Carbon emissions, and economic growth in Africa

Olusanya, Olubusoye and Musa, Dasauki

Laboratory for Interdisciplinary Statistical Analysis (UI-LISA), Department of Statistics, University of Ibadan, Ibadan, Oyo State, Nigeria., Babcock Univeristy, Ilishan Remo, Ogun State, Nigeria

6 February 2018

Carbon Emissions, Energy Consumption and Economic Growth in Africa

Olubusoye O. E

* Laboratory for Interdisciplinary Statistical Analysis (UI-LISA),
Department of Statistics, University of Ibadan,
Ibadan, Oyo State, Nigeria.
Busoye2001@yahoo.com

Dasauki M.C.

Babcock University, Ilishan-Remo, Ogun State, Nigeria.
mdasauki@gmail.com; +234 703 087 6865

ABSTRACT: I*n this study, we applied the recently proposed income elasticity approach to investigate the presence of an inverted U relationship also known as the environmental Kuznets curve (EKC) in 20 African countries. we grouped the countries into three panels not according to any know regions, but according to income such as Low-income African economies, lower- Middle African economies and upper-Middle income African economies. We tested for the presence of an inverted U relationship for both individual-specific countries and for the 3 panels using short-run and long-run income elasticity approach. We conclude the presence of an inverted-U relationship exists when long-run Income elasticity is smaller than short-run income elasticity, meaning that as income increase over time, carbon emissions have reduced. In other words, as these individual African countries experience economic growth over time, their carbon emissions level has declined. This empirical finding is true only for Benin, Malawi, cote div our, south Africa, Botswana, and Libya, representing approximately 30% of the sample. With regards to the panel groups, we found evidence supporting the presence of an inverted U relationship only in the panel of low-income African countries with long-run income elasticity smaller than the short-run income elasticity, thus, the low-income African countries have reduced their carbon emissions level as economic growth is attained.*

Keywords: Environmental Kuznets curve, economic growth, Co2 Emissions
Word count: 198

1. Introduction

Climate change is one of the greatest challenges of man in the 21st century. It has brought about more frequent and extreme weather events accompanied by melting glaciers, rising sea levels and will impact people and nature alike. The global temperature and precipitation have changed rapidly over the last century due to increases in anthropogenic greenhouse gases (GHGs) in the atmosphere which includes burning of fossil fuels, like coal, petroleum, natural gas as well as large scale deforestation (IPCCC). According to the 5th IPCC assessment, most climate scientists agree that the main cause of the current global warming trend is the human expansion of the "greenhouse effect". Over the last century is the burning of fossil fuels like coal and oil which has increased the concentration of atmospheric carbon dioxide (CO2). This is so because the coal or oil burning process combines carbon with oxygen in the air to make CO2. To a lesser extent, respiration, the clearing of land for agriculture, industry, and other human activities have increased concentrations of greenhouse gases. Among the greenhouse gases, CO2 plays a powerful role in enhancing the greenhouse effect and is responsible for greater than 60 percent of this effect (Ozturk and Acaravci, 2010).Among all the greenhouse gases, CO2 is the most dominant gas in the atmosphere and it accounts for over 60% of the greenhouse effect (Ozturk and Acaravci, (2010).

Although Africa is the lowest source of GHG emissions (due to low levels of industrial development) compared to other regions of the world like Asia, USA, and Europe, Africa paradoxically remains the most defenseless to climate change impact and its magnitude (Beg et al., 2011, Huq et al., 2004 and Bewket, 2012) Africa is projected to be impacted by climate change with greater magnitude caused by land degradation, and desertification (Hummel, 2015). The Developing countries (LDCs), especially those in Africa rely significantly on output from the climate change sensitive-agricultural sector. Relying on such sector has placed such African economies on a more vulnerable position and the most vulnerable to the impact of climate change (Bruckner, 2012). Most African countries have very low ability and capacity to adjust to climate changes and the impact on the region (Bruckner, 2012; Hummel, 2015). According to IPCC, global temperature is expected to increase from 1.4 to 5.8°C by the year 2010 which is as a result of an increase in GHG concentration in the atmosphere, with carbon emissions as the most dominant GHG. The IPCC further made forecast temperature in Africa to rise from 2 to 6 degree Celcius in the next 100 years as sub-Saharan Africa will make losses worth US$26 million by 2060 as a result of climate change and on the other hand, high flooding and drought will follow in Africa as well (Dessalegn and Akalu 2015).

African countries are pursuing the so-called vision2020, intended to make such countries among the top 20 developed countries in the world which have been postponed and rephrased as vision 2030. Higher growth accompanied with a higher population, higher activities in all sectors of the economy such as agriculture, industrial activities, transportation, and Services; will require higher electricity production and consumption. Most African countries depend more on nonrenewable sources of energy such as those that will require the combustion of fossil fuels such as diesel, Gas, Petrol also known as PMS and also the burning of firewood, and charcoal which is dirty - carbon-emitting which will add significant amount carbon into the atmosphere over time. Thus, higher growth for Africa will be accompanied by higher environmental degradation through carbon emissions which will also come with higher consequences of climate change in African.

Since the current contribution of Africa to global emission is very insignificant compared to other developed countries, should African nations attain growth and development by first polluting or degrading the environment and later on clean up? Can African countries leapfrog the Pollution and environmental degradation stage of their growth? Alternatively, is it possible for Africa to change the direction of growth – degradation relationship in the region? This primary goal of this study investigates the relationship between carbon emission, energy consumption and economic growth under different income levels in different African countries. The study is anchored on a theoretical proposition called the environmental Kuznets curve (EKC), which states that economic growth is responsible for the degradation of the environment and subsequently the quality of the environment will improve. This study will furnish policymakers with empirical evidence of on impact of pursuing economic growth policies on the environment so as to improve the development plan of the African Region. We will also identify countries whose economic growth path is consistent with the ekc (ekc refers to an Inverted-U between carbon emission and economic growth) hypothesis to enable Policymakers in such countries can take the appropriate policy to create a turning point.

We follow the method proposed by Narayan and Narayan (2010) to test for the ekc to avoid the multi-co-linearity problem most often associated with the polynomial specifications designed to investigate the ekc-Inverted U relationships. The polynomial specification contains as independent variables such as GDP, the square of GDP and in some cases GDP raise to the third degree which enables detection linear, quadratic and cubic relationships respectively. However, Narayan et. al (2010) demonstrated that high co-linearity will exist in such models which will lead to spurious results, thus, inferences drawn from spurious results will be misleading in policymaking with great implications. Narayan et. al (2010) proposed the criteria to investigate the presence of ekc. When the long-run income elasticity of income (GDP) is less than the short-run income elasticity. Alternatively, if the short-run income elasticity is positive and statistically significant and the long-run income elasticity is negative and statistically significant, then it suggests the presence of ekc, which implies that carbon emissions have increased and reduced over time as income in the country increases. We examine the ekc for individual specific countries and for panels of countries which are organized not according to known regions of the world such as North, East, South nor West Africa etc, but based on income as organized by the World Bank grouping of countries for 2018. The countries in each panel were organized according to income because we observed that even those countries within the same region do not grow nor develop at the same pace, as some countries grow and develop faster than others even in the same region. Thus, we categorized African countries into 3 panels consisting of Low-Income African economies, Middle-Lower Income African economies, and Middle-Upper Income African Economies.

2. Literature Review

Narayan and Narayan (2010) investigated the presence of the environmental kuznet curve (henceforth, ekc) for 43 developing countries covering 1980-2004 using their respective short-run and long-run income elasticity. The study propounded that, a long-run income elasticity that is smaller than short-run income elasticity is evidence supporting the presence of ekc or inverted U relationship between carbon emission and economic growth. the study tested the short and long-run income elasticity of 43 developing countries to examine the EKC hypothesis from 1980–2004. They propounded as evidence of EKC that if the long-run income elasticity is smaller than the short-run income elasticity, then a country has reduced CO_2 emissions due to the increased income. Empirical findings of the study suggest the presence of ekc for approximately 35% of the sample, indicating that carbon dioxide emissions have reduced in the long-run as income increased. The presence is an inverted-U relationship (EKC) is also detected for panels of Middle Eastern and South Asian panels.

Perman and stern (2003) applied panel cointegration to investigate the presence and path of the ekc. covering a panel of 74 countries. per capital sulfur oxide emissions and per capita income and per capita income square. The study did not support the presence of the (ekc).

Dijkgraaf and Vollebergh (2001) investigated the ekc in the relationship between carbon emissions and per capita GDP for OECD counties from 1960-1990. The study also followed the polynomial specification with income and square of income and independent variables but did not find evidence supporting the presence of ekc.

Azomahou, Laisney, and Van (2006) applied a nonparametric approach to investigate the presence of ekc hypothesis. The sample for the study covered 100 countries from 1960-1996. The study found evidence supporting ekc for some of the countries.

Galeoti et al. (2006) estimated the existence of EKC using a Weibull functional form; the model was estimated by Maximum Likelihood (ML) on carbon emission for 125 countries. The findings appear mixed; with evidence of an EKC with a reasonable turning point for the period 1960-1967 for OECD countries, while a concave pattern with no reasonable turning point is obtained for non-OECD countries during 1971-1997.

Bertinelli and Strobl (2005) attempt examining the existence of an EKC in a cross country study using a semi-parametric regression estimator for 122 countries for the period of 1950-1990 and the result was unable to reject the linearity of the relationship between income and pollution. In another Similar study, Bertinelli and Strobl (2004) and Nguyen-Van (2009) found evidence in support of EKC for SO_2 and CO_2. While Omisakin (2009) investigated the relationship between economic growth and environmental quality in Nigeria using Johansen cointegration analysis for the period 1970-2005 with no evidence to support EKC.

Charfeddine and Mrabet (2017) employed Pedroni panel cointegration test and Granger causality in panel VECM framework to evaluate the EKC hypothesis for 15 MENA (the Middle East and North African) countries over the period 1975–2007. EF was used as a proxy of environmental degradation. Other variables are energy used, real GDP, life expectancy at birth, fertility rate and political-institutional index. The estimation was done for all MENA 15 countries, for oil-exporting and non-oil-exporting countries sub-samples. real GDP per capita exhibits an inverted U-shaped relationship with EF in oil-exporting countries and in the sample as a whole, hence, the EKC hypothesis is validated. For the non-oil-exporting countries, the relationship between EF and economic growth is U-shaped, hence EKC is not supported.

Methodology

2.1 Data and Result

Data

This study is focused on only African countries with data set covering the period of 1990 to 2014. The countries each panel was chosen by the availability of data. We obtained Carbon emissions and Gross domestic product (GDP) data from the World Bank. The study divided 20 African countries into three-panel groups, not according to any known regions of the world, but according to income – following World Bank grouping of countries

in the world according to income, and this is simply because different countries grow at a different pace even for countries within the same region. The 20 countries are grouped into 3-panel groups composed of: a panel of 9 Low-income African countries; a panel of 6 Middle-Lower African countries and a panel of 5 Middle-Upper-income African Countries.

4.1 Discussion of Unit root test results

As a pre-test for cointegration in panel regression analysis, we applied Augmented Dickey fuller tests to ascertain the order of integration of the individual variables in the study. We confirmed after application of ADF model that all variables under consideration – GDP, Carbon Emissions and Energy consumption, for all 21 African countries, are integrated of order one, however they become stationary after first difference. Although there are numerous unit root tests for panel analysis, this study will apply panel unit root tests proposed by Breitung (2000) this is simply because Hlouskova and Wagner (2006) provided evidence that in using Monte Carlo simulations the Britung (2000) panel unit root has the highest power and the least size of distortions from among a suite of panel unit root tests. (Narayan, et. al (2010) further that a significant limitation of the Breitung (2000) is in the autoregressive coefficient, which is often restricted to appear identical across units under the null hypothesis as well as under the alternative hypotheses. This limitation of Breitung (2000) has been solved by IM et al (2003) by avoiding the assumption that all units converge towards equilibrium at the same adjustment speed (Narayan, et. al (2010). The unit root test statistics for IPS and Breitung are reported in panel A of table1. For all the three panels, the two test statistics showed evidence supporting that carbon emission; energy consumption and economic growth (GDP) are Panels non-stationary.

Table 1

Panel results

	IPS			Breitung t-test		
Panel A: Unit root test for Panel regression analysis	lGDP	lECONS	LCO_2	lGDP	lECONS	LCO_2
Income-Group Panel						
Low-Income African Countries	-8.10 **	-5.91***	-6.33***	-9.29***	-5.047***	-2.10**
Middle-Lower Countries	-5.88***	-5.76***	-5.88***	-5.01***	-1.74**	-5.01***
Middle Upper countries	-5.73***	-6.42***	-4.88***	-2.42***	-4.57***	-1.03
Panel B: Test estimates from Pedroni Panel cointegration test	**Panel PP**		**Panel ADF**	**Group PP**	**Group ADF**	
Income-Group Panel						
Low-Income African Countries	-1.85*		-1.95**	-1.81**	-2.64***	
Middle-Lower Countries	-1.70**		-1.77**	-0.74	-0.67	
Middle Upper countries	-3.87***		-4.02***	-4.03***	-3.98***	
Panel C: Long and short-run income elasticity for each panel	**Long-run**		**Short-run**			**ECT**
Income-Group Panel						
	GDP	**ECONS**	**D(GDP)**	**D(ECONS)**		-0.154***
Low-Income African Countries	-0.03	0.62***	0.05	1.20*		-0.21***
Middle-Lower Countries	0.15**	0.007	0.01	1.69**		-0.44***
Middle Upper countries	0.05	0.15**	0.026	0.39**		-0.44***

Note
: *, **, *** represents statistical significance at 10%, 5% and 1% respectively.

4.3 Panel Cointegration Test

In this study, we applied Pedroni suit proposed by Pedroni (1999) and Westerlund (2007) to investigate the presence of panel long-run cointegration among carbon emissions(C02 emissions), Energy consumption and Economic Growth in Africa. According to Narayan et. al (2010) Pedroni cointegration is a suit with seven test statistics; panel v-statistics, panel t-statistics (non-parametric), panel ρ- statistics, the panel t-statistics (parametric), the group ρ-statistics, the group t-statistics (non-parametric) and the group – statistics (parametric). We specify the regression of panel cointegration as follows:

$$lCo2_{i,t} + \beta_i + \beta_i lGDP_{I,T} + \beta_2 Econs_{i,t} + \varepsilon_{i,t}$$

T=1,…, T; i=1,…, N

Table 2: Long-run and short-run income elasticity for individual countries

AFRICAN COUNTRIES	Long-run GDP	Long-run ECONS	Short-run D(GDP)	Short-run D(ECONS)	Short-run ECM
Panel A: Low-Income Countries					
Benin	**0.74** (2.39)**	**0.008 (0.02)**	**0.34* (1.97)**	**0.008 (0.03)**	**-0.45 **(-2.47)**
Burkina Faso	**0.50*** (10.8)**	**0.20*(1.76))**	**0.29*** (3.76)**	**-0.085 (-0.66)**	**-0.58*** (-3.68)**
Burundi	**0.09 (0.73)**	**-1.45***(-6.59)**	**0.069 (0.85)**	**0.55**(-0.66))**	**-0.79***(-3.22)**
Ethiopia	**0.17 (1.80)**	**0.68 (3.22)****	**0.07 ()**	**0.29** (3.45)**	**-0.42** (=2.31)**
Liberia	**-0.34**(-1.87)**	**1.18**(2.71)**	**-0.23**(-2.12)**	**0.79**(3.10)**	**-0.67***(-4.34)**
Malawi	**-0.23 (0.26)**	**1.24 (1.22)**	**-0.8 (2.14)**	**-0.43 (0.15)**	**-0.34 (0.21)**
Zimbabwe	**1.18 (1.63)**	**-7.10 (4.35)**	**-0.19(-1.06)**	**0.22(0.22)**	**-0.18**(-1.90)**
Senegal	**-0.233(-1.51)**	**1.24(0.81)**	**-0.08(-1.32)**	**0.43(0.93)**	**-0.34(-1.69)**
Mali	**0.09(0.21)**	**0.34(0.23)**	**0.03(0.20)**	**-1.99(-1.45)**	**-2.99*(-1.90)**
Panel B: Middle-Lower Countries					
Nigeria	**-0.56(-1.14)**	**3.88(1.42)**	**-0.12(-1.12)**	**5.57***(3.30)**	**-0.22**(-1.12)**
Zambia	**6.16(0.09)**	**-18.8(-0.09)**	**0.053(0.72)**	**3.81**(3.90)**	**0.008(0.09)**
DR Congo	**1.26 (0.32)**	**0.90 (0.14)**	**-0.25*(-1.12)**	**1.17(1.28)**	**-0.14 (1.44)**
Egypt	**-0.11(-1.05)**	**0.86***(4.08)**	**-0.07 (-1.22)**	**0.55**(2.68)**	**-0.06**(-2.54)**
Kenya	**0.38(0.53)**	**-1.46(-0.53)**	**0.08 (0.55)**	**3.51**(2.21)**	**-0.22(-1.50)**
Cote di vour	**-0.28(-0.63)**	**0.20(0.32)**	**0.37(1.23)**	**1.21**(2.38)**	**-0.51**(-2.53)**
Panel C: Middle-Upper Income Countries					
South Africa	**-0.01 (0.22)**	**0.32 (1.42)**	**0.12 (1.05)**	**0.19 (1.20)**	**-0.60 (3-3.84)*****
Botswana	**0.03(0.26)**	**0.39(1.14)**	**0.025(0.26)**	**0.27(1.16)**	**-0.70**(-2.42)**
Libya	**-0.01(0.11)**	**0.32(1.29)**	**0.12(1.51)**	**0.19(1.33)**	**-0.60***(-3.06)**
Gabon	**0.19(0.93)**	**-0.50(-2.67)**	**0.07(1.09)**	**-0.20**(-2.01)**	**-0.40**(-1.94)**
Namibia	**0.32**(2.64)**	**0.10(0.42)**	**-0.22(-0.01)**	**0.73(1.44)**	**-0.94***(-4.14)**

Note:
( ) t-statistics
*, **, *** represents P-value statistical significance at 10% , 5% and 1% respectively.

From the above equation, lGDP, lEcons and lCo2 represent the natural logarithm of real GDP, energy consumption and carbon emissions respectively. The study carried out cointegration test using Pedroni's suite of tests and estimates from the tests are reported in panel B of Table 1. All the test statistics support the presence of cointegration relationship between GDP, carbon emissions and energy consumption at least at 10% level of significance for all the countries in all panels except carbon emissions for Group PP test statistics for middle-upper economies

4.4 Individual/country-specific results

Table 2 contains the long and short-run income elasticity for individual countries as well as the lagged value of the error correction term for the 20

African economics grouped into three panels according to income. Based on the world bank grouping of economies according to income for the year 2018, we present in panel A the result for countries that fall within the low income African economies which consists of 9 countries; Panel B is composed of Middle-lower income economies in Africa composed of 6 countries and Panel C for Middle-upper income African economies consisting of 5 countries.

For the Low-income African Economies, in the Long-run income elasticity is less than short-run income elasticity with coefficients of 0.34 and 0.73 respectively, which are not statistically significant. The error correction term does not support long-run cointegration.

The result shows that in the short run Benin, Burkina-Faso, Burundi, Ethiopia and Mali, GDP has a positive effect on carbon emission but only Benin, Burkina Faso are statistically significant while Liberia Malawi, Zimbabwe, and Senegal have a negative effect on carbon emissions in the short run. The short-run income elasticity for the individual countries in this panel ranges from 0.03 for Mali to 0.8 in the case of Malawi. All the countries in this panel have income elasticity less than 1. Since none of the countries with positive short-run income elasticity have corresponding negative long-run income elasticity, they do not support the presence of EKC. However, an alternative way to detect the presence of EKC-inverted U relationship as proposed by Narayan et. al (2010) is to compare the long-run impact of income on emissions with the short-run impact i.e. if the short-run income elasticity is larger than the long-run income elasticity, Vice versa, we accept the EKC hypothesis, suggesting that over time carbon emissions has increased and reduced as income increases. Based on this criterion, no low-income country is consistent with ekc hypothesis, however, the error correction terms are all signs indicating the presence of long-run cointegration except for Benin and Malawi.

The result for middle-lower income economies in Africa, only Nigeria, Egypt and Cote divour has statistically significant error correction terms which indicates the presence of long-run cointegration among carbon emissions, energy consumption and economic growth. The long-run income elasticity ranges from 0.11 for Egypt to 6.16 for Zambia. Short-run and long-run income elasticity for Nigeria, Zambia, Democratic Republic of Congo, Egypt and Kenya are not consistent with the ekc. Nigeria and Egypt have negative income elasticity in both short-run and long-run; Zambia and Kenya has statistically insignificant elasticity in long run but Kenya has significant short-run elasticity. They are all not consistent with EKC hypothesis except for cote d vour. Only cote d vour has satisfied the two criteria for the presence of ekc. It has a negative long-run coefficient and a positive short-run coefficient. In addition, it also shows that the long-run income elasticity is smaller than the long-run income elasticity. Both short-run and long-run income elasticity are statistically significant.

For Middle-Upper Income African Economies, only South Africa and Libya support the presence of the ekc, satisfying the two criterions for the presence of ekc-inverted U relationship. Both countries have negative long-run income elasticity and positive short-run income elasticity. They also satisfy the second criteria with long-run income elasticity smaller than the long-run income elasticity and are all significant at 1% significance level.

Our empirical result for Botswana and Gabon shows statistically significant positive short-run and long-run income elasticity, with long-run income elasticity larger than short-run income elasticity while in Namibia, we found evidence of positive long-run income elasticity and negative short-run income elasticity. It also shows that long-run income elasticity is greater than short-run income elasticity which is also not consistent with ekc hypothesis. Thus we do not find any evidence of the presence of ekc for Botswana, Gabon, and Namibia, however, only South Africa and Libya support Ekc hypothesis within middle-upper income countries.

5. Policy Implication

Our empirical evidence showed that only six countries out of 20 countries, representing 30% of the countries covered in this study have reduced their emissions over time as income increases. The remaining 12 countries representing 70% rather increased their emissions as income increases. Thus we suggest deployment of all necessary measures to help reduce emissions level such as using more energy-efficient devices, carbon trading system, the imposition of a carbon tax on polluters among several other measures.

6. Conclusion

There is quite a large pool of empirical studies that investigated the ekc, however, most of the studies, due to spurious nature of the model such studies follow; we applied a recently developed technique to detect the presence of ekc proposed by Narayan and Narayan (2010). Our study differs from Narayan et al (2010) by extending the study to the year 2014.

We contribute to the existing empirical literature by performing the first notable empirical study to apply the income elasticity approach proposed by Narayan and Narayan (2010) to investigate the presence of ekc strictly focusing on only African countries, to best of our knowledge. by performing a panel study on 20 African countries pooled into 3 panels according to world banks income groups such as low income, middle-lower income, and middle upper-income African countries. We found evidence that in six (6) countries, Benin, Malawi, Cote divour, South Africa, Botswana, and Libya, representing 30% of the sample, there is a reduction in carbon emissions over time. Alternatively, we found no evidence of an inverted U relationship in low-income countries. These countries will increasing their future emissions and a turning point has not been reached. When we considered the lower-middle-income countries we found an inverted U relationship only for Cote devour out of 6 lower-middle-income countries. We found evidence of an inverted-U-relationships in the Middle-Upper income African countries for South Africa and Libya. Thus we can conclude that as income increases in Africa, the level of environmental degradation, in this case, carbon emissions, will increase for 14 countries considered in this study, while only 6 countries have reached a turning point.

We recommend adoption of renewable energy such as solar, hydroelectricity, wind and all other forms of clean energy as well development of favourable economic policies that will ensure smooth financing and adoption of this new technology on a wide scale into production, transportation, household; and the use of legal institutions etc. all of these efforts will help to create a turning point (an inverted U relationship) which will ensure the attainment of both the objective of economic growth without degrading the environment and averting the future impact of climate change.

References

Azomahou, T., Laisney, F., Van, P.N., 2006. Economic development and CO2 emissions: a nonparametric panel approach. Journal of Public Economics 90, 1347–1363.

Beg N, Morlot JC, Davidson O, Afrane-Okesse Y, Tyani L, Denton F, Sokona Y, Thomas JP, La Rovere E, Parikh JK, Parikh K, Rahman(2011). Linkages between Climate Change and Sustainable Development. Clim. Policy 2(2-3):129-144.

Bertinelli, L., Strobl, E., 2005. The environmental Kuznets curve semi-parame- trically revisited. Economics Letters 88, 350–357.

Bewket W (2012). Climate change perceptions and adaptive responses of smallholder farmers in Central Highlands of Ethiopia, Int. J. Environ. Stud. 69(3):507-523.

Breitung, J., 2000. The local power of some unit root tests for panel data. In: Baltagi, B. (Ed.), Advances in Econometrics, Nonstationary panels, panel cointegration, and dynamic panels, 15. JAI Press, Amsterdam, pp. 161–178.

Bruckner M (2012). Climate change vulnerability and the identification of least developed countries (LDCs). The United Nations Development Policy and Analysis Division Department of Economic and Social Affairs. pp. 3-15.

Bruno, M. and W. Easterly (1998), "Inflation Crisis and Long-Run Growth", Journal of Monetary Economics, Vol. 41

Charfeddine, L., & Mrabet, Z. (2017). The impact of economic development and social-political factors on ecological footprint: A panel data analysis for 15 MENA countries. Renewable and Sustainable Energy Reviews, 76, 138–154. https://doi.org/10.1016/j.rser.2017.03.031

Dijkgraaf, E., & Vollebergh, H.R.J. (1998). Environmental Kuznets revisited – time series versus panel estimation: the CO2 case (OCFEB Research Memorandum No. 9806). Netherlands: OCFEB.

Dijkgraaf, E., & Vollebergh, H.R.J. (2001). A note on testing for environmental Kuznets curves, environmental policy, economic reform and endogenous technology (OCFEB Working Paper Series 7). Netherlands: OCFEB.

Galeotti, M., Lanza, A., Pauli, F., 2006. Reassessing the environmental Kuznets curve for CO2 emissions: a robustness exercise. Ecological Economics 57, 152–163. Hlouskova, J.,Wagner, M., 2006. The performance of panel unit and stationary tests: results from a large scale simulation study. Econometric Reviews 25, 85–116.

Gosh, A. and Phillips, S. (1998), "Warning: Inflation May Be harmful to your Growth", IMF Staff Papers, 45(4).

Huq S, Reid H, Konate M, Rahman A, Sokona Y, Crick F (2004). Mainstreaming adaptation to climate change in LDCs. Clim. Policy 4(1):25-43.

Im, K.S., Pesaran, M.H., Shin, Y., 2003. Testing for unit roots in heterogeneous panels. Journal of Econometrics 115, 53–74.

Intergovernmental Panel on Climate Change (IPCC). (2007). Climate change 2007: Synthesis Report. Cambridge: Cambridge
IPCC (2009). Mitigation of Climate Change: The Working Group III Contribution to the IPCC 4th Assessment Report.

IPCC (2014). Hijioka, Y., E. Lin, J.J. Pereira, R.T. Corlett, X. Cui, G.E. Insarov, R.D. Lasco, E. Lindgren, and A. Surjan (2014). Asia. In:Climate Change. pp. 1327-1370.

IPCC (2014). Jiménez Cisneros, B.E., T. Oki, N.W. Arnell, G. Benito, J.G. Cogley, P. Döll, T. Jiang, and S.S.

Kuznets, S. (1955). Economic growth and income inequality. American Economic Review, 49, 1-28.

Narayan and Narayan (2010) Carbon dioxide emissions and economic growth: Panel data evidence from developing countries. *Energy Policy* 661–666

Narayan, P. K, & Narayan, S. (2010). Carbon dioxide and economic growth: panel data evidence from developing countries. Energy Policy, 38, 661-666.25(2), 191-198.

Narayan, P.K., et al., Economic growth and carbon emissions, Econ. Model. (2015), http://dx.doi.org/10.1016/j.econmod.2015.10.027

Narayan, P.K., Narayan, S., Smyth, R., 2008. Are oil shocks permanent or temporary? Panel data evidence from crude oil and NGL production in 60 countries. Energy Economics 30, 919–936.

Omisakin, A.O. (2009). Economic Growth and Environmental Quality in Nigeria: Does Environmental Kuznets Curve hypothesis hold? Environmental Research Journal,3(1), 14-18.

Pedroni, P., 1999. Critical values for cointegration tests in heterogeneous panels with multiple regressors. Oxford Bulletin of Economics and Statistics Special Issue, 653–670.

Perman, R., Stern, D.I., 2003. Evidence from panel unit root and cointegration tests that the environmental Kuznets curve does not exist. The Australian Journal of Agricultural and Resource Economics 47, 325–347.

Stern, D.I., Common, M.S., 2001. Is there an environmental Kuznets curve for sulfur?. Journal of Environmental Economics and Management 41, 162–178. Stern, D.I., 2004. The rise and fall of the environmental Kuznets curve. World Development 32, 1419–1439.

Westerlund, J. 2007. Testing for error correction in panel data. Oxford Bulletin of Economics and Statistics 69: 709–748

Ozturk, Ilhan, Acaravci, Ali,2012.The long-run and causal analysis of energy, growth, openness, and financialdevelopmentoncarbonemissionsinTurkey.Energy Economics36(c),262–26710.1016/j.eneco.2012.08.025.