Investigating the Relationship between Environmental and Economic Goals: The Case of Developing Countries

Pinkey Sainani[1], Niaz Ahmed Bhutto[2], Kamran Ali Kalhoro[3], Jawad Ahmed Solangi[4], & Falahuddin Butt[5]

ABSTRACT

The Environmental Kuznets curve (EKC) hypothesis conjectures a nonlinear relationship between pollution and economic growth, in a way that as countries economically move in development phase, pollution initially increases but then reaches a turning point before declining in the end. Most of the EKC literature has focused on testing this basic assumption and estimating the turning point; level of development at which the per capita pollution-growth relationship changes sign. This approach has not emphasized the specific issues related to growth dimensions or the potential role of growth variables. This paper introduces a modified EKC specification which conditions the pollution (CO_2 emissions) and growth relationship on factors like manufacturing value added, agriculture value added, GDP per capita and population density. These variables are found to be significant, and have negative relationship with Co_2 emissions.

Keywords: Environmental Kuznets Curve, Growth, Co_2 Emissions.

1. INTRODUCTION

The modern world is facing serious environmental challenges. Many scientists have suggested that economies can't wait for a development path which can take them on the way of sustainable growth. They emphasized that time has come to take efforts to keep moving on the track of prolonged development. Reversing environmental losses and ensuring continuous flow of services from the earth's resources have many dimensions: maintaining forests, protecting plant and animal species, reducing carbon emissions and limiting and adapting to the effects of climate change. Improving the built environment is also important. Environmental protection is one of

[1] The author is Student in the Sukkur Institute of Business Administration, Sukkur Sindh.
[2] The author is Associate Professor in the Sukkur Institute of Business Administration, Sukkur Sindh. Corresponding author: niaz@iba-suk.edu.pk
[3] The author is Student in the Sukkur Institute of Business Administration, Sukkur Sindh.
[4]The author is Student in the Sukkur Institute of Business Administration, Sukkur Sindh.
[5] The author is Assistant Professor in the Sukkur Institute of Business Administration, Sukkur Sindh.

the eight Millennium Development Goals (MDG) adopted by the United Nations in 2000. Environmental problems, like air pollution, water pollution, diminishing natural resources, water logging, forest depletion, climate change and global warming have become the biggest threat for the human beings. The global average temperature has increased by 0.8^0C during 20th century; this trend of increase is alarming that, in future the environment can be too severe to face, for the human race. The main cause of global warming is the increment in the amount of greenhouse gasses and which increases because of human activities, i.e. uses of more fossil fuel and deforestation. It has been investigated that carbon-di-oxide is one of the most primary greenhouse gases in the atmosphere. It constitutes more than 75 percent of greenhouse gas emissions. About 80 percent of carbon-di-oxide is produced by the energy sector. Since the beginning of the industrial revolution 150 years ago, these emissions began to surge in the second half of the 20th century, reaching more than 30 petagrams (billion metric tons) a year in 2006.

One can think what is relationship between environmental quality and economic activity? Initially, Simon Smith Kuznets, a Russian- American Economist made a hypothesis about the relationship between economic growth and income inequality. He told that first income inequality rises with the rise in economic growth, but after a certain point, it tends to decrease with the increase in economic growth in the long run. This relation can be shown in the shape of inverted U-curve and was known as Kuznets curve in 1955. In 1991, Grossman and Krueger studied NAFTA and then the idea of relating environment to Kuznets curve was emerged and it was named as Environmental Kuznets Curve in 1995. According to them, as economic growth (GDP per capita) increases, environmental pollution increases. But then a turning point (threshold level) comes, after which environmental quality tends to increase as economic growth increases, but this turning point comes after a long period of time as shown in figure 1.3.

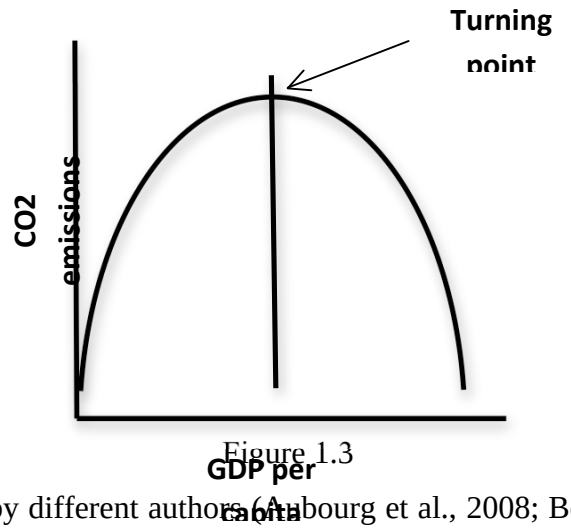

Figure 1.3

Many studies conducted by different authors (Aubourg et al., 2008; Bousquet et al., 2005), have found an inverse relationship between pollution and level of economic development for some pollutants. Because at low levels of GDP per capita, societies are more concerned about their social and economic needs than environmental pollution, they do not trade off consumption of goods and services for better environment. After reaching at a sustainable level, they start thinking seriously about their environmental quality and develop environmental standards and policies. Many environmentalists, like (Dasgupta et al., 2002; Islam, 1999), say that during the course of economic growth, there is necessarily some degradation of environment. If this will be continued in the future, then the pollution absorption level will decline by time. In order to limit this pollution progress, there should be technological improvement in pollution-saving methods; so that production can be increased without increase in pollution level.

As the environmental issues have become concern for developing countries, so keeping in view its importance, this study is devoted to check the existence of EKC. The main purpose of this study is to extend the earlier research done on Environmental Kuznets curve for developing countries by including SAARC and some emerging developing countries. The research has been done by introducing variables which contribute mainly to economic growth of countries. The technique of Regression analysis has been widely used in previous studies in learning about the EKC. The earliest EKCs are simple quadratic functions of the levels of income. Some other studies, including Grossman and Krueger, (1991) used a cubic EKC in levels and found an N-shape EKC. However, neither a quadratic nor a cubic function can be considered as a good and realistic representation of the environment–income relationship.

The article primarily analyzes the relationship between CO_2 emissions and GDP per capita and examines the ways through which countries can achieve better environmental quality and reach to sustainable growth. The rest of this article is organized in five sections. Section 2 gives the literature review on the relationship between economic activity and environment. Section 3 describes empirical analysis (Econometric model). Section 4 presents the results and section 5 concludes.

2. LITERATURE REVIEW

Many Scientists (Drabo, 2010; Aubourg et al., 2008; Bousquet & Favard 2005; Yörük & Zaim 2006; Dasgupta et al., 2002; Jorgenson, 2006; Maih et al., 2010; Dinda et al., 2010), have analyzed the relationship between environmental pollution and per capita income and their result indicates the existence of EKC. Studies suggest that the EKC result is not same for all the countries; it can be of inverted U shape, S shape as investigated by Mukherjee, (2006) in the study of India. Whereas Shen et al., (2004) found N-shape after studying the China. This specifies that, it depends upon the economy of the countries and their focus towards environment. In some of the studies conducted by (Bertinelli and Strobl, 2004; Eriksson et al., 2003; Tiezzi, 1999), the relation between economic growth and environmental quality was positive.

There is difference between the environment of developed and developing countries. Developed countries give more importance to their environment and their people are also conscious about their living style. But developing countries are lagging behind in environmental concern. That’s why the environmental quality of developed countries is better than developing countries. The authors (Nahman and Antrobus, 2005; Jorgenson, 2006), have worked on the theory of unequal ecological exchange which proves that the developed countries keep their environment clean by importing polluting goods from developing countries. When developing countries export more to developed countries, then after some time they face higher rate of deforestation in their environment.

There are several factors which can impact on environment like greenhouse gases, pollutants like CO_2, SO_2, political factors and the role of not-for-profit organizations etc. Lee et al., 2008 found a near-fitting inverted "U" curve trend by examining the relation between global greenhouse gases (GHG) emissions per capita and GDP per capita. Furthermore, Aubourg et al., (2008) explains that, policies for reducing debt burdens, introducing political reforms, can be

used as approaches to reduce pollutant emissions in developing countries. Not only political factors but also not-for-profit organizations play role in betterment of society, which create a positive impact on environment as studied by John M. et al. (2004). Authors have used different techniques to establish EKC like (Yörük and Zaim, 2006; Taskin, 2000), established environmental Kuznets curve relationship between environmental efficiency and income for OECD (Organization for Economic Co-operation and Development) countries by constructing an environmental efficiency index. Deacon and Norman, (2004) used GEMS/AIRS data. Lee et al., (2005) have worked on the relation between environment sustainability and economic growth, they used the Environmental Sustainability Index (ESI) and main focus was given to air and water quality.

SAARC countries are more vulnerable to pollution and it is necessary to know the level of pollution in these countries. In order to find the effects of environmental pollution on economic growth of these countries, economists have done research for individual countries of SAARC like several studies have been conducted by (Miah et al., 2011; Islam, 1999), about the Bangladesh. The results were supporting EKC. Barua and Hubacek, (2003) studied 16 states of India. States were divided on the basis of income, and high income states experienced U shape curve. Relatively same results for high income groups were found by Tsurumi and Managi, (2010) but not for middle income groups. In China, Shen and Hashimoto, (2004) found inverted U shape for some provinces and N shape in other.

Nowadays EKC has become an important matter for policymakers; the turning point in EKC has a major place in issues and debates. Egli and Steger, (2005) are of the opinion that turning point is affected by the use of abatement technologies. There should be subsidies provided for abatement technologies rather than tax on polluting consumption. If the countries will wait for turning point then it may take longer time to reach at that point. So the countries should become aware, and as the increasing trend is observed they must take proper steps to save the environment from pollution and try to achieve the turning point by focusing more on environmental quality and GDP.

3. EMPIRICAL ANALYSIS

3.1 Estimation Methodology

In this section, empirical analysis has been done with the help of an econometric model. The model is given below:

$$dCO_2 = \beta o + \beta_1 d(lny) + \beta_2 d(m) + \beta_3 d(p) + \beta_4 d(a) + \beta_5 d(lny) * d(p) + \beta_6 d(lny) * a + \beta_7 d(p) * d(a) + u$$

Where: d = First difference,

a = Agriculture value added (% of GDP)

m = Manufacturing value added (% of GDP).

p = Population density (people per sq. km of land area),

CO_2 = Carbon-di-oxide emissions (metric tons per capita),

lny = Natural log of GDP per capita PPP (current international $),

u = error term.

Here CO_2 is taken as dependent variable and all other as independent variables, in order to see the impact of economic growth on environmental pollution.

3.2 Variables and data

In the EKC study, the key variable is signifying environmental degradation. In this analysis CO_2 emission is taken to define environmental quality measured in metric tons per capita. Carbon dioxide emissions are those stemming from the burning of fossil fuels and the manufacture of cement. They include carbon-di-oxide produced during consumption of solid, liquid, and gas fuels and gas flaring. The other important dimension is growth, and GDP per capita is used for that. To create comparable data on real incomes, the data are in current international dollar adjusted with purchasing power parity. There are 44 countries in this study, including SAARC countries, countries which show willingness to be the part of SAARC Association and also some developing countries. Each country is observed for 17 years from 1991 to 2007. For the Growth or development of any country, factors like population density, manufacturing value added (% of GDP) and agriculture value added (% of GDP) also play vital role, and hence used in this study. Analysis has been done by using panel model on balanced data, which is taken from World Development Indicators (2010).

4. RESULTS AND DISCUSSIONS

This paper examines the relationship between growth rate of GDP per capita and change in CO2 emissions for developing countries, to see if the overall pattern accords with the predictions of EKC theory. The model in the first column of the table indicates negative relationship between change in Co_2 emissions and growth rate of GDP per capita. This can be said as basic model in which independent variable explains 0.008% of variation in dependent variable. In most of the studies; (Aubourg et al., 2008; Bousquet and Favard, 2005), the relation between these variables is positive initially, but it becomes negative afterwards. By the use of pollution abatement technologies efficiently, the emissions due to CO_2 gas will decrease and this will result in better environment. Whatever the relationship CO_2 has with GDP, there will be same relationship between CO_2 and all those factors which are related to GDP. As previously stated, economic growth of any country also affects environmental quality. So, the second model includes manufacturing value added (% of GDP) as additional variable. The effect of manufacturing value added is significant. Most importantly, the inclusion of this predictor alters the coefficient of growth rate of GDP per capita to a great extent and the R-squared has jumped from 0.008% to 18.72%. Statistically, results of this model show negative relationship with manufacturing value added; with the help of research and development, societies become efficient and they find new and better ways of producing the goods at lower cost. So in this way the manufacturing value added as percentage of GDP will increase and it will cause the pollution to decline. But if there is no efficient use of technology, then there are quite good chances that the relation can be positive. The third model has been developed with the inclusion of additional variables like Population density and Agriculture value added. Change in Population density and change in agriculture value added negatively affects the growth rate of GDP per capita. Now the results have become stronger than before; all the variables are statistically significant at the 1% level and R^2 has jumped to 25.06%. The relative magnitude of growth rate of GDP per capita has also changed considerably by adding these variables. Population density can contribute in pollution reduction in a sense that as the population increases then plantation of trees will increase and this affects the CO_2 negatively, moreover social investment (investment for trees, forests, social campaigns and arrangement of workshops for betterment of society) can be increased by the increase in population density. Besides this, as population grows the markets for goods and services become

larger and they become more proficient in machine use, and by the use of specialized machines, the quantity of smoke emitted may decrease.

Dependent Variable: CO_2 emissions per capita (metric tons)						
Variables	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
C	0.000526	0.000717	-0.00512	0.00500	0.017553	0.00151
dlny	-0.033127*	-0.22886*	-0.47117***	-0.618523***	-2.49428***	-2.66649***
dm		-0.00148***	-0.00161***	-0.00161***	-0.00172***	-0.00171***
dp			-0.00272***	-0.002661***	-0.00289***	-0.00711***
da			-0.09744***	-0.102712***	-0.03503***	-0.03154**
dlny* dp				0.004232***	7.34E-05	0.000894
dlny*a					0.121821***	0.126195***
dp*da						0.000321***
R-Squared	0.00008	0.187193	0.250628	0.266273	0.40838	0.419327
Adjusted R-Squared	-0.001264	0.185005	0.246583	0.261316	0.403576	0.41382
S.E of Regression	1.461986	1.319005	1.268197	1.255736	1.128375	1.118625
Durban-Watson Stat	2.056609	2.086666	2.091075	2.091498	2.069603	2.066936
Prob (F statistic)	0.807202	0.00000	0.00000	0.000000	0.00000	0.0000

Note: * is for 1% significance, ** is for 5% significance and *** is for 10% significance level.

This model also includes agriculture value added change as an additional control. The relative effects of manufacturing value added change are quite similar to the preceding model, while the inclusion of agriculture value added change lessens the effect of population density change. Keeping all other things constant, the agriculture value added can also help out in lessening CO_2 emissions; the logic behind this is very clear that using new forms of production and cultivating the land in a better way, will not only strengthen the economy of a country but will also decrease the pollution which may be increased either.

To find out the statistical significance of joint effects in the model, the rest of the columns have been ascertained by adding interaction terms. R^2 is increasing as we are adding interaction terms; and almost all the variables are showing significance statistically, it confirms

that the interaction terms matter. By considering the results, it shows that growth rate of GDP per capita and population density change have negative relations with CO_2 emissions, but the joint effect of these two variables is positive with respect to CO_2 emissions. It means that as the population density of developing countries is increasing, the GDP per capita will also increase, and due to more population many new factories can be established in a country, that will cause more emission of smoke and thus the CO_2 emissions will increase rapidly. Model also shows the joint effect of agriculture value added and GDP per capita on CO_2 emissions positively. In developing countries, for the purpose of more production of agricultural goods; people use more fertilizers in cultivation, by using the fertilizers the economies achieve the purpose of more production but on other hand it creates more pollution. The research suggests that most of developing countries rely on agriculture sector, and as population increases, the agriculture value added increases. The combined effect of these both variables in this model is positive on CO_2 emissions. Apart from these findings, there is no perfect multi-collinearity among the variables.

5. CONCLUSION AND RECOMMENDATIONS:

This paper contributes to the theoretical literature on the relation between pollution and the level of income per capita. More specifically, it analyzes the relationship between pollution and economic growth. In order to get estimated results, Ordinary Least Squares method has been used by mainly focusing on the growth factors of developing countries. According to the statistical results of this model, there is negative relationship between growth rate of GDP per capita and change in CO_2 emissions. It means there is contribution of CO_2 emissions in environmental pollution and if this continues for long time, then the growth of the developing countries will decrease. The Model 6 is robust comparatively to other models. The combined effect of the variables shows positive effect on CO_2 emissions, whereas, these variables have negative effect separately. These results strengthen the argument that, for the economic growth of developing countries, the environmental quality plays vital role.

Countries that make the policies only for the economic growth and neglect the environment will penalize themselves and have fewer chances to reach at their destination. Such policies reduce economic growth through adverse effects on health, and other channels. A good example of such policy is that more production in manufacturing will expose our environment to more pollution and finally it becomes very harmful for the people to survive in such

environment. In this aspect, developing countries should not ignore environmental concerns in the hope that environment would be much better with the rise in the income in future. On the contrary, policy makers should devise some policies regarding environmental issues and air quality standards should be established by local authorities in those countries. Governments should take climate conscious political decisions and investments should be done in research to develop cost-effective renewable and efficient energy technologies. Besides this, development of infrastructures should be enhanced to implement technologies that reduce CO_2 emissions. Developing countries should take measures to abate the pollution or the technologies should be imported from developed nations. Moreover, the nature of this relation depends upon the economic conditions and economic policies adopted by the countries. So, the results vary from country to country.

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