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Energy Waste And Economic Growth In Sub-Saharan Africa: A Panel Var Analysis

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ABSTRACT
The paper critically investigated the impact of energy waste on economic growth in sub-Saharan Africa. The coverage period was from 1970 to 2019. Sub-Saharan African is broken into four regional bloc. This is imperative because there may be policy variation difference among the regional bloc. The regional bloc include West Africa, Eastern Africa, Southern Africa and Central Africa. A panel VAR estimate was obtained to unravel the direction of causality between energy waste and economic growth in each of the regional bloc. There is a relative improvement in the result when energy waste was used as a proxy for energy efficiency. There is a significant causal relationship running from energy waste to economic growth in SSA. Though, the direction of causation is negative in all the regional bloc suggesting that a decrease in energy waste is important to economic growth particularly in Southern Africa followed by Central Africa. In all the regional blocs and SSA, causality also run from economic growth to energy waste. This implies that economic growth raises energy waste. The study therefore recommends that the policy maker in SSA should concentrate more on how to reduce energy waste in order to bring about efficient use of energy.
Keywords: Energy Waste, Economic Growth, SSA, Panel VAR

1. INTRODUCTION

Energy is conceived as an important input in the production process and so is a major driver of economic growth in all economies of the world. Prior to the first oil shock in 1970, energy consumption specifically oil, has been argued to be directly related to economic growth (Akinlo, 2008; Omisakin, 2008; Odularu & Okonkwo, 2009; Machame and Orhewere, 2011; Obindah, Morgan and Romanus, 2020). Energy contributes to economic growth directly as it provides jobs and values associated with extracting, transforming and distributing of energy. In addition, energy sector activities relate to and strengthen all other sectors of the economy as energy forms an input for all production processes of goods and services.Supply interruptions of many sources of energy are known to have adverse impact on the economy of a country like Nigeria (Mckinsey, 2015). Furthermore, stable and lower energy prices could help stimulating the growth rate of any economy. This is because lower energy prices result in increasing disposable income for consumers and lowering cost for firms. The end result shows increase in firm's profit margins and higher disposable income for consumers.

However, available data shows that, since the first oil shock in the 1970s, energy prices have risen by over 100 percent per annum on the average (International Energy Agency –IEA, 2016). The continuous rise in oil prices is driven majorly by high energy demand which has adverse effect of rising energy prices on economic growth (Hamilton and Herrera, 2004; Jiranyakul, 2006). Higher energy prices, especially oil, result in fall in energy demand; depending on the energy intensity of production, increase cost of production of goods and services which can fuel inflation with negative effect on profits of firms and hence economic growth (Hamilton, 1983; 2009; Killian, 2008; Bhattacharyya, 2011). In spite of its adverse environmental consequences, conventional energy demand is expected to grow by 1.6 percent per year on average between 2006 and 2030 to an overall increase of 45 percent (International Energy Agency, 2008). No doubt this will put pressure on energy prices. Since energy is a vital input in the production process, governments and policy makers in developed and developing nations alike have paid significant attention to energy issues particularly the efficient utilization of energy since the first oil shock in the 1970s (Jiranyakul, 2006; Bhattacharyya, 2011).

Apart from the rising energy prices that may result from increased energy demand, the environmental concern of energy use, economic competiveness through improved industry profitability, improvement in livelihoods and the issue of energy supply security has further reignited keen interest among governments and policy makers in developed and developing nations including Africa on the need to produce more economic output with less energy input (Govindarajalu, Levine, Niemeyer, and Taylor and Ward, 2015). Available data shows that Global energy demand increased by 0.9% in 2019 i.e 120 million tones of oil equivalent (Mtoe), 40% percent is the rate of growth observed in 2018. But the global GDP growth declined from 3.6% in 2018 to 2.9% in 2019, curbing energy demand growth. The economic slowed down was witnessed in all most economies. In developed economies, economic growth declined sharply to 25% between 2018 and 2019. The capital situation in Africa is somewhat different. African energy demand has been driven by the growing needs of North Africa, Nigeria and South Africa. In 2018, primary energy demand was more than 830million tones of oil equivalent (Mtoe). North Africa share (40%), Nigeria (19%) and South Africa (16%) and they together accounted for almost 60% of this despite making up of 35% of the population. Average energy consumption of most African countries is well below the world average of around 2 tonnes in per capita terms. The per capita energy consumption in sub-Sahara Africa is as follows: South Africa has the highest per energy consumption of 2.3(Mtoe/capita) while Nigeria per capita energy consumption stood at 0.8 Mtoe/capita (Africa Energy Outlook, 2019). Most other sub-Saharan Africa have per capita energy consumption of around 0.4 Mtoe/capita. The rate of growth in energy demand in sub-Saharan Africa has slightly slowed in recent years and remains lower compared to GDP growth. Between 2000 and 2010, energy demand increased at an annual average rate of 3%, but this slowed to 2.5% from 2010 to 2018, with very marked variations. Fossil fuel represents almost 40% of all the overall energy mix in sub-Saharan Africa and which is more than half of the African energy mix, oil demand stands at almost four million barrels per day (mb/d) (African Energy Outlook, 2019).

In spite of the hike in energy prices, world economic growth has also increased by 4.12 per annum on the average with China, India and Middle East having the highest growth (World Development Indicator, 2019).Several factors including the movement away from energy-intensive industries towards the service sector and the efficient use of energy have explained economic growth globally and in these countries (Climate Institute, 2019).

Energy efficiency usually defined as ratio of energy consumption to Gross Domestic Product has declined significantly over the years (World Energy Commission, 2016) . The recent focus on energy efficiency is to ensure a clean environment and energy security. The efficient use of energy will mitigate the adverse effects of climate change. This is because energy efficiency has been acknowledged as the least cost to reduce the severe damage of climate change. Since energy efficiency encompasses energy saving and resources, it could also be seen as a tool to address poverty in most developing economies. The reason being that money saved from using less energy could be diverted to other productive uses in these economies. Available data indicates that global energy intensity (total energy consumption per unit of GDP) improved by 2.1% in 2019 i.e faster than its historical trend (-1.6% per year on average between 2000 and 2018 and -1.2% in 2018). However, this improvement remains far from the 3.5% per year decrease needed to achieve 2^0C scenario (Climate institute, 2020).

Energy intensity levels and trends varies across world regions reflecting differences in economic structure and energy efficiency achievement (BP's Energy outlook, 2020). For instance, China's energy intensity reduction continued in 2019 (-2.8% close to its historical trend; in 2019, its energy intensity stood at 44% between its 2000 level, still 17% above the world average, (World Energy Commission, 2020).

Collins and Fortune (2014) argued that the efficient use of energy can contribute to steady and higher economic growth by reducing the amount of energy required per unit of output which will in turn lead to a reduction in energy demand and, hence, prices. Also, given the rising energy costs and increasing taxation of emissions, including emissions from energy generated from fossil fuel, energy efficiency can provide industries and countries with a competitive advantage (Collins and Fortune, 2014). As real energy prices have been rising over the last decade and energy is a significant factor of production, more energy efficient industries and countries have a competitive cost advantage which will lead to job creation and hence reduction of poverty, (McKinsey, 2011). In addition, energy efficiency enables countries to alleviate the financial burden of oil import on their balance of trade, improve energy security and access as well as help household to save cost (World Energy Commission, 2013).

Despite the benefits of energy efficiency, there are numerous market barriers to energy efficiency. These barriers according to lEA (2010) include; lack of education, lack of access to financing, inappropriate pricing and regulation; misplaced incentives; misinformation; flaws in market structure and gold plating. Since energy efficient technologies are undertaken by private individuals, existence of market failures will imply some corrective actions are required, giving ground for government intervention (Bhattacharyya, 2011). In the case of energy efficiency, information related problem is an area where government intervention can be legitimate as private parties may not be interested in providing such a public good. Also in the presence of externalities, when prices do not reflect the correct cost to users, the consumption decision will be incorrect and governments can intervene to correct such externalities through pricing and regulation (McKinsey, 2011). Swisher and Jannuzzi (1997) suggest a number of government initiatives like information and labeling; standards and regulation, financial and fiscal mechanism. It is against this background that this study investigates how energy efficiency proxy by energy waste can serve as a driver of growth in sub-Saharan Africa.

2. LITERATURE REVIEW

In a study conducted by Nicola Cantore, Massimiliano and Dirk Willemte Verde (2016) on the relationship between energy efficiency and economic growth for a large sample of manufacturing firms across 29 developing countries to determine the relationship between energy efficiency and economic growth. The results reveal, that a lower levels of energy intensity are associated with higher total factor productivity for the majority of these countries. The estimates also shows similar robustness at the macro levels as wells. However, the paper mainly consider the sectoral level visa vis manufacturing sector.

In another study conducted by Kenneth Gillingham, David Raspson and Gernot Wagner (2015) on energy efficiency and economic growth. This study discuss how some studies in the literature consider rebound effect that results from a costless exogenous increase in energy efficiency, whereas others examine the effects of a specific energy efficiency policy. This study presents a new way out about the size of energy efficiency rebound effect. It concludes that overall, the existing studies provides little support for the growth effect of energy efficiency. However, the paper failed to give quantitative estimate of this relationship.

In a study conducted by Obindah, Morgan and Romanus (2020) on the relationship between energy intensity and economic growth in selected West African countries over the period 1988 to 2013 given data availability. The study adopted a panel fully modified least squares and panel dynamic least square. Their results indicate a positive association between energy intensity and economic growth (GDP) and GDP and electricity on the other hand. The study found that energy conservation and efficiency are needed to decide investment for the West African Power Pool (WAPP) and that energy efficiency policies and measures are also important even in countries with low access thereby increasing productivity per unit of energy consumed. The study concentrated on measurement only rather than relationship between energy intensity and economic growth. It also failed to consider an alternative measure of energy efficiency.

Philip and Xiujian (2020) investigated how China was able to achieve medium term strong economic growth with desirable target for energy efficiency. The study covers the period 2017 to 2030. A large version of computable general equilibrium was used as a means of estimation. Their results indicate that without additional action the share of coal consumption in total energy consumption will be on the increase and that the renewable forms of energy will penetrate the energy market at a slow speed. The study concluded that a well designed energy policy is needed by the Chinese economy to meet the challenges of strong economic growth.

Pan, Chen, Ying and Zhang (2020), analysed the trend of energy utilization efficiency from 1990 to 2013 with a focus on 35 European countries. Empirical result revealed that Labour correlate negatively with energy efficiency. The result also showed that price fluctuation will increase price of energy with a resultant effect of reducing the country's energy efficiency. The study also found that energy efficiency and economic development revealed a quadratic U-shaped relationship suggesting that a long term energy efficiency of the country will first decline and then rise during economic activities.

The study conducted by Katherine, Pauline, Enrique and Michelle (2020) on the need to enhance energy efficiency to increase affordability in residential lighting at Peru. The study used energy efficiency initiative to reduce expenditure by consumers for the same products or services. The initiatives include replacement of domestic appliance and equipment and the improvement of dwelling characteristics. The result of their study clarifies that the energy efficiency initiatives in developed economies varies from that of developing economies. The study observed that in developed countries, the initiatives design to improve energy efficiency will be successful if energy consumption is reduced. But in developing countries, the use of energy efficient technologies can lead to a higher consumption of energy which is a sign of affordability of energy services. The study focus only on measurement on energy efficiency. In another study conducted by Kwaku, Eric and Evelyn (2020) on the energy efficiency assessment of 46 African countries. The study made use of three different methods namely the slack based measure, bootstrapped truncated regression and two stage least squares. The results from their study indicate that African countries was on the average of 50 percent energy efficient during the study period and that based on sub-regional comparison other African sub-regions could adopt the energy efficiency policy of North Africa as a bench mark to improve energy efficiency. It was also discovered that economic development and technological progress have a significant positive effect on energy efficiency on African economies, while higher energy price lead to higher inefficiency. The study focus only on measurement.

Nelson, Amowine, Zhiquangma, Mingxing and Zhixiang (2020) conducted a study on measuring dynamic energy efficiency for 25 selected African countries from 2007-2014 using a slack based approach. Their results suggest that the 25 selected African countries are far away of being energy efficient. The study concluded that both adjustments and projections on the inputs, output should be considered to enhance energy efficiency. The study focus on measurement only.

You, Lin, Kwang, and Wee (2020) study on the linkage between energy efficiency and economic growth in Malaysia from 1971-2013. The study used an autoregressive distributed lagged model. Their results indicate that energy efficiency granger cause economic growth at the aggregate level, but not in each of the three main sectors namely primary, secondary and tertiary of the economy. The result concluded that the policy maker in Malaysian should design appropriate policies in each sector that would lead to robust growth in the economy. Again, the policy maker should also look for an alternative strategy to achieve a long-run economic growth in the economy. The study is flawed because is sectorial in nature.

Rabia, Akram, Fuzhong, Fahad, Zhiweiye, and Mohammad (2019) study on the heterogeneous effect of energy efficiency and renewable energy on economic growth in BRICS countries from 1990 to 2014.The study used panel quantile regression analysis. Their results reveal that the effect of energy efficiency on economic growth is significantly positive across all quantiles, but the effect is more pronounced at 50^{th} and 60^{th} quantiles of economic growth in BRICS countries. It was also discovered that the heterogonous panel causality test result confirmed the existence of feedback hypothesis between energy efficiency and economic growth in the BRICS countries. The findings also confirmed the existence of bi-directional causal relationship between renewable energy consumption and economic growth and a uni-directional causality existence between energy efficiency and renewable energy consumption. The study concluded that there should be more prolific use of energy in order to stimulate economic growth in BRICS countries through improvement in energy efficiency and renewable energy. It ignored non renewable energy.

In a study conducted by Leiw and Lixure (2020) on the relationship between energy efficiency and energy consumption and its influencing factors in China. The study adopts HP filter analysis from 2002-2015.

Their findings revealed that China's energy efficiency and economic growth is non-linear and that before the reform and opening up, China's output energy efficiency changed greatly. The growth energy efficiency remains stable in the long-run. While in the short run output energy efficiency relationship was influenced by fluctuation factors. The study projected that in preparing policy objectives and means of energy efficiency the long-run and the short-run must be separated. And that from the angle of sector specific based analysis, the loss of energy efficiency must be attributed to a short-run fluctuation factors, thus ensuring a stable economy is conducive to improving energy efficiency. The study is country specific in nature.

Navdeep, Bhadbhade, Selin Yilmaz, Jibran, Wolfgang, Chhmmer and Martin (2020) study on the evolution of energy efficiency in Switzerland in the period 2000-2016. The study made use of ODYSSEE energy efficiency index. a physical energy efficiency was analysed i.e the contribution of technical progress to energy efficiency improvement. The result found out that Switzerland improved its physical energy efficiency by 1.4 percent per annum in the period 2000-2016 with household being the fastest and the industry being the slowest improving sector. The study concluded that Switzerland needed to increase their rate of energy efficiency improvement in order to meet 2050 targets of Swiss energy strategy 2050. This study is country specific.

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Studies by Sergey Balitskiy, YuriyBilan, Wadim and Dalia Streimikiere (2016) on energy efficiency and economic growth in European countries from 1997 to 2011 that covers 26 EU member states represented by countries of the Euro zone. The study built a test of multivariate model originating from the neo-classical model that is augmented to include gross fixed capital formation and total labour as explanatory variables. The study used panel cointegration test and error correction model to determine whether there exists a long-term causality between economic growth and Natural gas consumption in the EU. Their result show positive association between natural gas consumption and economic growth in the EU member states. Their findings suggest a framework targeting and increasing energy intensity and efficiency. It is mainly on measurement rather than relationship.

Study conducted by Erik *et al.*(2016) on the strategic role of energy efficiency and its effectiveness in reducing climate change. The paper argued the need to move closer to the "systemicity" of the problems in the efficiency and replacement formula. They concluded that there is a need for better thinking, but also for a new primary instrument to drastically reduce energy demand and fossil fuel use. And that attention should be shifted from gains in energy efficiency to substantial year over year reduction in energy demand. Also Avik and Madhya (2015) examined the relationship between energy efficiency and economic growth in India. The study considers a reduction in energy waste as a proxy for energy efficiency and analyzed its interplay with economic growth for 1971-2010. They used vector error correction model. Their result reveal that a unidirectional causality exists from economic growth to energy waste, and this causal association is both in the short run and long run. They also observed that energy waste is negatively related with economic growth along the energy efficiency frontier. Study conducted by Hubin et al (2016) on the influential factors of energy efficiency in China in 29 provincial administrative regions in China during 1997-2011. The study applied spatial panel models to explore regional clustering. The results show that China experienced a continuous increase in energy efficiency during the sample period. In addition, they found evidence of the diffusion of energy efficiency improvements.

John and Laitner (2014) conducted an empirical studies on the link between energy efficiency and economic growth for improving the robustness of the U.S. Economy. The paper builds on a new set of data and insights of U.S data of 2010. The study noted that in 2010, U.S economy wastes 86% of the energy used in the production and distribution of goods and services. This level of energy inefficiency imposed an array of cost that hinders the robustness of American Economy. However, this study failed to discuss the relationship that exist between energy efficiency and economic growth during the period of the study.

Study conducted by Juan (2016) on the evaluation of research in the field on energy efficiency using publications data bases. The paper studied the problem of energy efficiency by using scientometric analysis to examine the trends and patterns that allow the identification of the main variables and study approximation related with a further development of models to integrate energy efficiency into policy making for small communities. The study is flawed because it is theoretical in nature.

Study conducted by Nicholas *et al* (2015) on the energy efficiency of selected OECD countries. The study analyzed the energy efficiency of selected OECD countries by using slack based method with undesirable outputs with two stage approach to assess the relative efficiency of OECD countries using the most frequent indicators adopted by the literature on energy efficiency. The result revealed different impacts of contextual variables such as economic blocs and capital-labour ratio on energy efficiency levels.

Otsuka (2017) study on the relationship between energy efficiency and economic growth in Japan, the study examined the impacts of agglomeration economies on energy efficiency on Japanese manufacturing industries. The data set (Panel data) from Japanese energy consumption prefecture statistics was used. The study came out with three empirical findings namely agglomeration economies serves as a driving force for productivity growth, have improved energy efficiency, second, productivity growth have improved energy efficiency of Japanese manufacturing industries and finally, agglomeration economies that is based on localization which occur for many medium sized cities. The study is flawed because it is sectorial in nature of which policy emanated from findings cannot be applicable to national level. The study is country specific and sectorial in nature.

RESEARCH METHODS

The coverage period was from 1970 to 2019. Sub-Saharan African is broken into four regional bloc. This is imperative because there may be policy variation difference among the regional bloc. The regional bloc include West Africa, Eastern Africa, Southern Africa and Central Africa. A panel VAR estimate was obtained to unravel the direction of causality between energy waste and economic growth in each of the regional bloc.

DATA ANALYSIS AND INTERPRETATION OF RESULT

Test for Unit root

This test is conducted to ensure that panel data used is stationary. This is because regression results conducted, where the series is not stationary may be spurious because the estimated parameters would be inconsistent. The researcher therefore, conducted the Unit Root test using Levin Lin and Chu test.

Results of the Panel Unit Root Test on Gross Domestic Product (GDP), Energy Intensity (EI), Energy Waste (EW), Labour Force (LF), Gross fixed capital formation (GFCF) and Real Price Level (PL),

Variable	95% Critical value of ADF	LLC Test Statistics	P-Value	**Order of Integration**	**Remarks**
D(EI)	164.209	-7.9334*	0.0000	I(1)	Stationary
D(EW)	184.377	-9.2328*	0.0000	I(1)	Stationary
(GDPGR)	129.668	-5.4072*	0.0000	I(0)	Stationary
D(GFCF)	228.836	-11.743*	0.0000	I(1)	Stationary
D(LF)	59.6404	0.7203***	0.0763	I(1)	Stationary
D(PL)	50.3167	1.8399***	0.0671	I(1)	Stationary

Source: Author's computation, using E-view 10, 2021
Note: * = significant at 1%, ** = significant at 5%, *** = significant at 10%

The results of the Unit Root test presented in table, showed the Levin Lin and Chu statistics with their corresponding P-values. Result showed that the probability value in reference to each variable is smaller than the alpha value at 10%. Thus, the null hypothesis that the panel contains a unit root is rejected at 10% level of significance. Thus, all the specified variables (that is, EI, EW, GFCF, PL, LF are I (1) variables, while GDP is I(0) variable. Based on the Unit Root test, these variables would yield plausible regression output.

Table 4.9: Panel VAR estimate showing causal relationship between energy efficiency (Energy Waste) and economic growth

VARIABLES	FULL SAMPLE	WEST AFRICA	EASTERN AFRICA	SOUTHERN AFRICA	CENTRAL AFRICA
GROWTH RATE					
$GROWTH\ RATE_{-1}$	0.0987	0.287**	0.0433	0.245***	0.241***
	(1.63)	(3.18)	(0.84)	(7.82)	(6.16)
$ENERGY\ WASTE_{-1}$	-9.109***	-6.873***	-3.545**	-40.53***	-19.19***
	(5.87)	(9.28)	(2.92)	(7.06)	(8.54)
CAPITAL $FORMATION_{-1}$	-2.374***	-4.576***	-6.897***	-0.258	1.440***
	(-4.00)	(-5.13)	(-6.16)	(-0.40)	-6.26
$LABOUR\ FORCE_{-1}$	7.136***	3.817**	3.548	25.18***	10.15***
	(7.58)	(2.84)	(1.55)	(6.89)	(11.14)
$PRICE_{-1}$	0.497***	1.940***	1.804**	-0.325	0.215***
	(8.88)	(12.17)	(3.09)	(-1.91)	(11.65)
ENERGY WASTE					
$GROWTH\ RATE_{-1}$	-0.0004	0.00162	-0.0005	-0.000698***	-0.00029
	(-0.98)	-1.34	(-0.16)	(-4.76)	(-0.83)
$ENERGY\ WASTE_{-1}$	0.925***	0.813***	1.033***	0.894***	0.666***
	(36.91)	(27.31)	(61.78)	(32.21)	(20.63)
CAPITAL $FORMATION_{-1}$	0.0130*	0.0346	-0.0298**	-0.0465***	-0.00963***
	(2.40)	(1.61)	(-2.89)	(-11.91)	(-5.78)
$LABOUR\ FORCE_{-1}$	-0.0294**	-0.00047	0.0441	0.0352	-0.124***
	(-2.63)	(-0.01)	(1.55)	(1.94)	(-10.24)
$PRICE_{-1}$	-0.00094	-0.0461***	-0.00862	-0.0133***	0.00339***
	(-1.74)	(-6.42)	(-1.28)	(-11.55)	(14.94)

CAPITAL STOCK					
GROWTH RATE$_{-1}$	0.00478	-0.00369	0.000167	0.0103***	0.00509***
	(1.85)	(-1.27)	(0.07)	(9.07)	(3.78)
ENERGY WASTE$_{-1}$	-0.118	0.137	0.316***	-0.840***	-0.599***
	(-0.97)	(1.64)	(5.92)	(-6.02)	(-4.59)
CAPITAL STOCK$_{-1}$	0.760***	0.611***	0.623***	0.650***	0.406***
	(19.59)	(8.03)	(11.63)	(19.70)	(21.57)
LABOUR FORCE$_{-1}$	0.0776	-0.0399	0.540***	0.0209	0.164***
	-0.94	(-0.34)	(6.24)	(0.19)	(4.07)
PRICE$_{-1}$	0.0158*	0.0855***	-0.0810***	-0.0237**	0.0265***
	(1.98)	(4.36)	(-3.59)	(-2.92)	-20.6
LABOUR FORCE					
GROWTH RATE$_{-1}$	0.00	0.00	0.000108*	-0.000230***	0.00
	(1.21)	(0.23)	(2.21)	(-7.62)	(-0.21)
ENERGY WASTE$_{-1}$	0.00582	0.0125	0.00217	-0.0345***	0.00278
	(1.48)	(1.22)	(1.12)	(-8.26)	(0.11)
CAPITAL STOCK$_{-1}$	0.00856***	-0.00992	0.0110***	0.00359***	0.00918
	(6.60)	(-0.52)	(7.32)	(4.86)	(1.00)
LABOUR FORCE$_{-1}$	0.993***	1.015***	0.995***	0.952***	1.000***
	(505.95)	(97.52)	(323.25)	(271.77)	(112.13)
PRICE$_{-1}$	-0.000417***	-0.00474	-0.00069	0.00193***	-0.00057
	(-4.20)	(-0.83)	(-0.98)	(7.78)	(-0.59)
PRICE INDEX					
GROWTH RATE$_{-1}$	-0.00980***	-0.00676**	-0.00114	-0.00597***	-0.0212***
	(-3.72)	(-2.71)	(-0.89)	(-12.09)	(-6.74)
ENERGY WASTE$_{-1}$	0.175	-0.103	-0.219***	0.224*	0.523***
	(1.09)	(-1.48)	(-4.14)	(2.45)	(5.24)
CAPITAL STOCK$_{-1}$	-0.557***	0.329***	0.0131	-0.175***	-1.114***
	(-8.61)	(6.17)	(0.52)	(-12.89)	(-40.21)
LABOUR FORCE$_{-1}$	0.672***	-0.134*	-0.0262	0.757***	1.079***
	(6.44)	(-2.01)	(-0.42)	(11.46)	(28.19)
PRICE$_{-1}$	0.839***	0.939***	0.972***	0.801***	0.854***
	(91.95)	(49.12)	(64.06)	(199.6)	(409.58)
OBSERVATIONS	415	70	170	91	82

Source: **Author's Computations using Stata 13.1, 2021**
Note: values in the parentheses are t-value
***, **, * indicate significant at 1%, 5% and 10% respectively.

When energy waste replaced energy intensity as proxy for energy efficiency, there is relatively more improvement in the result. Meanwhile, like in the case of energy intensity models, there is a significant causal relationship running from energy waste to economic growth in SSA. However, unlike the energy intensity model, the direction of causation is negative in all the regional blocs. The result suggests that decrease in energy waste is important for economic growth particularly in Southern Africa followed by the Central Africa. In all the regional blocs and SSA, causality also run from economic growth to energy waste. However, the result shows that economic growth raises energy waste. Thus it is clear that while reduction in energy waste reduces economic growth, increase in economic growth, due to more energy demand tends to increase energy waste. This result is consistent with the empirical finding of (Lee, 2005; World Bank, 2012). The bi-causality and particularly the negative effect observed in this region suggests that the region's economic activity is tending towards maturity and by implication, this leads to more improved energy use. This argument is supported with the findings of Lee (2005) and Ayres (2006).

In the same vein, economic growth is caused by capital and employment in the full sample and all the regional blocs except Southern Africa where such causation does not occur. Meanwhile, direction of causation is not uniform. For instance, capital accumulation negatively causes economic growth in the full sample and all the regional blocs except Central Africa. However, employment (labour) exerted positive causation on economic growth in the whole sample and all the regional blocs. Like the case of energy intensity model, price level in the energy waste model also indicated positive and significant causation on economic growth in SSA and all the regional blocs except Southern Africa where a negative but insignificant causation was observed. This implies that price level appears not to influence economic growth in Southern Africa.

Causality also runs from energy efficiency to capital stock in East Africa, Southern Africa and Central Africa. In any of these regional blocs, reduction in energy waste causes increase in capital stock. The direction of causation is negative in Southern and Central Africa. Such outcome could not be established in SSA and West Africa. Capital stock causes energy efficiency in SSA and all the regional blocs except in West Africa. This result therefore suggests that there is no uni-causal or bi-causal relationship between energy efficiency and capital accumulation in West Africa. Reduction in energy waste failed to cause employment in all the regional blocs except in Southern Africa where improvement in energy efficiency, (that is reduction in energy waste) causes increase in employment. There is also a significant correlation between employment and capital accumulation in the energy waste model. As the result shows, increase in capital accumulation leads to increase in employment in SSA as a whole and in all the regional blocs except in West Africa where negative causation was observed. It is also of note that price level negatively cause employment in SSA and Southern Africa. In other regional blocs, price level does not play any role in employment.

Price level causes energy efficiency in West Africa, Southern and Central Africa. In these regional blocs, it is only in Central Africa that a positive causation occurs. This implies that in Central Africa, increase in price level will cause increase in energy waste (will lead to inefficient use of energy) while in other two regional bloc where the causation is significant (West Africa and Southern Africa), the reverse is the case. Other causations shown in the Table include price and employment which is positive in SSA, Southern Africa and Central Africa. In West Africa, the causation is reverse while in Eastern Africa, there is no causation running from employment to price level. The positive causation in Southern Africa suggests that in that region, increase in employment will cause price level to rise. In West Africa however, increase in employment precipitates price level while in Eastern Africa, price level is not affected by employment. Hence it could be suggested that Southern Africa is tending towards its long run given its level of technology while West Africa bloc appears to be substituting capital for labour in their aggregate production technology. This is evidenced in the causation running from capital accumulation to price level. In West Africa, the causation is positive, suggesting that increase in capital causes price level to increase. This finding provide information to different channels through which price level is affected. Pressure on capital demand causes price level to rise in West Africa while pressure for labour demand contributes to price level in Southern Africa.

CONCLUSION

In Southern Africa, there was a bi-causal relationship between energy waste and economic growth. The negative sign suggests that in this region, decrease in energy waste and economic growth reinforces each other. The bi-directional causality between energy waste and economic growth implies that energy conservation may be viable without being detrimental to economic growth. Thus the focus should be energy waste reduction rather than energy intensity reduction. No causality was found between energy waste and economic growth in West Africa, East Africa and Central Africa. This result was in line with the findings of Hendonoyiannis et al (2002) and Huang et al (2008). The fact that causality runs in different form and direction across the regional blocs implies that recommendations should be provided on regional-specific basis.

RECOMMENDATION

A regional bloc that exhibit bi-causal relationship when energy intensity was proxy for energy efficiency is Eastern Africa. Meanwhile, direction of causation is not the same. Specifically, increase in energy intensity causes economic growth while increase in economic growth causes reduction in energy intensity. Thus, it is recommended that the Eastern Africa policy makers should embark on policies that will raise economic growth rather than focusing on energy conservation. In West Africa and Southern Africa, energy conservation will reduce economic growth. Since there is no causation running from economic growth to energy intensity in these regions, they should also focus on economic growth rather than energy conservation policy.

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