in composition (service instead of manufacturing industry) and technique (e.g. cleaner technology) are able to compensate for an increased scale (e.g. economic growth). These major mechanisms that create the shape of the curve are discussed as follows.

In particular from an economic perspective, three aspects that have an influence on the development of a country’s environmental impact recur in literature: scale, structural composition and technique (e.g. Carson 2010; Copeland & Taylor 2004; Dinda 2004; Grossman and Krueger

¹ I.e. a sufficient amount of capital needs to be allocated to the abatement of environmental degradation.
A brief summary of the effects of scale, composition and technique is found in Wagner (2008: 391):

“For unchanging composition of output and unchanging technology emissions rise alongside with the scale of economic activity. For given scale and technique emissions can rise or fall when the composition of output is changing towards a more or less emissions intensive composition. Finally, emissions (per unit of output), i.e. emissions intensity, can decrease by improvements in technology, e.g. via improved abatement. Depending upon the relative magnitudes of the three effects a monotonous, a U-shaped, an inverted U-shaped or in fact any pattern between GDP and emissions may emerge.”

Any pattern also includes a “reversed C” (Tisdell (2001: 189) implying that at a certain level of pollution GDP will decrease due to the impact of environmental degradation on the economy, e.g. resulting from increased health issues, depleted resources etc.

However, it is not only the economic structure, i.e. scale, composition, and technique that are suggested to affect the environmental impact. Population size and density, household composition and urbanization and other demographic or economic variables can have varying effects (e.g. Dietz and Rosa 1994; Ehrhardt-Martinez 1998; Dietz et al. 2007; Franklin & Ruth 2012; Liu et al. 2003). Likewise, biogeographical characteristics such as use of ecosystems or climactic conditions of the region have been discovered by research (e.g. Dietz et al. 2007; York et al. 2003). In addition, environmental regulation (i.e. policy measures) is discussed as one of the major drivers behind declining environmental stresses in more developed countries (Dasgupta 2002: 152).

The above theorized positive effects of GDP on the environment may conceal some of drawbacks. The so called pollution-haven hypothesis assumes that richer countries use the opportunity to export dirty industries to lower income countries as a result of higher environmental standards in wealthy nations and a more open trade between countries (e.g. Bagliani et al. 2008; Berlik et al. 2002; Cole 2004; Dinda 2004; Mayer et al. 2005; Michida and Mishikimi 2007; Schütz et al. 2004; Wang et al. 2013). Inter alia, Boutaud et al. (2006: 297) find that despite decreasing their local environmental impact, developed nations “tend to consume more and more 'global' resources, which might often come from developing nations.”

Various authors mention that an increased environmental concern and willingness to pay for environmental protection in developed countries may contribute to the decreasing environmental pressure when a tipping point of economic development is crossed (e.g. Dinda 2004, 2005; Kijima et al. 2010, Wang et al. 2013). However, the authors do not quote evidence for the assumption of a higher environmental concern in developed nations; despite the existence of such evidence. For instance, Franzen and Meyer (2004, 2010), Franzen and Vogl (2013), Freymeyer and Johnson (2010) or Hadler and Haller (2011) find positive effects of a nation’s wealth or development
on people’s environmental concern or behavior. These results are not uncontested. Givens and Jorgenson (2011) or Knight and Messer (2012) find environmental concern rather negatively correlated to affluence while Dunlap and York (2008) conclude that environmental concern is not dependent on affluence or “affluence-based postmaterialist values” (Dunlap and York (2008: 529) but rather has globalized. Concluding from these few examples, caution is advisable when environmental concern as a mechanism of a decreasing environmental impact with increasing wealth is discussed. More research is needed that links environmental concern to a society’s environmental impacts.

Because the present study is a first venture into investigating the EPI from an EKC perspective, it cannot account for the amount each of these mechanisms may or may not contribute to the relationship between the society’s development and their environmental performance. These are mentioned to clarify what is in question to be at work and to stimulate research that can build on this study.

State of research

If there can be a general remark that can be made about the research on the EKC, it would be that the results are mixed. The major reason is the application of different measures of environmental impact or pressure as the following summary of the state of research shows.

To start with, some scholars indeed find an inverted U-shaped trajectory of the economic development and environmental impact. In particular, when single indicators (especially CO₂ and SO₂ emissions) are used that are local and have direct effects, for instance on health, the EKC is visible (e.g. Cole 2004; Dinda 2004; Gergel et al. 2004; Grossman and Krueger 1995a, 1995b; Kleemann & Abdulai, 2013; List and Gallet 1999; Panayotou 1993). For threatened birds and mammals, McPherson and Nieswiadomy (2005: 395) present results that “indicate a possible EKC”. Managi (2006) finds an inverted U-shape for pesticides within the USA over time but caution that “inverted U-shaped relationships might become N-shaped curves in the long run” (Managi 2006: 631). Culas (2012), in the case of emissions from deforestation, identifies an EKC Latin America and Africa while in Asia the curve follows a U-shape. Al-mulali et al. (2014) show an EKC for higher middle and high income countries while in lower middle and low income countries a higher GDP leads to a higher EF. In his recent study, Liddle (2015: 69) find

2 However, one reason for these differences by income category might be due to the fact that lower middle and low income countries could not yet develop sufficiently to reach the tipping point of the curve.
“when both cross-sectional dependence is addressed and the nonlinear transformation of potentially integrated GDP per capita is avoided, there is no carbon Kuznets curve” but he discovers the EKC for emission/GDP per capita. This in turn means that the carbon intensity of income/consumption declines but level of emission increase. Bertinelli and Strobel (2005) find support for a rather linear increase in CO₂ and sulfur emissions with an increasing GDP per capita whereas Martines-Zarzoso et al. (2004) results indicate a N-shaped curve (for CO₂), however, with a pronounced heterogeneity between countries. Other authors use more general measures of environmental pressure, in particular the ecological footprint (EF), where the EKC disappears. In a study of 27 EU countries, Lopéz-Mendéz et al. (2014: 372) find a “four-category country classification. Thus, only four countries (Cyprus, Greece, Slovenia and Spain) show an inverted-U shape, while 11 correspond to increasing patterns, 9 show a decreasing path and the remaining 3 countries lead to U-shaped curves”. Furthermore, the authors split their sample in countries with less than 20% renewable energy sources (RES) and at least 20% RES. For the first group they find an N-shaped curve and for the latter one they indeed discover the EKC. Their results support the assumption that it is not income or development per se but rather sound environmental policies that reduce emissions. Rosa et al. (2004) find the resemblance of an EKC for CO₂ and ozone depleting substances, while CH₄ (methane) and EF (including various subcomponents) increase with affluence. Bagliani et al. (2008) show that the relationship between EF and GDP per capita is best described by a cubic function. Generally, this would result in an N-shaped curve meaning that with economic development the EF increases, when a level of development is reached, EF declines and after some further growth it climbs again. However, the authors’ results show that, first, with economic growth the EF indeed increases. Instead of declining at a certain turning point, the EF remains relatively stable until another turning point is crossed. From then on, EF increases again but mostly to a lesser degree than in the early stages of development. In total, this means that a higher GDP per capita entails a higher environmental impact, not linearly increasing, though. Only concerning the energy based EF shows an inverted U-shape. Nevertheless, the overall cubic effect of GDP on EF outweighs the quadratic effect of energy EF. Franklin and Ruth (2012) present a quite similar result for CO₂ emissions and GDP per capita which reduces to a traditional ECK pattern with the inclusion of demographic variables. Substituting GDP for the Genuine Progress Indicator (GPI)³ as a gauge of wealth, the correlation with CO₂ emissions dis-

³ The GPI is based on GDP but takes into account income inequality, crime, environmental degradation, loss of leisure services from consumer durables, public infrastructure benefits from volunteering and housework (Franklin &
appears. Similarly, “we find no evidence of an EKC relationship between per capita output and the EF or any of its subcomponents, with exception of land in agriculture, and to a lesser extent land use in pasture and timber” (Caviglia-Harris et al. 2009: 1157). Separating the EF by the EF of consumption and EF of production, Wang et al. (2013) first discover an inverted U-shape but when controlling for spatial dependencies of a country’s and its neighbors’ characteristics such as GDP per capita or biological capacity on one another the EKC disappears. As result, a higher GDP per capita entails a high EF, both of consumption and production. Likewise, the results of York et al. (2003, 2009) point towards economic growth entailing an increasing environmental impact.

Using the broader concept of ecological intensity of well-being (EIWB), Dietz et al. (2012) find a U-shaped curve. First, the EIWB decreases with GDP per capita but at some point it increases again. Their findings reverse the EKC hypothesis. Knight and Rosa (2011) turn the perspective and use the EF as a measure of consumption and relate it to average life satisfaction. They discover that high levels of environmental consumption do not necessarily lead to a higher life-satisfaction. To transfer it to the EKC literature an increased well-being does not automatically go along with a high environmental impact. Combining life-satisfaction and EF to a measure of environmental efficiency of well-being (EEWB) and regressing it on GDP per capita the authors uncover an inverted U-shape. In this case this means that at low GDP levels a growth in GDP improves the EEWB (i.e. more satisfaction and less EF) and after a turning point the EEWB gets worse again (i.e. for more satisfaction a higher EF is needed). These results, as those of Dietz et al. (2007, 2012), run counter an EKC. In a same manner the outcomes of Boutaud et al. (2006), who use the EF and the HDI, also find evidence that in part oppose the EKC by explaining that with development, the local environment improves while the global impact increases. Stern (2004) reviews research from the nineties and very early 00s and concludes that a decline in the concentration of pollutants emerges from middle income levels on while emissions rather increase monotonically (p. 1426). In a meta-analysis of the literature on an EKC for deforestation, Choumert et al. (2013: 20) find that more than half of the studies published on that issue do not find an EKC. In recent years with improved data and more sophisticated econometric techniques the EKC hypothesis is rather rejected than accepted.

---

4 EIWB is the EF divided by life expectancy at birth (Dietz et al. 2012: 23).
With regard to the environmental performance index prior research is quasi non-existent. However, the EPI report of 2012 notes that there is a relationship between EPI and GDP per capita, “although there is a diversity of performance within every level of economic development” (EPI Report 2012: 8). Additionally, the report points out that the environmental performance on specific aspects varies between countries. Bad performance concerning CO₂ is rather a problem of wealthy nations while developing nations are more likely subject to drinking water or sanitation issues. Switzerland, a highly developed nation, is the best performing country, in the top 5 Latvia and Costa Rica, two less developed regions, are also present. “This suggests that income alone is not a sole determinant of environmental performance – policy choices and good governance also matter” (EPI Report 2012: 27).

**Hypothesis**

Derived from the theoretical background on the EKC and prior research the following hypotheses can be stated:

- **H₁**: The relationship between the overall EPI and HDI will follow an EKC
- **H₂**: The higher the HDI the higher the EPI for local indicators
- **H₃**: The higher the HDI the lower the EPI for global indicators
- **H₄**: Indicators with implications for human health improve more strongly than ecosystem vitality with an increasing HDI

**Data and variables**

*Environmental Performance Index*

The Environmental Performance Index (EPI) is an index of 22 environmental indicators available for 132 countries. These indicators are clustered within 10 policy categories which in turn are separated into two major goals: environmental health and environmental vitality. The first objective summarizes the effects on humans’ health by environmental burdens while in the latter the effects on the environment or ecosystems are captured. “The EPI tracks outcome-oriented indicators based on best available data in core policy categories” (EPI Report 2012: 11). The 10 policy categories are Environmental Health, Water (effects on human health), Air Pollution (effects on human health), Air Pollution (ecosystem effects), Water Resources (ecosystem effects), Biodiversity and Habitat, Forests, Fisheries, Agriculture, Climate Change & Energy (EPI Report 2012: 13). “Data sources for the 2012 EPI come from international organizations, research institutions,
government agencies, and academia” (EPI Report 2012: 14). It measures how close the respective countries are to the policy objectives, i.e. higher scores indicate better performance. In contrast to single indicators that measure environmental impacts, such as CO₂ or SO₂ emission, or composite indices such as the ecological footprint that summarizes the ecological impact from consumption or production based perspectives, the EPI is a policy based measure. It tries to answer the question how well do countries perform with regard to environmental protection? However, it is an overall indicator that hides the areas where the respective country improved, e.g. child mortality, as well as those where rather a decline in performance can be observed, e.g. climate change (EPI Report 2012: 8). Therefore, is it necessary not only to investigate the EPI as a whole. Disaggregation into single indicators is also necessary.

The targets for a good performance are, however, not policy targets of the respective country itself but come from a variety of sources, depending on the indicator. These include the Millennium Development Goals, expert opinions, the Intergovernmental Panel on Climate Change (IPCC), the Convention on Biological Diversity (CBD) and the World Health Organization (WHO) (see EPI Report 2012 Appendix 1).

The first dependent variable is the overall Environmental Performance Index of 2012. Furthermore the index will be disaggregated into the two policy goals, environmental health (EH) and environmental vitality (EV). Finally, two single indicators are chosen. These are air pollution and climate change. The reason to select these two indicators are the findings of Lachmann (2016) who found that these two are the most important environmental problems for the respondents of the International Social Survey Programme 2010 (ISSP) among a set of selected countries. Air pollution, then, is separated into effects on human health (EH air) and effects on ecosystems (EV air). In total, six measures of environmental performance will be tested against the EKC hypothesis with the working hypothesis stated above. The EPI has maximum of 100. The highest value is found in Switzerland (76.69) and the worst performer is Iraq (25.32). The mean EPI 2012 is 53.06 with a standard deviation of 9.61.

**Human Development**

Although still widely used, various authors stress that GDP is not an adequate or sufficient measure of well-being (Brady et al. 2007; Van den Bergh 2007) but rather measures economic activity (Ayres and Martinas 2005: 128). At best, it is an indicator for consumption (in a more active economy more is consumed) where it is questionable that more consumption ultimately leads to
higher well-being. Knight and Rosa (2011: 938) show that “relatively high levels of well-being are achievable with sustainable levels of consumption”. However, they use the ecological footprint as a measure of consumption rather than the GDP because GDP “also includes gross domestic investment, net exports, and government expenditures” (Knight and Rosa 2011: 937). Dietz et al. (2007) also report that life expectancy and education (two aspects of well-being and parts of the Human Development Index) can be improved without ecological impacts while affluence increases the impact. The relationship between economic wealth (in terms of GDP) and well-being is an intricate matter and sensitive to measures applied, it also depends on other aspects such as inequality, institutions, health care, norms or education (Graham et al. 2009).

Overall GDP might not be a good indicator for well-being or a society’s development; hence, for the present study the Human Development Index (HDI) will be used. The HDI combines three dimensions into one index: health, education and living standards. These dimensions are measured by four indicators namely life expectancy at birth, mean years of schooling, expected years of schooling and gross national income (GNI) per capita (UNDP 2013). Surely, these indicators do not encompass all aspects of human development or well-being; nevertheless, HDI measures a broader concept of development than GDP or GNI and hence is the preferred index of use.

The independent variable is the Human Development Index (HDI) and ranges from 0-1 where 1 indicates highest level of development. Highest development within the 132 countries is found in Norway (0.96) and lowest in the Democratic Republic of Congo (0.30). The mean HDI is 0.71 with a standard deviation of 0.16.

To control for environmental performance dependencies, i.e. in how far a countries performance is related to the performance of countries within the same region, regional dummies are included after the linear, quadratic or cubic equation is fitted. For the categorization, the United Nations’ composition of macro geographical regions was taken as the basic guideline (United Nations Statistical Division). Due to the quite small number of countries that would fall within some regions various regions are grouped together into one group as follows: Western Europe encompasses Northern, Southern, and Western Europe; Eastern Europe as originally categorized by the UN; Central America includes Central America and the Caribbean; South America as originally categorized by the UN; Central and Southern Asia are combined; Eastern and Southeastern Asia are combined; Northern and Western Africa are combined; Middle, Eastern and Southern Africa are combined; Northern America and Oceania are combined. Even though Northern America (i.e. USA and Canada) and Oceania (i.e. Australia
and New Zealand) do not form a geographical region they are put into one group because of various communalities. They have quite similar HDI and EPI scores (see table A1 in the appendix), are all Anglo Saxon countries and finally they can all be grouped into Esping-Andersen’s (1990) liberal welfare state regime (see Vroman 2012:469). The practical reason is to increase the group’s size from two in each group to four in the joint group.

Taiwan is excluded from analysis because no HDI is available for that region. Table A1 depicts the 132 countries with the respective EPI and HDI scores and the regions they are categorized into.

**Methods**

The EPI was only introduced in 2006 as a successor of the Environmental Sustainability Index (ESI) developed in 2000. Long-term time-series or panel data is not available. Consequently, the present study aims at a first insight into a nation’s environmental performance from a cross-sectional perspective. This cross-sectional analysis, of course, cannot account for a single country’s development, i.e. whether a country that now is at a low development might follow any of the trajectories presented in the results-section. Neither are we thus able to infer causality. The results only tell that at present nations with different degrees of development show different environmental performances and how these relate.

Regression analysis using robust maximum likelihood (MLR) estimation will be conducted to test the relationship between HDI and EPI. As mentioned above, higher order polynomial terms may influence the path of the standard EKC. Therefore, three models per EPI indicator are estimated. The first model only includes the HDI (linear), the one second adds the squared HDI (polynomial, two degrees) and finally a cubic HDI (polynomial, three degrees) is introduced into the equation. To deal with multicollinearity between HDI, HDI² and HDI³ the HDI is z-standardized before being squared or cubed. In the tables only the best fitting model for each indicator will be presented. These analyses are complemented by a graphical representation of the relationship between HDI and EPI in form of scatterplots with a linear or a polynomial (of two or three degrees) regression line. The following equation will be specified. Eq. 1 exemplifies the full model with both the squared and cubic term included

\[
EPI = b_0 + b_1 \times (z - HDI) + b_2 \times (z - HDI)^2 + b_3 \times (z - HDI)^3 + \varepsilon
\]  

(Eq. 1)
where $b_0$ is the constant, $b_1$, $b_2$ and $b_3$ are the parameters to be estimated for the $z$-transformed HDI ($z - \text{HDI}$). $\epsilon$ is the error term. After fitting this basic equation the regional dummies are included to control for regional dependencies among countries that might bias the results of the regression analysis if not taken into account.

**Results**

Figure 1 plots the HDI against the six selected environmental performance indicators. As the graphs 1a-1f show, depending on the indicator the curves are quite diverse. Table 1 depicts the regression coefficients for the best fitting model for the respective indicator. All three types of relationships are found: linear, squared and cubic.

Looking at figure 1a the relationship of the overall EPI and HDI seems to approximate a U-shaped curve in the graphical representation. This would be in line with the EKC hypothesis (H$_1$). The U-shape (instead of an inverted U-shape) results from the reversed perspective: in EKC literature usually environmental impacts are measured, i.e. higher values mean higher impact, while here environmental improvements are investigated, i.e. higher values mean lower impact. However, a closer look at the coefficients and the intercept in table 1 rather speak for a positive effect that becomes larger after a certain tipping point. Despite the delusive scatterplot, H1 is rejected.

Figure 1b shows a steadily improving performance on the Environmental Health policy goal the higher the HDI (H$_2$, H$_4$). The coefficients in Table 1 show that at a certain level of development the slope even becomes slightly steeper. In contrast, the Environmental Vitality goal is barely related to a nation’s development as pointed to by the $R^2=0.152$. The graph (1c) indicates the tendency of the U-shaped curve but as the size of the coefficients and the $R^2$ show not much of the variation is due to differences in development (H$_4$). Nevertheless, the general tendency is in line with the EKC hypothesis.

In stark dissonance, especially with figure 1a and 1b is the performance on the Climate indicator (1d). The squared or cubic function does not improve the linear model; therefore, the linear model is preferred. The results show that a higher development goes along with a performance worse than at lower development (H$_3$). About 38% of the variance in performance regarding climate change can be attributed to a country’s state of development.

The last two graphs in figure 1 (1e and 1f) are representatives of local indicators for the Environmental Health and Vitality goals (H$_2$). As the figures show, they resemble the trajectory of the overall respective policy goals (1b and 1c). Air pollution with an effect on human health is well
dealt with while the effects on ecosystems show much more variability and the line almost indicates an N-shaped curve (H₄). Again, the R² for environmental health (R²=0.667) is much larger than for ecosystem vitality (R²=0.200).

Table 1: Regression coefficients – EPI and HDI

<table>
<thead>
<tr>
<th></th>
<th>EPI</th>
<th>EH</th>
<th>EV</th>
<th>Climate</th>
<th>EH - Air</th>
<th>EV - Air</th>
</tr>
</thead>
<tbody>
<tr>
<td>HDI</td>
<td>7.101***</td>
<td>25.827***</td>
<td>-3.605†</td>
<td>-13.446***</td>
<td>23.394***</td>
<td>-6.151*</td>
</tr>
<tr>
<td></td>
<td>(0.762)</td>
<td>(0.866)</td>
<td>(1.895)</td>
<td>(1.523)</td>
<td>(1.524)</td>
<td>(2.954)</td>
</tr>
<tr>
<td>HDP</td>
<td>2.967***</td>
<td>2.681***</td>
<td>4.684***</td>
<td>3.666**</td>
<td>9.384***</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.615)</td>
<td>(0.700)</td>
<td>(1.279)</td>
<td>(1.232)</td>
<td>(1.993)</td>
<td></td>
</tr>
<tr>
<td>HDI²</td>
<td>2.967***</td>
<td>2.681***</td>
<td>4.684***</td>
<td>3.666**</td>
<td>9.384***</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.615)</td>
<td>(0.700)</td>
<td>(1.279)</td>
<td>(1.232)</td>
<td>(1.993)</td>
<td></td>
</tr>
<tr>
<td>HDI³</td>
<td>1.439†</td>
<td>2.971*</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.828)</td>
<td>(1.291)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>50.047***</td>
<td>62.823***</td>
<td>43.837***</td>
<td>45.762***</td>
<td>67.273***</td>
<td>32.810***</td>
</tr>
<tr>
<td>R²</td>
<td>0.402</td>
<td>0.888</td>
<td>0.152</td>
<td>0.375</td>
<td>0.667</td>
<td>0.200</td>
</tr>
</tbody>
</table>

Notes: † p<0.1; * p<0.05; ** p<0.01; *** p<0.001; unstandardized regression coefficients, maximum likelihood estimation; standard errors in parenthesis; own calculations
Including the regional dummies does not change the results for the HDI substantially (table 2). While in most cases the coefficients slightly decrease in size, the effect on EV, Climate and EV – Air increase in absolute size. The main effect of HDI on EH – Air is also a little stronger than in the model without regional dummies.

Even though the regional dummies are only control variables, the exclusion of the HDI variables produces some notable changes to the estimates which are summarized as follows. For the overall EPI, the effects of West Europe and North America/Oceania experience large increases. While in
East Europe, Central America, South America and East Asia the effects slightly increase the remaining coefficient remain relatively stable. The largest increases are found in the second model in table 2 for EH (EH – M2). Except for Northern Africa all coefficients increase massively, in Northern America by 31.5 times. The same tendency holds for EH – Air. Human development is strongly connected with better performance concerning environmental health risks for humans; other aspects of the society only play a minor role. In contrast, as was shown in table 1, EV (and also EV – air) are only marginally affected by the HDI and consequently the differences in the effect sizes when excluding the HDI are small in table 2 as well; and they mostly decrease. This indicates that it is something other than the society’s development that drives the performance on environmental vitality.

Most notable, however, are the changes concerning climate performance. The effects of Western Europe, Eastern Europe, North America/Oceania as well as Eastern Asia become negative. The already negative coefficient of Western Asia even intensifies. These groups are the worst climate performers. However, the positive effects of Western Europe in model 1 indicate that when controlling for HDI, their policy performance can counter a part of the negative performance that comes along with higher development. This result clearly shows that there are other characteristics of a society, in addition to its development, that drives environmental performance with regard to the climate indicator. The same tendency holds for Central and South America. They perform relatively well when controlled for their development. Contrary to the western countries, the increased coefficient of Southern Africa demonstrates that much of their good performance is due to their low development as seen by the non-significant coefficient when the HDI is included. For Northern Africa, both coefficients are non-significant.

To summarize, all stated hypotheses, except H1, find support in the analysis. Local level environmental burdens with impacts on human health are obviously very well tackled by a nation’s development (H2), while global performance worsens with higher development (H3). Indicators with an impact on human health are more successfully dealt with than impacts on the ecosystems (H4).
Table 2: Regression coefficients for HDI and regional dummies

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>HDI</td>
<td>5.289***</td>
<td>23.135***</td>
<td>-5.491**</td>
<td>-16.182***</td>
<td>25.791***</td>
<td>-7.617*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(1.170)</td>
<td>(1.476)</td>
<td>(1.996)</td>
<td>(2.278)</td>
<td>(2.511)</td>
<td>(3.358)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HDP</td>
<td>2.171**</td>
<td>2.593**</td>
<td>5.113***</td>
<td>3.024*</td>
<td>10.942***</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.691)</td>
<td>(0.871)</td>
<td>(1.495)</td>
<td>(1.482)</td>
<td>(2.515)</td>
<td>(2.515)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

|                | 2.127**  | 3.268*   | (0.794) | (1.336) |

<table>
<thead>
<tr>
<th>Region</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Western Europe</td>
<td>12.546***</td>
<td>23.219***</td>
<td>9.120*</td>
<td>51.929***</td>
<td>12.301*</td>
<td>10.916**</td>
<td>16.742*</td>
<td>-12.184†</td>
<td>12.286†</td>
<td>60.084***</td>
<td>13.307†</td>
<td>14.199*</td>
</tr>
<tr>
<td>Northern America/Oceania</td>
<td>4.963</td>
<td>18.008***</td>
<td>1.624</td>
<td>51.102***</td>
<td>1.617</td>
<td>3.825</td>
<td>7.548</td>
<td>-25.069*</td>
<td>4.802</td>
<td>60.107***</td>
<td>-18.379†</td>
<td>-10.188</td>
</tr>
<tr>
<td>South America</td>
<td>12.072***</td>
<td>15.147***</td>
<td>0.759</td>
<td>18.591*</td>
<td>19.303***</td>
<td>13.672*</td>
<td>22.608**</td>
<td>8.984</td>
<td>18.148**</td>
<td>37.943***</td>
<td>19.003**</td>
<td>9.012</td>
</tr>
<tr>
<td>Western Asia</td>
<td>-0.264</td>
<td>2.948</td>
<td>8.335*</td>
<td>24.873***</td>
<td>-2.253</td>
<td>-6.448†</td>
<td>-10.536†</td>
<td>-22.758**</td>
<td>16.687†</td>
<td>35.075***</td>
<td>-1.665†</td>
<td>-8.660</td>
</tr>
<tr>
<td>Northern Africa</td>
<td>5.830*</td>
<td>5.826*</td>
<td>2.697</td>
<td>-3.113</td>
<td>7.090†</td>
<td>9.658*</td>
<td>-0.133</td>
<td>5.452</td>
<td>26.171***</td>
<td>19.807**</td>
<td>12.168†</td>
<td>18.534*</td>
</tr>
</tbody>
</table>

| Constant       | 43.179***| 41.407***| 59.084***| 46.02***| 34.013***| 39.43***| 40.407***    | 50.941***    | 54.354***    | 39.893***    | 25.672***    | 35.903***    |
|                | 0.578    | 0.510    | 0.903    | 0.684    | 0.443    | 0.350    | 0.534       | 0.353        | 0.731        | 0.472        | 0.388        | 0.220        |

Notes: † p<0.1; * p<0.05; ** p<0.01; *** p<0.001; unstandardized regression coefficients, maximum likelihood estimation; standard errors in parenthesis.
Conclusions
As a first step into investigating a country’s environmental performance, the results of the study show some clear relationships between a country’s development and environmental performance. It also unveils that different aspects of environmental performance are affected quite differently. While local stressors decrease with development, global ones increase, which supports the assumption of pollution haven hypothesis. This explanation is at best tentative and would need further research to find the pollution havens.

The clear differences between developed and developing countries also underline that the differences of scale, composition, and technique between countries invoke different environmental performances. Further research disentangling the scale, composition, and technique effects with respect to environmental performance needs to be conducted to discover the share each of these aspects contributes.

Whether an increased environmental concern or awareness contributes to these differences was not tested in this study but upcoming investigations might include this issue. Of particular interest would be the question if the effects of the HDI are mediated via environmental concern. Likewise, various EPI indicators and the impact of environmental concern should be investigated to support or falsify this untested assumption.

Finally, it is clear that there are “substantially different processes across states” (Carson 2010: 12) at work. The author even discovers substantial disparities between federal states in a country, in their case the USA. Others argue that even different groups of people within a country or a community will be affected differently by environmental degradation and therefore have their own, groups-specific ECK (Liu 2012). Of course, one should also not conclude that every nation will develop in the same way as the now developed nations did. In the same manner, different patterns of environmental performance are likely to emerge with further development.

Based on this first venture, additional research on environmental performance is needed to widen the insights at the drivers of this performance. Besides panel data and the inclusion of further covariates, such as those suggested in section 1 also the spatial dimension (i.e. the relationship between neighboring countries) as investigated by Wang et al. (2013) seem promising. Thus, it can be investigated to what extent countries stimulate or inhibit the performance of their neighbors. The mere inclusion of regional dummies in the present study and the in part fundamental changes in their effect sizes when taking the HDI variables out of the equation, suggest that the employment of additional special and country specific characteristics is indeed necessary.
Literature


Disclaimer: This paper (FUB Discussion Paper FUB 2017-01) was written while during the work on my dissertation. I did not receive any financial support and the paper serves mere academic purposes.