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Revisiting the linkage between oil and agricultural commodity prices: Panel evidence from an Agrarian state

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Abstract

This paper utilizes panel methods to consider the dynamic relationship between oil and agricultural commodity prices. The study makes use of monthly measures realized data for six agricultural commodity prices, including cocoa, coffee, wheat, palm oil, soybeans, beef and crude oil. The dataset spans the period 2006–2015 and includes a measure for the effective exchange rate. The results of a panel unit root test suggest that all the variables are stationary after taking the first difference. The Fisher/Johansen cointegration test is then used to suggest that the dataset includes a single cointegrating vector. A regression on the long-run characteristics of the data is then used to show that crude oil prices are positively correlated to agricultural commodity prices. This suggests that oil price for the case of Nigeria drives demand for agricultural crop commodity. The results show that agricultural commodity prices in Nigeria are responsive to global oil prices. The subsequent causality test that account for heterogeneity tests performed on the first difference of the variables reject the null hypothesis of no Granger causality in either direction between crude oil prices and agricultural crop commodity. This suggests that oil prices drive agricultural commodity prices and vice versa. Based on these outcomes several policy directions were rendered in concluding section.

KEYWORDS

agricultural commodity, Nigeria, oil prices, panel data econometrics

1 | INTRODUCTION

World commodity prices have experienced a surge in recent decades, and agricultural commodities are no exception. This has drawn the attention of numerous empirical works (Balcilar, Chang, Gupta, Kasongo, & Kyei, 2014; Gözgör & Kablamaci, 2014; Kapusuzoglu & Ulusoy, 2015; Nazlioglu, 2011; Nazlioglu & Soytas, 2012). Figure 1 below gives visual evidence of the co-movement among these agricultural commodities over the years. This trend is worthy of investigation in order to create for policymakers a sufficient platform for a decisive policy framework as well as to spur avenues for investors and interest groups. This phenomenon has also been a matter of debate among scholars in the energy-food domain with respect to unravelling the rationale behind the simultaneous hike in both oil and agricultural commodity prices. These scholars include Abbott, Hurt, and Tyner (2008), who posited that the core economic drivers in agricultural commodity prices are found in strong ties among macro-economic indicators such as interest rates, oil prices, exchange rates and unemployment. However, the perpetual hike in the demand for food and the corresponding agricultural productivity were also captured as key drivers of an increased price surge in the agricultural commodity market alongside national policy

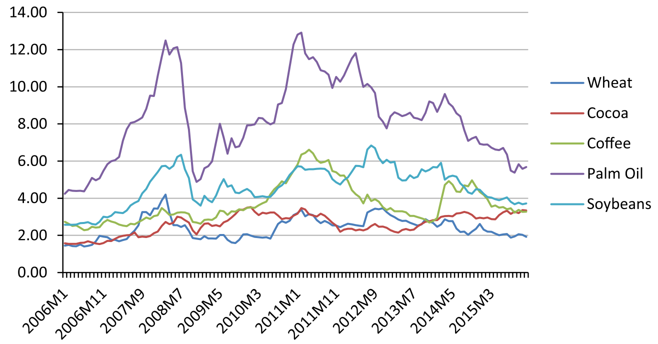

FIGURE 1 The historical trends of the agricultural commodities under review [Colour figure can be viewed at wileyonlinelibrary.com]

choice. The current global food system is highly fuel- and transportation-dependent. Modern agricultural practices use oil products to fuel machinery and to transport inputs to the farms as well as to transport output to the ultimate consumers. Thus, there are concerns raised among the key actors and interest groups that high, volatile oil prices may cause food prices to continue to increase.

Several factors have been mentioned as responsible for the increased agricultural commodity prices, but among these factors, oil price is highly pronounced (see FAO, 2008; Mitchell, 2008; OECD, 2008). However, this conclusion is based on the premise that a synergy exists between the agricultural and energy markets since the escalation of biofuel production in 2006. This means that some form of co-movement and causal relationship exists between oil and agricultural commodities. This relationship birthed the increased usage of agricultural crops in the production of biofuels and some agricultural crops (ethanol, biodiesel), as these biofuels were seen as substitutes for diesel as well as for other fuels and gasoline (Dehn, 2000). World globalization has left economies more interconnected around the globe, relative to previous years. Thus, any shock or deviation in macroeconomic indicators such as oil prices is transmitted across economies due to this interconnection.

There is extensive literature on the linkage between oil and agricultural commodity prices, and against this backdrop, the current study extends the literature in several ways. According to Baltagi, Bratberg, and Holmås (2005), a panel data approach provides superior, robust findings, helping to increase the power of the unit root and cointegration test, given that it combines both time series and cross-sectional dimension. The merit of the technique allows a higher degree of freedom as well as less collinearity among variables. Few studies have investigated the phenomena of interest using panel data econometric techniques, and there are scant works with divergent empirical findings (see Fowowe, 2016; Nazlioglu & Soytas, 2011), so we intend to fill this gap. Premised on this ambiguity in the literature, we seek to revisit the oil and agricultural commodity price nexus, as the outcomes of previous studies have been inconclusive.

We also aim to investigate the extent to which oil prices influence agricultural commodity prices. To the best of the author's knowledge, no study has used the above econometric methods for Nigeria to investigate the linkage between the variables in question; thus, the present study will be the first to explore the dynamic relationship between oil and some selected agricultural commodities for the case of Nigeria. The choice of the selected agricultural commodity crop stems from their cash potentials as well they form majority of stable food crop in Nigeria, which are readily available and affordable. The mentioned commodity also possesses export ability to bring export earnings at both international and domestic commodity market (Akpan & Udoh, 2009). The need to explore the interaction between crop commodity prices and foreign exchange and dwindling oil prices is necessary in Nigeria, which has not be address in the previous literature. It is important to dig deeply into this theme, considering the pivotal role, which the agricultural and oil sectors play in that country's economic growth (see Aliyu, 2009). We also seek to examine the effect of oil prices on non-oil-producing crops, as most studies dwell on oil-producing crops. Finally, the study seeks to provide new insight into the questions under consideration for policymakers and interest groups.

The remainder of this paper proceeds as follows. The next section is focused on the literature survey. Section 3 dwells on the data and the econometrics procedure. Section 4 presents the empirical findings and the conclusion is rendered in Section 5.

2 | LITERATURE REVIEW

The energy-food nexus literature has produced well-documented studies in recent years, for example the seminal study of Hanson, Robinson, and Schluter (1993) on the impact of oil shock on the U.S. agricultural sector. Using the General Computational Equilibrium model for the period 1973–1982, the study was an invitation to produce several other empirical works in the energy-food literature. The authors posited that the agriculture sector is energy-intensive and that the impact of an oil shock varies across diverse agricultural commodities.

Meanwhile, Zhang and Reed (2008) as well as Zhang, Lohr, Escalante, and Wetzstein (2010) published several works on the energy-food nexus where they investigated the impact of world crude oil on China's agricultural commodity prices, food and fuel. From their findings, it was revealed that oil shock does have a significant effect on agricultural commodity prices.

The food-energy literature can be grouped into three broad categories. The first category concludes that oil has no effect on agricultural commodity prices, with the common term in this literature being "neutrality" (see Balcilar et al., 2014; Nazlioglu, 2011; Nazlioglu & Soytas, 2011; Reboredo, 2012; Zhang et al., 2010) while the second finds evidence for oil prices influencing agricultural commodity prices (Balcilar & Bekun, 2020; Du, Yu, & Hayes, 2011; Fowowe, 2016). Finally, the third category's (see Nazlioglu, 2011; Nazlioglu & Soytas, 2012) findings deviate from the common methodology adopted as well their findings coincide with the time of global financial distress (see Chen, Kuo, & Chen, 2010; Nazlioglu, Erdem, & Soytas, 2013).

Nazlioglu and Soytas (2012) also empirically examined the dynamic relationship between oil prices and agricultural commodities for 24 sampled crops in the United States. Their empirical model was built in such a way that it captured the relative strength of the U.S dollar through a panel analysis framework. However, their empirical findings reveal strong evidence for world oil prices influencing on agricultural commodities.

In the same vein, Nazlioglu (2011) examined the linkage between world oil and agricultural commodity prices, employing weekly data from 1994, week 1, to 2010, week 29. The novelty of his study relative to others is that it made use of nonlinear causality in capturing the association between soybeans, corn and wheat. Nazlioglu's empirical evaluation using linear causality revealed no evidence of oil prices driving agricultural commodity prices; however, nonlinear causality showed strong evidence for oil prices influencing agricultural commodity prices. Balcilar et al. (2014) confirmed Nazlioglu's findings, where their study also used nonlinear causality, although through quantile regression analysis, to examine the oil and agricultural commodity nexus. Balcilar et al. (2014) posited that the impact of oil prices on agricultural commodities such as corn soybeans, sunflower, wheat and so forth. fluctuated across different quantiles of conditional distribution.

Du et al. (2011) also queried the degree to which oil price volatility is transmitted into agricultural commodity prices. The study engaged a stochastic volatility model with weekly data spanning 1998 to 2009. They evaluated the relationship between agricultural commodity prices (where they used corn and wheat as variables of interest) and crude oil. They found that crude oil had a spillover effect on the selected agricultural commodities, which agrees with the findings of Charles, Ogbuabor, and Obinna (2016).

Several of these studies were conducted in the African context. Fowowe (2016) examined the relationship between oil and agricultural commodity prices for South Africa using weekly data for the period 2003–2014. He applied nonlinear causality and a cointegration estimation technique to investigate the dynamic relationships among these prices, sampling the crops maize, sunflower and soybeans. He found no evidence for oil price as a driving force for agricultural commodity prices. This implies that any shock to the agricultural commodity prices is neutral, an implication to which earlier studies lent support.

Fernado (2014), on the other hand, unravelled the rationale between oil prices and agricultural commodity prices using the Vector Auto Regressive and the Vector Error Correction models to capture the dynamic short-run and long-run relationship. An impulse response technique was used to evaluate the impact of an oil price shock on the selected agricultural commodities (corn and soybeans). From Fernado's findings, it was discovered that an adverse causality relationship exists between oil prices and agricultural commodity prices.

Table 1 below provides further insight into the literature as well as the empirical findings.

3 | DATA AND METHODOLOGY

To examine the dynamic relationship between agricultural commodity prices and oil prices, the current study leveraged the empirical studies of Nazlioglu and Soytas (2012).[1] Agricultural commodity prices are modelled as a function of oil prices and the effective exchange rate. The empirical functional relationship of the model is given below:

$$Cp = f(op, XR) \tag{1}$$

A logarithm transformation was carried out on Equation (1),

$$\ln CP_{it} = \beta_0 + \beta_1 \ln OP_{it} + \beta_2 \ln XR_{it} + \varepsilon_{it} \tag{2}$$

where CP_i is the price of the agricultural commodity, i, under review (1...6; viz., cocoa, coffee, wheat, palm oil, soybeans and beef). The commodity choices are based on their export potentials in the study area as well as on the fact that they are predominately produced in the study area. Many of these agricultural commodities (e.g., soybeans) are also alternatives to crude oil. OP is the oil price, given by World Texas Intermediate in U.S. Dollars per barrel, and XR is real effective U.S. dollar exchange rate. All the commodities were converted to dollar term as well as the selected agricultural commodities were seasonally adjusted in order to circumvent for

TABLE 1 Summary of literature survey of oil-agriculture commodity price nexus

Study (author)	Period	Region	Methodology	Commodity	Empirical findings
Fowowe (2016)	2003–2014	South Africa	Nonlinear causality and cointegration estimation	Maize, sunflower, soybeans, oil	Agricultural commodity in South Africa is neutral to global oil prices
Balcilar et al. (2014)	2005–2014	South Africa	Quantile regression	Soybeans, wheat, sunflower, corn	Impact of oil on agricultural commodity fluctuates across different quantile of conditional distribution
Gözgör and Kablamaci (2014)	1990–2013	United States	Panel first- and second-generation model	Wheat, maize, sorghum, rice, barley, soybeans, soybean oil, olive oil, groundnuts	Agricultural commodity prices show strong unit root properties
Zhang et al. (2010)	1989–2008	Brazil	VECM, Granger causality	Ethanol, corn, rice, soybeans, sugar, wheat, gasoline, crude oil	No direct long-run price relations between fuel and agricultural commodity prices
Nazlioglu (2011)	1994–2010	United States	Toda-Yamamoto and disc Panchenko causality analysis	Corn, soybeans, wheat	The nonlinear causality analysis of oil, corn and soybeans
Nazlioglu and Soytas (2011)	1980–2010	United States	Panel cointegration and Granger causality	Barley, maize, wheat, sorghum, rice, cotton, coconut oil, olive, fishmeal, petroleum, exchange rate	Positive impact of a weak dollar on agricultural prices is also confirmed
Hassouneh, Serra, Goodwin, and Gil (2012)	2006–2010	Spain	Multivariate local linear regression	Biodiesel, sunflower, crude oil	Study traces long-run equilibrium relationship among the three prices
Papiez (2014)	2007–2014	Poland	Augmented VAR, Toda-Yamamoto	Crude oil, corn, ethanol	Results reveal dependencies between prices of energy sources and food price change in time
Chen, Kuo, and Chen (2010)	1983–2010	China	ARDL	Crude oil price, corn, soybeans, wheat	Grain price found to significantly influence the changes in other grain prices
Fang, Lee, and Chang (2014)	2004–2012	China	Toda-Yamamoto causality and impulse response analysis	Rice, flour, soybean oil, peanut oil, grape salt, white chicken meat, fuel oil price	Neutrality (no causal relation)
Nazlioglu (2012)	1986–2011	United States	Variance causality	Wheat, corn, soybeans	Variance causality shows risk transmission between oil and agriculture in the pre-crisis period
Esmaeili and Shokoohi (2011)	1961–2005	Iran	Principal component analysis	Egg, meat, oilseed, Rice, sugar	Crude oil prices have indirect effect on food price
Sheng et al. (2010)	2005–2008	China	ARDL bound test-	Corn, soybean, wheat	Change in grain price is significantly influenced by changes in oil price
	1991–2014	Turkey	VECM and Johansen	Wheat, corn, soybeans	Neutrality (no causal effect as well as no long-run relationship)

(Continues)

TABLE 1 (Continued)

Study (author)	Period	Region	Methodology	Commodity	Empirical findings
Adämmer and Bohl (2015)	1993–2012	United States	MTAR, VECM, Granger causality	Corn, soybeans, wheat	Speculative bubbles are present in wheat prices
	1969–2008	Italy	Granger causality	Soybeans, wheat corn monetary expansion, oil price, GDP growth	Economic growth, oil price affect agricultural commodity price
Kaltalioglu and Soytas (2011)	1980–2008	Turkey	Granger causality	Oil prices, food production, agricultural raw material index	Neutrality (no causal relation)
Rosa and Vasciaveo (2012)	1999–2012	United States and Italy	Cointegration analysis, Granger	Wheat, corn, soybeans, crude oil.	Indecisive neutrality (no causal relation)
Alghalith (2010)	1974–2007	Trinidad & Tobago	Nonlinear ordinary least	Crude oil, food basket	There exists a spillover effect of transmission from higher oil prices to food prices
Chang et al. (2010)	2000–2008	United States	Volatility models	Crude oil, corn, soybeans	Spillover effect running from crude oil to agriculture commodity
Alom, Ward, and Baiding (2011)	1994–2010	Asia and Pacific Countries	VAR model	Crude oil, food price index	Divergent correlation among indices of food price volatility and world oil prices
Cevik and Sedik (2014)	1990–2010	Malaysia	Ordinary least squares	Crude oil, fine wine	Key drivers of agricultural commodity prices are macro-economic indicators
Du et al. (2011)	1998–2009	United States	Stochastic volatility	Crude oil, corn, wheat	Crude oil causes a spillover effect on commodity
Hassouneh et al. (2012)	2006–2010	Spain	Multivariate OLS	Biodiesel, sunflower, crude oil	Equilibrium relationship traced among three variables
Serra (2011)	1990–2008	Brazil	ST-VECM	Ethanol, corn, crude oil, gasoline	Long-run equilibrium relationship
Kristoufek, Janda, and Zilberman (2012)	2003–2011	United States	Minimal spanning and hierarchical tree	Biodiesel, ethanol, fuels, corn, wheat, soybeans, sugarcane	Study captures causal effect among the series
Charles et al. (2016)	2000–2013	Nigeria	GARCH	Balance of payment, exchange	Showed causality from BOP to CPI as well as low percent of volatility spill
Fernado (2014)	1986–2012	United States	VECM, Granger causality	Corn, soybeans, Oil prices	Inverse causality from crop to oil prices
Christiane and Lutz (2014)	1988–1995	United States	Impulse response	Corn, soybeans, wheat, rice, CPI, oil price	Evidence not found on the effect of oil on selected crops of interest
Fang et al. (2014)	2004–2012	Taiwan	Toda-Yamamoto, impulse response	Oil, rice, flour, soybeans eggs, sugar, wheat, salt	Fuel exhibits short-run effect and long-run relationship among series

Source: Authors' creation.

spurious analysis and by extension misleading inferences from subsequent analyses. Oil price is expected to be positive. Oil price explains most production cost processes in the agricultural and food domain; thus, an increase in this price will also result in a corresponding increase in agricultural food price. Similarly, the dollar–Naira parity also explains the expected signs on the exchange rate.

The current study employs monthly data spanning 2006 M1 to 2015 M12. The data were retrieved from the African Development Bank for commodity prices, while oil prices and exchange rates were sourced from the Thomson Reuters database (DataStream). The study period was chosen based on data availability and on the need to capture the dynamics in the food-energy domain since biofuel production beginning in 2006.

3.1 | Empirical procedure

This study employs a panel unit root testing procedure, cointegration and causality testing to capture the dynamic nexus between oil prices and agricultural commodity prices in Nigeria. The empirical route of this study follows four paths. First, we evaluate the stationarity properties and the asymptotic stability traits of the variables via panel unit root testing. Then, after estimating the stationarity properties of the variables, we evaluate the cointegration relationship to ascertain the long-run equilibrium relationship among the variables of interest. We then estimate the cointegration regression via Dynamic Ordinary Least Square (DOLS) and Fully Dynamic Ordinary Least Square (FMOLS) regression analysis. Finally, we analyse the causal relationship among the variables under observation.

3.2 | Stationarity (panel unit root test)

Estimating non-stationary variables would create a problem of spurious regression and, by extension, misleading policy implications. Therefore, it is pertinent to ascertain the order of integration as well as the asymptotic characteristic properties of an empirical analysis. However, given that the conventional unit roots test (Augmented Dickey–Fuller and Phillip–Perron) are weak in power and size, many recent empirical studies depend on the panel unit root test in their empirical findings. To this end, Im, Pesaran and Shin's (IPS) (2003) and Hadri's (2000) confirmatory tests are employed in this current study.

The IPS unit root test relaxes the assumptions of Levin, Lin and Chu's (LLC) (2002) unit root test. The LLC unit root test is very restrictive. The IPS unit root test, on the other hand, offers a procedure that accommodates ρ, which varies across all i. Thus, it is less restrictive than LLC. Thus it is less restrictive than LLC. The IPS equation is estimated as·

$$\Delta y_{it} = \mu_i + \rho y_{it-1} + \sum_{j=1}^{k} \alpha_j \Delta y_{it-1} + \delta_i t + \theta_t + \varepsilon_{it} \tag{3}$$

where $\rho = 0$ for all i and the alternative hypothesis of $\rho < 0$ for at least one i. Thus, all series are non-stationary against the alternative of stationarity; that is, the series are stable.

In the same vein, the Hadri (2000) test holds a different claim of reversed null hypothesis of stationarity. In order to have a test with superior power, the test is estimated via Lagrange Multiplier statistics, which can be estimated as

$$LM = \frac{1}{N} \sum_{i=1}^{N} \left[\frac{\frac{1}{T^2} \sum_{t=1}^{T} S^2{}_{it}}{\hat{\sigma}^2{}_{\varepsilon}} \right], S_{it} = \sum_{j=1}^{t} \hat{e}_{ij} \tag{4}$$

where $\hat{\sigma}^2{}_{\varepsilon}$ is consistent with Newey and West (1987), who evaluate the long-run variance of the stochastic term. Hadri (2000) implements heterogeneous and serially correlated errors on account of their superior power.

3.3 | Cointegration analysis test

In order to evaluate the long-run equilibrium relationship among the variables of interest, we apply the panel cointegration test proposed by Fisher (1932). This is a residual-based cointegration test derived from a combined test which uses the result of the individual test. The test has a null of no cointegration against the alternative of cointegration. The test can be estimated by the following equation:

$$\hat{e}_{it} = \hat{\rho} e_{it-1} + \sum_{j=1}^{p} \vartheta_j \Delta \hat{e}_{it-j} + v_{itp}. \tag{5}$$

where the null hypothesis is no cointegration; thus, the ADF test statistics can be given further as

$$ADF = \frac{t_{ADF} + \sqrt{6N\hat{\sigma}_v}/2\hat{\sigma}^2{}_{0v}}{\sqrt{\frac{\hat{\sigma}_{0v}}{2\hat{\sigma}_v{}^2} + \frac{3\hat{\sigma}_v{}^2}{10\hat{\sigma}^2{}_{0v}}}}, \tag{6}$$

where t_{ADF} is asymptotically normally distributed with $N \sim (0,1)$ given by the sequential limit theory.

3.4 | Estimating the cointegration coefficient relationship

To further buttress the long-run equilibrium dynamic relationship, DOLS and FMOLS are the commonly adopted techniques by which to estimate panel coefficients. There exist other approaches, namely those within and between group estimators. However, DOLS and FMOLS stand out with superior features. According to Harris and Sollis (2003), FMOLS is a non-parametric estimator which accommodates for serial correlation, while the DOLS estimator is parametric in nature. DOLS estimators take a lag of first difference term; that is, the lag, leads and contemporaneous values of the regressors are augmented when DOLS is employed. Cointegration parameters are derived via the grouped mean panel of the FMOLS and DOLS methods. The panel estimator is estimated as.

$\hat{B}_{GFM}{}^{*} = N^{-1} \sum_{i=1}^{N} B^{*}{}_{FMi}, where B^{*}{}_{FMi}$ is obtained as given in Equation (1) ∀ in the panel.

In the same vein, the corresponding t-ratio can be estimated as.

$$t^{-1}\bar{B}_{GFM}{}^{*} = N^{\frac{-1}{2}} \sum_{i=1}^{N} t_{\bar{B}^{*}FMI} \tag{7}$$

To obtain a cointegration, the following equation was derived,

$$\begin{aligned} \ln cp_{it} &= \beta_{0i} + \beta_1 \ln op_{it} + \beta_2 \ln xr_{it} \\ &+ \sum_{q=-q1}^{q_1} \alpha_q \Delta \ln op_{it} + \sum_{q_1=-q_1}^{q_1} \lambda_q \Delta \ln xr_{it} + \varepsilon_{it} \end{aligned} \tag{8}$$

where −q and q are the leads and lag, respectively.

3.5 | Panel causality analysis

The study traces the long-run equilibrium relationship, which does not detect the direction of causality. Therefore, it is important to examine the interactions among the variables of interest. This was done by adopting the Dumitrescu and Hurlin (2012) causality technique, where the Engle and Granger (1987) two-step procedure is applied. First, the ordinary least square of Equation (2) is estimated, and the residual $\hat{e}_{it}$ (error correction term) is obtained. The second step is the causality auxiliary regression. The dynamic model is given below,

$$\begin{aligned} \Delta cp_{it} &= \theta_{1j} + \lambda_{1i}\varepsilon_{it-1} + \sum_{k} \theta_{11ik} \Delta cp_{it-k} \\ &+ \sum_{k} \theta_{12ik} \Delta op_{it-k} + \sum_{k} \theta_{13ik} \Delta xr_{it-k} + \mu_{1it} \end{aligned} \tag{9}$$

$$\begin{aligned} \Delta op_{it} &= \theta_{2j} + \lambda_{2j}\Sigma_{it-1} + \sum_{k} \theta_{22ik} \Delta op_{it-k} \\ &+ \sum_{k} \theta_{21ik} \Delta cp_{it-k} + \sum_{k} \theta_{23ik} xr_{it-k} + \mu_{2it} \end{aligned} \tag{10}$$

TABLE 2 Descriptive statistics

	LNCOMMPRICES	LNOILPRICE	LNXR
Mean	5.939	4.355	5.006
Median	5.828	4.422	5.029
Maximum	8.451	4.897	5.284
Minimum	4.943	3.617	4.760
SD	0.532	0.281	0.142
Skewness	1.158	−0.649	0.025
Kurtosis	5.851	2.756	2.529
Jarque–Bera	404.609	52.406	6.728
Probability	0.000	0.000	0.035
Sum	4,276.020	3,135.473	3,604.082
Sum Sq. Dev.	203.512	56.898	14.454
Observations	720	720	720

Note: All variables are in logarithm form to make the variables homoscedastic.

$$\begin{aligned} \Delta xr_{it} &= \theta_{3j} + \lambda_{3j}\Sigma_{it-1} + \sum_{k} \theta_{31ik} \Delta xr_{it-k} \\ &+ \sum_{k} \theta_{32ik} \Delta cp_{it-k} + \sum_{k} \theta_{33ik} op_{it-k} + \mu_{3it} \end{aligned} \tag{11}$$

where K is the optimum lag length chosen via the Akaike information criterion with the help of E-views 9 statistical software.

4 | EMPIRICAL RESULTS AND DISCUSSION

This section of the study renders the discussion of study empirical simulations. The study set off with the interpretation of summary statistics among the variables under consideration over the sampled period.

Table 2 depicts the descriptive statistics of the variables. The natural logarithm of the commodity prices had the highest average, while oil prices recorded the lowest. All variables showed overwhelming deviations from the mean. None of the variables were normally distributed, so we could reject the Jarque–Bera probability of normality. All variables were positively skewed with the exception of oil price, which is expected given its high volatile nature.

The Pearson correlation coefficient matrix analysis is presented in Table 3 represents. The correlation matrix shows the extent of the linear relationship between the variables of interest. The results reveal significant and statistical correlation exists among all the interest variables over the period considered. There exists a negative

TABLE 3 Pearson correlation coefficient estimate

	LNCOMMPRICES	LNOIL_PRICE	LNXR
LNCOMMPRICES	1		
	—		
	—		
LNOIL_PRICE	0.136663	1	
t-stat	3.696649	—	
p-value	.0002	—	
LNXR	0.239982	−0.248844	1
t-stat	6.624	−6.884476	—
p-value	.0000	.0000	—

Source: Authors' Creation.

TABLE 4 Unit root test results

	Level		First difference	
Variables	Intercept	Trend and intercept	Intercept	Trend and intercept
LNXR	3.418 [0.999]	−0.791 [0.214]	−19.906 [0.00][a]	−20.112 [0.000][a]
LNCOMMP	−1.349 [0.0888]	0.414 [0.667]	−19.838 [0.000][a]	−20.255 [0.000][a]
LNOILP	−2.560 [0.0052]	−0.465 [0.321]	−16.130 [0.000][a]	−16.282 [0.000][a]

Note: Im et al. (2003).
[a]Level of rejection at 1%, while values in brackets give corresponding probability value.

TABLE 5 Unit root test results (Hadri, 2000)

	Level		First difference	
Variables	Intercept	Trend and intercept	Intercept	Trend and intercept
LNXR	15.631 [0.000][a]	0.209 [0.417]	−0.436 [0.668]	0.982 [0.163]
LNCOMMP	80242 [0.000][a]	6.447[0.000][a]	0.9230[0.178]	0.175 [0.430]
LNOILP	−0.144[0.557]	5.081[0.000][a]	0.210 [.0417]	−0.471 [0.681]

[a]Level of rejection at 1%, while values in brackets give corresponding probability value.

association between exchange rate and oil prices. However, a significant and statistically positive relationship exists between oil price and the selected commodity crops under review. Although correlation analysis test alone is not sufficient to validate empirical claims. Thus, the current study proceeds to apply other more robust econometrics tests in the subsequent sections to either validate or refute the study position.

Tables 4 and 5 summarize the panel unit root test results. The test was conducted with model of intercept and with intercept and trend. The consensus of both the IPS (2003) test and the confirmatory Hadri (2000) test is that all variables are stationary after the first difference. Thus, the study continues to investigate for possible long-run equilibrium relationship among the variables.

The long-run analysis is rendered in Table 6, which traces a long-run equilibrium relationship via the ADF Fisher multivariate cointegration test. The results show that rejection was possible for at least one cointegrating vector. Thus, by implication, there exists a long-run equilibrium bond among agricultural commodity prices, oil prices and effective exchange rate, as they all converge to their long-run equilibrium path.

Table 7 reports the magnitude of long-run regression between the outlined variables under consideration. The signs of the estimations align with the study's a priori expectation. The results go further to reveal that an increase in oil price leads to a statistical significant increase in the selected agricultural commodity prices over the sampled period. That is, precisely a 1% increase in oil prices translates into an elastic effect of 2.56% and

2.46% increase in demand for the selected commodity crops for the DOLSs and FMOLS regression, respectively. This suggests that oil price for the case of Nigeria drives demand for agricultural crop commodity. The results show that agricultural commodity prices in Nigeria are responsive to global oil prices. This outcome is in line with the study of Fowowe (2016) for the case of South Africa. Similarly, a surge in the exchange rate also increases agricultural commodity prices positively. The results of both long-run regressions (DOLS and FMOLS) validate the fact that the current study joins the strands of literature that oil prices drive agricultural crops commodities (see Fowowe, 2016; Nazlioglu & Soytas, 2012). This finding is indicative to policymakers and government administrators that design agricultural policies and programmes. This is key also to all stakeholder especially farmers of the dynamic interaction between oil prices, exchange rate fluctuations and agricultural commodity crops commodity prices in an oil dependent economy like Nigeria as the nation strive to diversify her economy given the perpetual interference of oil prices fluctuation on agricultural commodity prices over the years.

TABLE 6 ADF Fisher cointegration

No. of CE(s)	Trace	*p*-value	Max-Eigen	*p*-value
$r = 0$	25.06[a]	.0145	24.12	.0196
$r \leq 1$	9.524	.6577	7.363	.8327
$r \leq 2$	8.578	.7385	8.578	.7385

[a]Rejection level at 0.01 level.

TABLE 7 Cointegration coefficients

Variables	DOLS	*p*-value	FMOLS	*p*-value
LnOil price	2.557[a]	.000	2.455[a]	.000
	(4.608)		(4.717)	
LnXR	1.043[a]	.000	1.095[a]	.000
	(6.543)		(6.466)	
R-squared	0.717		0.674	
Adjusted R-square	0.698		0.671	
SE of regression	0.288		0.304	
Long-run-run variance	0.307		0.377	

[a]Rejection at 0.01 significant level while numbers in () are t-statistics.

The direction of causality flow is pertinent for policy construction. Thus, in Table 8, the current study reports the causality relationship among the outlined variables. Between oil price and commodity prices, we find a bidirectional causality relationship, so by implication; oil price is a good predictor of agricultural commodity prices. That is, oil price drives agricultural commodity prices in Nigeria. These findings resonate with certain other studies (see Nazlioglu, 2011; Nazlioglu & Soytas, 2012). Furthermore, a unidirectional causality relationship between exchange rate and oil price over the investigated period. This result is in line with Ricardo and Sraffa's (1955) comparative advantage postulate. In an open economy, where countries must depend on each other, this can promote causality relationships between the variables in question. For example, a high demand for an imported agricultural commodity and/or crude oil would influence the rate at which one currency is exchanged for another, thereby having a greater impact on the exchange rate and vice versa. These finding aligns with the current disposition of Nigeria that is heavily depends on crude oil exportation where crude oil exploration and exploration remains main stay of her economy (Fowowe, 2016).

5 | CONCLUSION

This study empirically investigates the dynamic relationship between the world oil price and some selected agricultural commodity prices while accounting for the role of currency parity (effective exchange rate) in the case of Nigeria. The study is conducted in a balanced panel setting for the period from 2006 to 2015 using monthly frequency data. The cointegration results reveal that agricultural commodity prices, oil prices and the effective exchange rate in Nigeria exhibit a long-run equilibrium

TABLE 8 Dumitrescu and Hurlin panel causality test

Null hypothesis	W-stat	Zbar-stat	*p*-value	Causality
Oilprice ≠> Commprice	1.9779	1.6937	.0903	Yes
Commprice ≠> Oilprice	5.9685	8.6057	.0000	Yes
XR ≠> oil price	0.3442	−1.1359	.2560	No
Oilprice ≠> XR	3.5719	4.4547	.0000	Yes
Commprice ≠> XR	0.7773	−0.3858	.6996	No
XR ≠> Commprice	1.6881	1.1919	.2333	No

Note: The notation ≠>implies that the variables does not Granger cause one another.

relationship. The finding of DOLS and FMOLS lend support to the claim that oil price drives agricultural commodity prices, as their coefficients were statistically significant in confirmation of the current study *apriori* expectation. According to the Dumitrescu and Hurlin (2012) causality test, a causality relationship runs from oil price to agricultural commodity prices. The study also reveals a rich unidirectional causality from oil price to the exchange rate. Since the oil sector is a dominant sector in Nigeria, then any fluctuation in oil price will influence agricultural commodity prices and the exchange rate as well as other sectors in the economy. This justifies the causality relationship obtained earlier.

These study findings amplify the existing resource curse hypothesis that the Nigerian economy is a monoculture economy where the oil sector has been the dominant sector (Bekun, Hassan, & Osundina, 2018; Gokmenoglu, Bekun, & Taspinar, 2016). The oil sector has been the major source of foreign reserves, and it has, in one way or another, crowded out other sectors (such as manufacturing and service, among others). Thus, the present study can conclude that the current findings have done more justice to this prevailing trend.

It is on this note that the current study urges public authorities and policymakers, as a matter of urgency, to create sound, reliable agricultural policy designs, which will curb the influence of oil price shock on commodities prices, especially on those of agricultural commodities. This can be done through diversifying the economy and, by implication; it would make other sectors less reliant on oil, thereby reducing the influence of oil prices on the economy. However, failure to put this policy into place will considerably affect the masses by increasing their cost of living and thereby throwing them and the economy into more abject poverty. On the other hand, an exchange rate regime, which captures and minimizes the impact of this oil price shock, should be put into place, as the study reveals causality estimation on agricultural commodities. This implementation would require a sound knowledge of how the exchange regime works, in accordance with domestic and international market policies, on the export/import of agricultural commodities, as oil price and exchange rate fluctuations are better predictors of agricultural commodity prices (see Nazlioglu & Soytas, 2012; Zhang et al., 2010; Zhang & Reed, 2008).

ENDNOTE

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DATA AVAILABILITY STATEMENT

Data applied can be made available upon request

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