

# Environmental kuznets curve definition and usage



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The Environmental Kuznets Curve (EKC) is a pragmatically, relationship that is assumed to trace the pollution path followed by countries as their per capita gross domestic product (GDP) grows and describes the relationship between per capita income and indicators of environmental degradation (Unruth and Moomaw, 1998). In the infant stages of development, the levels of some pollutants climb with increases in per capita income, while at advanced levels of development, environmental degradation follows a downward trend as income per capita is moving upwards. These results give rise to a bell shaped curve relating economic growth to environmental degradation, redolent of the relationship hypothesized by Kuznets (1995) between economic and income inequality (Nahman and Antrobus, 2005). The concept of EKC came out in the early 1990s with Grossman and Krueger's (1991) path-breaking study of the potential impacts of NAFTA (North American Free Trade Agreement).

## **Origins of the EKC**

The environmental Kuznets curve is a hypothesized relationship between different indicators of environmental degradation and income per capita. At first stages of economic growth degradation and pollution increase, but further than some level of income per capita, the movement reverses, so that at high-income levels economic growth leads to environmental improvement. This means that the impact of environmental indicator is an inverted U-shaped function of income per capita (David, 2003)

In other words, the distribution of income becomes more asymmetrical in early stage of income growth and then the distribution moves towards greater equality as economic growth continues (Kuznets, 1955). This liaison

between income per capita and income inequality can be represented by a bell-shaped curve. This is viewed as an empirical phenomenon known as the Kuznets Curve (Dinda, 2004). The link between per capita income and income inequality is shown on Figure 1(refer to appendix)

### **Criticism and drawbacks of the Kuznets Curve**

The Kuznets Curve has helped in studying the relationship between environmental pollutants and GDP of countries but it does have drawbacks too. Even Kuznet (1955) himself indicated that the Kuznets Curve Theory is not a perfect one and the relationship between income inequality and economic development cannot be assumed. He also declared that lot information in the paper has been speculated and thus further research work must be carried out.

### **The reason behind the development of the Environmental Kuznets Curve**

Since the last decades, the increasing threat of global warming and climate change has been of major continuing concern. Organisations such as the United Nations have been trying to diminish the unfavourable impacts of global warming through intergovernmental and binding accords. After immense negotiations, the agreement namely the Kyoto protocol was signed in 1997. This protocol has the objective of reducing greenhouse gases (GHG) that cause climate change. The Kyoto protocol recognises limitations to environmental pollutants and necessitates a timetable for realisation of the emission reductions for the developed countries. During 2008 - 2012 periods the demands reduction of the GHG emissions to 5. 2 % lower than the 1990 level. In 2005 it came into force: 178 states have signed and approved the

protocol since April 2008 (Halicoglu, 2008). Greenhouse gas emissions particularly carbon dioxide (CO<sub>2</sub>) emissions, are considered to be the core causes of global warming. Consequently, to prevent global warming a number of countries have signed the Kyoto Protocol and agreed to diminish their emission levels. Galeotti and Lanza (1999) indicated that some developing states refused to sign the Kyoto Protocol based on the argument that the industrialisation and development process should be subject to no constraints, particularly for energy production and consumption. One probable foundation for this position is the belief that while pollution increases with growth in GDP, it happens a point where pollution goes down. This view calls for a careful analysis of the relationship between economic growth and pollution. This relationship is obviously very complex as it depends on numerous different factors such as:

The country's size,

The sectoral structure, including the composition of the demand for energy,

The vintage of the technology,

The demand for environmental quality,

The level and quality of environmental protection expenditures.

Shafik (1994) reports that the relationship between economic growth and environmental quality has been a source of great disagreement for a lengthy period of time. On one side it has been observed that greater economic activity unavoidably leads to environmental degradation and finally to possible economic and ecological collapse. At the other side is the view that

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those environmental nuisances worth solving will be tackled more or less automatically as a consequence of economic growth.

Previous to 1970, there was a conviction that the raw materials consumptions, energy and natural resources were growing at the same pace as economy grows. In the early 1970s, the Club of Rome's Limits of Growth view (Meadows et al., 1972) was brazen about the concern for the accessibility of natural resource of the Earth. They argued that the finiteness of ecological resources would prevent economic growth and advocated for a solid state economy with zero growth to avoid striking ecological circumstances in the future. This view has been criticised on both hypothetical and empirical grounds. Experimental works shows that the ratio of consumption of some metals to income was falling in developed countries during the 1970s, which brings divergence with the predictions set out in the Limits to Growth view (Maleness, 1978). Natural environment not only provide natural resources important for economic development but also execute the vital function of supporting life, if man persist to exploit environment recklessly, then it would not be able to sustain life any longer.

## **Environmental Kuznets Curve definition and graphical illustration**

The EKC follows the name of Nobel Laureate Simon Kuznets who had remarkably hypothesized an inverted ' U' income-inequality relationship (Kuznets, 1955). In the 1990s economists detected this relationship between economic growth and environmental degradation. Since then this relationship is known as Environmental Kuznets Curve.

According to the EKC theory as a country develops, the pollution increases, but after reaching a specific level of economic progress ( $Y^*$ ) pollution begins to decrease as in figure 2. The EKC hypothesis suggests that environmental degradation is something unavoidable at the first stage of economic growth, so a developing country is forced to tolerate this degradation in order to develop. The x-axis symbolizes the economic growth which is measured by GDP per capita and the y-axis represents the environmental degradation which is measured by many different pollution indicators such as carbon dioxide, sulfur dioxide, nitrogen oxide, deforestation etc.

### **The shapes of the Environmental Kuznets Curves.**

The relation between income and environmental pressure can be sketched in a several ways; firstly one can distinguish monotonic and non-monotonic curves. Monotonic curves may show either mounting pollution with rising incomes, as in the case of municipal waste per capita or decreasing. But, non-monotonic patterns may be more probable in other cases and two types have been recommended, namely inverted-U and N-shaped curves. The pattern discovered in experiential research depends on the types of pollutants scrutinised and the models that have been used for inference. Four speculative opinions are presented in favour of an inverted-U curve for (local) air pollutants, which can be listed as:

Positive income elasticity's for environmental quality,

Structural changes in production and consumption,

Rising information on environmental consequences of economic activities as income rises and

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More international trade and more open political systems with increasing levels of income (Selden and Song 1994).

Others, for example Pezzey (1989) and Opschoor (1990), have argued that such inverted-U relationships may not hold in the long run. They anticipated a so-called N-shaped curve which demonstrates the same pattern as the inverted-U curve initially, but beyond a certain income level the relationship between environmental pressure and income is positive again. Delinking is thus considered a temporary phenomenon. Opschoor (1990), for example, argues that once technological efficiency enhancements in resource use or abatement opportunities have been exhausted or have become too expensive, further income growth will result in net environmental degradation. Despite these considerations empirical evidence so far has been largely in favour of the inverted-U instead of the N shaped relationship (de Bruyn et al., 1998).

### **The shortcomings of EKC analysis**

A number of critical studies of the EKC literature have been published (e. g. Ansuategi et al., 1998; Arrow et al., 1995; Ekins, 1997; Pearson, 1994; Stern et al., 1996; Stern, 1998).

#### Theoretical critique

This section discusses the criticisms that were raised against the EKC on theoretical (rather than methodological) grounds.

One of the main criticisms of the EKC models is the assumption that environment and growth are not interrelated. In simple words the EKC

hypothesis assumes no feedback between income and the pollution of environment.

Fare et al., (2001) refer that due to the non-availability of actual data on environmental quality is the major restriction of all EKC studies.

Environmental quality is something that is not measured accurately.

Therefore, a guide of environmental quality, which could be a better measurement, should be developed and used to examine the EKC hypothesis.

According to Ekins (2000), consideration in assessing the strength of the estimation is the reliability of the data used. However, there is little sign that the data problems are serious enough to shed doubt on the basic environment-income link for any particular environmental indicator, but the results in fact imply that this might be the case.

Stern (2004) draws his attention to the mean - median problem. He underlines that early EKC studies showed that a number of indicators: 2 SO emissions, x NO, and deforestation, peak at income levels around the current world mean per capita income. A hasty glimpse at the available econometric estimates might have lead one to believe that, given likely future levels of mean income per capita, environmental degradation should turn down from the present onward. Income is not yet, normally distributed but very skewed, with much larger numbers of people below mean income per capita than above it. Hence, this shows a median rather than mean income that is the relevant variable.



Another problem related with the EKC studies is the little attention that has been paid to the statistical properties of time series. Very few studies in the past investigated the presence of unit root in time series of variables used to investigate the validity of the EKC.

## 2) Econometric critique

Stern (2004) in a survey argues that the econometric criticisms of the EKC fall into four main categories: heteroscedasticity, simultaneity, omitted variables bias, and cointegration issues.

Perman and Stern (2003) investigate the data and models for unit roots and cointegration respectively. Panel unit root tests designate that all three series - log sulfur emissions per capita, log GDP capita, and its square - have stochastic trends. Results for cointegration are less definite. About half the individual country EKC regressions cointegrate but many of these have limitations with "incorrect signs". Some panel cointegration tests point out cointegration in all countries and some accept the non-cointegration hypothesis. However, even when cointegration is found, the form of the EKC relationship varies radically across countries with many countries having U-shaped EKCs. In case there is a common cointegrating vector in all countries it will be strongly rejected.

Coondoo and Dinda (2002) carried out an analysis for Granger Causality between CO<sub>2</sub> emissions and income in various individual countries and regions. In general model that emerges is that causality runs from income to emissions or that there is no significant relationship in developing countries,

while in developed countries causality runs from emissions to income. Still, in every case the relationship is positive so that there is no EKC type effect.

## **Data and Time Series Properties**

To study the relationship between the GDP of Mauritius and the CO<sub>2</sub> emission in Mauritius the annual data that are being used are; total CO<sub>2</sub> emission from 1976 to 2008, the real GDP from 1976 to 2008, and the population of Mauritius from 1976 to 2008.

From these sets of data it can be clearly seen that while population and CO<sub>2</sub> emission has been increasing, during these years the real GDP has been fluctuating a bit. In mid 1970's after the independence there has been a lot of development and transformation in our country. Our economy was diversified and more jobs were created. Furthermore we received more foreign aid. By the late 1970's our economy deteriorated a bit mainly due to the increase in petroleum price in the world market and this led to less government subsidies and devaluation of our Mauritian Rupees. Then by late 1980's the economy experienced steady growth and also a high level of employment, declining inflation and more domestic savings. This period was also marked by the boom in the sugar industry. Though the development slowed down in the 1990's there was a gradual development of the local financial institutions and at the same time our domestic information telecommunication industry boomed. By the start of the 21st century there our financial services sector became a very important pillar of the economy with an increasing number of offshore enterprises. Finally our economy developed a lot due to the seafood processing and export during the last 10 years.