MEDWELL PUBLISHING
Environmental Research Journal 3 (1): 14-18, 2009
ISSN: 1994-5396

Economic Growth and Environmental Quality in Nigeria: Does Environmental Kuznets Curve Hypothesis Hold?

Omisakin A. Olusegun
Department of Economics, University of Ibadan, Ibadan, Nigeria

Abstract: This study investigates, the relationship between Economic Growth (GDP) and environmental quality (CO_2) in Nigeria. The Environmental Kuznets Curve (EKC) hypothesis is investigated and tested with annual data of CO_2/capita and GDP/capita from 1970-2005. EKC hypothesis postulates a relationship between economic growth and environmental degradation such that in the early stage of economic growth, the rate of environmental depletion would be on the rise and as income rises above some threshold level the magnitude of environmental impacts due to economic activity would begin to fall. The study reveals that there is no causal or long run relationship between carbon emissions/capita and income/capita in Nigeria. Again, the regression line (curve) gotten from regressing CO_2 on GDP and its square completely refute the EKC hypothesis in the case of Nigeria. Interestingly, the curve depicts a 'U-shaped' rather than an 'inverted U-shaped' curve (as suggested by the EKC hypothesis), meaning that with increase in GDP/capita, CO_2/capita first experiences a declining trend then starts rising again.

Key words: Economic growth, carbon emissions, environmental quality, environmental, kuznets curve

INTRODUCTION

The global environmental concern which has received an increasing attention is the subject that relates to the linkages or the interrelationship between economic growth and the demand for environmental quality. Economic growth implies an increase in the level of national income over time, while the issue of environmental quality concerns the state or condition of the environment. Environmental quality is a normal good though heterogeneous. Issues like global climate change, quality drinking water and air quality all fall under the purview of environmental quality. With an increase in the income of a nation, the demand for a clean and better environment is expected to increase. Therefore, a demand for environmental quality can be said to be income elastic.

From this illustration, it could be inferred that the poorer a nation is, the less concerned its people are as regards environmental protection. Since, the last part of the previous century, a good number of economic-environment researchers and various international agencies have been exploring and investigating the interaction between economic growth and the state of the environment. There have been different theoretical contributions that relate to economic growth and the environment. Grounded in the heart of these theories are economic explanation of the interrelationship between human economic activities and the ultimate response of the environment. Despite rigorous theoretical and empirical explorations, there is yet to be a univocal result as regards this relationship. Actually, most of these empirical studies have been concentrating on the 'Environmental Kuznets Curve' (EKC) hypothesis.

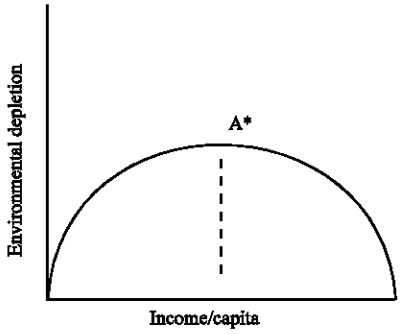

Fig. 1: Environmental kuznets curve

The EKC postulates a relationship between economic growth and environmental degradation such that in the early stage of economic growth, the rate of environmental depletion would be on the rise and as income rises above some threshold level the magnitude of environmental impacts due to economic activity would begin to fall. Following this trend, therefore, eventually an inverted 'U-shaped' curve is exhibited. Figure 1 illustrates the Environmental Kuznets Curve showing different level of economic growth and environmental depletion. Different

points on the curve reveal different level of environmental damage associated with a given income level. For instance, any position on the curve before point 'A' indicates that as income increases the pressure on the environment also increases leading to environmental depletion. Thus, point 'A' represents the threshold income level. Then after this threshold income level, the pressure on the environment is now getting reduced. This may be as a result of the fact that the people's willingness to pay for a clean environment has increased. Therefore, attention is now focused on environmental protection.

Following the pioneering research of Grossman and Krueger (1995), various empirical studies on environmental economics have focused more on the Environmental Kuznets Curve (EKC) hypothesis. There have been divergent opinions as relates to the most appropriate methodological specification that accurately capture the environment-economy relationship, the type of variable that truly represents environmental degradation and whether the analysis should be based on the cross-country or single-country time series. To this end, a remarkable number of new contributions have investigated this relationship empirically, correcting for some of the drawbacks of early studies. Despite the use of more sophisticated econometric techniques, there is still no unambiguous evidence to support the existence of the EKC hypothesis. Thus, findings from the empirical studies on EKC hypothesis still remain inconclusive.

Meanwhile, as earlier stated, one of the central issues that remain unresolved in the analysis of EKC hypothesis is whether the application should be based on cross-country or single country time series. Though, different empirical studies on environment-income relationship have been exploring the possibility of EKC hypothesis by using cross-country relationships (Shafik, 1994), arguments have been raised in favour of single-country time series analysis. Since, the developing countries contribute largely to global pollution for which data is not available, the actual level of pollution are thus underestimated with the sample selection made in cross-country studies. Also, it has been noted that the cross-country analysis may simply reflect the juxtaposition of a positive relationship between pollution and income in developing countries with a fundamentally different, negative one in developed countries, not a single relationship that applies to both categories of countries (Vincent, 1997).

Furthermore, individual analysis of EKC has been preferred to the cross-country analysis based on the fact that more could be learnt from examining the experiences of individual countries at varying levels of development as they develop over time (Stern *et al*., 1994). Moreover, the assumption of cross-country EKC that all countries will follow the same pattern in order to infer the environment-income relationship of a single country over time becomes faulty where there are regional differences among the countries investigated. Since, the cross-country analysis may fail to predict the income-environment relationship in single countries, further study is therefore, needed to understand the development of environmental degradation relative to income in a single country over time.

It is against this background that this study aims at reinvestigating the original concept of EKC by exploring the relationship between economic growth and the environmental quality for a small open developing country, Nigeria. The idea is to test whether the Environmental Kuznets Curve (EKC) hypothesis as originally proposed by Grossman and Krueger (1995) also holds for a single country rather than concentrating on panel or cross-section data for a set of countries. Another objective of this study is to determine the direction of causal relationship (if any exists at all) and cointegration evidence between environmental quality (proxied by carbon emissions) and economic growth in Nigeria. Since the reduced-form relationships reflect correlation rather than a causal mechanism (Cole *et al*., 1997), it is therefore, pertinent to establish a causal relationship between these variables in Nigeria. Again, this study reviews the carbon emissions and economic growth trends in Nigeria. Consequently, it is of paramount interest for the purpose of economic, social and environmental policies to investigate whether increase in per capita income actually lead to a reduction in environmental degradation in Nigeria.

MATERIALS AND METHODS

Economic growth and environmental issues in Nigeria: The substantial damage to Nigerian environment has been traceable to the growth of the oil industry, population explotion and a lack of environmental regulations. Nevertheless, other sources like automobiles and diesel-fired eletricity generators also contribute to air pollution. In 2001, Nigeria emitted about 23.5 million metric tons of carbon, slightly down from a high of 27.7 million metric tons of carbon emitted in 1996 but still an overall increase since 1980, when the same figure was 18.9 million. From Fig. 2, carbon emossions/capita in Nigeria started to experience a decreasing trend from 1980 with about 0.9946 metric ton to about 0.3207 metric ton in 1995. This level though reletively sustained till 2004 with carbon emission of about 0.4163 metric ton, as at 2005, the carbon emission/capita amounted to 0.5190 metric ton. Figure 3

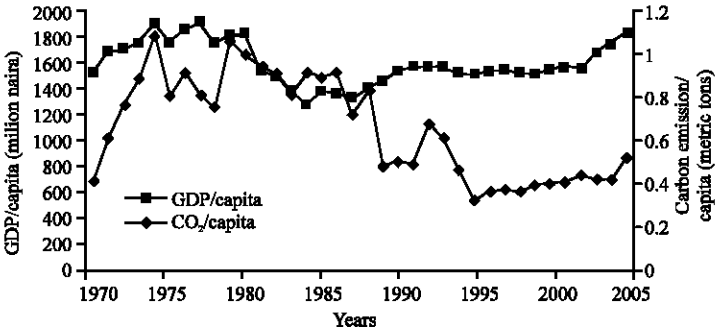

Fig. 2: GDP/capita and carbon emissions/capita trends in Nigeria (1970-2005). Source: World Development Indicators (WDI), 2007

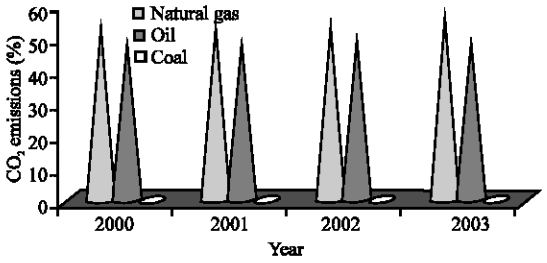

Fig. 3: Fraction of carbon emissions from natural gas, oil and coal in Nigeria (2000-2003). Source: Energy and Environment Data Reference Bank (EEDRB), 2005

also indicates the fraction of carbon emissions from natural gas, oil and coal in Nigeria from 2000-2003. While, natural gas and oil account for a larger proportion, coal only accounts for a very negligible fraction.

Scope of the study, data sources and definition: In an attempt to investigate the relationship between economic growth and environmental quality in Nigeria, this study shall employ annual time series data for Nigeria from 1970-2005. Data used in this study are sourced from World Development Indicator (WDI), 2007 CD-Rom and Energy Information Administration, 2005. The variables for the study are: Gross Domestic Income (representing income), Carbon Emissions (representing environmental quality) and Population. All variables are in their log forms and are expressed in per capita.

Model specification: In order to investigate the relationship between environmental degradation and economic growth, the following reduced-form equation model by Grossman and Krueger (1995) is specified:

$$E_t = \psi_0 + \psi_1 Y_t + \psi_2 Y_t^2 + Z_t + \varepsilon_t \quad (1)$$

From Eq. (1) Et, as dependent variable, represents the environmental quality, while Y_t is the independent variable representing the national income and Z_t other covariates. In this model Y_t is expected to influence E_t in such as a way that an inverted U-shaped curve is established. It should be noted that this relationship requires ψ_1 to be positive and ψ_2 negative. The advantage of a reduced-form approach by Grossman and Krueger (1995) is in the fact that the equation gives the net effect of national income on pollution (or environmental quality).

RESULTS AND DISCUSSION

Unit root test: Table 1 indicates the result of stationary/unit root test. The Augmented Dickey Fuller (ADF) and Phillip-Perron (PP) tests are employed in order to test the order of integration of the variables namely GDP/capita and Carbon Emission/capita. This is necessary for the purpose of determining the underlying properties of the process that generate these time series variables. Examination of test results shows that all the time series data employed in this research are stationary at first difference. The null hypothesis of 2 is rejected for all variables at the 5% significance level. Thus, the evidence suggests that first differencing is sufficient for modeling the time series considered in this study.

Causality test: In Table 2 Granger Causality result is depicted. The essence of this test is to investigate and test for causality relationship between carbon emission (CO_2) and economic growth (GDP). This test is important in the sense that it informs us about the direction of causality between these variables. There are basically 4 possibilities of these test. There could be a unidirectional, bidirectional or 'neutrality' relationship. In this study, the result reveals a 'neutrality' hypothesis thus affirming no long run relationship at all between the variables of interest namely carbon emissions and economic growth.

Cointegration test: A vector of variables integrated of order one is cointegrated if there exists linear combination

Table 1: Unit root test

	ADF				PP			
	Without trend		With trend		Without trend		With trend	
	Level	FD	Level	FD	Level	FD	Level	FD
CO_2	-0.203	-4.617	-2.119	-4.361	-0.281	-5.116	-3.345	-4.512
GDP	-2.852	-5.814	-2.849	-6.472	-2.766	-6.574	-4.593	-6.472

Note: i. ADF = Augmented Dikey Fuller, PP = Phillip-Perron and FD signifies First Difference

Table 2: Granger causality test

Null hypothesis	Lags	F-statistics	Probability
CO_2 does not Granger Cause GDP	2	2.16018	0.13350
GDP does not Granger Cause CO_2	2	1.75812	0.19025

Table 3: Johansen cointegration test

Trace test k = 2					Maximum eigenvalues Test k = 2				
			Critical values (%)					Critical values (%)	
Ho	H_A	(λ trace)	5	1	Ho	H_A	(λ max)	5	1
r≤0	R>0	11.05240	15.41	20.04	r = 0	r = 1	5.744302	14.07	18.63
r≤1	R>1	5.308094	6.02	6.65	r = 1	r = 2	5.824	7.2132	8.012

Note: r represents the number of cointegrating vectors while k represents the number of lags in the unrestricted VAR model

Table 4: Regression result

Variable	Coefficient	SE	t-statistics	Probability
Constant	12.920	2.668	4.843	0.000
GDP	-0.016	0.003	-4.706	0.000
GDP^2	4.992	1.042	4.801	0.000

Adjusted R^2 = 0.436

of the variables, which are stationary. In this study, following the approach of Johansen and Juselius (1990), two likelihood ratio test statistics, the trace and maximal eigenvalue test statistics, were utilized to determine the number of cointegrating vectors. The results of the trace and maximal eigenvalue cointegration test statistics are presented in Table 3. The null hypothesis, Ho, states that there are no cointegrating vectors. A rejection of the hypothesis would lead to testing the alternative hypothesis, H_A. The trace test statistics indicate that the hypothesis of no cointegration among the variables, Ho, is rejected. The results reveal that no cointegrating vector exists between the variables of interest. Since the variables are not cointegrated, there is, therefore, no long run relationship between the variables. This also confirms, the Granger Causality test result where no relationship is established between the economic growth and carbon emission in Nigeria.

Model estimation: Meanwhile, having confirmed the long run relationship of these variables, the next step is the estimation of the regression model specifying CO_2 as a function of GDP. It is expected that the regression equation line would also be useful by showing the shape of the Environmental Kuznets Curve (EKC) in the case of Nigeria. The curve would therefore, show whether the relatioship between carbon emission/capita and economic

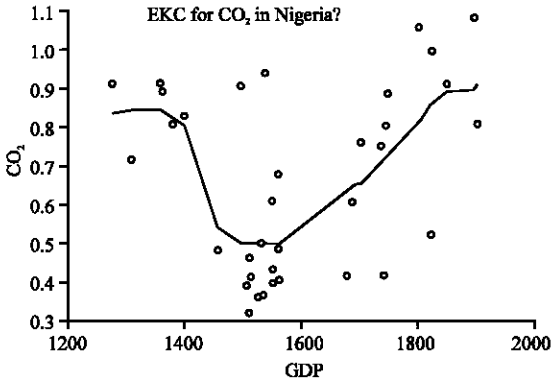

Fig. 4: Carbon emissions regression curve

growth/capita truely support the EKC or not. Table 4 reveals the Ordinary Least-Squared (OLS) regression result of our model specified in Eq. (1). Here, CO_2 is regressed on GDP/capita and the squared od GDP/capita. It could be seen from the result that the sign of GDP and GDP2 coefficients, contrary to the Environmental Kurznets Curve hypothesis where they are expected to be positive and negative, respectively, are rather negative and positive, respectively. The aim here is to test wether the coefficient signs conform to that of Grossman and Krueger (1995) model.

Figure 4 shows the results of regression emissions of CO_2/capita on GDP/capita and its squre from 1970-2005. A close examination of this figure shows that a U-shaped rather than an inverted U-shaped curve is depicted. It follows therefore that, given the time frame, initial increase in GDP/capita lead to a sharp decline in CO_2 recording about 0.5 metric ton at a point where the

GDP/capita amounts to about 1500. This declinning trend immediately begin to rise when the GDP/capita almost reach 1600 to a level where the carbon emission/capita is as high as 0.9 metric ton. This figure simply refutes the EKC hypothesis in the case of Nigeria.

CONCLUSION

There have been different theoretical contributions that relates to economic growth and environment. Grounded in the heart of these theories are economic explanation of the interrelationship between human economic activities and the ultimate response of environment. One of these theories primarily concerns itself withe relationship between the economic growth (GDP) and the environmental quality (CO_2).

This study reinvestigates the original concept of EKC by exploring the relationship between environmental degradation and economic growth for a small open developing country, Nigeria with the aim of varifying whether the Environmental Kuznets Curve hypothesis as originally proposed by Grossman and Krueger (1995) holds for a single country. This study presents the CO_2 and GDP trend in Nigeria where a decreasing trens in both variables are observed from 1975-2004. The study also reveal that there are three main sources of CO_2 in Nigeria namely natural gas, oil and coal. Exactly in 2004, natural gas contributed about 52.3%, followed by oil with about 47.5%. The contribution of coal is very negligible recording about 0.2%.

The result of Granger Causality shows that there is no causal relationship at all between the variables (CO_2/capita and GDP/capita). The Johansen Cointegration test again comfirms the causality test thus revealing no long run relationship between the variables. Finally, the regression result finds no evidence in support of EKC in Nigeria. This is due to the fact that the signs of the coefficients of both GDP and its square are negative and positive, respectively. This result therefore indicates a U-shaped rather than an inverted U-shaped (EKC-supported curve).

Based on these findings, this study concludes that though the trends of both carbon emissions and economic growth have been declining, no causal or long run relationship could be established between them and also the model estimated with the regression curve refute the EKC hypothesis in Nigeria. However, further study can still be carried out in the case of Nigeria incorporating other possible factors responsible for carbon emissions in Nigeria, for instance, the impact of trade openness and energy policy. This study recommends that the government, non-government organisations and international oil companies should research together with the aim of ensuring an improved environmental quality in Nigeria.

REFERENCES

Cole, M.A., A.J. Rayner and J.M. Bates, 1997. The environmental Kuznets curve: An empirical analysis. Envt. Dev. Econ., 2: 401-416.

Grossman and Krueger, 1995. Econmic Growth and the Environment. Quart. J. Econ., 110: 353-377.

Johansen, S. and K. Juselius, 1990. Maximum likelihood estimation and inference on cointegration with applications to the demand for money. Oxford Bull. Econ. Stats., 52: 169-210.

Shafik, N., 1994. Economic development and environmental quality: An econometric analysis. Oxford Economical Papers, 46: 757-773.

Stern, D.I., M.S. Common and E.B. Barbier, 1994. Economic growth and environmental degradation: A critique of the environmental Kuznets curve. Discussion Paper in Envt. Econ. Envt. Mgt., University of York, Vol. 9409.

Vincent, J.R., 1997. Testing for environmental kuznets curves within a developing country. Envt. Dev. Econ., 2: 417-431.