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Asymmetric and Dynamic Effects of Oil Price Shocks and Exchange Rate Fluctuations: Evidence from a Panel of Economic Community of West African States (ECOWAS)

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ABSTRACT

Researches intended to influence key decisions on energy policy are paramount for Economic Community of West African States (ECOWAS') development agenda. Therefore, we employ fixed effect model to examine the impacts of oil price shocks and exchange rate volatility (erv) on real gross domestic product (rgdp) in the ECOWAS countries. For each oil price shock, three equations are estimated: The sample of all ECOWAS countries and the samples with net-oil exporters and net-oil importers. The empirical results provide evidences of both linear and asymmetric effects of oil price shocks on rgdp for the full ECOWAS sample and for the net-oil importers. Additionally, there are evidences that erv negatively and significantly influence rgdp of the full ECOWAS sample and the net-oil importers. Therefore, we recommend the implementation of economic diversification policy away from oil reliance toward dependence on other energy types, and implementation of monetary policies to stabilize volatile exchange rate regime in oil-importing ECOWAS countries.

Keywords: Asymmetry, Economic Community of West African States Countries, Exchange Rate Volatility, Oil Price Shocks
JEL Classifications: C33, F31, C5, E6

1. INTRODUCTION

The Economic Community of West African States (ECOWAS) is a regional body that was founded on 28 May 1975 to promote regional cooperation and integration within Member States. ECOWAS originally consisted of 16 Member States until Mauritania withdrew in 2001. Today, ECOWAS constitutes 15 member countries, whose mission is to promote unity and growth in all aspects of economics by removing all forms of trade barriers and hindrances in order to promote free movements of individuals and free trade zone for businesses, as well as to formulate regional sector policies.[1]

Despite ECOWAS' objective to promote a common market and create a common monetary zone, recent developments in various ECOWAS nations point towards macroeconomic fluctuations and economic hardships among the inhabitants. For example, businesses in Liberia closed in February 2017 to mount pressure on the national government because of higher exchange rate regime and increases in the level of taxes and prices of goods and services.[2] In general, economic developments in almost all ECOWAS countries reflect currency depreciation, increases in the general level of prices of goods and services, slow or declining economic growth, among others. Therefore, in view of recent economic development in the ECOWAS nations, the objective of this study is to utilize a more recent dataset for the purpose of modeling the links between economic activities and the volatilities in oil price and exchange rate in the ECOWAS Member States.[3]

1 The list of ECOWAS Member States list presented in the Appendix A and B.

2 Citizens of Liberia gathered in the major cities to protest against the high tax levied by the central government on export and commercial activities and due to the persistent increase in exchange rate as well as increases in the general level of commodity prices (http://www.frontpageafricaonline.com/index.php/business/3232-mass-protest-looms-over-tattered-liberian-economy).

3 Refer to Appendix A for the currency composition of the ECOWAS Member States.

Volatility in oil price or exchange rate is defined as a statistical measure of increase or decrease in oil price or exchange rate within a period. On the one hand, volatile exchange rate regime makes trade and investment decisions more challenging because of uncertainty about future increases or decreases in exchange rate regime. It can be argued that, in ECOWAS countries, there exists floating exchange rates, which are riskier and susceptible to macroeconomic fluctuations, political instability, and fluctuations in the World economy. On the other hand, volatile oil prices have varying implications for different economies. Although oil-producing economies benefit from higher international oil prices, increases in global oil prices result in unfavorable terms of trade in the external sectors of oil-importing economies, which can even be transmitted into their economies in the long-run. Crude oil is an important export commodity in few ECOWAS countries (Côte d'Ivoire, Ghana, Niger and Nigeria) and an important factor for productive activities in many ECOWAS countries' (Benin, Burkina Faso, Cape Verde, The Gambia, Ghana, Guinea, Guinea-Bissau, Liberia, Mali, Senegal, Sierra Leone, Togo). For these reasons, this study contributes to the existing literature by applying panel fixed effects model to examine the asymmetric and causal links between exchange rate movement, oil price shocks and economic output in the ECOWAS countries in order to provide a broader insight on how to reduce volatility and boost trade and investment. Additionally, the study intends to establish whether there are significant differences between net oil-exporters and net oil-importers in the ECOWAS region.

As may be seen from the review of studies in the next section, a number of empirical contributions now exist that have modeled the connections between exchange rate fluctuations, oil price shocks and economic activities in both developed and developing economies. While the literatures have produced conflicting results, most empirical researches show that oil price fluctuations can directly influence economic activities (Amano and Norden, 1995; Coudert et al., 2008; Jin, 2008). To a larger extent, it can be argued that exchange rate fluctuations tend to increase the risk and uncertainty associated with transactions dominated in international currencies (Celasun, 2003; Setser, 2007; Jin, 2008), while fluctuations in international oil prices have both the supply-side and demand-side effects on macroeconomic indices. On the supply side, higher oil prices favor oil producers by increasing their oil receipts and gross domestic product (GDP) growth rates, which brings about more investments and economic growth. On the demand side, however, higher oil price hurt oil importers by raising the general level of prices of commodities produced from oil intensive sectors such manufacturing, transportation, agriculture and other productive sectors. Additionally, investment demand in oil-importing economies may drop during higher oil price regime because the increased production cost shrinks the rate of return on investment and also because of the uncertainties associated with future oil prices (Robinson et al., 2000; Cashin, 2012).[4,5]

Conversely, when oil price depreciates, net-oil producers tend to experience reduction in their oil receipts, which has negative repercussions on fiscal management, macroeconomic stability and economic growth (AfDB et al,, 2016). Oil being a major export commodity for oil exporters, lower oil prices adversely affect foreign exchange inflows, corporate tax revenues and can even result in domestic currency devaluation. However, when oil price depreciates the economies of oil importers tend to grow because they experience reduction in the cost of fuel, manufacturing, transportation and other productive activities. The underlying concept behind these scenarios is that oil price volatility has varying implications for different economies (Basnet and Upadhyaya, 2015; Husain et al., 2015).

Considering the current debate on the supply-side and demand-side effects of oil prices and exchange rate volatilities on economic activities, it becomes expedient to empirically test these links especially when international oil prices are in a falling regime and exchange rate regimes in the ECOWAS countries are becoming volatile. While the results of the study may have broader implications, mainly for developing countries, the focus on the ECOWAS countries is supported by several reasons. To begin with, war and civil strives in the ECOWAS region have damaged much of the region's economy, making it difficult to attain satisfactory level of growth in the region.[6,7] In addition, since the end of June 2014 crude oil price has been in declining state, without sign of returning to an acceptable level in the near future as predicted by the US Energy Information Administration (EIA) and other energy agencies.[8] Given these uncertainties and the current low level of economic development in the ECOWAS states, it is important to evaluate whether falling oil prices and volatile exchange rate regimes do present opportunities for ECOWAS' energy security and macroeconomic developments. One must not forget that 11 of the 15 ECOWAS countries are net oil-importers, which makes them very susceptible to fluctuations in global oil prices. Given that oil is perhaps the most tradable economic commodity and since the world economy is still dependent on oil for agriculture, manufacturing, and other productive activities, this study does not only provide valuable platform for examining potential gains or losses from oil commodities and exchange rate behavior in the ECOWAS nations, it also provides opportunities for developing effective hedging strategies against potential risk associated with oil and the monetary sector (Lin et al., 2014). Also, the four oil-rich economies in the ECOWAS region rely heavily on oil incomes to support their budgets, but international oil prices are undergoing turbulences and becoming more volatile. As oil prices become volatile, these economies will continue to have uncertain future. Therefore, the study is relevant because it exposes the magnitude and direction of oil price shocks and exchange rate fluctuations on the macro-economy of these ECOWAS countries.

4 The recent decline in the price of oil is behind a "positive supply shock" in part responsible for the recent boost in economic activity and decline in unemployment in the US (Hartley, 2015).

5 Chapter II, "Current Issues in the World Economy," October 2000, World Economic Outlook.

6 Noticeable examples are the conflicts that existed in Liberia, Ivory Coast, Sierra Leone, Mali, and constant uprising in Nigeria between the government and militant groups.

7 Also, the failure of leaders to give way to political change is hindering growth (e.g.: The Gambia).

8 The EIA reports that based on uncertainty in the crude price outlook of November 3, 2016, WTI prices in February 2017 is expected to range from $35/b to $66/b at the 95% confidence level (http://www.eia.gov/forecasts/steo/).

Moreover, the floating exchange rates in the ECOWAS countries are currently undergoing serious turbulences which have negative implications on trade and investment in the region. Additionally, as the ECOWAS Member States aim to create free economic trade zones and formulate regional sector policies, the agendas for economic growth, poverty reduction and infrastructural development in the ECOWAS region demand a complete knowledge of the casual relationship between oil price shocks, exchange rate fluctuations and macroeconomic activities. This is important because such understanding provides significant opportunities for oil price/exchange rate - macroeconomic policy framework.

The rest of this paper is structured as follows. In Section 2, we review the relevant empirical literatures on oil price/exchange rate and macroeconomic performance. In Section 3, we present and discuss the variables. Section 4 presents the methods and estimation techniques for the econometric models. Section 5 presents and discusses the main empirical results, while Section 6 concludes and recommends key policy measures.

2. REVIEW OF PREVIOUS STUDIES

Several empirical contributions now exist that have modeled the effects of oil price shocks and exchange rate volatility on economic activities (Pierce and Enzler, 1974; Gordon, 1975; Gisser and Goodwin, 1986; Alotaibi, 2006). For instance, after the collapse of the Bretton Woods exchange rate system in 1973, a floating exchange rate regime now exists in the West African Monetary Zone. Since the emergence of flexible exchange rate system, exchange rates in the ECOWAS states have been prone to various macroeconomic and political instabilities and have triggered several debates among researchers about increased exchange rate risk and its leverage effects on macroeconomic activities and the empirical literatures have produced mixed results. Most of these studies have found evidence of the negative influence of increased volatility of real exchange rates on macroeconomic indices in both developed and developing economies, while others have found positive correlation between erv and economic activities.

On the one hand, Vergil (2002) demonstrates that increasing volatility in exchange rate has significant and adverse repercussions on trade and a country's balance of payments. Similarly, some researchers (Hooper and Kohlhagen, 1978; Cote, 1994; Arize et al., 2000) debate that volatility of exchange rate weakens trade performance. Therefore, in line with the theory of risk-aversion, this implies that trade may be negatively associated with erv.

Using data from 1972 to 1987 and by applying a panel data method, Ghura and Greene (1993) examined the influence of erv on the trade movements of the Sub-Saharan African economies. Their study established a significantly negative and severe impact of erv on trade flows. Also, Aliyu (2008) employed a vector co-integration model and used quarterly data for a 20-year period to study the connection between erv and key macroeconomic variables in Nigeria. The study uncovered that volatility in the Naira exchange rate resulted in a 3.65% decline in Nigeria's non-oil exports. Bah and Amusi (2003) employed the autoregressive conditional heteroskedastic (ARCH) and general ARCH (GARCH) models to gauge the influence of real erv on exports in South Africa from 1990:1 to 2000:4. The authors found a significantly negative interaction between the Rand's real exchange rate variability and exports both in the short and long-runs in South Africa.

While some researchers demonstrate that erv negatively influences economic activities, there are other studies that provide supporting evidences of significant positive correlations between erv and economic activities (de Grauwe, 1988; Asseery and Peel, 1991; Chowdhury, 1993). For instance, de Grauwe (1988) maintains that if merchants are sufficiently risk-averse then a rise in erv will lead to an increase in anticipated marginal utility of export earnings which could serve as an incentive for them to increase their exports in order to maximize their profits. Also, Franke (1991); Sercu and Vanhulle (1992) argue that volatility in exchange rate can positively influence trade volume. Their result is supportive of de Grauwe's (1988) argument that highly volatile exchange rate regime has the propensity to improve trade performance because investors will prefer to export more with the hope of making profits, thereby increasing the volume of trade.

Besides those studies mentioned above, there are other studies that have also found positive association between real erv and trade performance. Todani and Munyama (2005) applied the autoregressive distributed lag bounds testing method and used quarterly data from 1984 to 2004 and applied the moving average method of standard deviation along with the GARCH (1, 1) model to measure erv. Their results show the existence of a significant and positive relationship. Yusuf and Edom (2007) adopted the Johansen co-integration methodology and employed data from 1970 to 2003 to gauge the association between official exchange rate and trade in Nigeria. They established that depreciation in the official exchange rate led to an increase in the export of sawn wood and round wood in Nigeria.

Turning to the oil price - macroeconomic literature, a number of empirical studies (Mork and Hall, 1980; Burbidge and Harrison, 1984; Schneider, 2004; Kilian, 2005; Lardic and Mignon, 2006; Sill, 2007; Farzanegan and Markwardt, 2009; Jbir and Zouari-Ghorbel, 2009, Schubert and Turnovsky, 2011) have modeled the links between oil price shocks and economic activities. These empirical researches argue that increases in the international price of oil have strong and adverse consequences on the macro-economy. These researches maintain that higher oil prices have different impacts across country groups. In an oil-exporting economy, for instance, rising oil price is perceived to be a positive shock because it improves the local economy, but it generally increases inflation. For an oil-importing economy, however, both data and theory point to an adverse correlation between oil price increases and economic activity. For example, Hamilton (1983) showed that after the two oil price rises in the 1970s, there were clear evidences of stagnation in the US economy, which occur 6 months to 1 year.

Since the dramatic fall in oil prices in 1986 the model of oil price-macroeconomic activity has been substantially examined. There have been no insubstantial evidences to substantiate that declining oil price stimulates economic growth contrary to how rising oil price impedes economic activity. Thus, numerous empirical researches have evolved that have re-examined the connections between oil price and economic activity by employing asymmetric techniques (Mork, 1989; Mork and Olsen, 1994; Lee et al., 1995; Hamilton, 2003; Jimenez-Rodriguez and Sanchez, 2005; Askari and Krichene, 2010). These studies reconfirm strong and negative connections between changes in oil price and the level of economic activity.

Practically, Rautava (2004) applied the vector autoregressive (VAR) model and used cointegration approach to study the relations between real GDP (rgdp), government revenues and oil prices in Russia. The result was that rgdp and government revenues were negatively and strongly affected by variations in oil prices, and in both the short-run and long-run oil price fluctuations have direct consequences on real exchange rate. In a related study, Cuñado and de Gracia (2005) used the VAR methodology to study the impacts of oil price shocks on economic variables in Malaysia, Thailand and Philippines and other Asian countries. Similar to the results of Rautava (2004), they found evidence of asymmetric relationship between oil prices and macroeconomic activities for some of the Asian economies. Jimenez-Rodriguez and Sanchez (2005) empirically examined the links between oil price shocks and real economic activity of the main industrial economies by applying multivariate VAR methodology and using both linear and asymmetric models. Their results pointed to asymmetric behavior between oil prices and rgdp growth. The found that oil price increases caused stronger and larger impacts on rgdp growth than oil price decreases, where the impact of oil price decreases was not mostly statistically significant. They also showed that in a group of oil-importing countries, oil price increases have adverse impact on economic activity in all cases, except for Japan. Moreover, the impact of oil price shocks on rgdp growth pointed to downward trend for UK, but it showed an upward movement for Norway. Also, using a VAR methodology, Rafiq et al. (2009) studied the effect of oil price volatility on GDP in Thailand. Their results showed that realized volatility of oil prices has a strong and negative impact on GDP.

Akpan (2009) used the VAR method of analysis and found evidence of a significantly positive asymmetric impact of oil price shocks on real government expenditure in Nigeria. His findings reconfirmed the results obtained in previous researches by Ayadi (2005), and Olomola and Adejumo (2006) in Nigeria. Similarly, Aliyu (2009) used a non-linear model and found that asymmetric oil price increases have stronger and positive effects on rgdp. Iwayemi and Fowowe (2011) used an unrestricted VAR methodology in an oil price-macro-economy study in Nigeria. The authors found that oil price shocks only have a little effect on GDP growth in Nigeria. They found evidence of asymmetric effects of oil price shocks because negative oil shocks significantly affected GDP growth and the real exchange rate. Oriakhi and Osaze (2013) used quarterly data and applied the VAR method to gauge the effects of oil price variability on economic growth in Nigeria from 1970 to 2010. Their results demonstrated that oil price volatility impacted directly on real government expenditure, real exchange rate and real import, while impacting on rgdp, real money supply and inflation through other variables, notably real government expenditure.

After examining the literatures above, we realize that the lack of consensus amongst policymakers has led to the different exchange rate regimes that countries have pursued over time. Also, there are evidences that the oil price volatility models have produced conflicting results in the oil price-macroeconomy study. Additionally, fluctuations in oil prices have not been uniformed and have led to many errors in estimation. Therefore, to evade these biases, we transform our data to avoid sporous and misleading interferences in the results. Furthermore, the review of studies presented above indicate that much attention has not been paid to other ECOWAS countries, except for Nigeria and partly Ghana, and the literature has produced mixed results. Besides, the increasing volatilities in oil prices and exchange rates movements have increased the need for developing sound macroeconomic policies to avert the negative consequences and risks associated with these volatilities. Hence, this study contributes to the literature by lending its voice on the oil price/exchange rate-macroeconomic policy framework within the context of the ECOWAS countries.

3. DATA AND PRESENTATION

3.1. The Applied Data and Sources

This study scrutinizes the influences of erv and real oil price shocks on economic output in a panel of ECOWAS countries from 1980 to 2015. The year 1980 has been chosen as the start off time due to availability of usable data for analysis. The selected macroeconomic variables are rdgp, consumer price index (cpi), trade (tra), erv, and five real oil price shocks (opc_t, $popc_t$, $nopc_t$, $sopi_t$, $sopd_t$).[9] Data for rGDP, cpi, and trade are from the World Development Indicators database. The oil price data are the West Taxes Immediate (WTI) price series from the EIA database. The official exchange rates data are from HistData.com.

To avoid spurious and misleading inferences, the datasets have been transformed. The rgdp data is the inflation-adjusted measure of GDP at constant prices (2010 = 100). The official exchange rate data is the annual average of the official rate of exchange between the local currency unit (LCU) and a unit of the United States dollar (USD). Official exchange rates data are expressed as ratio of LCU to one unit of the USD or LCU/USD. The cpi data is the annual average of consumer's prices, not end-of-period data. The cpi measures changes in the prices of goods and services that households consume. Such changes affect the real purchasing power of consumers, especially their incomes and welfare. In this paper, cpi is assigned a value up to 100. Any value above this threshold implies extreme inflationary situation. The trade data was computed by multiplying the contribution of trade to GDP (% of GDP) by the rgdp data. All rGDP, cpi, and trade data are expressed in logarithmic scale.

3.2 Oil Price Shocks Estimation

Hamilton (2003) argue that incorrect functional form specification of oil price shocks could lead to inconsistent empirical results and misleading interference from oil price-macro-economy study. As

9 opct, popct, nopct, sopit, sopdt are oil price changes, positive oil price changes, negative oil price changes, scaled oil price increase, and scaled oil price decrease, respectively.

a result he suggests that oil price volatility should be calculated as the logarithmic difference of the annual average prices. Using Hamilton's (2003) method, we compute the annual changes (volatility) in oil prices by taking the natural logarithmic difference between two oil price values. Hence,

$$opc_t = \ln(oilP_t)-\ln(oilP_{t-1}) \text{ for } t \in \{1,\ldots, T \text{ years}\} \quad (1)$$

Where opc_t is oil price changes; $\ln(oilP_t)$ is the natural logarithm of oil price at time t and $\ln(oilP_{t-1})$ is the natural logarithm of oil price at time t−1. An interpretation of the correlation between opc_t and $rgdp_t$ is that there exists a linear relationship between oil price changes and rgdp.

Because asymmetric relationship between oil price and economic activity could arise, we employ positive and negative changes of oil price shocks as nonlinear specifications. According to Mork (1989), this approach is valid because positive and negative opc (nopc) might have nonlinear implications for rgdp. Hence, real oil price increase (popc) is specified as:

$$popc_t = \max(0, opc_t) \quad (2)$$

Similarly, real oil price decrease (nopc) is expressed as:

$$nopc_t = \min(0, opc_t) \quad (3)$$

Lee et al. (1995) proposed a very rigorous method for calculating opc, known as scaled opc. Using this tactic, scaled oil price increase (sopi) is computed as follows:

$$opc_t = \theta + \sum_{j-1}^{k} \gamma_j opc_{t-j} + \mu_t \qquad \mu_t \,|\, I_t \rightarrow N(0, s_t^2) \quad (4)$$

Where,

$$s_t^2 = \alpha 0 + \alpha 1 \mu_{t-1}^2 + \alpha 2 s_{t-1}^2 \quad (5)$$

Therefore,

$$sopi_t = \max\left(0, \frac{\mu_t}{s_t}\right) \quad (6)$$

By applying the methods used to develop Equation 6, the equivalent scaled oil price decrease (sopd) is denoted as:

$$sopd_t = \min\left(0, \frac{\mu_t}{s_t}\right) \quad (7)$$

Where $sopi_t$ denotes sopd. In equations 5 through (7), α,γ and θ are constants, μ_t is the white noise process, s_t^2 is the variance, and s is the standard deviation. An explanation of the relationship between sopi and rgdp is that a certain amount of scale oil price increase might cause a decline in rgdp, while a price increase in a highly volatile period might not essentially affect it.

3.3. Erv Estimation

A number of studies have documented various methods of computing erv. Some studies use the moving average standard deviation specification, while others apply the ARCH and GARCH models to compute volatilities. For example, Anderton and Skudelny (2001) compute erv by taking the quarterly variance of the weekly nominal exchange rate, whereas Zubair and Jega (2008) evaluate exchange rate volatility by taking the standard deviation of each series through their sample. Gujarati (2003) propose that the use of mean-adjusted and the variance of each series in a sample can adequately represent erv. Since exchange rate fluctuates much as oil price does, in line with Hamilton's (2003) method, this study computes the annual changes (volatility) in official exchange rates by taking the natural logarithmic difference between two exchange rate values. Hence,

$$erv_t = \ln(EXC_t)-\ln(EXC_{t-1}) \text{ for } t\in \{1,\ldots,T \text{ years}\} \quad (8)$$

Where erv_t is erv; $\ln(EXC_t)$ is the natural logarithm of official exchange rate at time t; and $\ln(EXC_{t-1})$ is the natural logarithm of official exchange rate at time t−1. An interpretation of the link between EXV_t and $rgdp_t$ is that there exists a linear relationship between erv and rgdp.

The authors implemented the GARCH (1, 1) methodology to generate scaled oil price volatilities ($sopi_t$ and $sopd_t$). We adopt the GARCH (1, 1) model because of its capacity to capture volatility in most time series data. Refer to Table 1 for the list of all the examined variables and their units of measure.

3.4. Statistical Properties of the Data

The statistical properties of the data are presented in Table 2. A preliminary study of the data demonstrates that it consists of 498 observations. The findings illustrate that the means of all variables are not zero. Also, the sample standard deviations lie in the bound of 0.14 and 12.09, signifying that sopi is the most volatile variable and positive opc (popc) is the least volatile. The results point out that rgdp, trade, erv, popc, and sopi are skewed to the right, while cpi, opc, nopc and sopd are skewed to the left. On the one hand, erv, sopi, cpi, nopc, sopd, rgdp, trade and opc are leptokurtic, indicating that their distribution are peaked relative to a normal distribution. Nonetheless, erv has the highest level of excess kurtosis, suggesting that extreme changes frequently occur for erv. On the other hand, popc is platykurtic, indicating that its distribution is flat relative to a normal distribution. Moreover, the Jarque-Bera statistic rejects normality at the 1% significance level for all variables.

Table 1: Variables and units of measure

Variable	Notation	Unit of measure	Data source
Real gross domestic product	rgdp	Million USD	WDI
Exchange rate volatility	erv	LCU/USD	WDI
Consumer price index	cpi	Index	WDI
Trade	tra	Million USD	WDI
Oil price changes	opc	USD	EIA
Positive oil price change	popc	USD	EIA
Negative oil price change	opc	USD	EIA
Scaled oil price increase	sopi	USD	EIA
Scaled oil price decrease	sopd	USD	EIA

WDI: World development indicators; EIA: Energy information administration

Table 2: Statistical properties of the examined variables

Statistic	Variables[a]								
	rdgp	cpi	tra	erv	opc	popc	nopc	sopi	sopd
Mean±SD	3.60±063	1.85±0.60	3.39±0.64	0.09±0.24	0.02±0.27	0.12±0.14	−0.10±0.17	5.29±12.09	−3.44±5.01
Skewness	0.76	−1.77	0.77	4.13	−0.72	0.82	−2.16	4.54	−1.82
Kurtosis[b]	4.06	8.91	3.60	32.52	3.20	2.33	6.70	25.02	5.83
Jarque-Bera	67.94*	939.29*	54.48*	18555.48*	41.45*	61.61*	639.99*	11207.54*	419.42*

[a]All variables have their usual meanings. *Indicates significance at the 1% levels. [b]Should be around 3 for a normal series, SD: Standard deviation

3.5. Pre-testing Time Series Properties of the Data

The non-stationarity of many time series variables often leads to misleading inference, spurious results and deceptive conclusions and recommendations in econometric analysis. Therefore, it is essential to employ specialized tactics in econometric analysis to evade these estimation biases. As a preliminary step, we start by conducting unit-root test to scrutinize the stationarity property of our variables in order to avert non-spurious results.

According to Maddala and Wu (1999) panel unit-root test leads to more robust results compared to individual time series methods. For example, the individual panel unit root tests of the Im et al. (2003) and Fisher-type tests of the Augmented Dickey-Fuller (ADF) and Philip-Peron (PP) statistics have better stationarity properties compared to ordinary time series. Hence, we begin by conducting the Augmented Dickey and Fuller (1979) unit-root test. The testing procedure for the ADF test follows the model:

$$\Delta y_t = \alpha+\beta t+\gamma y_{t-1}+\delta_1\Delta y_{t-1}+\ldots+\delta_{p-1}\Delta y_{t-k+1}+\varepsilon_t \quad (9)$$

Where α is an (nx1) intercept vector, β is an (nxn) time trend coefficient matrix; k is the lag order of the autoregressive process; γ, δ_1, and δ_{p-1} are coefficients to be estimated; and ε_t is the (nx1) generalization of a white noise process. If $\alpha=\beta=0$, then we have a random process, but imposing the constraint $\beta=0$ leads to a random process with a draft. By including lags of the order k the ADF process allows for higher-order autoregressive processes, which indicates that the lag length has to be determined when implementing the test.[10] In this study, the optimal lag length for the ADF unit-root tests is based on the default setting of the Schwarz (1978) Information Criterion (SIC). The unit-root test is conducted under the null hypothesis that $\gamma=0$ against the alternative $\gamma<0$. Once the test statistic is calculated, its value is compared to the appropriate critical value of the Dickey–Fuller Test. If the t-statistic is less than the critical value (more negative), then we reject the null hypothesis and conclude that the series has no unit-root; meaning that it is stationary.[11]

However, it is now understood that the outcomes of ADF test are lag dependent. According to Agiakoglu and Newbold (1992), the ADF test often tends to under-reject the null hypothesis of no unit-root. Therefore, in confirmation to the outcomes of the ADF test, we also implement the Phillips and Perron (PP, 1988) and (Im et al., 2003) unit-root tests in this study. The PP test is implemented by means of a nonparametric procedure, which controls for autocorrelation in the unit-root process. The optimal bandwidth selection of the PP-test is based on the default setting of the Newey and West (1987) method and the test probabilities are computed by asymptotic Chi-square distribution.[12] Like the ADF method, the PP unit-root test tests the null hypothesis that a time series y_t is I(1).

Like the ADF method, the IPS method works on the principle of individual unit root process and chooses lag length based on the SIC. The unit-root test is conducted under the null hypothesis that $\gamma=0$ against the alternative $\gamma<0$.

Stationarity test outcomes for IPS, ADF and PP tests are reported in Table 3. The outcomes demonstrate that the null hypothesis of unit roots is rejected for all variables, except for rgdp and trade at level. However, the first differenced series of all variables are stationary. These results indicate that the influences of exogenous shocks to the variables are temporary, but yet, do not compromise attempts to model oil price shocks and erv impacts on economic output.

3.6. Summary Plots of the Oil Shocks Data

Figure 1 illustrates changes in the various oil price shock variables. It shows that the oil price environment has not been uniform, but has been rising and falling; thereby having varying macroeconomic implications for the ECOWAS countries.

4. ECONOMETRIC METHODS

4.1. Empirical Framework

Since our data shows unit root processes for some variables and stationarity of others at level, it became necessary to check the stationarity properties of the differenced series. Because the differenced series demonstrate stationarity of all variables we implement the procedures presented in Figure 2 to estimate our model (Figure 2) illustrates a number of econometric techniques used to estimate our model.

4.2. Model Selection and Estimation Procedures

In a panel data analysis, the selection of the most appropriate model is critical to the study results and their validity. Therefore, we begin our estimation by pooling all observations together in a pooled regression model, neglecting the cross country effect and time series nature of the data. The main problem of this type of model is that it fails to distinguish between the countries in the model. In other words, by combining our 15 countries by pooling we deny the heterogeneity that may occur among them. The pooled regression model is specified as follows:

$$Y_{it} = \alpha_i+\beta_i X_{it}+\varepsilon_{it} \text{ for } t = 1,\ldots, T \text{ and } i = 1,\ldots, N \; E[\varepsilon_{it}\, \varepsilon_{jt}]=0 \quad (10)$$

10 The Akaike (1973) Information Criterion (AIC), Schwarz (1978) Bayesian Criterion (SBC) (or Schwarz information Criterion, SIC), and the Hannan and Quinn (1978) Criterion (HQC) are used to determine optimal lag order for the autoregressive process.

11 This test is non symmetrical, so we do not consider an absolute value.

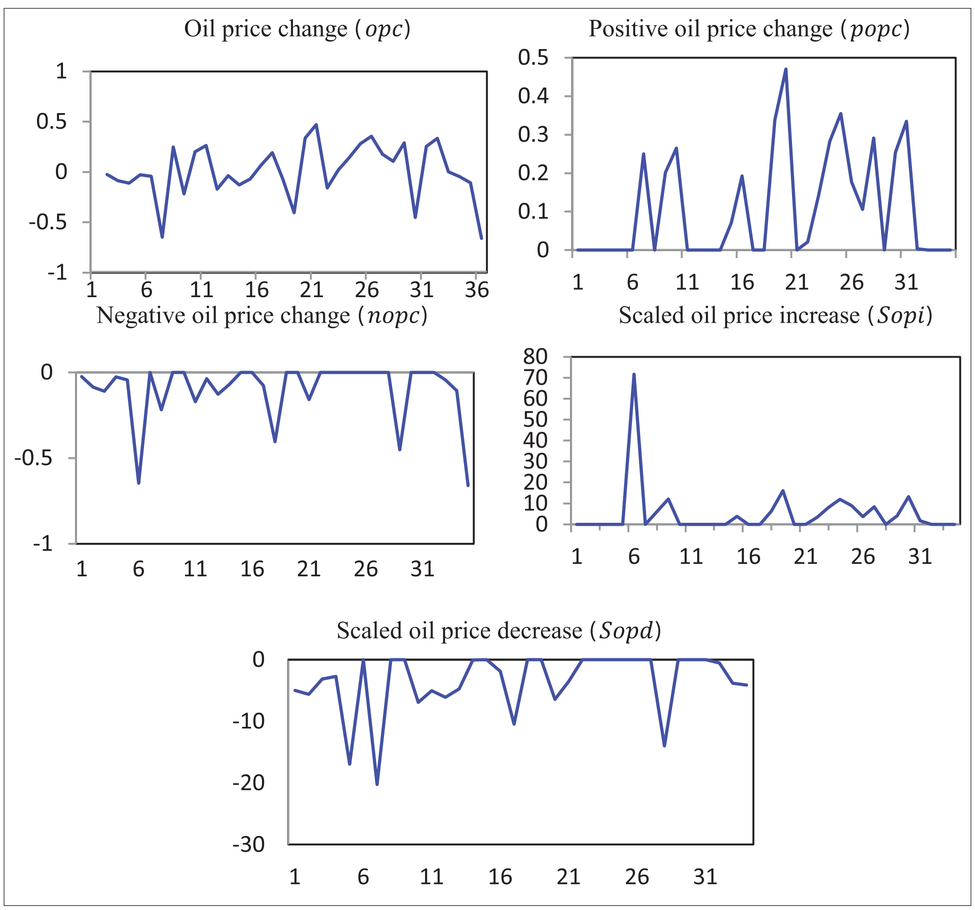
12 The default setting of the test is Bartlett (1937) kernel.

Table 3: Panel stationary tests outcomes[a]

Panel A: Panel unit-root test results at level								
Variables	IPS W-stat[b,c]		Fisher-ADF[b,d]			Fisher-PP[d,e]		
	Intercept	Intercept and trend	Intercept	Intercept and trend	None	Intercept	Intercept and trend	None
rgdp	7.41	−0.05	12.76	37.80	0.32	21.91	29.42	0.28
erv	−12.31*	−10.81*	196.29*	15s8.29*	506.77*	201.55*	415.45*	382.14*
cpi	−4.48*	−2.41*	94.41*	49.33**	5.31	86.46*	32.48	1.52
tra	3.70	−0.65	12.60	37.98	2.70	13.74	36.48	2.31
opc	−14.67*	−12.89*	246.25*	191.14*	359.38*	253.28*	210.27*	359.06*
popc	−11.08*	−10.43*	173.62*	150.44*	171.62*	190.39*	142.65*	166.14*
nopc	−16.01*	−13.64*	266.70*	205.88*	237.32*	258.14*	211.48*	258.50*
sopi	−18.01*	−16.25*	300.50*	248.42*	327.40*	299.91*	250.05*	331.68*
sopd	−21.14*	−11.71*	355.02*	172.50*	297.77*	362.19*	532.65*	316.72*
Panel B: Panel unit-root test results at first difference								
rgdp	−14.51*	−13.00*	236.60*	205.77*	138.22*	263.09*	487.46*	196.71*
erv	−21.61*	−20.96*	360.57*	343.93*	586.46*	751.22*	1682.11*	1962.51*
cpi	−9.68*	−9.43*	159.67*	140.78*	162.86*	169.99*	208.69*	163.35*
tra	−19.82*	−19.43*	327.90*	309.38*	419.16*	341.05*	922.32*	491.22*
opc	−22.41*	−20.29*	380.24*	324.50*	567.71*	518.40*	3465.24*	2978.92*
popc	−22.80*	−13.87*	392.22*	214.18*	604.47*	399.69*	3340.74*	3354.25*
nopc	−29.29*	−29.09*	472.40*	567.62*	947.40*	500.77*	1995.26*	2626.78*
sopi	−22.25*	−20.28*	375.60*	324.97*	559.27*	319.47*	3465.26*	3355.27*
sopd	−22.35*	−20.25*	376.11*	318.14*	553.84*	514.45*	3463.00*	3460.92*

[a]All values in the table are t-statistics. [b]The lag length selection is based on SIC. [c]Probabilities are computed assuming asymptotic normality. [d]Probabilities are computed using asymptotic Chi-square distribution. [e]Band width is selected based on Newey and West (1987) method. * and ** indicate significance at the 1% and 5% levels, respectively

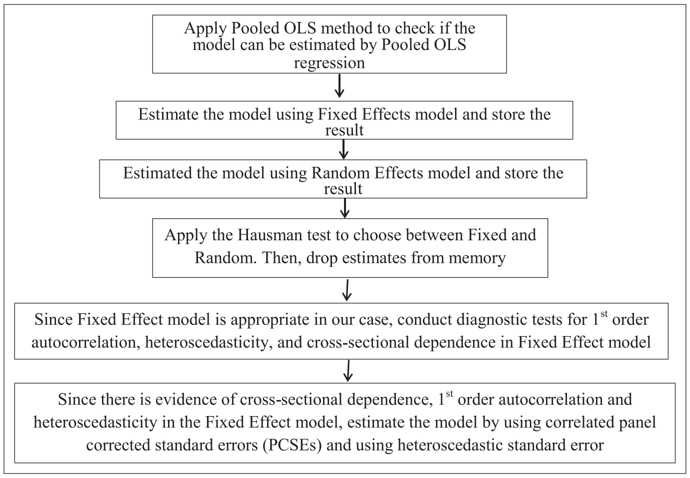
Figure 1: Plots of oil shock variables



Source: Author's plots

Where N is number of countries; T is the number of observations for each country; Y_{it} is the dependent variable (depvar) observed for country i at period t; α_i is the constant term; X_{it} represents the independent variables (indepvar); β_i is the coefficient of the independent variables and ε_{it} is the white noise process. The expression $E[\varepsilon_{it}\ \varepsilon_{jt}]=0$ implies that the mean of the errors is zero.

Figure 2: Modeling framework



Source: Authors' construction

An explanation of i is that repeated observations on individual i are linearly independent.

Next, we estimate our model by fixed and random effects, assuming that all variables are non-stationary at level, but their first differenced series are stationary. The fixed effect model allows for heterogeneity or individuality among our 15 countries by enabling them to have their own intercept values. The expression fixed effect is due to the fact that though the intercept may vary across the countries, but the intercepts don't differ over time and are thus time invariant. According to Stock and Watson (2011) fixed effect model is specified as follows:

$$Y_{it} = \theta_i+\beta_i X_{it}+\varepsilon_{it} \quad (11)$$

Where $t\in\{1,\ldots,T\}$ and $i\in\{1,\ldots,K\}$; $E[\varepsilon_{it}\,\varepsilon_{jt}]\neq 0$; Y_{it} is the dependent variable observed for country i at period t; θ_i is the unknown time-invariant individual effect; X_{it} represents the time-invariant 1xn regressor matrix (independent variables); β_i is the coefficient of the independent variables and ε_{it} is the white noise process. In time-series longitudinal data the β coefficients imply that for a chosen country, when X fluctuates over time by one unit, Y decreases or increases by β units (Bartels, 2008).

On the other hand, estimation of the random effect model demonstrates that our 15 countries have common mean value for the intercept. An explanation of the random effects model is that, unlike the fixed effects model, the difference across countries is presumed to be random and unrelated to the predictor or independent variables incorporated in the model. Random effects assume that the country's error term is not correlated with the predictors and allows for time-invariant variables to serve as explanatory variables. In random-effects one has to identify the individual characteristics that may or may not affect the predictor variables. The disadvantage of this is that some variables may be absent, thereby leading to omitted variable bias in the model. The random effect model is specified by:

$$Y_{it} = \alpha+\beta_1 X_{1it}+\ldots+\beta_n X_{nit}+\nu_{it} \text{ and } \nu_{it} = \varepsilon_{it}+\mu_{it} \quad (12)$$

for $t \in \{1,2,\ldots,T\}$ and $i\in\{1,2,\ldots,N\}$, where Y_{it} is the dependent variable observed for country i at period t; α is the intercept; X_{it} represents the independent variables; β_1-β_n are the coefficients of the independent variables and v_{it} is the composite error term, such that ε_{it} is the with-in entity error and μ_{it} is the idiosyncratic or between-entity error. For a random effect model, the expectations are restricted to zero. Hence, $E[\mu_{it}X_{1it}] = E[\mu_{it}X_{2it}] = E[\mu_{it}X_{nit}] = 0$.

Table 4: Panel data models selection[a]

Model/test	Full sample	Net oil-exporters	Net oil-importers
Pooled OLS regression model	0.0000	0.0000	0.0000
Fixed effect model	0.0000	0.0000	0.0000
Random effect model	0.0000	0.0000	0.0000
Hausman test	0.0000***	0.0000***	0.0000***

[a]All values in table are P values. ***Indicates rejection of the null hypothesis at the 1% level

Once the fixed and random effects models have been estimated, the choice of the appropriate econometric model is decided by the Hannan and Quinn (1978) specification test. The null hypothesis is that the random effect model is preferred over the fixed effect model, while the alternative hypothesis is that the fixed effect model is appropriate instead. It basically tests whether the unique errors (μ_{it}) are correlated with the predictors; the null hypothesis is that they are not. Given a statistically significant P value ($P \le 0.1$), the null can be rejected and a fixed effect model can be estimated. However, if the P value is statistically insignificant ($P > 0.1$), the random effect model is applied instead.

As may be seen from Table 4, this study applies the fixed effect model because the null hypothesis of random effect is rejected for the full sample. Similarly, the outcomes indicate that the fixed effect model is appropriate for the samples of net oil-producers and net oil-importers.

4.3. Diagnostic Tests

To establish the consistency and validity of the selected fixed effect model, diagnostic tests are conducted. We begin by testing for entity and time fixed effects to check whether the dummies for all years are equal to zero and are correlated across all entity. The P value (0.000) of the test rejects the null hypothesis of no entity and time fixed effects. Therefore, we estimate our fixed effect model in this paper by using both individual and time fixed effects.

According to Baltagi (2005), cross-sectional dependence is problematic in macro panels with longer time dimension and smaller cross-sections (i.e. when T > N and T > 30 years).[13] Therefore, we test for cross-sectional dependence in our model since our cross-sections are more than 30 years and there are fewer countries. The outcomes indicate the existence of cross-sectional dependence and must be corrected during the final estimation.[14] Also, we implement the Wooldridge (2010) test for first-order autocorrelation in panel data

13 Pasaran CD (cross-sectional dependence) test is employed to test if the residuals are correlated across entities. CD (also called contemporaneous correlation) can lead to bias in tests results.

14 Cross sectional dependence is corrected by default in the final estimated model: Either FGLS or PCSE estimation.

to check for serial correlation in the fixed effect model and to examine if the residuals are correlated across entities. Serial correlation leads to smaller standard errors of the coefficients than they actually are and causes higher R-squared values. The Wooldridge's method uses the residuals from the regression by first-differencing the data to remove the individual-level effect, the term based on the time-invariant covariates and the constant. Mathematically, this is represented as:

$$\Delta Y_{it} = \beta_i \Delta X_{it} + \Delta \varepsilon_{it} \quad (13)$$

Where Δ is the first difference operator and β_i is the parameter to be estimated by regressing ΔY_{it} on ΔX_{it}. Given that the P values (0.000) for the full sample and for the samples with net oil-producers and net oil-importers are statistically significant, the null hypothesis of no serial correlation is strongly rejected and we conclude that the models are serially correlated.[15] Also, we test for heteroskedasticity in fixed effects model. The null of homoskedasticity (or constant variance) in the modified Wald test for group-wise heteroskedasticity is rejected because of a P value of 0.000. Therefore, we conclude that our data suffers from cross-sectional dependence, heteroskedasticity and first-order autocorrelation. To correct for cross-sectional dependence, serial correlation and heteroskedasticity in our model, two tests are available: Feasible generalized least square (FGLS) estimation or correlated panel corrected standard errors (PCSE) estimation. While the FGLS estimation produces more efficient estimates of the models' parameters, Beck and Katz (1995) maintain that the improvement in power using FGLS is small and that the estimated standard errors are unacceptably optimistic (anticonservative). Since the FGLS method tends to produce optimistic estimates of standard errors and doesn't work well with unbalanced panels, we implement the PCSE in this paper.[16, 17]

Since our data has now satisfied all testing conditions, we can now estimate the fixed effect model using equation 14. In the estimation, rgdp is the dependent variable and is regressed on the other variables. The five real oil price shock variables are entered into the equation one at a time to estimate their impacts as well as the impacts of other examined macroeconomic variables on rgdp. Hence, we expand equations 11 as follows:

$$rgdp_{it} = \beta_0 + \beta_1 cpi_{it} + \beta_2 tra_{it} + \beta_3 erv_{it} + \beta_4 (oil_{it}) + \mu_{it} \quad (14)$$

In equation 14, oil_{it} represents each of the five real oil price shock variables (opc_{it}, $nopc_{it}$, $sopi_{it}$, $sopd_{it}$) that is entered into the equation at a time. β_0 is the constant term; β_1 through β_4 are the coefficients of the regressors; μ_{it} is the generalization of white noise process, and all other variables have their usual meanings.

15 Tests results are available upon request by the editors.

16 The Prais and Winsten (1954) method is a technique applied to correct serial correlation of type AR(1) in a linear regression model. It was developed by Sigbert Prais and Christopher Winsten as a modification of Cochrane and Orcutt (1949) estimation in that it does not lose the first observation, making it more efficiency in dealing with generalized least squares regressions.

17 In STATA, the test is implemented by applying the following command: xtpcse depvar indepvar, het c(ar1), where depvar implies dependent variable and indepvar means independent variable (s). This test corrects cross-sectional dependence by default.

5. RESULTS AND DISCUSSIONS

5.1. Empirical Findings

In this section, we report results for the econometric model. For each oil price shock, three sorts of equations are estimated: (i) The panel with the full ECOWAS samples, (ii) the panel with the net-oil exporters, and (iii) the panel with the net-oil importers. The results for the fixed effects estimation of equation 14 for opc are reported in Table 5. In Panel A, the results show that all examined variables have explanatory power over rgdp for the full ECOWAS sample. Precisely, trade correlates positively and significantly with rgdp for the full ECOWAS sample at the 1% significance level. This result implies that a 1% increase in trade in the ECOWAS region leads to a

Table 5: Effect of oil price changes and other variables on real GDP in Africa

Rgdp	oef	Het-corrected standard error	z	P>|z|	[95% Confidence	interval]
Panel A: Full sample						
tra	0.719	0.032	22.340	0.000	0.656	0.782
cpi	−0.059	0.025	−2.400	0.016	−0.108	−0.011
erv	−0.029	0.013	−2.230	0.026	−0.055	−0.004
opc	−0.027	0.008	−3.310	0.001	−0.043	−0.011
_cons	1.272	0.103	12.330	0.000	1.070	1.474
Panel B: Net oil-producers						
Tra	0.597	0.063	9.530	0.000	0.474	0.720
Cpi	−0.073	0.047	−1.570	0.117	−0.164	0.018
Erv	−0.021	0.023	−0.910	0.365	−0.066	0.024
Opc	−0.010	0.014	−0.730	0.465	−0.037	0.017
_cons	2.028	0.212	9.560	0.000	1.612	2.443
Panel C: Net oil-importers						
Tra	0.595	0.032	18.690	0.000	0.533	0.658
cpi	0.025	0.022	1.130	0.256	−0.018	0.068
erv	−0.025	0.011	−2.230	0.026	−0.048	−0.003
opc	−0.028	0.009	−3.180	0.001	−0.045	−0.011
_cons	1.427	0.097	14.740	0.000	1.237	1.617

Table 6: Effect of positive oil price changes and other variables on real GDP in Africa

rgdp	Coefficient	Het-corrected standard error	Z	P>|z|	[95% confidence	interval]
Panel A: Full sample						
tra	0.725	0.032	22.660	0.000	0.663	0.788
cpi	−0.058	0.025	−2.360	0.018	−0.106	−0.010
erv	−0.028	0.013	−2.140	0.032	−0.054	−0.002
popc	−0.038	0.018	−2.160	0.031	−0.073	−0.004
_cons	1.254	0.103	12.200	0.000	1.053	1.456
Panel B: Net oil-producers						
tra	0.611	0.062	9.820	0.000	0.489	0.733
cpi	−0.076	0.046	−1.650	0.099	−0.167	0.014
erv	−0.021	0.023	−0.920	0.359	−0.067	0.024
popc	−0.008	0.030	−0.270	0.789	−0.068	0.051
_cons	1.978	0.211	9.380	0.000	1.565	2.391
Panel C: Net oil-importers						
tra	0.601	0.032	18.850	0.000	0.538	0.663
cpi	0.026	0.022	1.180	0.239	−0.017	0.070
erv	−0.024	0.012	−2.040	0.041	−0.046	−0.001
popc	−0.041	0.019	−2.170	0.030	−0.079	−0.004
_cons	1.413	0.097	14.580	0.000	1.223	1.603

71.9% rise in rgdp. Interestingly, opc, erv, and cpi are negatively and significantly associated with rgdp for the full ECOWAS sample. In Panel B, however, the findings suggest that only trade is significant to explain rgdp in net-oil exporting ECOWAS countries.

When the oil shock is popc, the outcomes for fixed effects estimation of equation 14 are reported in Table 6. Similar to the outcomes in Table 5, all examined variables are statistically and significantly correlated with rgdp for the full ECOWAS sample at the 5% significance level. Also, the outcomes in Table 6 demonstrate that trade boasts rgdp growth in the ECOWAS region, be it net-oil exporters or net-oil importers. Similar to the findings in Table 5, erv and popc do not have significant explanatory power over rgdp of net-oil exporting ECOWAS countries, but can negatively and significantly influence the rgdp of net-oil importers in the ECOWAS region. However, the results in Panel B show that cpi is negatively and significantly associated with rgdp of net oil-exporters in the ECOWAS states, indicating that a 1% fall in cpi of net-oil exporters leads to a 7.6% decrease in their rgdp.

Fixed effects estimates for nopc and sopd are presented in Tables 7 and 8, respectively. The outcomes show that all examined variables are statistically and significantly correlated with rgdp for the full ECOWAS sample at the 5% significance level, be it nopc or sopd. Similar to the outcomes in Tables 5 and 6, trade positively and significantly influences rgdp in the ECOWAS region, be it the full ECOWAS sample, the sample with net oil-producers, or net-oil importers. Additionally, the outcomes in Tables 7 and 8 show that, unlike net-oil exporters, erv, nopc and sopd correlate negatively and significantly with the rgdp of net-oil importers in the ECOWAS region. However, in Table 8, there exists a significant negative correlation between cpi and rgdp of net-oil exporters. No such significant relationship exists for net-oil importers. These results further demonstrate evidence of significant differences between net-oil producers and net-oil importers in the ECOWAS region.

When the oil shock is sopi, the outcomes for fixed effects estimation of equation 14 are reported in Table 9. Similar to the results reported previously, all the examined variables correlate significantly with rgdp for the full ECOWAS sample. Additionally, there exists strong positive and significant relationship between trade and rgdp for the full ECOWAS sample and for the samples with net-oil exporters and net-oil importers. Interestingly, the coefficient for sopi is zero for both net-oil exporters and net-oil importers, indicating that the effect on rgdp is neutral. Similar to all the results reported in this paper, erv negatively and significantly influences rgdp of net-oil importers, but has not significant impact on rgdp of net-oil exporters. Also, cpi correlates negatively and significantly with rgdp of net-oil exporters, but has no significant effect on rgdp of net-oil importers in the ECOWAS region of Africa.

Table 7: Effect of negative oil price changes and other variables on real GDP in Africa

rgdp	Coefficient	Het-corrected standard error	Z	P>|z|	[95% confidence	interval]
Panel A: Full sample						
tra	0.715	0.032	22.160	0.000	0.652	0.778
cpi	−0.060	0.025	−2.430	0.015	−0.109	−0.012
erv	−0.029	0.013	−2.240	0.025	−0.055	−0.004
nopc	−0.042	0.012	−3.480	0.001	−0.066	−0.019
_cons	1.283	0.103	12.410	0.000	1.080	1.486
Panel B: Net oil-producers						
tra	0.580	0.s063	9.200	0.000	0.456	0.703
cpi	−0.068	0.047	−1.450	0.147	−0.161	0.024
erv	−0.021	0.023	−0.910	0.363	−0.065	0.024
nopc	−0.019	0.020	−0.940	0.348	−0.058	0.021
_cons	2.089	0.213	9.800	0.000	1.671	2.507
Panel C: Net oil-importers						
tra	0.589	0.032	18.410	0.000	0.527	0.652
cpi	0.024	0.022	1.100	0.272	−0.019	0.068
erv	−0.025	0.011	−2.240	0.025	−0.047	−0.003
nopc	−0.043	0.013	−3.240	0.001	−0.069	−0.017
_cons	1.442	0.097	14.810	0.000	1.251	1.632

Table 8: Effect of scaled oil price decrease and other variables on real GDP in Africa[a]

rgdp	Coefficient	Het-corrected standard error	z	P>|z|	[95% coefficient	interval]
Panel A: Full sample						
tra	0.748	0.032	23.690	0.000	0.687	0.810
cpi	−0.077	0.025	−3.080	0.002	−0.127	−0.028
erv	−0.029	0.013	−2.140	0.033	−0.055	−0.002
sopd	−0.001	0.000	−2.290	0.022	−0.002	0.000
_cons	1.209	0.102	11.840	0.000	1.009	1.409
Panel B: Net oil-producers						
tra	0.692	0.060	11.530	0.000	0.574	0.810
cpi	−0.127	0.047	−2.720	0.006	−0.218	−0.036
erv	−0.022	0.025	−0.870	0.384	−0.070	0.027
sopd	0.000	0.001	−0.180	0.856	−0.001	0.001
_cons	1.729	0.201	8.620	0.000	1.336	2.123
Panel C: Net oil-importers						
tra	0.598	0.033	18.340	0.000	0.534	0.662
cpi	0.017	0.023	0.730	0.466	−0.029	0.062
erv	−0.023	0.011	−2.020	0.044	−0.046	−0.001
sopd	−0.001	0.000	−2.220	0.027	−0.002	0.000
_cons	1.434	0.100	14.390	0.000	1.239	1.630

Table 9: Effect of scaled oil price increase and other variables on real GDP in Africa

rgdp	Coefficient	Het-corrected standard error	Z	P>|z|	[95% confidence	interval]
Panel A: Full sample						
tra	0.756	0.031	24.320	0.000	0.695	0.817
cpi	−0.079	0.025	−3.200	0.001	−0.128	−0.031
erv	−0.029	0.013	−2.200	0.028	−0.056	−0.003
sopi	0.000	0.000	−2.560	0.011	−0.001	0.000
_cons	1.193	0.100	11.880	0.000	0.996	1.390
Panel B: Net oil-producers						
tra	0.703	0.059	11.880	0.000	0.587	0.819
cpi	−0.131	0.046	−2.870	0.004	−0.220	−0.041
erv	−0.021	0.025	−0.850	0.397	−0.070	0.028
sopi	0.000	0.000	−1.750	0.080	−0.001	0.000
_cons	1.693	0.197	8.580	0.000	1.306	2.080
Panel C: Net oil-importers						
tra	0.601	0.032	18.500	0.000	0.537	0.665
cpi	0.015	0.023	0.670	0.506	−0.030	0.060
erv	−0.024	0.012	−2.040	0.041	−0.046	−0.001
sopi	0.000	0.000	−1.820	0.068	−0.001	0.000
_cons	1.433	0.099	14.460	0.000	1.239	1.627

5.2. Implications of the Results

Similar to the results of many researches that trade can boast economic output; this study follows similar line or argument. Clearly, the results show that whether oil shocks are linear or non-linear benchmark, estimation of the fixed effects model points to strong and positively significant relationship between trade and rgdp in the ECOWAS states. However, estimation of the model using linear and non-linear oil shocks show significant differences between net-oil exporters and net-oil importers in the ECOWAS states. Clearly, the rgdp of net-oil importers is significantly negatively influence by erv, whereas rgdp of net-oil exporters is negatively and significantly influenced by cpi.

Findings that the linear and non-linear benchmarks of oil price shocks can significantly and negatively influence rgdp of net-oil importers are somewhat reasonable. First, the huge dependence of net-oil importers on oil for oil intensive activities can lead to negative trade balance, which can in turn affect their balance of payment position and their rgdp. Second, while oil price decreases might seem to boast trade and economic output of net-oil importers, one must not forget that in most of the ECOWAS countries manufacturing, industrial and agricultural activities are mainly labor intensive, rather than oil driven to the extent that oil price decreases will boast rgdp. Third, finding that sopi has no effect on rgdp of importers and exporters is reasonable. The question then is what boasts rgdp in the ECOWAS region? Wesseh et al. (2013) computed substitution elasticities between oil and the classical factors of production in Africa and found the substitution between capital, labor and oil to be about unity for most countries. Their study also showed that labor contributes almost three times as much as petroleum to rgdp in Liberia. What this implies is that when there are shocks to oil prices, instead of reallocating resources from the oil-intensive sectors, which would be rather costly, capital and labor intensities are increased (manual operation). Because labor contributes massively to rgdp in Liberia than oil, the effects of high labor-intensity go beyond those of high oil prices. Consequently, there is no leverage effect on rgdp.

Fourth, one must not forget that much of ECOWAS lacks structured financial market as stated earlier. Since it is not mandatory for Central Banks in the region to issue monetary policy in response to oil price shocks, finding that decreases in oil price would impact rgdp negatively is reasonable because the uncertainty and stress of financial markets as well as the responses of monetary policy to oil price shocks are important factors to explain the effects of oil price fluctuations on the macroeconomy (Ferderer, 1996; Tatom, 1993; Balke et al., 2002; Brown et al., 2002; Hamilton,1988).

Turning to the influence of erv on rgdp in the ECOWAS states; recent economic developments point to currency depreciation and extreme inflationary crisis, which have translated into the domestic economies of the member countries. Therefore, findings that erv can affect the level of rgdp of net-oil importers are not surprising. Remember that these economies depend on imported oil to satisfy their energy needs and that oil transactions are dominated in international currencies. Therefore, it is not surprising that oil price volatility will influence exchange rate movement to the extent that it can negatively affect rgdp of net-oil importers.

6. CONCLUSIONS AND POLICY RECOMMENDATIONS

This study analyzes the impact of oil price shocks, erv and key macroeconomic variables on rgdp in the ECOWAS states in Africa. The study employs fixed effects model and finds evidence of both linear and nonlinear correlation between oil price shocks and rgdp for the full ECOWAS sample and for sample with net-oil importers. The study observes that the linear and asymmetric benchmarks of oil shocks correlate negatively with rgdp for the full ECOWAS sample and for the net-oil importers. However, there are no significant impacts of oil shocks on rgdp of net-oil exporters.

Additionally, the study establishes that trade is strongly and significantly positively associated with rgdp in the ECOWAS states, be it net-oil exporters or net-oil importers. A significant negative relationship between erv and rgdp also exists for the full ECOWAS sample and for the net-oil importers, but no such correlations exist for net-oil exporters. Clearly, these results demonstrate significant differences between net-oil importers and net-oil exporters in the ECOWAS region.

A significant insight from the study is that net-oil importers ought to formulate policies to avert the negative consequences of oil price shocks. Such policies should be directed toward diversification away from oil dependence to reliance on other energy types, including hydro power and renewable energy. Also, the ECOWAS states (mainly net-oil importers) need to implement monetary policies that will stabilize their exchange rate regimes and boast trade and investment. One way to implement this policy is to promote the economic diversification policy, in addition to creating peaceful investment climate through eradication of corruption, improving the ease of during business, encouraging local manufacturing and exports among others.

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APPENDIX

Appendix Table A: Currency composition of the ECOWAS Member States

Countries	Currency	Countries	Currency
Benin	CFA franc	Liberia	Liberian dollar/US dollars
Burkina Faso	CFA franc	Mali	CFA franc
Cape Verde	Cape Verdean escudo	Niger	CFA franc
Côte d'Ivoire	CFA franc	Nigeria	Nigerian Naira
The Gambia	Dalasi	Senegal	CFA franc
Ghana	Ghanaian Cedi	Sierra Leone	Sierra Leonean Leone
Guinea	Guinea franc	Togo	CFA franc
Guinea-Bissau	CFA franc		

Appendix Table B: Sample period of the ECOWAS Member States

Countries	Countries
Benin (1980-2015)	Liberia (1999-2015)
Burkina Faso (1980-2015)	Mali (1980-2015)
Cape Verde (1980-2015)	Niger (1980-2015)
Côte d'Ivoire (1980-2015)	Nigeria (1995-2015)
The Gambia (1980-2015)	Senegal (1980-2015)
Ghana (1980-2015)	Sierra Leone (1980-2015)
Guinea (1986-2015)	Togo (1980-2015)
Guinea-Bissau (1980-2015)	