THE MAHARAJA SAYAJIRAO UNIVERSITY OF BARODA

FACULTY OF ARTS

DEPARTMENT OF ECONOMICS

SYNOPSIS

Economic Growth and Environment: A Structural and Decomposition Analysis of the Environmental Kuznets Curve

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1. Introduction

India has grown many folds over last 65 years. The transition of Indian economy from a mere an agrarian economy to not so fully industrial economy, jumping to a service sector in short span, tells its story. India has overcome many obstacles ranging from wars and BOP crisis to Demonetization and GST, in reaching where it is today, and continuing the battle of attaining optimum growth.

Of the many obstacles that India has faced, one that has been consistent is curbing, controlling, managing and regulating the environment for sustainable growth. Environmental degradation is gaining focus of the Governments across the globe again and again. Till date the measures to curb and control the environmental degradation has been initiated by various authorities.

Environmental education and brainstorming takes place time and again to tackle the degradation of one of the important factors of production. This is the result of growth and development that India has achieved in last 6 decades. The never ending needs of a developing country to explore and exploit the natural resource to participate in the growth race , doesn't give it an option of conserving and protecting one of the vital resource, making it a luxury good.

But the process of economic growth is essentially a steady process by which the productive capacity of the economy is increased over time to persistently and consistently achieve a certain level of National income. Prof. Simon Kuznets, Noble Laureate defines economic growth as "a long term rise in capacity to supply increasingly diverse economic goods to its population, this growing capacity based on advancing technology and the institutional & ideological adjustments that it demands"

Economic growth, therefore, is the capacity of a nation to supply goods and services to its people. This capacity should be based on technological, institutional and ideological adjustments needed in the society. The capacity to supply depends on the ease of availability of resources, which is built overtime, during the growth process.

The stage of growth that an economy passes through depicts its state of technological and institutional achievement. The growth path of current Developed countries is different

from that of Developing countries of the world. The catch lies in the adoption of technology and investment in technology and research for further advancements. India in tackling its population explosion couldn't get away with the labor intensive, traditional techniques of production, and is still hesitant in adopting the high end technology.

Moreover, the industry cannot absorb the working population and agriculture cannot help anymore, leading to higher dependency on other means of employment. This has resulted in overuse and misuse of environmental resources in the country.

Economic growth is essentially a steady process by which the productive capacity of the economy increases over the period of time leading to economic development. Prof. Simon Kuznets, Nobel Laureate in 1971 has defined economic growth as "a long term rise in capacity to supply increasingly diverse economic goods to its population, this growing capacity based on advancing technology and the institutional & ideological adjustments that it demands"

Economic growth is therefore the capacity of a nation to supply goods and services to its people. This capacity to supply should be based on technological, institutional and ideological adjustments needed in the society. It also depends on the natural resources availability. This differentiates the nations from each other and their capacity to supply. It is also important to mention the rate/stages of growth on the basis of which the countries can be categorized in developed and developing nations.

Given these points, the stages of growth of developed nations are far more different than the developing nations today. The transition has been different especially because of the availability of resources. The technique of production is the key to their growth. As a matter of fact, the rate of technological advancement in developed nations has been very fast. This was possible because of availability of capital to these nations. On the other hand the developing nations were and are too traditional in their approach to production activity. This is also due to availability of labour as a consequence of overpopulation.

Both have their share of challenges to overcome to achieve growth targets each year. One common parameter is during the course of growth process both the nations have ignored the "environmental degradation" that took place due to their respective production activities. No matter how many worldwide initiatives have been taken, the issue still remains a mystery for most of us. This gives an open space for the researchers to work on various aspects of environmental degradation.

The competitive environment and the process of globalization in the global markets have created a cheaper market for all goods and services. The economies in the race of

achieving good growth rates are allowing free flow of capital as well as goods from foreign countries. This has created a market for lower quality and less durable goods increasing the wastage and building inefficiencies, on the other hand greater extraction of natural resources for inputs. The capacity of the environment to assimilate the waste generated in the process of growth and development is limited. The cost of damage is never included in the cost of production allowing the firms to create negative externalities.

One school of thought says that the fastest route to environmental improvement is to earn higher incomes and become rich, as with higher incomes demand for goods and services are less materialistic which improves the environmental quality. But the damage done to environment is irreversible and sometimes the cost of damage is too high to be borne by individuals.

One such researcher and noble laureate Grossman Krueger did an attempt to answer host of question of environmental groups. Following him, there have been numerous researches on the relationship of environmental degradation and economic growth, but zeroing down to a unique solution seems impossible. This is due to very nature of environment itself.

The environmental Kuznets curve is a hypothesized relationship between various indicators of environmental degradation and per capita income. In the early stages of growth, while the economies are agrarian and in the process of industrial revolution, the pollution increases. And once a certain level of per capita income is attained, as the economy is service based, the environmental quality improves and pollution reduces. As seen in Figure 1, the curve initial is increasing at n increasing rate meaning the pollution increases as the economy starts the economic transition from agriculture to industry. The curve can be seen reaching a peak, which is known as the turning point after reaching a certain level of income, then after this point the environmental degradation decreases and environmental quality improves. This inverted U shape curve is named Environmental Kuznets Curve (EKC) for Kuznets who hypothesized income inequality first rises and then falls as economic development takes place.

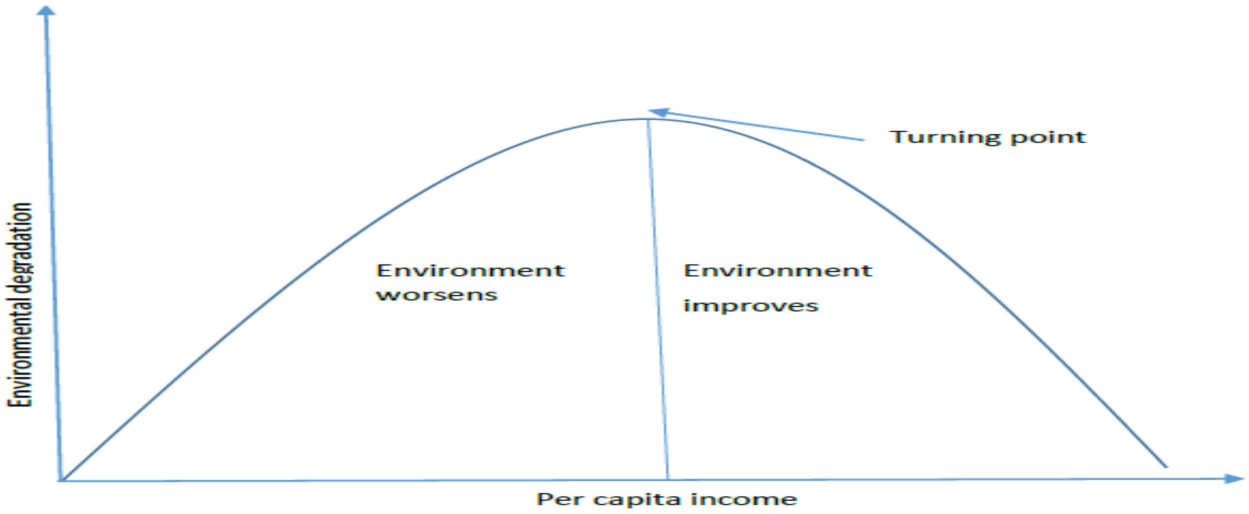


Figure 1: Environmental Kuznets curve (MPRA Paper No. 85024, posted 12 March 2018 18:14 UTC)

At the take off stage as there is intensification of the agriculture and economic development take place the resource depletion is greater than the resource regeneration. And once an economy attains intensive industrialization and service development there is gradual decline in the environmental degradation with increased environmental awareness. The hypothesis of EKC got popular with the Grossman and Krueger's research on the potential impacts of NAFTA in 1991 and World Development Report's study by Shafik and Bandyopadhyay in 1992. Others expanded it further, Beckerman in 1992 claimed that "there is clear evidence that, although economic growth usually leads to environmental degradation in the early stages of the process, in the end the best – and probably the only – way to attain a decent environment in most countries is to become rich".

It also summarizes a dynamic process of structural change that takes place in the economy. The structural change process is all about shifting the center of gravity of the economy from low-polluting agriculture to high-polluting industry and sooner or later to low polluting service economy depicting an inverted-U shape Environmental Kuznets Curve. There are several factors responsible for this to shape it as inverted-U: These factors are as follows (Dinda 2004)

1. Income elasticity of environmental quality demand
2. Scale effect
3. Technological effect
4. Composition effect
5. International trade (displacement hypothesis & pollution hypothesis etc
6. Market mechanism

7. Regulations (internalization of external effects – no abatement) (Christoph Martin Lieb-2003)
8. Substitution between pollutants
9. Increasing returns to scale in abatement
10. Shocks
11. Irreversibilities

To put things in nutshell, economic growth leads to increased output and eventually to higher pollution. The growth of industries in an economy creates more such issues. Income growth in the economy as explained by Grossman (1995) has three kinds of effects generated on environment, calling it the "decomposition analysis" of EKC. Analyzing the effect of income on the environmental quality is an incomplete story. There is much more to this environment-income relationship.

2. Literature Review

Increasing concerns of the environmental advocacy groups in the United States over linking trade liberalization with environmental degradation resulted into a historic research by Grossman & Krueger (1991). An attempt to answer host of question of environmental groups they went on to explain the relationship between economic growth and environmental using three variables; Dark matter, SO_2 (Sulphur dioxide) and SPM (suspended particulate matter). The major concern was over environmental degradation due to trade liberalization, to be precise, North American free trade agreements between the U.S and Mexico. Due to non-availability of systematic data on pollution, they kept their findings tentative. They examined the economic growth – environment relationship in a cross-section of countries and found that economic growth tends to alleviate pollution problem once a country's per capita income reaches about $4000 to $5000 U.S dollars, not overlooking the benefit, a more liberal trade regime generates income growth in the economy.

Secondly, trade liberalization increases the specialization in sectors that cause less environmental damage. That is, a more labor-intensive and agricultural activities require less energy input and generate less hazardous waste per unit of output compare to capital-intensive sectors.

An important take away from their research is that; environmental impacts of trade liberalization are country specific; it depends on effects of policy change on the overall scale of economic activity, change in the inter-sectoral composition of economic activity

and the technologies used for production; elaborating the role of scale effect, composition effect and technological effect.

Shafik and Bandyopadhyay (1992) observed a comprehensive range of ten environmental indicators and the significance of ten policy variables for examining the economic growth and environmental quality relationship. Income, as consistently, has the most significant effect on all the environmental indicators. Most environmental indicators deteriorate initially with rising income with a few exceptions. But many indicators improve as countries approach the middle income levels.

They found that even in lower income countries certain environmental indicators were taken care of; one that had higher private and social benefits for instance water and sanitation. As these countries moved to increased income level the indicators relatively costly to abate and imposed an external cost came into picture.

The environmental variables characterized by linear, quadratic and cubic functional forms. The greatest linear income elasticity is carbon dioxide emissions, as one percent change in income results in 1.62 percent increase in carbon dioxide emissions. At higher income levels, Sulphur dioxide and deforestation decline quickly and hence an inverted-U shape.

In the foundation research on environmental degradation and growth relationship Panayotou (1993) played an important role by again empirically validating the existence of EKC for developing as well as developed countries. He also derived the policy implications of such as relationship for employment, technology transfer and development assistance. He chose to emphasis that process of economic growth of an economy will bring about a change in the levels of environmental degradation only if it is the 'right' kind of growth (figure 2). It is inevitable to recover the initial resource depletion. The variables chosen are deforestation as a representative of natural resource depletion and Sulphur dioxide (SO_2), nitrogenous oxides (NO_X) and solid particulate matter (SPM) for industrialized energy related pollutants. For testing deforestation, whether EKC exists or not, trans log functional form is used to test deforestation as a function of income per capita and population density. Similarly, using log quadratic function for SO_2 , NO_X and SPM as a function of income per capita he tested the EKC relationship and was successful in validating the existence of EKC.

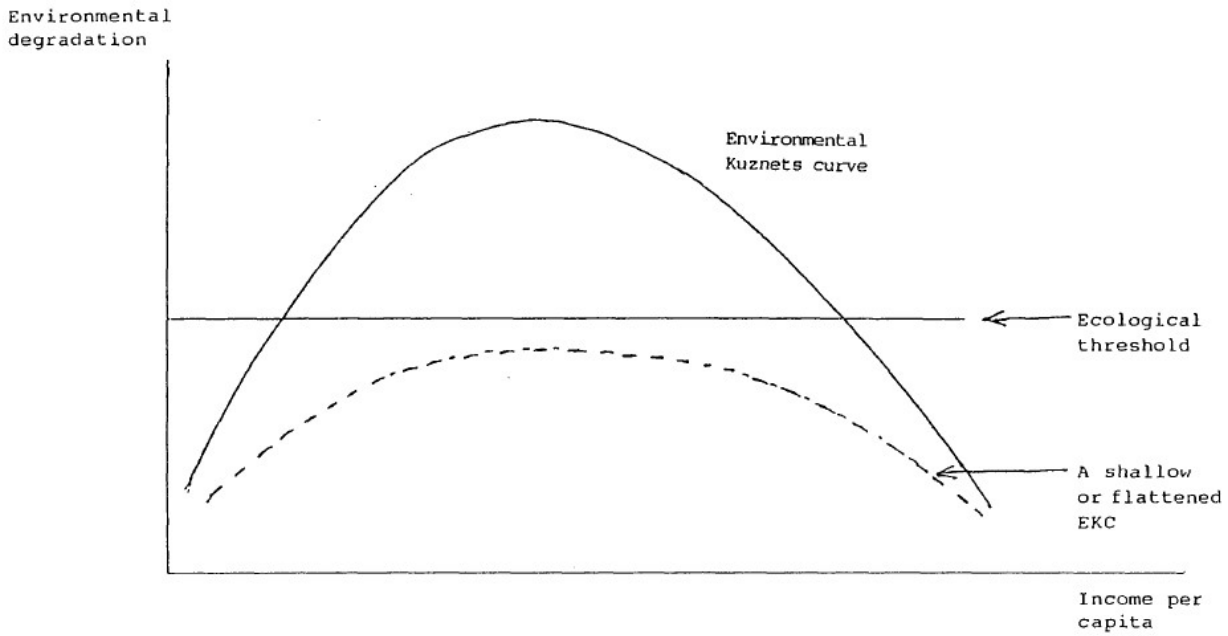


Figure 2: Environmental Kuznets Curve Source: T Panayotou 1993

Implications for employment reveal that as Labour movement takes place from agriculture sector to industrial sector the burden on urban lands increase worsening the situation of public lands, infrastructure and solid waste scatters. This leads to steeper and longer left leg of EKC and increases the probability of endangered ecological thresholds. Suggesting a cost effective solution to leapfrog the ecological thresholds Panayotou emphasis three changes in the policy structure; removal of subsidies, reduction of protection for capital intensive industries and increased investment in education and training.

The case of technology transfer is difficult than it is understood to be. The transfer of technologies at concessional terms by the developed countries to LDC's might reduce employment; intensify resource depletion and environmental degradation if the transfer is inappropriate. To overcome this, it is better to transfer information, know-how and skills to enable the LDC's to design the technologies best suited to their economic situation.

Other than these foundational studies there have been several researchers with varying opinions on the relationship of economic growth and environmental quality, summarizing some of them in Table 2.1. Table 2.2 summarizes the studies that have specifically concentrated on the CO_2 emissions as their dependent variable.

Table 2.1

Author (Year)	Contribution	Remarks
Shafik, N., & Bandyopadhyay, S. (1992)	Examine how eight indicators of environmental quality evolve in response to economic growth and policies across a large number of countries and across time	
Holtz-Eakin, D., & Selden, T. M. (1995)	The evidence from the study suggests a diminishing marginal propensity to emit (MPE) CO_2 as economies develop. despite the diminishing MPE forecasts indicate that global emissions of CO_2 will continue to grow at an annual rate of 1.8 percent continued growth stems from the fact that economic and population growth will be most rapid in the lower-income nations that have the highest MPE	
De Bruyn, S. M. (1997)	The author emphasizes that the downward sloping part of the EKC can be better explained by reference to environmental policy than to structural change and attempts to empirically test it.	The study attempts to examine existence of an EKC could be solely the effect of environmental policy, which indeed may be more ambitious in countries with higher incomes.
Hettige, H., Mani, M., & Wheeler, D. (1998)	To test for a Kuznets effect, they measure effect of income growth on three proximate determinants of pollution: The share of manufacturing in total output; the sectoral composition of manufacturing; and the intensity of industrial pollution at the end-of-pipe.	The study shows the manufacturing share follows a Kuznets-type trajectory. Sectoral composition gets 'cleaner' through middle-income status and then stabilizes. At the end-of-pipe, pollution intensity declines strongly with income

Panayotou, T., Peterson, A., & Sachs, J. D. (2000)	The study examines the changes in the capital stock as a result of structural change in the economy. Initial increase in capital stock increases the emissions due to industrialization; later as the economy switches to postindustrial stage the emissions are negative.	The proposes that economic growth brings about structural change that shifts the center of gravity of the economy from low-polluting agriculture to high polluting industry and eventually back to low polluting services. The result for trade is consistent with the "pollution haven" hypothesis.
Dinda, S. (2004)	The research attempts to explain the Environmental Kuznets Curve (EKC) or inverted U-shaped relationship between income and environmental degradation in the framework of endogenous growth model. Considering a closed economy, one part of capital is used for commodity production, which generates pollution that degrades existing environment, and the remaining part is used for abating pollution (i.e., upgrading environment). Sufficient abatement activity improves/restores environmental quality	The author suggests that to restore environmental quality, a sufficient investment is needed that is possible only when economy accumulates enough capital stocks. The shift from insufficient to sufficient investment for upgrading environment is the basis for curve down the pollution level, and thus, correspondingly forms the inverted U-shaped relationship between pollution and economic growth.
Copeland, B. R., & Taylor, M. S. (2004)	Income gains created by freer trade lead to a net reduction in pollution concentrations from scale and technique effects. There is a positive relationship between trade and pollution abatement	
Dinda, S. (2006)	Impact of globalization on environment heavily depends on the basic characteristics of a country and it's dominating comparative advantage.	Using panel data technique the author analyzes the impact of globalization on OECD and Non-OECD countries. The author concludes that the net impact of globalization increases the pollution as there is marginal reduction in OECD whereas emissions increase in Non-OECD

		due to pollution haven hypothesis.
Lipford, J. W., & Yandle, B. (2010)	The study examines Mexico's environmental record in the pre- and post-NAFTA periods. The evidence shows that although Mexico's environmental quality has improved by some measures, by most measures it has deteriorated	According to the research and empirical evidence, the growth has been slow for Mexico since 1994, so there has been an increase in the pollutants. EKCs can be a helpful guide in predicting longer-term environmental outcomes, EKC estimates enable policy makers to consider the risk associated with decisions that favor or disfavor economic growth.
Panayotou, T. (2016)	To pursue sustainable development and reduce environmental pressure, the most cost-effective way is to couple the command and control regulations with healthy economic instruments	Analysis of countries in transition and countries in ECE (Economic Commission for Europe) region, both due to different reasons experience decoupling of environment and growth. Author has suggested few common actions that can be taken by both categories of economies.
T. Subba Lakshmi Naresh Chandra Sahu (2012)	EKC should not be taken for granted and further investigations need to done	Also, both empirical results and theoretical discussions seem to agree that policy plays a more important role than income in the environmental transition observed in many countries

Table 2.2 Studies having CO_2 ***emissions as one of the degradation indicator.***

Study	**Environmental degradation indicator**	**Shape of the curve**	**Turning point (GDP/per)**	**Remarks**
Shafik & Bandyopadhyay (1992) GDP/per US$ 1985 ppp	Carbon emissions per capita and many more	Quadratic U-inverted	4000	Sample includes 149 countries for the period of 1960-1990
Holtz-Eakin & Selden (1992) GDP/per US$ 1985	CO_2	Quadratic U-inverted Cubic N-normal	35400 28010	Global: Emissions per capita
Shafik & Ba2ndyopadhyay (1994) GDP/per US$ 1985 ppp Time Series	Carbon emissions per capita and many more	Linear Upward	NA	Global: Data of the World Bank. Linear, quadratic and cubic logarithm are tested
Robert and Grimes (1997) GDP/per US$ 1987	CO_2	Quadratic U-inverted	NA	Data Come from World Bank and from the Carbon dioxide Information and Analysis Center (CDIAC)
Schmalensee, Stoker and Judson	CO_2	Log-linear	10000	National level panel data set for 47 countries from 1950 to 1990
Cole, Rayner and Bates (1997)	CO_2 and many more	Quadratic U-inverted	25100	Cross-country/region data from OECD countries
Moomaw and Unruh (1997)	CO_2 (panel) CO_2 (for each country)	Cubic N-normal Linear downward	12813 18333 NA	Data are from Oak Ridge National Lab and from the Penn World Tables

Ravallion Heil and Jalan (1997) GDP/per US$ 1985 ppp	Carbon emissions	Cubic N-normal	U-shape pattern	Data are from Oak Ridge National Lab and UN Statistical division
Unruh and Moomaw (1998) GDP/per US$ 1985 ppp	Carbon dioxide emissions	Cubic N-normal	NA	Data is obtained from Summers and Heston (1994) for 16 countries
Bruyn, Bergh and Oopschoor	CO_2 and two other indicators	Linear Logarithm	NA	Data from Netherlands, Western Germany, the UK and the USA. For various time intervals between 1960 to 1993
Galeotti and Lanza (1999)	Carbon dioxide	Quadratic U-inverted	13260	New data set developed by IEA that covers the period between 1960-1995

2.1 Theoretical critique

The intense debates on EKC have high stakes for both developed as well as developing countries. It is very much clear that concentrating on only variable and analyzing the relations is mystifying the issue rather than getting a solution. Since all the variables are interdependent, determining any one dominant variable is difficult.

And so EKC cannot be generalized for all types of pollutants, evidence agrees that there is an EKC for all air pollutants: SO_2, SPM, NO_x, CO, lead and VOC. However turning point estimates vary far and wide. As pollutants such as SO_2 and SPM cause severe local health risks, they are looked into even at lower income levels. On the other hand majority of the studies find a monotonically rising curve for CO_2 emissions. This curve tends to be rising because CO_2 is a global stock pollutant with a lifetime f about 125 years (Frey et al. 1991, 165). It does not create an immediate impact on the environment but a very severe and long term effect is created worsening the situation in the long run.

Many researchers (Bruyn et al., 1998; Dinda et al., 2000) argue that the EKC might not hold in the long run and the economies may foresee N- shaped curve due to change in the

relationship between income and environment- the relationship turns positive again (de Bruyn & Opschoor, 1997).

The population pressure on the environment is also an important indicator that cannot be ignored. The existing literature has enough evidence to prove that the higher population economies of the world is on the upward sloping portion of EKC (Dinda, S., 2004).

To conclude, "Becoming rich to improve the environmental quality is not the only way out". The falling portion of EKC can be achieved through deliberate efforts of policy changes (Panayotou, 1997) and is not automatic.

2.2 Critique of the estimation technique

Simone Borghesi (1999) in his work on survey of literature of the Environmental Kuznets curve has structured a comparison between the studies based on their approaches adopted to analyze EKC. He critically tries to find answer to: "whether and to what extent an EKC is empirically observed". Emphasizing the fact that in absence of single environmental indicator, the results depend upon the proxy indicator considered which leads to conflict on the existence of EKC and its shape. While comparing the results of such indicators in cross-country analysis, he observed that much of the concern is not only related to the turning points in these countries, but also about the very existence of EKC.

His observation on use of econometric approaches leads to use of more sophisticated models considering time series analysis. Simone's work strongly concludes that EKC relationship in developed countries should not be compared to that of developing countries.

Neha Khanna (2001) approaches the EKC discussion from a different perspective. The discussion revolves around effect of income on pollution in a controlled model. Summarizing the four factors that account for the EKC relationship; composition effect, trade policy, income elasticity of environmental quality and scale effect; this study focuses on validating EKC for individual pollutants and estimating the turning points.

Sharing a concern regarding the generalization of results of EKC for developed countries, study elaborates how the developing countries might not get the same opportunity while in transition. Yet another concern related to Data representation error by the earlier studies might have miscalculated the turning points, has been raised. Using this base the study focuses on an indidviadual country rather than cross-country analysis

The estimation techniques used for deriving the results has often been flawed and has attracted lot of criticism. Most of the studies have examined the EKC relationship using cross-section data set of countries. The country-specific EKC relationship did not get enough attention, which assumes that all countries considered for analysis follow same growth trajectory without any difference in economic, political and social factors. Such a results cannot be relied upon as they may not be true for all. Some common concerns (Dinda, 2004; Lieb, C.M, 2003) related to econometric critique are:

1. Simultaneity bias (not only does income influences pollution, pollution also influence income)
2. Heteroscedasticity
3. Use of other functional forms
4. Multicollinearity
5. Omitted variable bias

A host of researchers specify a reduced-form equation that includes a dependent pollution variable, independent GDP capita value (quadratic/cubic) as they believed economic theory provided no structure for the EKC analysis.

2.3 Research gap

Majority of the research on EKC has been on cross-section analysis of countries, very few researches have country specific pollution analysis.

The dominant technique to estimate environment income relationship is:

$$P_{it} = \alpha + \beta_1 Y_{it} + \beta_2 Y_{it}^2 + \beta_3 Y_{it}^3 + \beta_4 X_{it} + \varepsilon_{it} \qquad (1)$$

Where p is a pollution term measured in emissions per capita (or sometimes concentration of certain pollutant), y is GDP per capita measured in PPP, x is a vector of other explanatory variables, i is an index for a country, t is an index for time and ε is the error term.

The estimation of equation (1) can be done with and without the explanatory variables. Also sometimes the cubic term is not a part of the analysis as it becomes too favorable for the relationship of EKC (the cubic term has both probabilities, one can get an inverted U as well as rising EKC).
Some researchers have even used logarithm instead of levels data. This too is favorable, as when log of pollution tends to negative values, pollution approaches zero. The estimation of above equation is done using either Fixed effects or Random effects.

Any which way, the estimation of aforementioned reduced form equation is considered as a mystery – hides more than it reveals. It is also considered as "Black Box" (Panayotou 1997). Any attempt has been made to unveil the mystery behind this black box. The technique used for decomposing the effects of EKC and applicability of new family of statistical tools is discussed in the next section.

3. Research Methodology

On the basis of the research gap aforementioned this research attempts to explore a new perspective to Environmental Kuznets Curve hypothesis by introducing a new technique of estimation and more data. As the literature on the EKC seems to be deviating from the empirical results about the relationship of economic growth and environmental degradation, the research is an attempt to give a new dimension to the hypothesis by introducing Structural equation model (SEM). The following section summarizes the need for SEM and reason for choosing CO_2 emissions for the study.

3.1 Rationale of the Study:

3.1.1 Structural Equation Model (SEM)

So far the hypothesis of Environmental Kuznets Curve has been empirically tested for various developed countries and the results have been positive for some of the pollutants. However, it is still unknown whether the EKC exists for developing countries or not. One of the main reasons behind this is the unavailability of and poor quality environmental data in these countries.

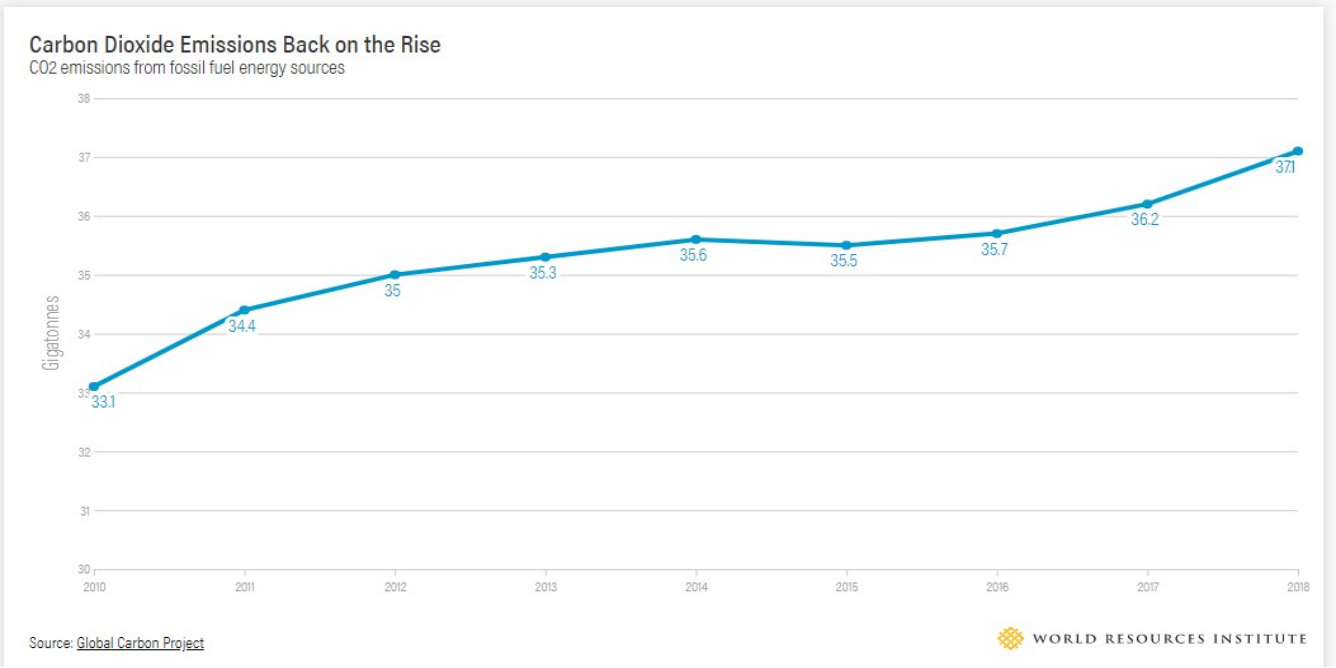
An attempt has been made to overcome this problem by introducing Structural Equation Modeling (SEM) in the EKC analysis. SEM is a powerful, multivariate technique found increasingly in scientific investigation to test and evaluate multivariate causal relationships (Fan, Y., Chen, J., Shirkey, G., John, R., Wu, S. R., Park, H., & Shao, C., 2016). Major difference between SEM and other modeling technique is pre-assumption of causal relationship between the variables considered. SEM allows for the incorporation of both observed and unobserved variables into theoretically-based probabilistic model (Grace and Bollen 2008).

To measure something like environmental degradation accurately is a challenge for the researchers. While direct values or units may not exist, we can derive them from other related variables. One such technique used is composite variables for applications of

SEM. They are also unobservable variables, is an exact linear combination of the indicator variables based on given weights (Fan et. Al 2016).

3.1.2 **For choosing CO_2 (Global Project report)**

According to a report by Union of Concerned Scientists (UCS) climate change is primarily a problem of too much carbon dioxide. "CO_2" sticks around. It remains in the atmosphere more than any other heat trapping gases emitted as a result of human activities. As per the announcement of Global Carbon Project energy use from fossil fuel is still outpacing low-carbon sources. Total carbon dioxide emissions from fossil fuels and industry rose by 1.6 percent in 2017 to 36.2 gigatonnes CO_2.



On the basis of the research gap found in the estimation technique and the drawbacks of the present studies, the next section highlights the objectives of the study.

3.2 Objectives of the study

- To analyze and evaluate the indicators responsible for inverted U shape curve of Environmental Kuznets Curve in Indian context (Decomposition analysis).
- To study the behavior of environmental pollution i.e. shape of the Environmental Kuznets curve, over time in India during pre-liberalization and post-liberalization periods. (Reduced form model)

- To locate the turning point of Environmental Kuznets Curve for India in terms of GDP.
- To do a structural analysis of Environmental Kuznets Curve for India.

3.3 Research questions

Based on the above objectives this study attempts to explore answers to the following research questions:

- Is there an Environmental Kuznets curve for India? If yes, which portion of the curve does India lie on?
- Is the environmental quality related to economic growth in India?
- Is the environmental quality related to demographic factors of the economy?
- Is the environmental quality related to governance factors of the economy?

3.4 Data

Empirically, the studies on EKC seem to suffer from lack of data in most cases. Other than Cole et al. (1997), no other researcher has attempted to overcome the problem of heteroscedasticity.

The data for most of the variables are retrieved from World development Indicators and International Country Risk guide. The time period considered is from 1960 till 2017 for most of the variables based on the availability of data. The intent behind taking data for last 57 years is to find the important structural breaks and impact of variables pre and post reform period in India.

3.5 Empirical Estimation

The empirical estimation in this study has been divided into three parts. The first part deals with the time series analysis of the environmental Kuznets curve, the second part deals with decomposition analysis of the environmental Kuznets curve and the third part deals with structural equation modelling (SEM).

3.5.1 Part A – Time series analysis:

In this part the traditional empirical technique is applied to environment-income relationship to find out whether the EKC hypothesis exists for India. And the turning

point in terms of GDP per capita is to be located on EKC. India is still on the rising part of the EKC when we run a regression for time series data of 57 years.

The analysis is to be carried out in two breaks to find whether there is any difference in the behavior of CO_2 emissions due to structural break in the economy. If yes, which factor has a greater impact on CO_2 emissions?

3.5.2 Part B – Decomposition analysis

The study attempts to separately examine the impact of economic variables, demographic variables, environmental variables and governance variables impact on CO_2 emissions.

So the main causes of the CO_2 emissions have been categorized into:

- Economic factors
- Demographic factors
- Environment factors
- Governance factors

The causes are considered to be having their individual impact on the CO_2 emissions. Using various measured variables representing the above mentioned factors the study tries to captures their individual impact on CO_2 emissions.

3.5.3 Part C – Structural equation model

The difference between other statistical models and structural equation model is that the later allows inclusion of observed as well as unobserved variables in one model. SEM has faced a lot of issues and challenges in incorporating the theoretical constructs into one model. Of all the issues mentioned one is use of composite variables which allows a researcher to incorporate theoretical constructs in the form of causal indicators only. This causality later helps in determining the possibility of impact of data on the dependent variable

4. Probable Results

In the last decade there has been renewed interest of researchers in testing the Environmental Kuznets Curve (EKC) hypothesis. This is because despite remarkable contributions by the investigators there is no clarity/clear evidence to support the hypothesis. The estimation results are even more misleading as various techniques has

been used giving no concrete evidence. The literatures on EKC using single variables are still unclear. Use of composite variable in examining the EKC hypothesis is very scare.

Economic growth alone with not be able to improve environmental quality of the country.

The economic factors are expected to have positive (+) correlation with CO_2 emissions; the demographic factors have both positive and negative correlation with CO_2 emissions whereas the governance factors have negative correlation with CO_2 emissions.

The present study too has its limitations in terms of availability of data for variables included in the analysis.

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