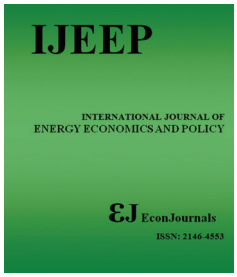

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Oil Price Volatility and Macroeconomic Performance in Non-oil Exporting Countries in Sub-Saharan Africa

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ABSTRACT

This paper examines the impact of oil price volatility on macroeconomic performance in fourteen non-oil exporting Sub-Saharan Africa (SSA) economies using panel ARDL model for the period 1980-2015. It also looks at the channels through which oil price volatility transmit to the three major sectors of their economies. The panel ARDL estimate indicates how persistent oil price volatility prevailed on the economy by measuring the short run and long run effects. The result shows that economic activity and sectors, respond very differently to oil price volatility depending on the time period whether short term or long term. In particular, oil price volatility has a negative effect on the macroeconomy in the short run but the effect becomes positive in the long run. The result also indicates that oil price volatility dampens the agricultural sector but improves the activities in the manufacturing and services sectors. The results further show that oil price volatility affects the exchange rate and interest rate channels negatively but positively through the inflation channel. The paper therefore shed some light on how the policy makers of these economies can use controlling mechanisms to stabilise the macroeconomy, key sectors and the transmission channels.

Keywords: Oil Price Volatility, Macroeconomic Performance, Sectors, Transmission Channels, Non-oil Exporting, SSA, Panel ARDL.
JEL Classification: B22

1. BACKGROUND

The world oil prices declining trend into the new millennium did not last long. The price began climbing steadily in 2002, reaching US$54.4 per barrel in 2005, up from US$25 per barrel in 2001. The pace at which the oil price was growing slowed somewhat in 2006, but the price per barrel remained at an average of US$65.4. It subsequently jumped up by about 11% between 2006 and 2007, but it was during 2008 that it pushed to new records, averaging US$113 per barrel during the first seven months of the year, and reachingUS$147.27 per barrel during the trading day of July 11, 2008. Between 2007 and 2008 the oil price climbed by 34%. During the period of booming oil prices, world prices also increased remarkably for other commodities. The slowdown of the world economy in the second half of 2008 has notably pushed the world prices of oil and other commodities down. Both supply and demand factors have contributed to this softening in commodity prices. In spite of the sharp global downturn that unfolded in late 2008, supply constraints will likely keep prices high in the medium term, as many of the fundamental forces behind the price surge are still in effect (International Monetary Fund, 2008, pp. 2, 4). In fact, having decreased to US$41.6 in December 2008 from its record high, the world price of oil has generally recovered and reached US$77.8 in September 2010 which is above its average for 2007. The excess oil supply which started in 2014 caused the monthly average price of crude oil to plummet from $112/bbl in June 2014 to about $32/bbl in February 2016 (Alban et al., 2016).

The crude oil glut was driven largely by growing US and Canada unconventional oil production and weak demand. Data from EIA

indicates that US production increased 58% from 2010 to 2015. OPEC maintained output discipline until 2014 when Saudi Arabia advocated higher OPEC production to regain market share. The increase in supply combined with growing turmoil in the Chinese Stock Market push oil prices down dramatically. No doubt, while net oil-exporting developing countries have enjoyed a remarkable oil price boom, net oil-importing developing countries must have been harmed by it. The key questions are to what extent and in what ways?. For the second group of countries, in particular, soaring oil prices impose a negative external shock that affects domestic relative prices, possibly sparking inflation, raising production costs, and weakening the balance of payments, all of which have undesirable economy-wide repercussions.

This paper considers the effects of oil price volatility on the macroeconomic performance of non-oil exporting economies in the Sub-Saharan region. Further, it considers the real GDP and current account balance as the measures of macroeconomic performance in selected economies of SSA. However, as a departure from previous studies, This paper investigates the effect of oil price volatility on primary, secondary and tertiary sectors, and the transmission channels of oil price volatility to macroeconomic performance of the selected non-oil exporting economies in SSA. It brings to the fore the neglected aspect of previous studies in the region, and to grace the understanding of sectors that are more vulnerable to shocks and enrich the available policy options for policy makers. The sampled economies are classified as net oil importers since their imports of crude oil and oil products by far exceed their corresponding exports.

The effects of oil price shocks on macroeconomic performance of oil and non-oil exporting countries in sub-Saharan Africa (SSA) and the likes has over the time attracted valuable input from scholars from diverse background across the globe. This is connected to the significant role it plays in the global economic performance. In recognition of this fact, efforts are directed by various governments and associations towards realising stable oil price in developing, emerging and developed economies. However, even in the presence of the efforts, the performance of the global economy has been muted owing to the vagrancies in macroeconomic indicators which have been traced empirically to be affected by volatility in both international and domestic oil prices. This has greatly affected every other sector of the global economy, especially countries where oil is the main source of their revenue. There has been so much controversy on oil price volatility and its influence on macroeconomic performance, while some scholars argued that oil price volatility promote macroeconomic performance (Aaron and Sherzod, 2009; Gounder and Bartleet, 2007; Akinlo and Apanisile, 2015 and Lim et al., 2011). Others are of the view that it has an inverse relationship with macroeconomic performance (Omisakin, 2008; Englama et al., 2010; Jerome et al., 2009; Manasseh et al., 2016; Dogah, 2015; Hunt et al., 2001; Chang and Wong, 2003 and Rebeca and Marcelo, 2004).

Taiwo and Olumuyiwa (2015) and Olumuyiwa (2014) examined the impact of the volatility of oil price on economic growth of 20 sub-Saharan African countries for the period of 1986-2012 using panel data. Panel A model estimation consisting of selected oil exporting countries shows that the volatility of oil prices has a positive significant effect on the economic growth of the selected oil exporting countries. The panel B result consisting of non-oil producing countries show that the volatility of oil price also has a positive insignificant impact on economic growth of selected non-oil producing countries. Omololaibi and Egwaikhide (2014) on oil price volatility and economic performance of five selected oil-exporting countries such as Algeria, Angola, Egypt, Libya and Nigeria in Africa, using quarterly data that span the period 1990q1 to 2010q4 and a panel vector autoregressive technique, in which the impulse response result shows that out of all the macroeconomic variables considered, gross investment respond more effectively to oil price volatility. William (2015) employed a similar method - ARDL cointegration approach, to explore more on the relationship between crude oil price and economic growth in Ghana using annual data set that ranges from 1967 to 2011 that seem to be larger in scope compared to works of Omololaibi and Egwaikhide (2014), Jumah and Pastuszyn (2007), and Tweneboah and Adam (2008). The results indicate the existence of a long run relationship between crude oil price and economic growth in Ghana which is consistent with the findings of Tweneboah and Adam (2008). Emmanuel (2015) investigated the impact of oil price volatility on economic growth in Nigeria for the period of 1970-2014. Engel-Granger co-integration test and Granger Representation theorem in testing the long run and short run relationships between crude oil volatility and economic growth respectively were adopted. The study found that, oil price volatility has negative impact on the economic growth of the Nigerian economy.

Mathew and Harold (2017) studied the oil price shocks transmission processes and its impact on economic performance of Africa's net oil exporting economies. Panel Structural Vector Autoregressive (P-SVAR) model was employed for the period of 1980-2015. The result shows a large impact of oil price shocks on the economic performance of Africa's oil exporting countries. Similarly, Obadi and Chimelova (2018) investigated the impact of oil price volatility on economic growth of oil exporting countries for the period of 2000-2017. A random effect model in panel data analysis for eight OECs was adopted. They found that 5 out of 8 selected countries have a negative sign effect. This shows that oil price volatility has a negative impact for majority of the countries selected.

Based on available literature, no study within the scope looked at the degree of the influence of oil price shocks on both current account balance and real GDP as a measure of macroeconomic performance of oil and non-oil exporting countries in SSA. Therefore, the addition to already existing knowledge would be essential and appropriate to enhance our understanding on the subject. Thus, we explored the weaknesses of previous studies by investigating the degree of oil price shocks on oil and non-oil exporting countries in SSA looking at real GDP and current account balance as measures of macroeconomic performance of the selected countries. Meanwhile previous studies in SSA (Omololaibi and Egwaikhide, 2014; Taiwo and Olumuyiwa, 2015, Mathew and Harold, 2017, Obadi and Chimelova, 2018) only focused on SSA countries and their GDP Growths, without

examining the effects of oil price volatility on current accounts; primary, secondary and tertiary sectors. This paper intends to fill this gap in empirical literature. This will enhance the understanding of the sector that is more vulnerable to shocks in non-oil exporting countries in SSA. The study also investigated the key channels through which oil price volatility transmit to macroeconomic performance of the selected countries. Thus, this knowledge could enrich the available policy options for policy makers.

2. DATA AND METHODOLOGY

2.1. Data Sources and Transformation

Aggregate data at the quarterly frequency were obtained from the International Monetary Fund (IMF, 2017), International Monetary Fund (IMF, 2017), while the quarterly data for crude oil prices were obtained from Energy Information Administration (EIA, 2017). Data spanning the period 1980Q1 to 2015Q4 were collected from these sources.

The components of the macroeconomic performances namely: real GDP for economic growth and current account balance, while the control includes oil price proxied by Brent, exchange rate, investments, rate of inflation, foreign reserves, employment and consumption. To capture the effects of oil price volatility on the primary, secondary and tertiary sectors, these were proxied by agriculture value added, industry value added and services value added respectively. To examine the key channels through which oil price volatility is transmitted to macroeconomic performance, the study used exchange rate, interest rate and inflation rate channels.

Except for variables with some negative values and rates, other variables in the equations were included in logarithmic functional form such that the coefficients are interpreted as elasticities. In predicting conditional variances as proxy for volatility, the study uses the GARCH model. The GARCH (1, 1) model accounts for volatility clustering, the property suggesting that volatility appears in clusters. The data are from 14 non-oil exporting SSA economies.

2.2. Models for the Study

Te paper employed linear ARDL (p, q, r) in estimating the research questions. It is important to state here that in order to achieve the objectives of this study; three sets of models were stated. The first set of models investigate the impact of oil price volatility on macroeconomic performance of non-oil exporting countries in sub-Saharan Africa; the second group of models ascertain the degree of oil price shocks on the performance of primary, secondary and tertiary sectors in non-oil exporting countries in sub-Saharan Africa while the third group of models investigate the key channels through which oil price volatility transmits to macroeconomic performance of non-oil exporting countries in SSA.

2.2.1. The economic growth model

$$\Delta MACPer_{i,t} = \sum_{j=1}^{p-1}\gamma_j^i \Delta MACPer_{i,t-j} + \sum_{j=0}^{q-1}\delta_j^i \Delta VOP_{i,t-j} + \sum_{j=0}^{r-1}\varphi_j^i \Delta X_{i,t-j} + \psi^i\left[MACPer_{i,t-j} - \left\{\sigma_0^i + \sigma_1^i VOP_{i,t-j} + \sigma_1^i X_{i,t-j}\right\}\right] + \xi_{it} \quad (1)$$

where *MACPer* is macroeconomic performance, which are the two proxies employed in this study, that is, the real gross domestic product and current accounts balance, *VOP* is the crude oil price(proxied by Brent) volatility while *X* is a set of independent control variables, γ, δ and φ represent the short-run coefficients of lagged dependent and independent variables respectively, σ are the long-run coefficients, and ψ is the coefficient of speed of adjustment to the long-run equilibrium. The subscripts *i* and *t* represent country and time indexes, respectively. The term in the square bracket of Equation (1) contains the long-run growth regression, which is derived from the following equation.

$$MACPer_{i,t} = \sigma_0^i + \sigma_1^i VOP_{i,t} + \sigma_1^i X_{i,t} + \varepsilon_{i,t} \quad where\ \varepsilon_{i,t} \sim I(0) \quad (1.1)$$

As it is seen in equations 1 and 1.1, real GDP and current accounts balance have been used to capture macroeconomic performance in these group of countries.

2.2.2. The sectoral model

Further, to ascertain the degree of oil price shocks on the performance of primary, secondary and tertiary sectors of non-oil exporting SSA countries. The following models are specified.

$$\Delta PRI_{i,t} = \sum_{j=1}^{p-1}\gamma_j^i \Delta PRI_{i,t-j} + \sum_{j=0}^{q-1}\delta_j^i \Delta VOP_{i,t-j} + \sum_{j=0}^{r-1}\varphi_j^i \Delta X_{i,t-j} + \psi^i\left[PRI_{i,t-j} - \left\{\sigma_0^i + \sigma_1^i VOP_{i,t-j} + \sigma_1^i X_{i,t-j}\right\}\right] + \xi_{it} \quad (2)$$

where *PRI* is the primary sector proxied by agriculture value added, *VOP* is the crude oil price(proxied by Brent) volatility while *X* is a set of independent control variables, γ, δ and φ represent the short-run coefficients of lagged dependent and independent variables respectively, σ are the long-run coefficients, and ψ is the coefficient of speed of adjustment to the long-run equilibrium. The subscripts i and t represent country and time indexes, respectively. The term in the square brackets of Equation (2) contains the long-run growth regression, which is derived from the following equation.

$$PRI_{i,t} = \sigma_0^i + \sigma_1^i VOP_{i,t} + \sigma_1^i X_{i,t} + \varepsilon_{i,t} \quad where\ \varepsilon_{i,t} \sim I(0) \quad (2.1)$$

For the secondary sector;

$$\Delta SEC_{i,t} = \sum_{j=1}^{p-1}\gamma_j^i \Delta SEC_{i,t-j} + \sum_{j=0}^{q-1}\delta_j^i \Delta VOP_{i,t-j} + \sum_{j=0}^{r-1}\varphi_j^i \Delta X_{i,t-j} + \psi^i\left[SEC_{i,t-j} - \left\{\sigma_0^i + \sigma_1^i VOP_{i,t-j} + \sigma_1^i X_{i,t-j}\right\}\right] + \xi_{it} \quad (3)$$

where *SEC* is the secondary sector proxied by manufacturing value added, the other variables and coefficients are as explained above. The term in the square brackets of Equation (3) contains the long-run growth regression, which is derived from the following equation.

$$SEC_{i,t} = \sigma_0^i + \sigma_1^i VOP_{i,t} + \sigma_1^i X_{i,t} + \varepsilon_{i,t} \quad where\ \varepsilon_{i,t} \sim I(0) \quad (3.1)$$

For the tertiary sector;

$$\Delta TER_{i,t} = \sum_{j=1}^{p-1}\gamma_j^i \Delta TER_{i,t-j} + \sum_{j=0}^{q-1}\delta_j^i \Delta VOP_{i,t-j} + \sum_{j=0}^{r-1}\varphi_j^i \Delta X_{i,t-j}$$
$$+\psi^i\left[TER_{i,t-j} - \left\{\sigma_0^i + \sigma_1^i VOP_{i,t-j} + \sigma_1^i X_{i,t-j}\right\}\right] + \xi_{it} \quad (4)$$

where *TER* is the tertiary sector proxied by services value added, *VOP*,*X*, γ, δ and φ, σ, and ψ are as explained above. The term in the square brackets of Equation (4) contains the long-run growth regression, which is derived from the following equation.

$$TER_{i,t} = \sigma_0^i + \sigma_1^i VOP_{i,t} + \sigma_1^i X_{i,t} + \varepsilon_{i,t} \quad where\ \varepsilon_{i,t} \sim I(0) \quad (4.1)$$

2.2.3. The transmission channels model

In addition, to investigate the key channels through which oil price volatility transmit to macroeconomic performance of non-oil exporting countries in SSA, interaction terms were employed between crude oil price volatility, and exchange rate, interest rate and inflation rate respectively.To achieve these objectives, the following models have been stated:

$$\Delta MACPer_{i,t} = \sum_{j=1}^{l-1}\lambda_j^i \Delta MACPer_{i,t-j} + \sum_{j=0}^{p-1}\gamma_j^i \Delta VOP * EXR_{i,t-j}$$
$$+\sum_{j=0}^{q-1}\delta_j^i \Delta EXR_{i,t-j} + \sum_{j=0}^{r-1}\varphi_j^i \Delta VOP * INFL_{i,t-j} + \sum_{j=0}^{s-1}\alpha_j^i \Delta INFL_{i,t-j}$$
$$+\sum_{j=0}^{u-1}\beta_j^i \Delta VOP * INT_{i,t-j} + \sum_{j=0}^{w-1}\rho_j^i \Delta INT + \psi^i$$
$$\left[MACPer_{i,t-j} - \begin{Bmatrix}\sigma_0^i + \sigma_1^i VOP * EXR_{i,t-j} + \sigma_1^i EXR_{i,t-j} \\ +\sigma_1^i VOP * INFL_{i,t-j} + \sigma_1^i INFL_{i,t-j} \\ +\sigma_1^i VOP * INT_{i,t-j} + \sigma_1^i INT_{i,t-j}\end{Bmatrix}\right] + \xi_{it} \quad (5)$$

where *VOP*EXR*, *VOP*INT* and *VOP*INFL* represent interaction terms between oil price volatility and exchange rate, interest rate and inflation rate respectively. These interaction terms measure the exchange rate channel, interest rate channel and inflation channel. All other variables are as described above. Also, the terms in the square brackets of Equations (5) contain the long-run growth regression, which isderived from the following equation.

$$MACPer_{i,t} = \sigma_0^i + \sigma_1^i VOP * EXR_{i,t-j} + \sigma_1^i EXR_{i,t-j}$$
$$+\sigma_1^i VOP * INFL_{i,t-j} + \sigma_1^i INFL_{i,t-j} + \sigma_1^i VOP * INT_{i,t-j}$$
$$+\sigma_1^i INT_{i,t-j} + \varepsilon_{i,t} \quad \text{where } \varepsilon_{i,t} \sim I(0) \quad (5.1)$$

Three different estimators can estimate equations (1), (2), (3), (4) &(5): the mean group (MG) model of Pesaran and Smith (1995), the Pooled Mean Group (PMG) estimator and the Dynamic Fixed Effects (DFE) estimator developed by Pesaran et al. (1999).

2.2.4. Model selection

The estimations of the Equations above are carried out with PMG, MG, and DFE. As the paper considers 14 non-oil exporting SSA, the sample is expected to be homogenous with respect to macroeconomic performance (economic growth and current account balance), primary, secondary and tertiary sectors. However, in the short run, there is bound to be country-specific heterogeneity due to the effect of local laws and regulations. The PMG estimator offers more efficient estimates compared to the MG estimators under the assumption of long-run homogeneity. Moreover, the time span for this study is 36 years, and all the estimators are well suited with enough degrees of freedom. However, to choose among the MG, PMG, and DFE methods, the Hausman test is used to test whether there is a significant difference between these estimators. The null of this test is that the difference between PMG and MG or PMG and DFE estimation is not significant. If the null is not rejected, the PMG estimator is recommended since it is efficient. The alternative is that there is, indeed, a significant difference and the null is rejected. If there are outliers the average estimator may have a large variance and in that case the Hausman test would have little power. The PMG will be used if the p-value is insignificant at the 5% level. On the other hand, if it happens to have a significant P-value, then, the use of MG or DFE estimator is appropriate.

Another important issue is that ARDL lag structure should be determined by some consistent information criterion. Based on the Schwartz Bayesian criterion, the study imposed the following lag structure (1,1,1,1,1,1,1,1,1,1,1) for the real GDP, current account balance, exchange rate, employment, foreign reserves, investment, oil price volatility, consumption, primary sector, secondary sector and tertiary sector respectively.

3. EMPIRICAL RESULTS AND DISCUSSIONS

3.1. Descriptive Statistics

Descriptive statistics of the variables used in this study are presented in Table 1 for non-oil exporting SSA countries. The

Table 1: Descriptive Statistics of Variables for Non-Oil Exporting SSA

Variable	Obs	Mean	Std. Dev.	Min.	Max.
Lnrgdp	2016	9.3132	1.1805	6.8792	11.8652
Lnexr	2016	4.6708	2.3736	−0.5201	8.8557
Lninvt	2016	2.8923	0.5872	0.2327	4.3183
Infl	2016	13.7033	21.9183	−14.936	215.4
Lncuta	2016	−5.6059	7.7629	−65.257	29.162
Lnop	2016	3.5307	0.6833	2.5463	4.7152
Lnfres	2016	24.3781	2.7433	14.0588	29.9632
Lnemp	2016	1.0359	1.2630	−1.7081	3.8129
Lncop	2016	9.1927	1.0888	7.0390	11.7094
lnpri_ag	2016	25.2314	3.1478	17.9603	30.9006
lnsec_ma	2016	23.7785	2.7878	16.8128	29.5271
lnter_ser	2016	25.7054	2.8191	18.8425	31.2338
Itr	2016	8.2520	6.3555	0.0402	62.2000

Source: Author's compilation using STATA 15. Note: lnrgdp, lnexr, lninvt, infl, lncuta, lnop, lnfres, lnemp, lncop, lnpri_ag, lnsec_ma, lnter_ser and itr represent natural logarithm of RGDP, exchange rate, investment; inflation, current account balance, oil price, foreign reserves, employment, consumption, primary sector (agriculture value added), secondary sector (manufacturing value added) tertiary sector (services value added) and interest rate

Table shows the basic characteristics of the variables in terms of their average value (Mean), standard deviation (SD), minimum (Min) and maximum (Max) values. In terms of definition, the mean value is the average outcome of a reference variable over a specific period of time. SD is the measure of dispersion of variables from the reference mean, and it measures the variability of spread data. Min and Max are the minimum and maximum values of the variables in question, respectively. For clarity and simplicity of analysis, the mean value is used for discussion, while other statistics, defined and explained above are presented in Table 1.

An analysis of Real Gross Domestic Product (RGDP) reveals a value of 9.3 on average; with 6.9 and 11.9 minimum and maximum values, while the standard deviation is 1.18. This indicates that there is little deviation of the RGDP value from its mean value. In terms of current account balance, the result showed a negative mean value of −5.6, minimum and maximum values of −65.5 and 29.2 respectively and high standard deviation of 7.8. Meaning that on average, non-oil exporting countries in Africa have poor performance in terms of international trade. That is a deficit current account with high level of deviation. Considering the level of exchange rate to the US Dollars among the SSA countries, it is found that on average the exchange rate is 4.7, with standard deviation of 2.4 whereas the minimum and maximum values are −0.5 and 8.9 respectively. Consistently, in terms of investment, the result showed a mean 2.9 and standard deviation of 0.6; the minimum value is 0.2 while the maximum value is 4.3.

The mean statistic for inflation, however, shows that average inflation is relatively higher for non-oil exporting SSA as indicated in Table 1; with a standard deviation of 21.9. The level of employment, rate of consumption and interest rate, on average, are1.0, 9.1 and 8.3 respectively, with standard deviations of 1.2, 1.0 and 6.4 respectively. Foreign reserve is high on average at 24.4 with a standard deviation of 2.7. The log of oil price (Brent) indicates a value of 3.5 on average and a low standard deviation of 0.9 within the period of investigation. Considering the primary, secondary and tertiary sectors, the average values are consistent with the foreign reserves with mean values of 25.2, 23.8 and 25.7 for the primary, secondary and tertiary sectors respectively. The statistics for primary, secondary and tertiary sectors can be seen to be consistent with *a priori* expectations since economies that depend less on proceeds from oil export, try to have a better agriculture, manufacturing and services sectors.

3.1.1. Panel unit root test results

As a rule for macro panels with large T, panel unit root tests were performed on the relevant variables. The preferred model for this study, which is the dynamic heterogenous panel data model, is usually considered where non-stationarity is a concern. It is conventional rather than exception in time series analysis to investigate the stationarity of macroeconomic variables before they are used in regressions. This is due to the fact that estimations with non-stationary variables result is bias and inconsistent of the estimates of coefficient standard errors thus increasing the likelihood of drawing incorrect inferences. For the purpose of this study, four different types of panel unit root tests were considered.

As presented in Appendix Table 1, the first type involves panel unit root tests with the null hypothesis of unit root with common process (Harris and Tzavalis, 1999; Breitung, 2000; Levin et.al., 2002 tests). The second type assumes unit root with individual unit root process (Im et al., 2003; Maddala and Wu, 1999 tests) while the third also assumes unit root in the null hypothesis but in the presence of cross-section dependence (Pesaran, 2007). The fourth category, however tests the null hypothesis of no unit root with common unit root process (Hadri, 2000 Lagrange Multiplier test). Since the various unit root test has different individual hypotheses and test regressions, these tests have been categorized into stationary (the fourth type - Hadri) and nonstationary (first, second and third – HT, Breitung and LLC; IPS and Pesaran respectively) tests in the literature. In addition, the Pesaran (2007) unit root test is particularly important in this study as it can also be used to test whether the various cross-sections in each group are homogenous or heterogenous. The null hypothesis for the test assumes homogeneous non-stationary as against the alternative hypothesis of possible heterogeneous alternatives.

All the variables used for this study were subjected to unit root test to ascertain their stationarity status. For robustness, the variables were subjected to four types of unit root tests. These unit root tests are as follows: unit root test that assumes unit root with individual unit root process i.e., Im et al. (2003), Maddala and Wu (1999) tests; unit root test that assumes no unit root with common unit root process i.e., Hadri, 2000; unit root test that assumes unit root with common process i.e., Haris and Tsavalis (1999); Breitung (2000) and Levin et al. (2002) and unit root test that assumes unit root in the presence of cross-sectional dependence, i.e., Pesaran (2007).

Irrespective of the type of unit root test, the unit root test of the non-oil exporting SSA countries confirm that the variables used for the study are either stationary at level, i.e., I(0) or at first difference, i.e., I(1). These results justify the use of panel Autoregressive Distributed Lag (ARDL) as the most appropriate estimation technique for the analysis.

Appendix Table 2 reports the short and long run estimates of macroeconomic performance (proxied with real GDP and current account balance) of non-oil exporting countries of SSA. As reoported, in the short run, oil price volatility is negatively related to real GDP and current account of non-oil exporting SSA countries. *Ceteris Paribus*, a 1% increase in oil price volatility will reduce real GDP and current account by 0.0009% (statistically significant at 10%) and 0.0265% respectively. This implies that oil price volatility is an important factor that reduces real GDP and the current account of this group of countries; though the magnitude of the impact of oil price volatility is more on current account than on real GDP. Investment, exchange rate, employment and consumption are positively and significantly related to real GDP of non-oil exporting countries in the short run. All other things constant, a 1% rise in investment, exchange rate, employment and consumption will rise real GDP by 0.0270%, 0.0329%, 0.109% and 0.538% respectively and are all statistically significant at 1%; suggesting that these variables are essential in strengthening real GDP in these countries. On the other hand, inflation and interest rate are negatively related to real GDP.

Table 2: Panel Regression Results for Channels Through which Oil Price Volatility Pass-Through to Macroeconomies of Non-Oil Exporting SSA

Variable	(3) PMG	(4) PMG
Short run	RGDP	CUTA
Constant	0.1110*	1.1660
	(0.0663)	(1.1310)
D.opvol*exr	0.0002	-0.1700
	(0.0009)	(0.4810)
D.lnexr	0.0600*	1.5310
	(0.0347)	(5.1920)
D.opvol*infl	-0.0001	-0.0148
	(0.0001)	(0.0184)
D.infl	-0.0001	-0.0146
	(0.0012)	(0.0734)
D.opvol*itr	-0.0002	0.1340***
	(0.0003)	(0.0477)
D.itr	-0.0002	-0.2830
	(0.0011)	(0.3360)
ECT	-0.0107	-0.0087
	(0.0066)	(0.0074)
Hausman test - χ^2_k	9.38	9.90
	(0.1535)	(0.1290)
Log Likelihood	6270.768	-2562.128
No. of cross section	14	14
No. of Obns	2,002	2,002

Source: Author's compilation. Note: opvol, exr, infl, cuta, op, and itr represent oil price volatility, exchange rate, inflation, current account balance, oil price, and interest rate. While opvol*exr, opvol*infl and opvol*itr are the interaction terms between oil price volatility and exchange rate, inflation and interest rate respectively. These interaction terms are used to measure/capture the three channels via which oil price volatility pass-through to the macroeconomies. Standard errors in parentheses *** P<0.01, **P<0.05, *P<0.1

A percentage increase in inflation and interest rate will reduce real GDP by 0.0001%; with the impact of inflation on real GDP being significant at 10%, suggesting that inflation is important in dwindling the GDP of these countries.

Exchange and interest rates have positive relationship with current account in non-oil exporting countries in the short run. As confirmed in Appendix Table 2, if there is a percentage increase in exchange and interest rates, the current account of these countries will rise by 2.791% (statistical significant at 1%) and 0.0177% respectively in the short run. Investment, employment, inflation and consumption are negatively related to current account of these countries in the short run. This suggests that these variables reduce current account in these countries in the short run. *Ceteris paribus,* if Investment, employment, inflation and consumption increase by 1%, current account will diminish by 5.660%, 0.917%, 0.0111% and 10.95% in the short run; with the impact of consumption and investment being significant at 1%. This means that consumption and investment are important in reducing current account in these countries.

Estimates of the long run confirmed that oil price volatility, exchange rate and consumption significantly raise real GDP in non-oil exporting countries; suggesting that these variables are important determinants of real GDP in the long run. In these countries, exchange rate insignificantly increases real GDP – it plays little role in augmenting real GDP. On the other hand, employment significantly reduces economic growth, while inflation insignificantly reduces economic growth in the long run. The results suggest that employment is an important factor that contracts real GDP in these countries. Moreover, the estimates confirm that a 1% rise in oil price volatility, exchange rate, investment, and consumption in the long run will increase economic growth by 0.0161%, 0.0390%, 0.242%, and 0.9805 respectively, while a 1% increase in employment and inflation will contract real GDP by 0.726% and 0.0047% respectively.

Oil price volatility, investment and consumption have positive and significant impact on current account in non-oil exporting SSA countries in the long-run. However, exchange rate, employment, inflation and interest rate have negative impact on the current account of these countries in the long-run. *Ceteris Paribus,* a percentage rise in exchange rate, employment, inflation and interest rate will diminish current account in these countries by 0.0654%, 0.983%, 0.0065% (all being statistically significant) and 0.0063% respectively; connoting that exchange rate depreciation/devaluation, employment and inflation are major factors that contract current account balance of these countries in the long run.

To establish long run relationship, the study relied on the Error Correction Model (ECM). Therefore, it is required that the Error Correction Term, ECT, be between zero and one, negative and statistically significant and only the short run results if otherwise. As indicated in Appendix Table 2, none of the sectors – primary, secondary and tertiary satisfies the ECT condition; hence we report only the short run results here.

In the short run, oil price volatility, exchange rate, investment and employment have negative insignificant impact on primary sector in non-oil exporting countries of SSA. It means that these variables play small role in hampering the performance of primary sector in these countries in the long run. *Ceteris Paribus*, a 1% rise in oil price volatility, exchange rate, investment and employment will reduce the performance of primary sector in these countries by 0.0166%, 0.0226%, 0.465% and 1.593% respectively. In this group of countries, inflation, consumption and interest rate are positively related to primary sector. Results in Appendix Table 2 shows that consumption is an important variable that boosts primary sector performance of non-oil exporting countries in the long run. Similarly, employment, inflation and consumption are positively related to secondary sector in the non-oil exporting countries in the long run. A percentage rise in employment, inflation and consumption will increase the performance of secondary sector by 0.288%, 0.0001% and 1.464% respectively. On the other hand, oil price volatility, exchange rate, investment and interest rate are negatively related to secondary sector in non-oil exporting countries; indicating that these variables diminish the performance of secondary sector in these countries. All else constant, a percentage rise in oil price volatility, exchange rate, investment and interest rate will dwindle the performance of secondary sector by 0.0069%, 0.0672% (significant at 1%), 0.103% and 0.0083%. Similarly, exchange rate, investment and interest rate diminish the performance of tertiary sector insignificantly in the long run. In contrast, oil price volatility, employment, inflation and consumption increase the performance

of tertiary sector of non-oil exporting countries in the long run. A 1% rise in oil price volatility, employment, inflation and consumption will promote the performance of tertiary sector in these countries by 0.0498%, 0.940%, 0.0001% and 1.641% (statistically significant at 1%).

Table 2 confirmed that in the short run, exchange rate, investment, foreign reserve, consumption and interest rate have negative impact on the secondary sector of non-oil exporting countries, with the impact of foreign reserve being statistically significant at 1%. This implies that foreign reserve is a major factor that hampers the performance of secondary sector of these countries. In contrast, oil price volatility, employment and inflation exert positive impact on the secondary sector of these countries, with the impact of employment being statistically significant at 1%; implying that employment is a major factor that promotes the performance of this group. Similarly, the long run impact of oil price volatility, employment and inflation on the tertiary sector of non-oil exporting countries is positive. Table 3 further indicated that employment is essential in enhancing the performance of tertiary sector of these countries. Exchange rate, investment, foreign reserve, consumption and interest rate dwindle the performance of tertiary sector of non-oil exporting countries in the short run. As seen inTable 3, investment, foreign reserves and consumption are important in undermining the performance of the tertiary sector of these countries.

Appenndix Table 2 confirmed that in the short run, exchange rate, investment, foreign reserve, consumption and interest rate have negative impact on the secondary sector of non-oil exporting countries, with the impact of foreign reserve being statistically significant at 1%. This implies that foreign reserve is a major factor that hampers the performance of secondary sector of these countries. In contrast, oil price volatility, employment and inflation exert positive impact on the secondary sector of these countries, with the impact of employment being statistically significant at 1%; implying that employment is a major factor that promotes the performance of this group. Similarly, the long run impact of oil price volatility, employment and inflation on the tertiary sector of non-oil exporting countries is positive. Appenndix Table 2 further indicated that employment is essential in enhancing the performance of tertiary sector of these countries. Exchange rate, investment, foreign reserve, consumption and interest rate dwindle the performance of tertiary sector of non-oil exporting countries in the short run. As seen in Appenndix Table 2, investment, foreign reserves and consumption are important in undermining the performance of the tertiary sector of these countries.

In order to look at the transmission mechanism of oil price volatility, interest rate, inflation and exchange rate models are estimated. Oil price volatility affects exchange rate, interest rate and inflation for both oil-exporting and oil-importing countries (Volkov and Yuhn, 2016). Oil price volatility encourages the outflow or inflow of Dollars which directly affects the exchange rate of oil exporting or oil importing countries that use US Dollars (Kaufmann and Ullman, 2009). This will affect economic activities and by extension the macroeconomic performance of a country.

Appenndix Table 2 showed the results for channels through which oil price volatility enters the macroeconomies of the Non-Oil Exporting SSA countries. Beginning with the short run, the results showed that oil price volatility has positive and insignificant impact on RGDP through the exchange rate channel. When we considered the current account balance model, we discovered that the effect is negative but still not statisticallysignificant. This means that a percentage point increase in oil price volatility will enhance economic growth by 0.0002% points but worsen the current account balance by about 0.173% points.

Conversely to the exchange rate channel, oil price volatility through the inflation channel is completely negatively associated with economic growth and current account balance for the non-oil exporting SSA. In terms of the magnitudes, a percentage point rise in oil price volatility results to a decline in economic growth and CUTA by 0.000009 and 0.015% points respectively through the inflation channel. The impact of oil price volatility through the interest rate channel is negative and insignificant on RGDP but positive and significant on CUTA at 1% conventional level. One percentage change in oil price volatility interacting through the interest rate channel generate a deteriorating effect of 0.0002% points in RGDP and an ameliorating effect of 0.134% points in CUTA in the short term. By implication, for the non-oil exporting economies, oil price volatility through exchange rate channel improves economic growth but decreases CUTA; through the inflation channel, however, it shrinks the macroeconomy (both RGDP and CUTA); contrarily, oil price volatility reduces RGDP but boosts CUTA through the interest rate channel.

4. CONCLUSION

This study investigated the effects of oil price volatility/shocks on macroeconomic performance of non-oil exporting countries in sub-Saharan Africa, the effect of oil price shocks on real GDP and current account balances of non-oil exporting countries in sub-Saharan Africa as well as the degree of oil price shocks on the performance of primary, secondary and tertiary sectors of non-oil exporting economies in sub-Saharan Africa. The paper equally examined the key channels through which oil price volatility transmit to macroeconomic performance of non-oil exporting countries in SSA between 1980Q1 and 2015Q4.

The paper observed that oil price volatility deteriorates economic growth in the short run. As oil price shocks intensify in the short run, economic activities depreciates for the non-oil exporting SSA economies. Contrary to the results in the short run, long run result showed a positive relationship between oil price shock and economic growth for non-oil exporting SSA economies. In terms of magnitudes, the coefficients suggested that a percentage point increase in oil price volatility in the short run reduced economic growth by 0.0009% points in non-oil exporting economies. The relationship in the long run between oil price volatility and economic growth is positively significant at 10% conventional level for non-oil exporting countries. These results are consistent with *a priori* expectations. The result further showed that oil price volatility and current account balance are negatively related for non-oil exporting countries in the short run. This showed that the

better the level of oil price fluctuations, the worst for economic growth in the non-oil exporting countries. In terms of significance, oil price volatility was insignificant for these groups of SSA at any conventional level. In the long run, oil price volatility becomes positive but still insignificant for the non-oil exporting countries.

Conclusively, oil price volatility deteriorates macroeconomic activities of non-oil exporting economies in the SSA in the short or medium term but the negative effects tend to fizzle out as countries adjust their policies. Considering the three sectors, oil price volatility unexpectedly dampens agricultural activities in these countries. A plausible reason for this outcome could be that a positive change in oil price increases costs of importation of agricultural inputs and machineries. Interestingly, manufacturing and services sectors seem to flourish in the face of unstable oil prices. As oil prices become volatile, the secondary and tertiary sectors perform better in these economies; a good reason could be as a result of governments' policy efforts in improving sectors other than mining and extractive sectors. The transmission channels through which oil price volatility enters these economies are exchange rate, interest rate and inflation. The results indicate that oil price volatility enters negatively through exchange rate and interest rate, but enters positively through the inflation channel. However, the effects appear to be stronger through the exchange rate channel, followed by the interest rate channel and lastly the inflation channel. The exchange rate is one of the intermediate policy variables through which monetary policy is transmitted to the larger economy through its impact on the value of domestic currency, domestic inflation (the pass-through effect), the external sector, macroeconomic credibility, capital flows, and financial stability. Therefore, changes (appreciation or depreciation) in the exchange rate have implications for individual spending and firms' investment beheviour, all of which can affect the macro economy.

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Appendix Table 1: Panel Unit Root Test Results for Non-Oil Exporting Countries of SSA

Variable	RGDP	EXR	INVT	INFL	CUTA	OP	FRES	EMP	COP	PRI_AG	SEC_MA	TER_SER	ITR
						Test Method							
Null hypothesis: unit root with common process													
Levin, Lin & Chu t*	-6.1092***[a]	-4.3781***[a]	-4.1886***[a]	-7.6466***[a]	-3.8278***[a]	-14.3799***[b]	-8.7175***[b]	-2.0520**[a]	-7.6423***[a]	-7.6964***[a]	-9.7997***[a]	-14.5433***[a]	-2.7999***[a]
Breitung t-stat.	-8.8102***[b]	-4.2652***[b]	-6.7421***[b]	-6.6531***[b]	-8.4277***[b]	-16.5783***[b]	-12.5534***[b]	-8.0236***[b]	-8.7703***[b]	-1.6375**[b]	-0.1934*[b]	1.1834*[b]	-10.3712***[b]
Harris-Tzavalis rho	0.8217***[b]	0.9655***[a]	0.7787***[b]	0.9706*[a]	0.7246***[b]	0.7074***[b]	0.6334***[b]	0.8228***[b]	0.8456***[b]	0.9586***[a]	0.9670**[a]	0.9715*[b]	0.9634***[a]
Null hypothesis: unit root with individual unit root process													
Im, Pesaran & Shin W Stat	-6.8378***[a]	-6.5087***[a]	-10.9646***[b]	-5.5331***[a]	-12.6651***[b]	-13.7253***[b]	-11.0336***[b]	-8.1095***[b]	-11.7140***[a]	-20.0166***[a]	-25.8595***[a]	-33.5855***[a]	-26.5262***[b]
ADF Fisher Chi-square	98.3481***[b]	111.2803***[a]	62.4987***[a]	100.9547***[a]	50.9386***[a]	203.3464***[b]	129.7662***[b]	109.9111***[b]	60.8508***[b]	84.9899***[a]	78.3226***[a]	82.5496***[a]	49.8837***[a]
Pesaran CD test2	-2.527***[a]	-3.257***[a]	-2.246**[a]	-3.267***[a]	-3.491***[b]		-3.123***[b]	-2.233**[a]	-2.422***[a]	-2.243***[a]	-3.839***[b]	-3.702***[b]	-3.657***[a]
Null hypothesis: no unit root with common unit root process													
Hadri Z-stat.	46.0452[b]	35.0226[b]	6.4252[b]	6.7487[b]	9.9705[b]	25.4970[b]	10.1161[b]	20.7984[b]	61.5811[b]	71.4434[b]	84.2945[b]	132.1866[b]	-1.4919[b]
No. of Cross-sections	14	14	14	14	14	14	14	14	14	14	14	14	14
No. of Periods	144	144	144	144	144	144	144	144	144	14	144	144	144
Total Obns	2016	2016	2016	2016	2016	2016	2016	2016	2016	2016	2016	2016	2016

Source: authour's compilation. Note: exr, invt, infl, cuta, op, fres, emp, cop, pri_ag, sec_ma, ter_ser and itr represent oil price volatility, exchange rate, investment, inflation, current account [b]alance, oil price, foreign reserves, employment, consumption, primary sector (agriculture value added), secondary sector (manufacturing value added) tertiary sector (services value added) and interest rate. Note: a & [b] denote stationarity at level and at first difference respectively, while ***, **, * indicate statistical significance at 1%, 5% and 10% respectively. All the varia[b]les here are expressed in natural logs. 2 Note that the Pesaran CD test is not conducted for the oil price series since it is considered to [b]e homogenous as it is cross-section invariant. Standard errors in parentheses.

Appendix Table 2: Panel regression results for oil price volatility–macroeconomic nexus (Non-Oil Exporting SSA)

VARIABLE	RGDP	CUTA	PRI_AG	SEC_MA	TER_SER
Long run					
Lnopvol	0.0161*	0.0051			
	(0.0086)	(0.0133)			
Lnexr	0.0390	-0.0654*			
	(0.0254)	(0.0368)			
Lninvt	0.242***	0.0245			
	(0.0563)	(0.0717)			
Lnemp	-0.726***	-0.983**			
	(0.216)	(0.403)			
Infl	-0.0016	-0.0065**			
	(0.0012)	(0.0027)			
Fres	-0.0000	0.0000			
	(0.0000)	(0.0000)			
Lncop	0.980***	1.195***			
	(0.0913)	(0.178)			
Itr	-0.0047	-0.0063			
	(0.0040)	(0.0068)			
Constant	0.0008	-0.7080	-2.5910*	9.0700**	3.2490
	(0.0142)	(1.4650)	(1.4240)	(4.2460)	(2.2550)
Short run					
D.lnopvol	-0.0009*	-0.0265	-3.3010	3.5020	8.4940
	(0.0005)	(0.0490)	(2.0550)	(1.5790)	(8.3850)
D.lnexr	0.0329***	2.791***	-7.7150	-9.6130	-4.7530
	(0.0086)	(0.885)	(1.1110)	(6.2130)	(3.3000)
D.lninvt	0.0270***	-5.660***	0.0301	-1.4180	-1.0940**
	(0.0042)	(0.430)	(0.183)	(1.0060)	(5.3430)
D.lnemp	0.109***	-0.917	-1.5740*	5.5620***	1.4400**
	(0.0274)	(2.818)	(8.1970)	(1.3560)	(7.2040)
D.infl	-0.0001*	-0.0111	-7.7150	2.0900	4.9800
	(0.0001)	(0.0079)	(1.1110)	(2.6790)	(1.4230)
D.fres	-0.0000	-0.0000	0.0301	-0.157***	-1.159***
	(0.0000)	(0.0000)	(0.183)	(0.0133)	(0.0706)
D.lncop	0.538***	-10.95***	2.0770	-2.7660	-7.6070***
	(0.0164)	(1.683)	(2.2810)	(3.6390)	(1.9330)
D.itr	-0.0001	0.0177	5.2570	-1.8770	-1.5080
	(0.0002)	(0.0232)	(1.6940)	(1.8700)	(9.9300)
ECT	-0.0189***	-1.170***	4.1250	2.2420***	5.4610
	(0.0036)	(0.369)	(3.0120)	(6.3700)	(3.3830)
Hausman test	0.0000	0.0000	0.0000	0.0000	0.0000
- χ_{κ}^{2}	(1.0000)	(1.0000)	(1.0000)	(1.0000)	(1.0000)
No. of cross section	14	14	14	14	14
No. of Obs	1989	1989	1989	1989	1989

Source: author's compilation. Note: opvol, exr, invt, infl, cuta, op, fres, emp, cop, pri_ag, sec_ma, ter_ser and itr represent oil price volatility, exchange rate, investment, inflation, current account balance, oil price, foreign reserves, employment, consumption, primary sector (agriculture value added), secondary sector (manufacturing value added) tertiary sector (services value added) and interest rate. Standard errors in parentheses *** $P < 0.01$, ** $P < 0.05$, * $P < 0.1$ All the variables except infl cuta itr & fres are expressed in logs