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The Effects of Energy Consumption and Economic Growth on Carbon Dioxide Emissions (CO_2) in Sub-Saharan Africa

Dauda Ibrahim Dan'Asabe[1], Alhaji Bukar Mustapha[2] and Muhammed Danladi Tukur[3]

[1]*Department of Economics, Faculty of Humanities, Social and Management Sciences Federal University, Wukari*
[2]*Department of Economics, Faculty of Social Sciences, University Maiduguri*
[3]*Department of Economics, Faculty of Social Sciences University of Maiduguri*
Email: ddaudaibrahim@gmail.com

Abstract
The main objective of this study is to examine the effects of energy consumption and economic growth on carbon dioxide emissions (CO_2) in 21 Sub-Saharan African countries (SSA) over the period 2006-2014. The data were analysed using static model (which include panel fixed effect and random effect model) and dynamic model of Generalize Method of Moment (GMM) which is the main model for the study are employed to conduct this empirical analysis. The empirical findings from the fixed and random effect model of the study reveals that energy consumption and economic growth have positive and significant effect on carbon dioxide emissions and the fixed effect model is more appropriated. The results from dynamic panel GMM estimation revealed that energy consumption and economic growth also do increase carbon dioxide emissions in the sample countries. The study recommends that a series of policy measures related to economic growth and energy consumption should be taken to reduce CO_2 emissions. The SSA Government should increase significantly the investment and the share of its green energy in the total energy consumption. They may equally promote strategies and implement economic growth expansion policies that are friendlier to environmental quality as predicted by Environmental Kuznets Curve (EKC).

Keywords: Carbon dioxide emissions, Sub-Saharan Africa, Economic Growth, Energy Consumption

1.0 Introduction

The increase in global warming and climate change and its effect on environment has been of immense concern to countries worldwide over the past decades. The world began to experience global climate change during the 19th and 20th century when industrialized nations commenced the use of fossil fuel like oil and coal. The global climate change could be attributed to major transformation in the use of energy. For example in the 19th century coal replaced waterpower, then to the use of oil to fuel engines and motor vehicles after the first transformation (Muller-Kuckelberg, 2012).

Carbon dioxide (CO_2) is one of the greenhouse gases (GHG) and is considered as the most concentrated greenhouse gas in the atmosphere and has over a century atmospheric lifetime. As a result, Brundtland Commission report (1987) declared the accumulation of CO_2 as one of the environmental threats to the planet (Global Environmental Outlook, 2007). There are several environmental damages which cause global warming and climate change, but CO_2 remain the dominant gas of the total GHG in the world and in 2010 was the highest in history (IEA, 2011). CO_2 is a natural gas that has its natural occurrence through photosynthesis, animal grazing, rock weathering and respiration of humans. The highest concentration of CO_2 could said to be human-induced through combustion, the use of fossil fuel for energy as well as deforestation and land-use practices. The clearing of forest for agriculture, bush burning, and urban development may release the stored CO_2 in trees and reduces the environment's future capacity to absorb CO_2 which could affect climate change. United Nations Framework Convention on Climate Change (UNFCCC) sees Climate change as a change of Climate which attributed directly or indirectly to human activity that alter the composition of the global atmosphere and which is in addition to natural climate variability observed over a comparable time periods (Global Environmental Outlook, 2007). The manufacturing sector plays a vital role in economic growth of every nation. However, its operation is associated to CO_2 emissions, which are perceived to be one of the main determinants of environmental damage that could affect and degrade the environmental quality.

Achieving sustainable, inclusive economic growth and development is considerably important and remains an issue of great concern to developing countries especially Sub Saharan Africa (SSA). In an effort to attain sustainable growth and development require not only the proper coordination of the different sectors of the economy but also encompasses the use of different policy instruments. Many countries in SSA have attempted several policies, many of which are intended not only to inject growth into their economies but also to ensure that growth is sustainable without tempering the quality of the environment.

It is often argued that promoting economic growth and development requires the use of natural resources in economic activities which implies tampering with the environment. This argument however, does not imply improper and inefficient utilization of environmental endowments but rather creates an urgent need for efficient, sound and sustainable utilization of the environment (Diarrassouba & Boubacar, 2009).

The SSA is making a progress with economic reforms and the region has maintained prudent macroeconomic policies, fortified financial institutions and is making reforms to transform their economy structurally. The reforms effort, supported by infrastructure investment, revenue from high oil prices, has resulted to significantly improve macroeconomic variables such as moderate inflation and strong GDP growth. The GDP growth rose from 3.51% in 2000 to an estimated 6.23%, 5.58% and 4.68% in 2005, 2010 and 2014 respectively (World Development Indicators, 2017). The growth in 2014, in the aftermath of the global economic slowdown of 2012, underscored the resilience of the region's economy and to the extent that the prudence of its economic policies. Medium-term prospects in SSA are also bright, with real GDP growth projected to stand strong and stable at 4.2%, in 2015 and 4.6 in 2016 and accelerated to 5.0% in 2017 (Global Economic Prospect, 2015).

In spite of these positive developments, the SSA countries remain confronted by many serious challenges. Rapid population growth, climate change coupled with massive increase in the rate of deforestation which could affect agricultural output and thus growth. The region albeit didn't sign Kyoto protocol as developing nations and have challenges of reducing pollutant emissions on energy use. Kyoto is an international agreement held in Japan in 1997 and took force in 2005, which mandated the industrialized nations to cut their GHG emissions and asked developing nations to comply willingly, others including China and India were exempted. Reaching these challenges remain difficult to attain in SSA countries since they are still in need of economic growth based essentially on energy, main cause of pollutant emissions. It is in the light of this that this study examined the effects of energy consumption and economic growth on carbon dioxide (CO_2) emissions in Sub Saharan Africa (SSA).

2.0 Literature Review

There are various empirical studies that dealt carbon dioxide emissions and other macroeconomic variables. Some of these studies focused on different study areas, time frame and some used different proxy variables for macroeconomic, carbon dioxide emissions and energy indicators as part of their contribution. For example, in their quest Rafindadi, et al. (2014) employ the regression by the ordinary least square on panel data and the fixed effects model on panel data regression by the least squares method of two courses to study the causal relationship between pollution and economic activity indicators in the Asia-Pacific countries for the period 1975–2012. In their study, pollution is measured by CO_2 emissions and economic indicators are measured by GDP, the production of water, the added value of natural resources, and energy consumption. They find the existence of a positive and significant relationship between CO_2 emissions and GDP. Also, they conclude that energy consumption affects positively pollution.

Apergis and Payne (2009) studied the causal relationship between carbon emissions, energy consumption, and GDP within a panel VECM for six Central American countries over the period of 1971–2004. The long-run results confirmed a positive effect of energy consumption on emissions. Granger causality test results from the authors showed a short-run causality running from energy consumption and real output to emissions, but long-run bi-directional causality was found between energy consumption and emissions. In another study, Apergis and James (2010) explore the relationship between carbon dioxide emissions, energy consumption and real output for 11 countries of the Commonwealth of independent states over the period 1992-2004. They found that in the long-run, energy consumption has a positive and statistically significant impact on carbon dioxide emissions. They equally found bi-directional causality between energy consumption and CO_2 emissions in the long run. But the short run dynamics reveal a unidirectional relationship running from energy consumption to carbon dioxide emissions and bidirectional causality between energy consumption and real output.

Al-Mulali (2011) uses a panel model for the Middle East and North Africa (MENA) countries during the period 1980-2009. Based on cointegration test results, he found that CO_2 emission, and oil consumption has a long- run relationship with economic growth. The empirical results reveal also a bi-directional Granger causality between oil consumption and economic growth in the short and long run. The author concludes that oil consumption plays a crucial role in the economic growth of the MENA countries.

To examine the effect of income, energy consumption and trade openness on carbon emissions Kwakwa and Adu (2015) uses panel unit root analysis, panel cointegration analysis and the method of FMOLS (Fully Modified OLS) and DOLS (Dynamic OLS) through the period 1977-2012 in the case of countries in SSA region. Their results show the presence of long run relationship between energy consumption and carbon emissions. They concluded that both energy consumption, income and non-income variables explain carbon emissions in SSA, albeit energy consumption and income have greater effects.

To examine the impact of economic growth and energy consumption on environmental degradation in eight Asian economies during the period 1991- 2013, by using the cointegration test, the Fully Modified OLS, and the panel causality. They utilized the trade openness, economic growth, population, energy consumption and financial development as economic indicators. The main findings of Jamel and Derbali (2016) of their study revealed that economic growth have a positive impact on environmental degradation. According to them, Fisher (1932), Pedroni (1997) and Kao (1999) confirmed the presence of long run relationship between environmental degradation and economic growth. They concluded that the existence of bi-directional linkage between environmental degradation and economic growth in case of eight Asian economies. This finding was in agreement with Omri (2013).

Farhani and Rejeb (2012) applied the panel unit root tests, panel cointegration methods and panel causality test to investigate the relationship between energy consumption, GDP and CO_2 emissions for 15 MENA countries covering the annual period 1973-2008. To deal with the heterogeneity in countries and the endogeneity bias in repressors, the authors applied respectively the Fully Modified Ordinary Least Square (FMOLS) and the Dynamic Ordinary Least Square (DOLS) approach to estimate the long-run relationship between these three factors. Their finding reveals that there is no causal link between GDP and energy consumption; and between CO_2 emissions and energy consumption in the short run. However, in the long run, there is a uni-directional causality running from GDP and CO_2 emissions to energy consumption.

Similarly, Akpan and Akpan (2012) applied a Multivariate Vector Error-Correct Model (VECM) to examine the long-run and causal relationship between electricity consumption, carbon emissions, and economic growth in Nigeria for the period 1970 to 2008. The results showed that an increase in economic growth increases carbon emissions although there was no support for the EKC hypothesis. A Granger causality test showed a uni-directional causality from income to emissions.

Bloch, Rafiq, and Salim (2012) utilize the cointegration Johansen, variance decomposition, and GC by the model error correction vectors for China during the period 1977–2008. These authors use CO_2 emission as an indicator of pollution and energy consumption, labor, capital, and GDP as indicators of economic and energy activities. Their main findings suggest that GDP and energy consumption have a positive impact on the pollution. S. Amin et al. (2012) relied on time-series data through the period 1976–2007 to examine the causal relationship among energy use, growth, and carbon emissions in Bangladesh. A Johansen cointegration test confirmed a long-run relationship among all the variables and a Granger causality test found a one way causality running from energy use to emissions.

However, all these empirical studies gave much attention to the developed and emerging countries in Asia and Europe, thereby ignoring the developing countries like Sub-Saharan Africa where the problems are even more apparent.

3.0 Methodology and Sources of Data

Model Specification

The specified model of this study was done in line with the study of Jamel and Derbali (2016) and Ali et al (2019). Remember the main objective of the study is to examine empirically and establish the impact of economic growth and energy consumption on carbon dioxide emissions in 21 SSA countries. Specifically, the study examines the impact of gross domestic product per capita and fossil fuel energy consumption on carbon dioxide emissions. The functional linear form of the model is expressed as follows:

$CO_2 = f\,(GDP, EC)$ (1)

Where: CO_2 stand for Carbon dioxide emissions per capita (CO_2), which is a function of economic growth (GDP) and fossil fuel energy as percentage to total energy (EC). The dynamic log linear econometric model that specified the cause effect relationship between the variables under study can then be express as:

$LCO_{2it} = \beta_{0i} + \alpha LCO_{2it-1} + \beta_1 LGDP_{it} + \beta_2 LEC_{it} + \beta_3 X_{it} + \lambda_t + \zeta_i + \varepsilon_{it}$ (2)

Where LCO_2 is the log Carbon dioxide emissions, αLCO_{2it-1} is the lagged dependent variable of the Carbon dioxide emissions, LGDP is the log gross domestic product (economic growth), LEC is the log energy consumption, and *X* is the vector of the other control variables [financial development (LFD), trade openness (LTO), and Urbanization (LUPO)]. While λ_t denotes country specific effect, ζ_t indicates time specific fixed effect, and β_0 corresponds to the constant. $\varepsilon_{t, (i)}$ represents the error terms. βji represents the estimated coefficients of all independent variables where j = 1, …, 5. The subscript i = 1…, 21 denotes the country. The subscript t = 1…, 9 denotes the time period. The model can be fully specified as follows:

$LCO_{2it} = \beta_{0i} + \alpha LCO_{2it-1} + \beta_1 LGDP_{it} + \beta_2 LEC_{it} + \beta_3 LFD_{it} + \beta_4 LTO_{it} + \beta_5 UPO_{it} + \lambda_t + \zeta_i + \varepsilon_{it}$
(3)

The prevalence of lagged-dependent in a model as part of the regressors make a model to be dynamic one and can cause a relationship between the disturbance term and the regressors because the lagged-dependent variable depends upon country specific effect (λ_t) and also upon time specific effect (ζ_t). To avoid Nickell (1981) bias estimation of Eq (2) which vanishes thereafter as T approaches infinity, we applied difference generalized method of moments (GMM) proposed by Arellano and Bond (1991) and a system GMM by Arellano and Bover (1995). It is in line with these techniques, once the first difference is taken in the model, the potential endogeneity, the time- and the country-specific effects and the simultaneity bias problem is removed. In order to test the validity of the estimated parameters, post-estimation test of Arellano-Bond test of second order serial correlation is conducted. The condition implies that the null hypothesis for the second order serial correlation cannot be rejected. Moreover, the Sargan test is also conducted to test the over-identification restriction because of the presence of too many moment conditions. In trying to improve in the efficiency of estimation, bias estimation may set in.

Baltagi (2005) recommended that applying a subset of these moment conditions would improve the trade-off of increased efficiency and reduced estimation bias.

Data

The data used in this study are drawn from World Bank, World Bank Development Indicators (WDI 2017) online database. We utilize annual panel data for a sample composed by twenty one Sub-Saharan countries (Angola, Benin, Botswana, Cameroon, Congo Democratic Republic, Congo Republic, Cote d'Ivoire, Gabon, Ghana, Kenya, Mauritius, Mozambique, Namibia, Niger, Nigeria, Senegal, Sudan, Tanzania, Togo, Zambia and Zimbabwe).

4.0 Empirical results and discussions

Descriptive Statistics

Table 1 highlight the descriptive statistics of the variables and shows the number of observations, the mean, standard deviation, and the minimum and maximum of the original data for the variables. For example, the mean for GDP per capita is U.S. $2,439.106 and thisd s low compared with the developed and other developing Asian countries. The minimum and maximum values of U.S. $306.5283 and U.S. $9467.364 respectively, are recorded for GDP per capita in Congo Democratic Republic in 2009 and Gabon in 2014. The mean energy consumption is 31.977563 while the highest and lowest consumption of fossil fuel energy are Mauritius and Congo Democratic Republic in 2014 and 2006 respectively. The mean for Carbon dioxide in terms of metric tons per capita is 0.7859224 and the country with highest and lowest carbon dioxide emissions are Botswana and Congo Democratic Republic with 3.367451 and 0.0280096 in 2014 and 2009 respectively.

Table 1 Descriptive statistics for the variables

Variables	**Obs**	**Mean**	**Std.Dev.**	**Minimum**	**Maximum**	**Unit of Measurements**
Carbon dioxide	189	0.7859224	0.891943	0.0280096	3.367451	Co_2 emissions metric tons per capita
Economic growth	189	2439.106	2580.011	306.5283	9467.364	GDP per capita
Energy consumption	189	31.97563	20.81908	2.6785	84.54236	Fossil fuel consumption
Financial development	189	22.37583	23.14506	-18.4406	120.3486	Domestic credit by financial sector ratio of GDP
Trade openness	189	77.09776	27.78394	19.45883	149.7796	Total exports and imports as a ratio of GDP
Urbanization	189	43.65791	15.05609	16.208	87.651	Urban population as ratio of overall population

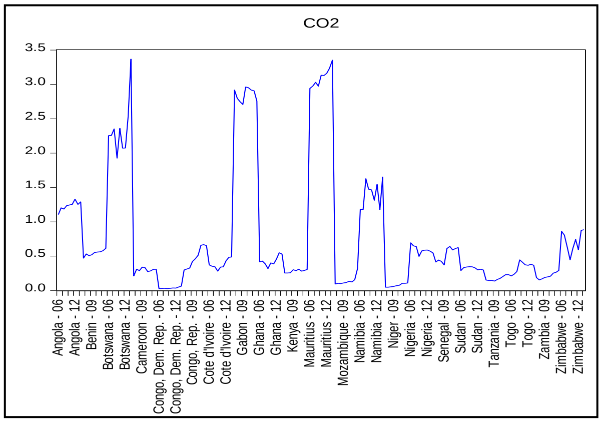
Source: WDI, 2017. Using STATA version 14

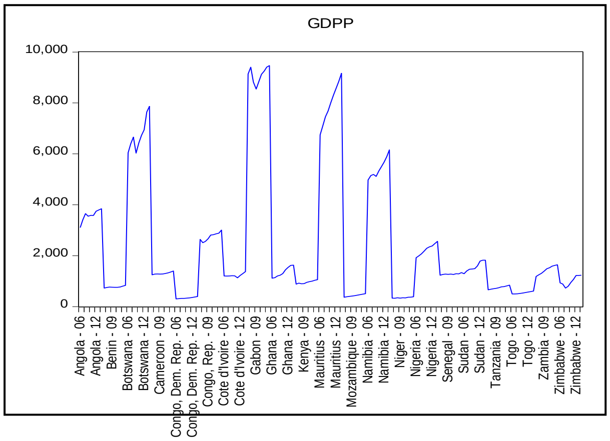
The correlation matrix shows that all the variables have a positive and significant correlation with the dependent variable (carbon dioxide emissions) as reported in Table 2. The correlation reveals no evidence of multicollinearity problem among the variables under study. Since none of the estimated coefficient among the independent variables is greater than 0.75 using the cut off line set by Tabachnick and Fidell (2007).

Table 2 Correlation matrix of the variables

	Co_2	Gdp	Ec	Fdf	To	Urbpop
Co_2	1.0000					
Gdp	0.9620	1.0000				
Ec	0.6539	0.6094	1.0000			
Fdf	0.4202	0.3349	0.5019	1.0000		
To	0.4635	0.4762	0.4219	0.1690	1.0000	
Urbpop	0.5847	0.6574	0.2968	-0.2289	0.4411	1.0000

Source: WDI, 2017/ Using STATA version 14.





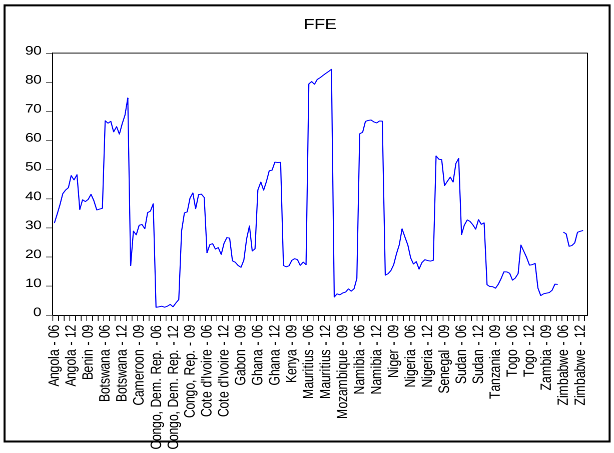


Figure 1: Trends in the Series

Before estimating the dynamic panel GMM model, which is the main model of this study, the static panel models for fixed and random effects were estimated and the results were presented in table 3. The finding reveals that there exist a significant relationship between economic growth, energy consumption and carbon dioxide emissions across the sample countries. However variables of trade openness has a positive relationship with carbon dioxide emissions, which means that increase in this variable will lead more carbon dioxide emissions.

In order to choose the appropriate model for carbon dioxide emissions in SSA Hausman test is conducted. According to the results, the fixed effect model is most appropriate than the random effect model, since the Chi-squared value (p = 0.0000) which is less than 0.05. Hence we cannot reject the null hypothesis that the fixed effect model is preferable than random effect model. The results for the main hypothesis (impact of economic growth and energy consumption on carbon dioxide emissions) are significant while the results for control variables of financial development and urbanization are insignificants, which might be due to fact that the model is not dynamic in nature. Hence dynamic panel model was applied to check if there might be changes in results since dynamic panel models are considered more efficient and have the potential in dealing with the endogeneity problems that may arises.

Table 3 Economic growth, energy consumption and Carbon dioxide in SSA: fixed and random effect models

Variables	Fixed Effect	Random Effect
Economic growth	0.5012*** (0.1619)	0.5794*** (0.0993)
Energy consumption	0.4070*** (0.0780)	0.6869*** (0.0683)
Financial development	-0.0299 (-1.0137)	-0.0162 (0.0256)
Trade openness	0.1753*** (0.0652)	0.1837*** (0.06267)
Urbanization	0.2139 (0.3938)	0.2441 (0.2379)
Number of Observations	171	171
Sample period	2006 – 2014	2006 – 2014
Number of time period (*T*)	9	9
Number of countries (*N*)	21	21
Hausman test		8.823 (0.116)
Redundant Fixed effect test (Chi-square)	63.300 (0.000) 389.09 (0.000)	

Notes *, ** and *** indicates significance levels of 10%, 5% and 1% respectively. Standard errors are in parenthesis.

The results of Arellano and Bond (difference GMM) and the Arellano Bover (system GMM) dynamic panel model is reported in table 4. Since system GMM is being considered to be more efficient and robust than the difference GMM our analysis will be based upon the system GMM. The main findings based upon the system GMM shows that economic growth and energy consumption have positive and significant impact on carbon dioxide emissions. These findings means that 1% increase in economic growth and energy consumption tend to increase carbon dioxide emissions by 0.345% and 0.276% respectively in the sample countries.

Table 4 Economic growth, energy consumption and carbon dioxide in SSA: dynamic panel GMM estimation

Variables	Difference GMM	System GMM
Lagged CO_2 emissions	0.0083 (0.0771)	0.6712 ***(0.0296)
Economic growth	0.8294 **(0.3415)	0.3457*** (0.0312)
Energy consumption	1.4257*** (0.1846)	0.2757*** (0.0248)
Financial development	-0.0322 (0.0241)	0.0388 *** (0.0129)
Trade openness	0.0544 (0.1287)	0.2246*** (0. 0327)
Urbanization	-1.6257 **(0.6425)	0.5802*** (0.1522)
Observations	171	158
Sample period	2006 – 2014	2006 – 2014
Number of code	21	21
No. of instruments	20	19
Sargan (p value)		16.30 (0.9956)
AR(2)	-0.4191 (0.6751)	-0.5439 (0.5865)

Notes *, ** and *** indicates significance levels of 10%, 5% and 1% respectively. Standard errors are in parenthesis.

These findings are in conformity with Farhani and Ben Rejeb (2012) and Jamel and Derbali (2016) who found that economic growth and energy consumption increase carbon dioxide emissions in MENA and Asian economies. The empirical results further reveal that the variables of financial development, trade openness, and urbanization also have a positive and significant impact on carbon dioxide emissions. This means that a 1% increase in financial development, trade openness, and urbanization could increase the level of carbon dioxide emissions by 0.039%, 0.225% and 0.580%, respectively.

The post-estimation tests of the models were also valid as we could not reject the null hypothesis for Sargan, which means the instruments were valid. The second order serial correlation AR (2), which is meant to check AR (1), was also valid. This mean was consistent with the GMM econometric theory. However, the main results were significant, as lagged dependent variable doesn't have any significant effect on carbon dioxide emissions in the study area when difference GMM was used.

5.0 Conclusion and policy recommendations

In this paper we empirically examined the dynamic impact of economic growth and energy consumption on carbon dioxide emissions in 21 Sub-Saharan countries, using dynamic panel GMM estimations. Based on the empirical findings, the study concluded that economic growth and energy consumption increases carbon dioxide emissions but economic growth has larger effect than the energy use in the selected countries. This means the more the increase in production and consumption of goods and services as well as the increase in consumption fossil fuel, the higher will be carbon dioxide emissions and so thus environmental degradation.

In order to reduce CO_2 emissions in the sample countries, number of measures related to growth expansions and investment in clean energy should be taken into consideration by Government and policy-makers. Specifically, the SSA Government should increase significantly the investment and the share of its green energy in the total energy consumption. They may equally promote strategies and implement economic growth expansion policies that are friendlier to environmental quality.

References

Akpan, G. E., & Akpan, U. F. (2012). Electricity consumption, carbon emissions and economic growth in Nigeria. *International Journal of Energy Economics and Policy, 2*(4), 292, 2146-4553.

Ali, H.S., Zeqiraj, V., Lin, W. L., Law, S. H., Yusop, Z., Bare, U. A. A., & Chin, L. (2019). Does quality institutions promote environmental quality? Environment Science and Pollution Research, 26:10446-10456.

Al-Mulali, U. (2011). Oil consumption, CO_2 emission and economic growth in MENA countries. *Energy, 36*(10), 6165-6171.

Amin, S. B., Ferdaus, S. S., & Porna, A. K. (2012). Causal relationship among energy use, CO_2 emissions and economic growth in Bangladesh: an empirical study. *World Journal of Social Sciences*, *2*(8), 273-290.

Apergis, N., & Payne, J. E. (2009)a. CO_2 emissions, energy usage, and output in Central America. *Energy Policy, 37*(8), 3282-3286.

Apergis, N., & Payne, J. E. (2009)b. Energy consumption and economic growth in Central America: evidence from a panel cointegration and error correction model. *Energy Economics, 31*(2), 211-216.

Arellano, M., & Bover, O. (1995). Another look at the instrumental variable estimation of error-components models. *Journal of econometrics, 68*(1), 29-51.

Arellano M, Bond S (1991) Some tests of specification for panel data: Monte Carlo evidence
and an application to employment equations. Rev Econ Stud 58(2):277–297

Baltagi BH (2005) Econometric analysis of panel data. John Wiley, Chichester

Bloch, H., Rafiq, S., & Salim, R. (2012). Coal consumption, CO_2 emission and economic growth in China: Empirical evidence and policy responses. *Energy Economics, 34*(2), 518-528.

Diarrassouba, M., & Boubacar, I. (2009). Deforestation in Sub-Sahara Africa.

Farhani, S., & Ben Rejeb, J. (2012). Energy consumption, economic growth and CO_2 emissions: Evidence from panel data for MENA region. Energy Economics and Policy, 2(2), 71-81.

Fisher, R. (1932). Statistical methods for research workers. London; Oliver and Boyd.

GEO4 (Global Environment Outlook 4), 2007. Environment for development. UNEP, Malta.

GEP (Global Economic Prospects) June, 2015

IEA (2011), International Energy Agency. http://www.iea.org/index_info.asp?id=1959

Jamel, L., & Derbali, A. (2016). Do energy consumption and economic growth lead to environmental degradation? Evidence from Asian economies. *Cogent Economics & Finance, 4*(1), 1170653.

Kao, C. (1999). Spurious regression and residual-based test for cointegration panel data. Journal of Econometrics, 90, 1-44.

Kwakwa, P. A., & Adu, G. (2015). Effects of Income, Energy Consumption, And Trade Openness On Carbon Emissions In Sub-Saharan Africa. *The Journal of Energy and Development*, *41*(1/2), 86-117.

Müller-Kuckelberg, K. (2012). Climate change and its impact on the livelihood of farmers and agricultural workers in Ghana. *Preliminary Research Results. General Agricultural Workers' Union of GTUC. Friedrich Ebert Stiftung (Fes)*, 1-47.

Omri, A. (2013). CO_2 emissions, energy consumption and economic growth nexus in MENA countries: Evidence from simultaneous equations models. *Energy Economics*, *40*, 657-664.

Pedroni, P. (1997). On the role of cross sectional dependency in dynamic panel unit root and panel cointegration exchange rate studies (Working Paper). Indian University.

Rafindadi, A. A., Yusof, Z., Zaman, K., Kyophilavong, P., & Akhmat, G. (2014). The relationship between air pollution, fossil fuel energy consumption, and water resources in the panel of selected Asia-Pacific countries. *Environmental Science and Pollution Research*, *21*(19), 11395-11400.

Tabachnick, B.G., Fidell L.S. (2007). Using Multivariate Statistics. 5th ed Boston: Pearson Education, Inc.

WDI (2017), World Development Indicators, World Bank. http://data.worldbank.org