

Environmental Kuznets Curve Theory: A Review

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Abstract

Over the past few decades the relationship between economic growth and environmental degradation has been the subject of intense research. In this paper we attempt to review and survey the litterateur about the environmental Kuznets curve theory which illustrates the impact of economic growth on the environment. It is observed that a large number of studies support the validity of EKC while others didn't find any empirical evidence to support it. It is important to note that there have emerged several factors other than those that were initially taken into account to employ the EKC. These include but may not be limited to the trade openness, population growth, income elasticity of environmental quality demand, FDI scale, and production and consumption patterns etc. Litterateur suggests strongly the importance of choosing suitable indicators and data while attempting to employ EKC. Moreover, the EKC provides help for the policy makers to devise a suitable policy in order to reduce pollution.

Keywords: Economic Growth, Environmental Degradation, Environmental Kuznets Curve "EKC"

1. Introduction

Environment is the host of all activities, also the economic activity under

consideration here. The economic activity has a cyclic relationship with the environment known as "input-output" processes in which it receives the raw materials from the environment and then gives a range of pollution such as waste, air and water pollution etc, back to the environment as an outcome of the production, consumption and/or utilization processes. The relationship between economic activity and the environmental degradation is explained through Kuznets curves theory.

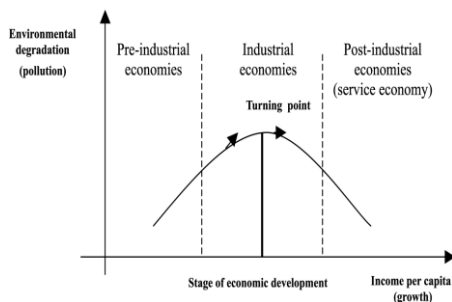
This study is intended to first introduce the EKC and its hypothesis along with associated shapes which will lead to the illustration of the standard model of EKC. Then, it shall put the studies supporting EKC as well as the inconsistencies observed in its hypothesis and finally the conclusion.

2. What Is EKC?

The environmental patterns has been called Environmental Kuznets Curve (EKC) due to the similarity with the relationship between the level of inequality and per capita income considered by Kuznets (1955) in his presidential address entitled by "Economic Growth and Income Inequality". He hypothesized an inverted -U- income – inequality relationship that when per capita income increases, the inequality also increase until at a certain point "income turning point" after, the inequality starts to decrease while the per capita income keeps increasing. A

resemblance of this theory was noted by Grossman and Kruger (1991) through their empirical study. They tested the validity of the EKC hypothesis and found that there was an inverse-U-shaped relationship between economic growth and environmental degradation.

The EKC hypothesis assumes that there exists an Inverse-U-Shaped relationship between economic activities, usually measured in terms of 'Income per Capita', and the environmental quality, measured by environmental indicators such as per capita CO₂ emission. That is to say, at the first stage of economic growth, environmental degradation would increase with an increase in per capita income, but would begin to decrease as a rise in per capita income passes beyond the income turning point.



Source: Panayotou (1993)

Fig. 1: The inverted U-shape of environmental Kuznets curve

So the EKC hypothesis illustrates that as a country develops its industry, the environmental degradation increases accordingly to it, and start decreasing after reaching a certain level of economic progress (Figure 1). Its implicitly suggests that environmental damage is unavoidable in the first phase of economic development. Panyotou (2003) suggested several reasons for the inversion of pollution patterns. First, the turning point for pollution is the result of more affluent and

progressive communities placing greater value on cleaner environment and thus putting into place institutional and non-institutional measures to affect this. Second, pollution increases, at the early phase of country's industrialization, due to rudimentary, inefficient and pollution generating industries appearing on the industrial arena. When industrialization starts to achieve more advanced levels until it is sufficiently advanced, the pollution will stop increasing anymore. Rather, it will start to take a U-turn. Moreover, service industries will gain prominence causing a further reduction in pollution.

Further long this trajectory, the polluted industries will shift from the developed countries to developing countries where the developing countries are in the early stages of economic development. The environmental regulations in developed countries might further encourage pollution generating activities to gravitate towards the developing countries Lucas et al (1992). For the sake of development, these countries sacrifice their environment accepting those industries being offered by the developed countries. The result is a greater amount of pollution in the developing countries Dinda (2004).

One of the best ways to explain the EKC is income elasticity of environmental quality demand. In the early stages of economic development, the people are more focused on and interested in eliminating poverty and improving their living conditions while ignoring, willingly or unwillingly, the importance of environmental protection because of low income elasticity of demand for environmental quality. As their income grows, their standards of living also increase. Then, they start caring about the quality of environment. Their desire and demand for a clean environment leads to structural changes in economy and environmental

policies to reduce the environmental degradation. Important to note is the point claimed by some researchers that the environment quality is a luxury good at the early stages of economic growth (e.g. McConnell, 1997; Kristrom and Rivera, 1996).

Other studies have found even significant cubic income-pollution relationship that takes the form of an N-shaped curve (Figure 2), like Grossman and Kruger (1991), with two turning points. Which means ; Environment degradation increase initially , declines after reaching the first point , and then increase indefinitely beyond the second turning point. Birgit Friedl et al (2003) also found a cubic N-shaped relationship between GDP and CO2 emissions.

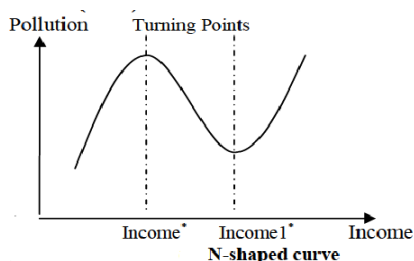


Fig. 2: the N-shape of environmental Kuznets curve

3. The Environmental Kuznets Curve Model

The earliest EKC models were simple quadratic functions of the levels of income. However, we consider a parametric cubic model which is quite standard in the EKC literature in order to investigate the various shapes and forms of EKC which may exist between the economic growth and the environmental degradation. The standard EKC model takes the following form:

$$E_t = \alpha_0 + \alpha_1 t + \beta_1 Y_t + \beta_2 Y_t^2 + \beta_3 Y_t^3 + \gamma x_t + \varepsilon_t \quad (1)$$

Where E_t is the environmental indicator like per-capita BOD emissions, Y_t is per capita real GDP, X_t refers to vector variables that may affect E_t such as Energy consumption, trade openness , population growth etc, ε_t is a random error term. α_0, α_1 are intercept parameters.

The model is usually estimated with panel data David I (2003). In the recent years many studies took place, in different countries, to investigate the specific patterns in each country or group of countries using different econometric method and tools in estimating EKC.

Eq. (1) allows to test various forms and shapes of environmental Kuznets curve ; $\beta_1 > 0, \beta_2 < 0$ and $\beta_3 > 0$ indicates an N- shaped relationship ; $\beta_1 < 0, \beta_2 > 0$ and $\beta_3 < 0$ indicates an inverse N-shaped relationship; $\beta_1 < 0, \beta_2 > 0$ and $\beta_3 = 0$ a U-shaped relationship ; $\beta_1 > 0, \beta_2 < 0$ and $\beta_3 = 0$ reveals an inverse U-shaped relationship , and When $\beta_1 > 0$ and $\beta_2 = \beta_3 = 0$ that indicates a monotonically increasing linear relationship and when $\beta_1 < 0, \beta_2 = \beta_3 = 0$ reveals a monotonically decreasing linear relationship.

The “turning point” level of income, where emissions or concentrations are at a maximum, can be found using the following formula:

$$\tau = \exp [-\beta_1 / (2\beta_2)].$$

Most part of the research on EKC has been aimed to identify the income turning point, where this point varies from pollutant to pollutant (Heil and Selden, 2001). Shafik (1994) found evidence about the validity of EKC hypothesis with no evidence of turning point and Grossman and Kruger (1995) estimated the income turning point under \$8000 for gas, Selden and Song's (1994) estimated that the income turning point is under \$10000. Neumayer

(2004) cited a range of between \$55,000 and \$90,000 as the income turning point for CO₂, based on assumptions. Because of the sensitivity of these results to changes in model specification imply that the conclusions drawn cannot be considered robust (Stern, 1998). Also, Stern (2004) suggests that many of this econometric work is flawed in that it often fails to take account of problems such as heteroscedasticity, simultaneity, omitted variables or co-integration. Alternatively, it may simply be the case that there is no single relationship between emissions and income, that the evolution of emissions is dependent on many factors that vary and change according to circumstances.

4. Study Results Consistent With The EKC Hypothesis

Investigating the relationship between the economic growth and environmental degradation is relatively a new thread. Before the empirical testing for EKC the earlier studies analyzed the theoretical issue on an inverted-U-shaped EKC. Beckerman (1972, 1992) focused on the loss of welfare of the population in developing countries. Simon (1981) led vigorous challenge to conventional beliefs about energy scarcity, natural resources and pollution of environment.

The first empirical study for EKC which appropriated to treat the relationship between the economic growth and the environmental degradation appears to have been the NBER working paper by Grossman and Kruger (1991) who noted the resemblance to Kuznets inverted -U-shaped relationship between income Inequality and development estimated EKC for SO₂, fire smoke, SPM. After this study many empirical studies appeared to test the validity of EKC model around the world. Shafik et al (1992) presented their study exploring the relationship between

the economic growth and environmental quality by analyzing the pattern of 10 different indicators; this was the background of the World Bank's report (1992) which confirmed on the necessity to integrate environmental considerations into development policy making. Many other studies like Yi Chia Wang et al (2011), Reka Homordi et al (2009), Lucena (2005), Michael Toker (1995), Jean Agres et al (1999), Fodah, M et al (2010) also found a significant evidence of prevalence of EKC in different countries, in a individual country as well as in set of countries, with different environmental indicators such as CO₂, SO₂, NO_x, BOD etc. Panyouto (1993,1997) study supported the prevalence of EKC in developing and developed countries, when he found that at least in the case of ambient SO₂ levels, policies and institutions can significantly reduce the environmental degradation at low income levels and speed up improvement in higher income levels. Thereby, he concluded flattening EKC and reducing the environmental price of economic growth. At the same time, he suggested that developed countries could help the developing countries through creative financing mechanisms such as global environmental facilitation. Dinda(2004) indicated that, in general, less developing countries use their whole stock of capital for commodity production which generates pollution for the sake of development. Differences may not only lie between the developing and developed countries in the level of pollution and income turning point level .Ying liu (2009) found in the same country that more developed coastal regions, had a high income level of turning point than the less developed central and western regions in China. Lopez (1994) Seldon Song (1995) considered exogenous technological change and found that pollution is generated by production, and the relationship between pollution and in-

come levels depends on the elasticity of substitution of goods. Erwin H. Bulte (2001) found that in developing countries production and consumption patterns of households are the main causes of environmental damage. Another study based on a conventional household model, Moconnell . EK (1997) said that pollution is generated by consumption rather than production activities, and also generated an inverted -U-shaped pattern under appropriate conditions persistent to EKC. Hsiang Chih Hwang (2007) study confirmed the existence of EKC between BOD and GDP per capita. Ferda (2008), Agras and Chapman (1999) , Abdul Jalil (2009), Muhammad Shahbaz et al (2010), Junghe Baek et al (2011), Z. Liu et all (2011) through their empirical studies found that the energy consumption and trade openness are significant variables in explaining CO2 emissions. In addition to these studies Ang, J. B (2007) found that more energy use, higher income, and greater trade openness tend to cause more CO2 emission.

Many studies tested the impact of energy consumption and population growth on environment, Xuemei Liu (2005) found that including energy consumption in regression implies a negative relationship between income and Co2 emissions, which is contrary to the previous findings. I.J. Lu et all (2007) suggested that the rapid growths of economy and vehicle ownership were the most important factors for the increased CO2 emissions. Energy conservation performance and CO2 mitigation in each country are strongly correlated with environmental pressure and economic driving force whereas population intensity contributed significantly to emission decrease. Anqing Shi (2001) found that population growth has been one of the major driving forces behind increasing carbon dioxide emissions. Richard York et al (2003) found that

population has a proportional effect (unitary elasticity) on the CO2 emission. Kaufmann, R.K. et al (1998) noted that some environmental problems can be ameliorated by slowing population growth and increasing income levels.

5. Study Results Inconsistent With The EKC Hypothesis

EKC hypotheses are spatial hypothesis for this theory. It assumes that the economic growth in the early stages causes harm to environment but after a certain point (income turning point) the economic growth becomes a cure where it fixes and reduces the environmental damage despite the economic growth continues in increasing. Some studies didn't find empirical evidence to support the validation of EKC hypothesis such as Moomaw et al (1997), De Bruyn et al (1998), V.lantz,Q feng (2005), those studies found that CO2 unrelated to GDP.

The estimation of EKC's for total energy is an attempt to capture environmental impact whatever its nature Suri and Chapman (1998). Both Arrow *et al.* (1995) and Stern et al (1996) argued that if there was an EKC type relationship it might be partly or largely a result of the effects of trade on the distribution of polluting industries. The environmental regulation in developed countries might further encourage polluting activities to gravitate towards the developing countries Lucas et al (1992). D. Stern et al (1996) critically examined the concept of EKC and they found the following result, it did not appear to them that the EKC approach has much to offer in the way of informing the choices arising for policy maker. Jordi Roca et al (2001) study presented evidence that there isn't any correlation between higher income level and smaller emissions, except for SO2 whose evolution might be compatible with the

EKC hypothesis. The authors argue that the relationship between income level and diverse types of emissions depends on many factors. Thus it cannot be thought that economic growth by itself will solve the environmental problems.

6. Conclusion

It is evident from the results of various studies that the EKC is valid in some cases while invalid for others depending upon the specific scenarios prevailing in different countries. This leads us to understand that the economic development is not the only variable affecting the degradation of environment. Environment can get degrade for several other factors, alone or in a mix. These include but not limited to trade openness, population growth, income elasticity of environmental quality demand, FDI, scale, production and consumption patterns etc. According to the empirical studies done on EKC, it is quite important to choose suitable indicators and data. Not less important is the fact that income turning point varies in the different scenarios and circumstances in terms of pollutant to pollutant and specificity of every country. Although EKC has been subjected to a criticism, nonetheless, it still prevalent and provides the bases for further research by providing the flexibility for more factors, which affect the environmental degradation in a positive or negative manner. The EKC illustrates that the economic growth and eliminating poverty is the 'primary goal' which the people are looking for in the early stages of economic growth. The EKC gives a sign to the policy makers helping them in devising policies to control Pollution in the first stages of economic development which may cost more in future. The industrial revolution which pushed the world economy and the developed countries forward had many negative impacts on the envi-

ronment as a consequence of that, the developed countries should share the responsibility of reducing the pollution with the developing countries helping them to achieve development on one hand while reducing the global environmental degradation.

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