Environmental Sustainability and Economic Growth: Evidence from Some Developing Countries

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Abstract:
The purpose of this paper is to estimate and evaluate the relationship between environmental sustainability index and economic growth in developing countries. Most studies adopted Environmental Kuznets Curve (EKC) hypothesis as a methodology to deal with the impact of deterioration environmental quality on economic growth, to verify an inverted-U curve. In this paper Environmental Sustainability index (ESI) the index varies between zero to 100 in such a way that a higher index means a better Environmental Sustainability. This index which is opposite of the environmental deterioration index has been used and therefore expect a u-shaped Kuznets Curve in order to support Kuznets hypothesis. However, our findings regarding the estimated panel regression analysis during 2001-2005 contradicts the normal Kuznets Curve. In other word, we found an inverted-U curve regarding the relationship between environmental sustainability and economic growth.

Key Words: Environmental Sustainability Index (ESI), Economic Growth, Environmental Kuznets Curve (EKC), Developing Countries.

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1. Introduction

Sustainability is a characteristic of dynamic systems that maintain themselves over time; it is not a fixed endpoint that can be defined. Environmental sustainability refers to the long-term maintenance of valued environmental resources in an evolving human context.

The best way to define and measure sustainability is contested. Economists often emphasize an accounting approach that focuses on the maintenance of capital stocks. Some in the environmental realm focus on natural resource depletion and whether the current rates of resource use can be sustained into the distant future.

The Environmental Sustainability Index (ESI) is a composite index that tracks a diverse set of socio-economic, environmental, and institutional indicators that characterize and influence environmental sustainability at the national scale. It was launched in 1999 by Professor Daniel C. Esty, director of the Yale Center for Environmental Law & Policy, in cooperation with Columbia University's Center for International Earth Science Information Network (CIESIN) and the World Economic Forum's Global Leaders for Tomorrow Environment Task Force.

The Environmental Sustainability Index (ESI) provides a gauge of a society's natural resource endowments and environmental history, pollution stocks and flows, and resource extraction rates as well as institutional mechanisms and abilities to change future pollution and resource use trajectories.

Environmental sustainability entails issues that are local as well as national and global in scale, all of which should figure in international comparisons (as they do in the ESI).

The ESI and its elements provide a foundation for more data-driven environmental analysis and decision-making. In doing so, it sheds light on a number of critical issues. The ESI demonstrates, for example, that income contributes to the potential for strong environmental stewardship, but does not guarantee it. Indeed, it is striking how many of the bottom rungs of ESI are occupied by countries that are relatively wealthy.

The ESI suggests that a more quantitative and systematic approach to environmental policymaking – where:

(a) Problems are tracked through a carefully constructed set of metrics and indicators.

(b) Policy progress is evaluated empirically.

(c) Governments benchmark their results against a relevant peer group – can help to highlight superior environmental programs, technologies, strategies, and approaches.

ESI-based analysis reveals some of the critical determinants of environmental performance: low population density, economic vitality, and quality of governance. Some of these variables have long been identified as theoretically important. The ESI provides empirical support for these theories.

1.1 The ESI Framework

The Environmental Sustainability Index (ESI) benchmarks the ability of nations to protect the environment over the next several decades. It does so by integrating 76 data sets – tracking natural resource endowments, past and present pollution levels, environmental management efforts, and the capacity of a society to improve its environmental performance–into 21 indicators of environmental sustainability. These indicators permit comparison across a range of issues that fall into the following five broad categories:

- Environmental Systems
- Reducing Environmental Stresses
- Reducing Human Vulnerability to Environmental Stresses
- Societal and Institutional Capacity to Respond to Environmental Challenges
- Global Stewardship

These five core components and the logic for their inclusion in the ESI are laid out in Table 1

Table 1: Environmental Sustainability Index (ESI) Building Blocks–Components

Component	Logic
Environmental Systems	A country is more likely to be environmentally sustainable to the extent that its vital environmental systems are maintained at healthy levels, and to the extent to which levels are improving rather than deteriorating.
Reducing Environmental Stresses	A country is more likely to be environmentally sustainable if the levels of anthropogenic stress are low enough to engender no demonstrable harm to its environmental systems.
Reducing Human Vulnerability	A country is more likely to be environmentally sustainable to the extent that people and social systems are not vulnerable to environmental disturbances that affect basic human wellbeing; becoming less vulnerable is a sign that a society is on a track to greater sustainability.
Social and Institutional Capacity	A country is more likely to be environmentally sustainable to the extent that it has in place institutions and underlying social patterns of skills, attitudes, and networks that foster effective responses to environmental challenges.
Global Stewardship	A country is more likely to be environmentally sustainable if it cooperates with other countries to manage common environmental problems, and if it reduces negative Tran boundary environmental impacts on other countries to levels that cause no serious harm.

Source: Yale Center for Environmental Law & Policy (2006)

This basic model builds on a broad base of theory in the ecological sciences and environmental policy. The core components of the ESI have a great deal of overlap with the widely used Pressure-State-Response (PSR) indicator model, and especially its more recent DPSIR variant that additionally breaks out Driving Forces and Impacts1. The cumulative picture created by these five components does not in any authoritative way define sustainability, but instead represents a comprehensive gauge of a country's present environmental quality and capacity to maintain or enhance conditions in the years ahead.

By giving each variable within an indicator the same weight and weighting each of the 21 indicators equally, we provide an imperfect but clear starting point for analysis. Table 2 shows in summary the nesting of indicators within components of ESI.

To calculate the ESI scores for each country and to facilitate the aggregation of variables into indicators, the raw data were transformed in a variety of ways. A number of variables require appropriate "denominators" to permit comparisons across countries of different scales, including transformations to improve the imputation model and the symmetry of the data. To avoid having extreme data points skew the results, we "trim the tails" of each data set distribution and construct a "z-score" for each variable that preserves the relative position of each country for each variable while providing a neutral way to aggregate the variable into indicators.

Table 2: ESI Component, Indicators and Indicator Number

Objective	Component	Indicators	Indicator Number
Environmental Sustainability Index	Environmental System	Air Quality	1
		Biodiversity	2
		Land	3
		Water Quality	4
		Water Quantity	5
	Reducing Environmental Stresses	Reducing Air Pollution	6
		Reducing Ecosystem Stress	7
		Reducing Population Pressure	8
		Reducing Waste & Consumption Pressure	9
		Reducing Water Stress	10
		Natural Resource Management	11
	Reducing Human Vulnerability	Environmental Health	12
		Basic Human Sustenance	13
		Reducing Environment-Related Natural Disaster Vulnerability	14
	Social and Institutional Capacity	Environmental Governance	15
		Eco-Efficiency	16
		Private Sector Responsiveness	17
		Science and Technology	18
	Global Stewardship	Participation in International Collaborative Effort	19
		Reducing Gas Emissions	20
		Reducing Transboundary Environmental Pressures	21

Source: Yale Center for Environmental Law & Policy (2006)

1.2 Developed vs Developing Countries Environmental Sustainability

While environmental sustainability is complex and hard to define, the ESI suggests that sustainability has multiple dimensions – and distinct challenges for developed versus developing countries. Developed countries must find ways to manage the environmental stresses of industrialization and consumption of natural resources, particularly those that are non-renewable. Developing countries face the risk of depleting renewable resources such as water and forests as well as the challenges of funding investments in environmental protection and creating functioning institutions that permit economic growth and support appropriate regulation.

While the core environmental challenges vary across countries, the ESI facilitates the process of finding relevant peer groups and benchmarking performance. Because of the range and complexity of issues that fall under the environmental rubric, policymaking needs to be made more data-driven and empirical. The ESI supports this goal.

1.3 Relationship between Environmental Sustainability and Economic Development

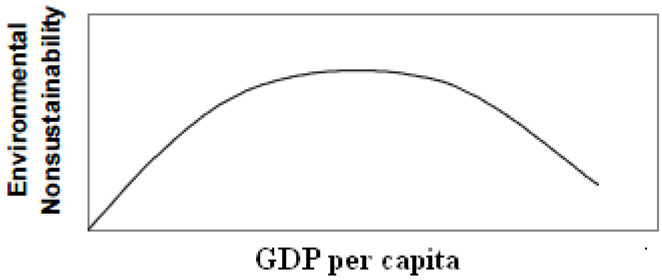
The relationship between environmental sustainability and economic development is complex. At every level of income, countries face environmental challenges. Some countries

manage their pollution control and natural resource management challenges relatively well while others do not. Development status is therefore not environmental destiny.
Economic conditions affect environmental outcomes, but a country's level of development is by no means the only driver of its performance and ESI score. Richer countries tend to score high in human vulnerability and social and institutional capacity, and poorer countries tend to score higher in reducing environmental stresses and environmental systems. The global stewardship component has no clear relationship to income.

2. Theoretical Background and Empirical Research

Corresponding to the early stage of economic growth, the awareness of environmental problems is low or negligible and environment friendly technologies are not available. Environmental degradation increases with growing income up to a threshold level beyond which environmental quality improves with higher income per capita. This relationship can be shown by an inverted U-shaped curve (see Figure 1). It is described as the EKC following the observation of Kuznets (1955).
Economic growth itself is often believed to lead to higher quality in environmental conditions in a given country. The Environmental Kuznets Curve is sometimes used to describe this relationship. Developing countries are forced to exploit their environment and cannot afford to protect the environment from pollution as they begin to develop. But as they carry out this exploitation, these developing countries reach a level of income where they are able to afford environmentally friendly production methods and can increase government resources devoted to protection of the environment. At that point, increasing per capita income is associated with an increase in environmental quality (Perkins, 2001):

Figure 1: **Environmental Kuznets Curve**



At the empirical level there are a large number of studies seeking to verify the early findings of the inverted U-shaped EKC, to expand the idea of the EKC to more pollutants, or to improve on the econometrics used.
The estimated relationships are in a reduced form specification that takes mainly cubic or quadratic forms. Estimation methods include a variety of methods such as OLS estimation, panel data estimations with fixed or random effects, Tobit estimation, or semi parametric estimation. Explanatory variables – aside from GDP per capita - also include its lagged values, population density locational variables, micro or macro policy variables, distributional variables, trade variables, as well as non-economic variables76 such as literacy rates or political rights.
Although the initial findings of the World Bank (1992) and Grossman and Krueger (1995) regarding the EKC seem to have gained acceptance over the last decade, Harbaugh, Levinson and Wilson (2002) suggest that the pollution-income relationship is less robust than previously thought in changes in data, extension of the lag-structure of the GDP per capita and inclusion of additional country specific covariates.

Another closely related issue is the relationship between environmental regulation and competitiveness. The conventional wisdom suggests that the cost of environmental regulation slows productivity growth and impedes competitiveness in international markets. The opposite view, expressed by the so-called Porter hypothesis and supported by a series of case studies, where firms under strict environmental regulation prove to be very successful, suggests that tough environmental regulation in the form of economic incentives can trigger innovation that may eventually increase a firm's competitiveness and may outweigh the short run private costs of this regulation (Porter and van der Linde 1995). On the theoretical level the validity of this hypothesis has not been established without resorting to specific assumptions regarding X-efficiency, or strategic trade models (Simpson and Bradford 1996). It has also been criticized for introducing a "free lunch" idea and potentially distracting attention from the cost-benefit analysis of environmental policy (Palmer, Oates and Portney 1995). It has also been shown (Xepapadeas and de Zeeuw 1999) that modernization of capital stock induced by a tougher environmental policy might not provide the full benefits assumed by the Porter hypothesis, but is expected to increase the productivity of the capital stock, along with a relatively less severe impact on profits and more emission reductions.
On the empirical level studies on the relationship between competitiveness, reflected in changes in the trade and investment patterns, and environmental regulation (e.g., Kalt 1998; Tobey 1990; Jaffe et al. 1995) do not find either a significant adverse effect of more stringent environmental policies on competitiveness, or evidence supporting the idea the regulation promotes competitiveness. The existing data are limited in their ability to measure the stringency of regulation, but other possible explanations of these inconclusive results are that the compliance costs are only a small fraction of total costs of production, that stringency differentials are small, and that investments follow the current state-of-the-art in technology even if this is not required by the environmental regulation in that country.

3. Model and Data

The present research using panel data estimates the relationship between environmental sustainability and economic growth for some developing countries. Applied model for estimation is as follows:

$$ESI_{it} = \beta_1 + \beta_2 GDPP_{it} + \beta_3 GDPP^2{}_{it} + \beta_4 OPEN_{it} + \beta_5 INDUST_{it} + \beta_6 GS_{it}$$

$$i = 1,2,\ldots,N$$

$$t = 1,2,\ldots,T$$

$$\beta_2 > 0, \beta_3 > 0, \beta_4 > 0, \beta_5 < 0, \beta_6 > 0$$

ESI: Environmental Sustainability Index
GDPP: Gross Domestic Product Per Capita.
OPEN: ratio of trade (imports + exports) to GDP as the measure of trade-openness.
INDUST: Industry value added (% of GDP) as Industrialization.
GS: Government Size that is represented by the share of government consumption in GDP
We used overall ESI data from the Yale Center for Environmental Law and Policy and other variable from WDI for some developing countries.

4. Empirical Results

In this paper, we use panel data model and for choosing between OLS the pooled model, Fixed Effects (FE) and Random Effects (RE) employ Chow, Lagrange Multiplier (LM) (by Breusch-Pagan) and Hausman tests (For more details about panel technique and the related tests, see Baltagi, 2005 , Hsiao, 2005 and Gujarati, 2004) by Stata 9.1 and Eviews 7.
Table 3 presents Chow, Lagrange Multiplier and Hausman tests for model.

Table 3: Chow, Lagrange Multiplier and Hausman Tests

Test	Test-Statistic	P-value	Result
Chow	8.56	0.0000	FE
LM	121.04	0.0000	RE
Hausman	6.37	0.2719	RE

Based on result of table 3, model is RE and the results of random effects panel data model are presented in table 4.

Table 4: Results of Estimation of Model

Depended Variable: Government Size

$$ESI_{it} = \beta_1 + \beta_2 GDPP_{it} + \beta_3 GDPP^2{}_{it} + \beta_4 OPEN_{it} + \beta_5 INDUST_{it} + \beta_6 GS_{it}$$

Independent Variable	Coefficient	t-Statistic	Prob.
GDPP	0.001150	2.6096	0.0096
$GDPP^2$	-3.54E-08	-2.0527	0.0411
OPEN	0.036715	2.0214	0.0443
INDUST	-0.034121	-0.8381	0.4027
GS	-0.380604	-3.0451	0.0026
F	4.029		
P-value	0.0000		
R^2	0.074		
Adjusted R^2	0.056		

Results of table 4 show that according to the theoretical priors, the coefficient of GDPP is positive and statistically significant and the coefficient of $GDPP^2$ is negative and significant. Based on these coefficients, we have an inverted-U curve regarding the relationship between environmental sustainability and economic growth. Thus, results don't support the Environmental Kuznets Curve (EKC) hypothesis.

Also, we find that the coefficient of openness is positive and significant. Industrialization and government size are negative but industrialization is insignificance.

5. Conclusion

In this paper, we estimated the relationship between environmental sustainability index and economic growth in developing countries. Environmental Kuznets Curve (EKC) hypothesis is often used to describe the relationship between economic growth and deterioration environmental quality that it refers to an inverted U-shaped curve. We used ESI as opposite of the environmental deterioration index in order to support U-shaped Kuznets Curve. The obtained results do not support and contradicts the normal Kuznets Curve. In other word, we found an inverted-U curve that it indicates economic growth in high level will degrade environmental sustainability in developing countries.

This result suggests that while conventional policies in developing countries focus more on pollution control, they need to be combined with policy options focusing on eco-efficiency aspects of environmental sustainability in the process of economic development.

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