Trade Intensity, Energy Consumption and Environment in Nigeria and South Africa

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Abstract

This study examines the causal relationship between energy consumption, trade intensity and environment in Nigeria and South Africa between 1981 and 2016. The study uses a causality analysis to examine the relationship between trade intensity, carbon emissions, real GDP per capita, energy consumption, investment, and the particulate emissions. We find that energy consumption granger causes the quality of environment in Nigeria and South Africa. However, trade unidirectionally causes CO_2 emissions in South Africa and we observe a feedback effect between trade intensity and carbon emissions in Nigeria. We recommend that both countries should focus on attracting investments that will produce only clean goods such that composition effect can reduce emissions and improve environmental quality.

Key words: Energy Consumption; Trade Intensity; Environment; South Africa; Nigeria.
J.E.L. classification: F18; Q49; Q56

1. Introduction

It is evident in empirical literature and among nations that the issue of global warming requires serious attention to make the global environment conducive and safe for both biotic and abiotic species. Global warming has been attributed to the green-house-gas emissions (GHGs) that are generated from human activities. Such human activities originate from opening of the economy to foreign trade. The rise in international trade among nations necessitates improvements in the volume of goods and services produced and this has implications for the environment. Also, in the literature, it has been established that economic growth and trade precipitates environmental pollution (Porter, 1999; Stern, 2004; Mesagan, 2015). Moreover, the need to leverage on international trade to boost economic growth comes with its associated environmental implications. Also, the desire to promote growth via trade openness accompanies with it increases in fossil fuel energy consumption and has environmental consequences. Theoretically, environmental Kuznets curve (EKC) proposition provides a basis for the linkage between environmental pollution and economic fundamentals. As discussed in Andreoni & Levinson (2001), Dasgupta *et al.* (2002), and Stern (2004), improvement in a country's income per-capita increases environmental pollution at the early growth stage, gets to a threshold point and pollution begins to drop as wealth increases. This implies that income generated by trade openness has implications on pollution in a country. For countries to be able to control pollution and improve environmental quality, they must be well-suited to control the type of trade and investment flow in their economies. Empirically, studies have identified foreign trade, capital investment, economic growth and energy use as having severe implications on environmental protection (see, Schleich, 1999; Coondoo & Dinda, 2002; Saibu & Mesagan, 2016). It thus means that growth produced by international trade and increases in energy use, to cater for the growing population, has short and long-run implications on the environment (Isola *et al.,* 2017).

Regarding environmental pollution, in Nigeria for instance, the air quality has continued to deteriorate since the early 1960s when the country started crude oil exploration in commercial quantities. According to the World Bank, CO_2 emissions, which was about 3,406.6 kilotonnes (kt) in 1960 increased significantly to 21,539.96kt in 1970, despite government efforts at stemming the tide. When the Nigerian government established the Federal Environmental Protection Agency in 1992, CO_2 emission was 46,614.9kt, but by 2002, a decade after, it has risen to 93,677.2kt. It means that CO_2 emission increased by over 200% within a decade in Nigeria. This upward emission trend continued to 2014 when CO_2 emissions in Nigeria stood at 96,280.5kt (WDI, 2017). For South Africa (SA), similar upward trend was recorded for CO_2 emissions between 1960 and 2014. However, the situation is more precarious in South Africa compared to Nigeria between 1960 and 2014. For instance, in SA, CO_2 emission was 97,934.57kt in 1960 and it increased significantly to 149,763.9kt in 1970. In 1992, CO_2 emission rose from 301,687.8kt to 356,637.8kt in 2002. Furthermore, in 2014, carbon emissions in South Africa was 489,771.9kt (WDI, 2017). The situation with air pollution in the two largest African economies necessitates this study. Also, the fact that energy consumed needs to rise continuously to take care of the ever-expanding population in the two countries makes it crucial to have a study of this sort. Moreover, for African economies to join the league of developed nations, trade expansion provides the easy route to supplement their low level of industrial production. Hence, the role of trade expansion in the environmental improvement discourse also occupies the heart of this present study for South Africa and Nigeria. The study will provide a template for other African countries to follow.

2. Literature Review

Regarding the increased concern about global warming, previous studies have taken the discourse from different perspective. For instance, Erdogan (2014) researched into the effect of international trade on environmental quality in OECD economies. It was observed that global trade brought improvement to OECD environment by lowering emissions by 32%. Recent study conducted by Mesagan *et al.* (2018) confirmed that income and energy consumed worsened environmental quality while capital investment improved the BRICS environment. Similarly, when interacted, energy use and investment improved the BRICS' environment. Cherniwchan (2017) focused on the nexus between environment and trade in the US using particulate matter and sulphur dioxide emissions between 1994 and 1998 to capture environmental quality. Findings confirmed that trade significantly improved environmental quality in the US manufacturing sector. Yu and Chen (2016) decomposed and estimated the carbon emissions contained in trade flows between China and South Korea. The study found that trade volume was not responsible for the embodied emission surplus between both countries. However, it also found that trade diversion between both countries significantly reduced China's CO_2 emissions between 2000 and 2010.

Moreover, Zhang (2015) examined the interaction effect of trade openness and energy consumption on East Asia's environmental quality between 1998 and 2011. Results suggested that trade in intermediate products mitigated the negative effect of energy consumption on environment in East Asia. Moreover, when compared with trade in final goods, it was confirmed that final goods trade intensity further reduced the adverse effect of energy use on environmental quality among the East Asian economies. Hence, the study noted that the international output fragmentation of trade in intermediate products is critical to emissions abatement in East Asia. Kohler (2013) focused on the South African economy by examining the nexus between carbon emissions, energy consumption, income and trade openness from 1960 to 2009. The research, which used the ARDL confirmed long-run association among the regressors. It also employed the Vector Autoregression (VAR) technique and found that trade openness improved environmental quality as it negatively affected carbon emissions in South Africa. Also, Achike and Onoja (2014) analysed for Nigeria the determinants of carbon pollution between 1970 and 2009 using the Seemingly Unrelated Regression (SURE) technique. The study observed that international trade is a major determinant of carbon emissions in Nigeria while income exogenously determined energy demand in the country. Thus, having reviewed the foregoing studies, it becomes crucial to examine the causal nexus between trade intensity, energy use and environment in Nigeria and South Africa because both countries are the largest economies on the African continent. Also, the fact that previously related studies have not done a comparative analysis on the subject matter for the two countries leaves a noticeable gap for the present study to fill.

3. Methodology

To conduct causal nexus between energy consumption, trade, and environmental quality, we employ the causality analysis of Engle & Granger (1987). It makes it possible to obtain the causal direction of regressors in the study. The major variables include particulate emissions (PM), carbon emissions (CO_2), energy consumption (EN), and trade intensity ratio (TI) while other variables like income per capita (GDP) and capital investment (INV) are used as complimentary variables in the study. This is because the two variables are strongly related to the main variables under consideration. Hence, as presented in Engle & Granger (1987), we specify the following unrestricted and dynamic error correction model (ECM).

$$\Delta E_t = \alpha_0 + \sum_{i=1}^{p} \alpha_1 \Delta E_{t-i} + \alpha_2 V_{t-i} + \varepsilon_t \qquad (1)$$

In equation (1), ΔE is the vector of the regressed variables in the model, and ΔE_{t-i} is the vector of independent variables in the model. Furthermore, V_{t-i} is used to denote the lagged error correction terms, Δ is the difference operator, P is the lag structure, $\propto_0$ is the intercept, $\propto_1$ and $\propto_2$ are the short-run coefficients, and then ε_t is the residual term. According to Engle & Granger (1987), we can determine causal nexus among the variables within the framework of the ECM with cointegrated variables. Therefore, the individual short run causality is captured by the coefficients of the individual lagged variables. The data for the study covers a period of 1981 to 2016 and are obtained from the World Development Indicators of the World Bank (WDI, 2017) for the two countries.

4. Results and Discussions

To determine the causal nexus between energy consumption, trade and environment between Nigeria and South Africa, we present the result of the scientific enquiry. First, we present the stationarity test result using the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test. This is followed by the Johansen cointegration test of long run association. Then, the Engle & Granger (1987) causal relationship test to enable us to determine the feedback effect between energy consumption, trade flows and environmental quality. For unit root testing, unlike the tests involving Augmented Dickey-Fuller (ADF) and Philips-Perron (PP), the study uses the KPSS test owing to its strength in testing stationarity for a small sample. Therefore, the data are stationarity when the KPSS test statistic is less than the critical values.

Table no. 1: Stationarity Tests for the two Countries

Variables	**South Africa**			**Nigeria**		
	KPSS @ Level	**KPSS @ First Diff.**	**Status**	**KPSS @ Level**	**KPSS @ First Diff.**	**Status**
TI	0.737583	0.104637**	Stationary	0.638842	0.296747**	Stationary
GDP	0.627472	0.281742**	Stationary	0.603746	0.194362**	Stationary
EN	0.507424	0.289946**	Stationary	0.593756	0.101834**	Stationary
CO_2	0.400464	0.392742**	Stationary	0.684722	0.281746**	Stationary
PM	0.692653	0.274731**	Stationary	0.745351	0.374615**	Stationary
INV	0.498287	0.385742**	Stationary	0.601835	0.281047**	Stationary

*Note: ** significant at 5% critical level, Asymptotic critical values are selected using the Newey-West automatic and Bartlett kernel criteria.*

A cursory look at results in Table 1 suggests that the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test confirms that trade intensity, real GDP per capita, energy consumption, capital investment, carbon emissions, and the particulate emissions are not stationary at level for South Africa and Nigeria. This implies that the study confirms the existence of unit root at levels by rejecting the null hypothesis at 5% critical level. However, the KPSS shows that when the variables are first differenced, there is stationarity of the data at 5% level. Therefore, it implies that the null hypothesis of stationarity at first difference is accepted and hence confirm that the series are stationary. Therefore, since the KPSS test confirm that trade intensity, real GDP per capita, energy consumption, capital investment, carbon emissions, and the particulate emissions are mean reverting and converge to their long-run equilibrium.

Table no. 2: Johansen Cointegration Test Result for South Africa

Hypothesized No. of CE (s)	**Trace Test**	**Probability ****	**Hypothesized No. of CE (s)**	**Maximum Eigen Test**	**Probability ****
None *	0.648373	0.0000	None *	34.62421	0.0000
At most 1 *	0.563721	0.0094	At most 1 *	28.51042	0.0284
At most 2	0.397386	0.0692	At most 2	22.74539	0.2846
At most 3	0.201757	0.2846	At most 3	9.473642	0.3152
At most 4	0.139565	0.2632	At most 4	2.757343	0.2974
At most 5	0.102723	0.2140	At most 5	2.194521	0.2002

*Note: ** significant at 5% critical level*

In Table 2, both the trace test and the max-eigen test confirm that for South Africa, two cointegrating equations are present at 5% critical level. The interpretation is that the study rejects the no cointegration stand of the null hypothesis and accepts the cointegration proposition of the alternative hypothesis. We therefore conclude that there exists long-run association between capital investment, real GDP per capita, trade intensity, carbon emissions, particulate emissions, and energy consumption in South Africa over the study period.

Table no. 3: Johansen Cointegration Test Result for Nigeria

Hypothesized No. of CE (s)	**Trace Test**	**Probability ****	**Hypothesized No. of CE (s)**	**Maximum Eigen Test**	**Probability ****
None *	23.74631	0.0005	None *	16.38519	0.0000
At most 1	19.90134	0.1358	At most 1	12.04513	0.1274
At most 2	15.86214	0.2323	At most 2	12.82640	0.2892
At most 3	5.930641	0.3426	At most 3	9.482913	0.3017
At most 4	3.857364	0.3752	At most 4	7.834752	0.3362
At most 5	2.047282	0.4824	At most 5	4.078013	0.4598

*Note: ** significant at 5% critical level*

In Table 3, both the trace test and the max-eigen test confirm that, one cointegrating equation is present at 5% critical level for Nigeria. The interpretation is that the study rejects the no cointegration stand of the null hypothesis and accepts the cointegration proposition of the alternative hypothesis. We therefore conclude that there exists long-run association between capital investment, real GDP per capita, trade intensity, carbon emissions, particulate emissions, and energy consumption in Nigeria over the study period.

Table no. 4: Feedback Analysis for South Africa

No Causality	**Unidirectional Causality**	**Bidirectional Causality**
INV —— CO_2	EN ⟶ PM, CO_2, GDP	TI ⟷ GDP
PM —— CO_2, INV, TI	TI ⟶ CO_2	CO_2 ⟷ GDP
EN —— TI	INV ⟶ GDP	TI ⟷ INV
	GDP ⟶ PM	EN ⟷ INV

Note: (——) No causality, (⟶) Unidirectional causality, (⟷) Bidirectional causality.

In Table 4, we present the Granger causality result for South Africa and result confirm that there is no presence of causal relationship between carbon emissions and investment, between CO_2 emissions and particulate emissions, between trade and capital investment, as well as, between trade intensity and energy use. Furthermore, the South African causality result shows that there is the existence of a unidirectional causality running from energy consumed to particulate emissions, from energy use to income, and from energy use to carbon emissions. Moreover, there is unidirectional causality running from trade intensity to carbon emissions, from investment to income and from income to particulate emissions. Finally, results confirm that trade and income, trade and investment, energy consumption and investment, and carbon emissions and income are mutually causal in South Africa. The intuition is that there is a feedback effect between CO_2 emissions and income per capita, while no causal nexus exists between CO_2 emissions and investment. However, energy consumption unilaterally fuels income and carbon emissions in South Africa over the period of study.

Table no. 5: Feedback Analysis for Nigeria

No Causality	Unidirectional Causality	Bidirectional Causality
PM —— CO_2, INV, TI	EN ⟶ PM, CO_2, GDP	TI ⟷ CO_2
EN —— TI	INV ⟶ CO_2, GDP	GDP ⟷ CO_2
	GDP ⟶ PM	EN ⟷ INV
		TI ⟷ INV

Note: (——) No causality, (⟶) Unidirectional causality, (⟷) Bidirectional causality.

In Table 5, we present the Granger causality result for Nigeria and result suggests that there is no causality between particulate emissions and investment, between particulate emissions and CO_2 emissions, as well as between particulate emissions and trade intensity in Nigeria. Also, no causal nexus was found between the amount of energy consumed and trade, which intuitively implies that energy use and trade do not influence each other in Nigeria. From the result in Table 5, the study confirms that amount of energy consumed has a unidirectional causal relationship with particulate emissions, carbon emissions, and income in Nigeria while income also unidirectionally caused particulate emissions. Moreover, there is the presence of a unidirectional causality running from investment to carbon emissions and income over the study period. The intuition is that energy consumption is a propelling force to both carbon emissions and particulate emissions in Nigeria. Lastly, we find a feedback effect between trade, income, and carbon emissions, while energy consumption and trade intensity also have bidirectional causality with capital investment. It means that trade intensity and carbon emissions are mutually causal. That is, as Nigeria opens its economy to international trade, environmental quality declines and this encourages more inflow of trade subsequently, thereby giving credence to the proposition of the pollution haven.

5. Summary and Conclusion

This present study examined the nexus between energy consumption, trade intensity and environment in Nigeria and South Africa between 1981 and 2016. In the study, we use mainly secondary data that were obtained from the World Bank (WDI, 2017). They include particulate emissions damage, capital investment, energy consumption, trade intensity ratio, carbon emissions, and the real GDP per capita. Pertaining to stationarity, the KPSS test confirmed that the series are stationary for both countries after first differencing them while the cointegration test by Johansen confirmed that long-run association exist among the series. Moreover, the Engle & Granger (1987) causal test confirmed that there is the presence of unidirectional causal relationship running from the volume of energy consumed to the two proxies of environmental quality in both economies considered in this scientific enquiry. For South Africa alone, trade intensity unidirectionally caused CO_2 emissions while we found feedback effect between trade intensity and carbon emissions in Nigeria. Hence, we conclude that energy consumption and trade intensity determine environmental quality in the two countries. We recommend that both countries should consider energy efficiency policies, which will see the usage of hybrid vehicles, to lower energy consumption and improve environmental quality. Also, they should focus on attracting investments that will produce only clean goods such that composition effect can reduce emissions and improve environmental quality.

6. References

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