Oil price shock and agricultural commodity prices in Nigeria: A Non-Linear Autoregressive Distributed Lag (NARDL) Approach

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Abstract
This study analyzed the impact of oil price shocks on agricultural commodity prices in Nigeria using monthly data on oil prices, maize, wheat and soybean and exchange rate from 1997 to 2016. Data on oil price and exchange rate were obtained from the central bank statistical bulletin while those of agricultural commodities were obtained from Food Agricultural Organization (FAO) website. Dummy variables were used to capture periods of structural breaks in the selected agricultural commodity prices. Linear ARDL and Non-linear ARDL with and without breaks were estimated. Asymmetric test using Wald Statistics revealed evidence of asymmetries in all the cases implying that positive and negative shocks of the same magnitude did not have equal impact on agricultural commodity prices. The study found significant positive oil price changes in all cases with the expected positive sign, implying that increases in oil price lead to increases in agricultural commodities. Similarly, exchange rate (a control variable) showed positive significant relationship with agricultural commodities. It is concluded that oil price has overall positive relationship and significant effect on agricultural commodity prices. The study recommended that since oil price was important in agricultural commodities prices, efforts should be geared towards local development of the oil sector as this will bring about positive spillover effect on the agricultural sector and ensure food availability at affordable prices thereby improving standard of living and welfare.

Keywords: NARDL, oil price, agricultural commodity, structural breaks, Nigeria.

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1. Introduction

Oil is an indispensible source of strength and a major driver of economic activities especially in a country like Nigeria that majors both as an exporter and importer of oil. According to Anyawu *et al*. (1997), it is referred to as a versatile, flexible, non-productive, depleting, natural resource which is hydrocarbon in nature and as well serves as a fundamental input in the modern economy and providing about 50% of the total energy demand in the world, excluding the former centrally planned economy. Oil not only provides the direct energy for industry, agriculture, transportation industry and commerce, but also has significant influence on the upstream and downstream firms of all the relevant industry chain, (Zhang 2016). It must be brought into view the relevance of this notable point of energy supply as it serves as the mainstay and a major source of revenue in the Nigerian economy.

The global history of oil can be traced to the 19th century but the events of the 20th century unfold major stories. Firstly, the rise of seven sisters (the seven oil giants who formed a cartel in the 1920s to control oil price). Secondly, the emergence of the National Oil Companies leading to the establishment of Organization of Petroleum Exporting Countries (OPEC) in 1960. Although the seven sisters were able to keep the prices of oil stable, ever since OPEC came into the scene, it started to ploy its influence on oil prices even to the extent on placing oil embargo on Netherlands and the United States.

The Nigerian economy is known also for her predominance in the production and consumption of agricultural commodities as this accounted for over 75 percent of the country's revenue before the discovery of oil (FAO report 2008). Hanson et al. (1993) argued that an increase in oil prices caused a rise in input cost and a corresponding rise in agricultural commodity prices, although the strength of this effect depends on several factors, such as the relative importance of oil in the production cost structure, oil characteristics as an input and the market power of agriculture to pass costs onto prices, which needs to be evaluated empirically.

Frankel and Rose (2010) argued that explanations for the observed commodity price increases include increased demand for commodities from emerging markets, quantitative easing in monetary policy and speculative commodity demands in stock markets. According to Busse et al. (2011), there has been an increasing positive correlation between agricultural commodity and energy prices, particularly during the 2006/2008 period. As a result, some studies found that there exists a clear-cut relationship between oil and agricultural commodities while some supports the neutrality hypothesis that oil prices do not drive agricultural prices. Some studies opined that the increase in agricultural commodities can be linked to the substitution effect that arises due to the increasing demand for biofuels as alternative means of energy when the price of oil was at its peak. The relationship that exists between biofuels and energy markets is responsible for the widely known food price crisis of 2006 (Saban Nazlioglu et al., 2012).

Most of these studies found that there exists little or no relationship between oil and agricultural commodities in the pre-crisis period unlike the post-crisis period where evident relationship between the oil prices and agricultural commodity prices exists. Chen et al. (2010) showed that changes in grain prices for corn, soybean and wheat were influenced by high crude oil prices, above all in recent years, when higher crude oil prices have induced higher derived demand for corn and soybean and greater competition for the planted areas of other grains. Therefore, as oil prices increase, there will be increase in the demand for agricultural commodities employed in the production of biofuels. The excessive price fluctuations have generated much interest resulting in various studies and economic analyses designed to understand the influences and after effects of financial crisis and energy policies Natanelov (2011).

It could be deduced that both commodities (oil and agricultural commodities) are of key relevance to the Nigerian economy. It is therefore necessary to analyse the effect of oil prices on agricultural commodity prices in Nigeria. Oil in the Nigerian economy is a significant determinant of economic activities as it is useful to almost all sectors of the economy. These sectors range from manufacturing, transportation, health, and of course agriculture. . However, due to its exogenous feature, the movement in oil price has been unpredictable and inconsistent that its sudden change affects the stability of prices mainly food prices which are derived from agricultural produce. The instability in oil prices can be viewed from its trend overtime. The price of oil was US$23.5 in January 1997 before it experienced an increase up to US$131.87 in July 2008 which is quite huge before drastically falling to as low as US$42.28 in December the same year. In March 2011, oil price rose to US$118.43 and fell to as low as US$37.76 in March 2016.

Also, the variations in agricultural commodity prices have raised interests in probing into it. This can be viewed from the trend in the considered agricultural commodities of wheat, maize and soybeans. The price of wheat in January 1997 was US$167.79 and it rose to US$304.14 in august 2008 only to later fall to as low as US$164.56 in January 2016. Maize on the other hand was US$118.70 in January 1997 and it took to a rise up to US$266.94 in July 2008 and then witnessed a drastic fall to US$161.03 in January 2016. Finally, soybean experienced a rise up to US$471.07 in august 2008 from US$268.10 in January 1997 and then fell to US$323.20.

The direction and movement in global oil prices (whether increase or decrease) is worthy of comparison with agricultural commodity prices of wheat, maize and soybeans. This can be spotlighted thus; as oil price rose to 33.15 in 2000 from 9.85 in 1998, wheat price fell to 107.78, maize price also fell to 84.71 and soybeans price fell to 173.61. As oil price witnessed decrease in July 2008, wheat price, maize and soybeans price also increased and they all fell to altogether in December the same year. In 2011, oil price rose and wheat, maize and soybeans prices also increased. From these, it can be seen that the pattern of change in oil prices in relation to agricultural commodities is not constant bringing about the need to access the relationship between them. This study therefore aims to examine the relationship between oil price and agricultural commodity prices in Nigeria. And to consider the trend in oil prices and agricultural commodity prices in Nigeria as well as Investigate whether the response to oil price variability is symmetrical or asymmetrical.

This study empirically evaluates the impact of oil prices on agricultural commodity prices. Although there have been various studies such as Nazlioglu *et al* (2010), Wang *et al* (2014), Han *et al*, (2015), Fowowe (2016), most of which are done on oil importing and developed countries, the symmetric or asymmetric effect of global oil price fluctuations including the short and long run relationship of oil price and economic growth have not been considered in most of these studies. This study which is conducted for Nigeria which is both an oil exporting and importing country is far more recent since it includes observations of 2014, 2015 till the very end of 2016 in its variable scope and it also uses monthly data on the global oil price and agricultural commodities prices in order to allow for seasonal variations so that fluctuations In oil price will be better explained. Also this study allows for more data coverage which spans from January 1997 to December 2016 and it assess the presence of symmetric or asymmetric effect of oil price variability by looking into the effect of oil price increase and decrease separately so as to get clearer picture of this effect in the Nigeria economy. It also assesses the short-run and long-run relationship of oil price and agricultural commodity prices.

Also, this study intends to expand the data scope to include recent development in oil market. In addition, this study considers structural breaks for oil price as they are dates of notable occurrences in the global oil market in order to reveal if the breaks are significant to the considered agricultural commodities. Not paying attention and ascertaining the effects of these notable dates in the global oil market as to how they affect agricultural commodities in Nigeria may generate spurious results. Furthermore, this study is conducted for Nigeria which is both an oil exporting and importing country unlike in past literatures that considered either oil importing countries or oil exporting countries. Finally, findings from this study may be useful for policy making and other players in the two sectors of the economy.

The structure of this study is in the following manner. Section two reviews different literature and theoretical framework. Section three explains methodology and data. Section four gives the empirical review of the study and section five concludes the study.

2. Empirical Review

Fowowe (2016) found that Structural breaks co-integration tests showed no evidence of a long-run relationship between oil prices and agricultural commodity prices in South Africa. Also, Nonlinear causality tests showed no evidence that agricultural commodity prices in South Africa respond to oil prices. The results show that agricultural commodity prices in South Africa are neutral to global oil prices. Siakwah, (2017) in the study titled Actor Network Theory, globalized assemblages and the impact of oil on agriculture and industry in Ghana; found that oil has only diversified Ghana's dependency on natural resources without structurally changing the national economy. The fact that the exploitation of oil merely reinforces and reconstructs a deep-seated structural dependency has profound consequences for national and local politics and for the country's prospects of economic development.

Nazlioglu, (2010) shows that the impulse–response analysis suggests the Turkish agricultural prices do not significantly react to oil price and exchange rate shocks in the short-run. The long-run causality analysis reveals that the changes in oil prices and appreciation/depreciation of the Turkish lira are not transmitted to agricultural commodity prices in Turkey. Hence our results support neutrality of agricultural commodity markets in Turkey to both direct and indirect effects of oil price changes. Wang et *al* (2013) found that the responses of agricultural commodity prices to oil price changes depend greatly on whether they are caused oil supply shocks, aggregate demand shocks or other oil-specific shocks mainly driven by precautionary demand in China. Oil shocks can explain a minor friction of agricultural commodity price variations before the food crisis in 2006-2008, whereas in post-crisis period their explanatory abilities become much higher. After crisis, the contributions of oil-specific factors to variations in agricultural commodity prices are greater than those of aggregate demand shocks.

Sadorsky (2014) found that Emerging market stock prices and oil prices display leverage effects where negative residuals tend to increase the variance (conditional volatility) more than positive ones. Correlations between these assets increased considerably after 2008, and have yet to return to their pre 2008 values. On average, oil provides the cheapest hedge for emerging market stock prices while copper is the most expensive but given the variability in the hedge ratios, one should probably not put too much emphasis on average hedge ratios.

Esmaeili *et* al (2011) found no direct long-run price relation between oil and agricultural commodity prices in Iran. That there is a positive relationship between food and oil prices. These results suggest that the influence of crude oil prices on food prices should be further investigated. The implication of this study for policy management is the monitoring of oil price and its influence on agricultural product prices and food security.

Han *et al*, (2015) in their study titled Exogenous impacts on the links between energy and agricultural commodity markets conducted for china concluded that the global financial crisis is the most influential shock on the price links between energy and agricultural commodities. Because price links are vulnerable to financial shocks, our results also suggest introducing state-based analysis to risk management and portfolio diversification across the energy and agriculture markets during times of turmoil. Cabrera *et al* (2016) found that in the long run prices move together and preserve an equilibrium, while correlations are mostly positive with persistent market shocks. Their results reveal that concerns about biodiesel being the cause of high and volatile agricultural commodity prices are rather unjustified for the German economy.

Du *et* al, (2011) found evidence of volatility spillover among crude oil, corn, and wheat markets in the United States of America after the fall of 2006. They further emphasized that it can be largely explained by tightened interdependence between crude oil and these commodity markets induced by ethanol production. Gardebroek *et al*, (2013) from their estimation results indicate a higher interaction between ethanol and corn markets in recent years, particularly after 2006 when ethanol became the sole alternative oxygenate for gasoline. They only observe, however, significant volatility spillovers from corn to ethanol prices but not the converse. They also do not find major cross-volatility effects from oil to corn markets. The results do not provide evidence of volatility in energy markets stimulating price volatility in the US corn market.

Gohin *et al*, (2010) found that the omission of macro-economic linkages has a substantial bearing on this relationship. A positive relationship due to the cost push effect has been identified in most analysis, but we find that the introduction of the real income effect may indeed imply a negative relationship between world food and energy prices. Jebabli *et al* (2014) found that in France, the volatility spillovers increase considerably during crisis and, namely after mid-2008, when stock markets become net transmitter of volatility shocks while crude oil becomes a net receiver. Shocks to crude oil or MSCI markets have immediate and short-term impacts on food markets which are emphasized during the financial crisis period. Moreover, we show that augmenting a diversified portfolio of food commodities with crude oil or stocks significantly increases its risk-adjusted performance.

Avalos (2013) show that structural stability is rejected and the transmission of oil price innovations to corn prices has become stronger after 2006 (no changes with respect to soybeans). There is also a significant transmission of corn price innovations to oil and soybean prices. Moreover, the data show evidence of a previously non-existent co-integration relationship between oil and corn prices in the United States. Cha (2011) found in the United States that an increase in the oil price would increase bioethanol demand for corn and corn prices in the short run and that corn prices would stabilize in the long run as corn exports and feedstock demand for corn decline. Consequently, policies supporting biofuels should encourage the use of bioethanol co-products for feed and the development of marginal land to mitigate increases in the feedstock price.

3. Theoretical framework

According to Saghaian (2010), there has not been any economic theory that sufficiently provides information about the causal structures among energy and commodity prices. However, nowadays, the links among oil, ethanol and commodity prices, and the nature of the relationship between the energy and agricultural sectors have become an important issue. Therefore, this study adopts The unidirectional hypothesis which could be running from oil prices to food prices or from food prices to oil prices. For the purpose of this study, we investigate the unidirectional approach to how oil prices affect food prices.

3.1 Data Sources, Scope, and Variable Measurement

This research study made use of secondary data which include monthly time series data on oil price, wheat price, maize price, and soybeans price from 1997 to 2016. Data on oil price is obtained from the central bank statistical bulletin and data on the three agricultural commodities is obtained from Food and Agricultural Organization (FAO) and exchange rate is obtained from the Central Bank of Nigeria Statistical Bulletin and Nigeria Bureau of Statistics (NBS). Also, the study includes dummy variables to account for structural breaks in the analysis. The break date will be ascertained from the formal pretest.

The US dollar being the official currency for which crude oil price is expressed in the international market, this study use bonny light to serve as a proxy for the Nigerian oil price. The choice of this proxy is made because the study is conducted for the Nigerian economy.
This study further included exchange rate for better specification of the model. As regards the definition of exchange rate it is measured in Naira (₦) per US dollar, meaning that an increase in exchange rate refers to depreciation in the Naira while a decrease means appreciation of the Naira.

Oil was adopted in this study because the Nigerian economy is an oil dependent economy as it is a major exporter and importer of oil. With this, the Nigerian economy depends on oil for almost all its economic activities. The various sectors inherent in the country thrive mainly on oil and the agricultural sector is one of the leading sectors depending on it. For this reason, it is necessary to examine the relationship between oil and agricultural commodities.

The study concentrated on identifying the price dependencies between oil and maize, oil and soybeans, and, oil and wheat. The selected agricultural commodities (maize, soybeans, and wheat) are the main crops used as raw materials for biofuel products and are the major agricultural products for food in the world. Hence, an assessment of the relationship between oil and agricultural products prices becomes imperative.

3.2 Model Specification

Nonlinear ARDL with Structural Breaks

Introducing structural breaks into the NARDL framework, the study estimated the relevant break dummies as follows:

$$\Delta wp_t = \vartheta_0 + \sum_{i=1}^{p} \alpha_1 \Delta wp_{t-i} + \sum_{i=0}^{q} (\beta_i^+ \Delta op^+_{t-i} + \beta_i^- \Delta op^-_{t-i}) + \sum_{i=0}^{u} \alpha_2 \Delta exr_{t-1} + \vartheta_1 wp_{t-1} + \vartheta_2^+ op^+_{t-1} + \vartheta_2^- op^-_{t-1} + \vartheta_3 exr_t + \sum_{r=1}^{s} D_r B_{rt} + \varepsilon_t \quad (1)$$

$$\Delta mp_t = \vartheta_0 + \sum_{i=1}^{p} \alpha_1 \Delta mp_{t-i} + \sum_{i=0}^{q} (\beta_i^+ \Delta op^+_{t-i} + \beta_i^- \Delta op^-_{t-i}) + \sum_{i=0}^{u} \alpha_2 \Delta exr_{t-1} + \vartheta_1 mp_{t-1} + \vartheta_2^+ op^+_{t-1} + \vartheta_2^- op^-_{t-1} + \vartheta_3 exr_t + \sum_{r=1}^{s} D_r B_{rt} + \varepsilon_t \quad (2)$$

$$\Delta sp_t = \vartheta_0 + \sum_{i=1}^{p} \alpha_1 \Delta sp_{t-i} + \sum_{i=0}^{q} (\beta_i^+ \Delta op^+_{t-i} + \beta_i^- \Delta op^-_{t-i}) + \sum_{i=0}^{u} \alpha_2 \Delta exr_{t-1} + \vartheta_1 sp_{t-1} + \vartheta_2^+ op^+_{t-1} + \vartheta_2^- op^-_{t-1} + \vartheta_3 exr_t + D_r B_{rt} + \varepsilon_t \quad (3)$$

The definitions of the parameters followed the sequence of the models. The study conducted structural break test to ascertain the significance of including the breaks in the NARDL model. Besides, F- distributed Bound test was used to confirm the presence of long run relationship and the Wald test was equally used to ascertain the presence of asymmetry in the presence of structural breaks.

4. Results and Discussion

Formal Pre-tests

Unit Root Test (without break)

Unit root test shows the result for the test of stationarity of the series used for model estimation. Following the assumptions of the Ordinary Least Square (OLS) technique, it is required that series must exhibit a constant mean, variance and covariance over time i.e. whether the series are time invariant in their unconditional moments. In other words, when series are not stationary, it is said to exhibit a unit root process. If non stationary series are adopted in a regression analysis, the resulting model is termed as spurious, unstable, and misleading and thereby, cannot be used for forecast. This is because non-stationary variables feature changes as time progresses. Thus, such variables are said to exhibit unit root and cannot be used for conventional modelling. This test is primarily important as the use of non-stationary series result in spurious regression which will generate misleading results. The unit root result using Augmented Dickey-Fuller (ADF) test, Philip-Perron (PP) test and the Perron break point test are provided in Table 1, 2 and 3 respectively:

Table 1: Augmented Dickey-Fuller Test Result

Variable	Level			First difference			I(d)
	Model A	Model B	Model C	Model A	Model B	Model C	
Oil price	-1.9833	-1.3459	-0.4714	-15.9852***	-16.1543***	16.0127***	I(1)
Maize Pricce	-5.5369	-2.2732	0.0696	-14.3768***	-14.4207	-14.4049***	I(1)
Wheat Price	-2.3874	-2.18977	-0.0998	-14.6216***	-14.6587***	-14.6533	I(1)
Soybeans Price	-2.6359*	-2.4050	0.0524	-------	------	-------	(0)
Exchange Rate	-1.3297	-2.1518	0.4980	-13.6941***	-13.7404***	-13.728***	(0)

Model A, B and C are unit root test with intercept ,with intercept and trend and without intercept and trend respectively.* indicate significance at 10% level, ** indicate significance at 5% level, and *** indicate significance at 1% level.

Source: Authors, 2018

Table 2: Philip-Perron Test Result for Unit Root

VARIABLES	Level			First Difference			I(d)
	Model A	Model B	Model C	Model A	Model B	Model C	
Oil Price	-1.9979	-1.3491	-0.0458	-15.9625***	-16.1431	-15.9888	I(1)
Maize Price	-2.7226*	-2.5075	0.04123	------	------	------	I(0)
Wheat Price	-2.5475	-2.3631	-0.6462	-14.6243***	-14.6557***	-14.6559***	I(1)
Soybeans	-2.8217*	-2.6334	0.0401	-------	-------	---------	(0)
Exchange Rate	-1.5520	-2.2722	-0.6246	-13.87510***	-13.8608***	-13.9019	(1)

Model A, B and C are unit root test with intercept ,with intercept and trend and without intercept and trend respectively.* indicate significance at 10% level, ** indicate significance at 5% level, and *** indicate significance at 1% level.

Source: Authors, 2018

The ADF and PP unit root test in Table 1 and Table 2 show the result for both the level and differenced form. The order of integration indicates the number of times a series is differenced to be stationary. From the ADF result, soybean prices and exchange rate that are stationary at level form, oil price and maize price and wheat price rate are not stationary in their level form. However, they are stationary in their first difference. This result of the Philip-perron test shows that the prices are intergrated of different (mixed) others just like that of the of the ADF.

On the other hand, the ADF breakpoint unit roots from Table 3 below which separates structural breaks from unit root indicates that oil price is integrated of order zero, so also soybeans and exchange rate. While that of maize and wheat price are stationary at first difference. The results obtained from the breakpoint unit root differs from the ones obtained in the ADF and PP test result, this is evident in oil price. This is because the break point unit root test indicates that it is the presence of structural breaks in oil price that has led to the conclusion of unit root by ADF and PP. thus, the ADF breakpoint unit root test suggest that although the unit root test result of other series are consistent, oil price exhibits structural breaks which has been misinterpreted by ADF and PP as having unit root.

Unit Root Test (with break)

Table 3 Augmented Dickey-Fuller Test Result for Breakpoint Unit Root

VARIABLES	Level			First Difference			I(d)
	Model A	Model B	Model C	Model A	Model B	Model C	
Oil Price	-6.3459***	-6.45595***	-3.6039	-------	-------	-------	I(0)
Maize Price	-6.3256	-6.4089	-3.9305	-2.3651*	-2.2957*	-2.2966*	I(1)
Wheat Price	-7.1602	-7.2804	-4.2245	-3.6584*	-3.5897*	-3.2458*	I(1)
Soybeans price	-6.5105***	-6.8084***	-3.8511	-----------	--------	---------	I(0)
Exchange Rate	-5.2380	-5.2427***	-3.8759	--------	--------	---------	I(0)

Model A, B and C are unit root test with intercept ,with intercept and trend and without intercept and trend respectively.* indicate significance at 10% level, ** indicate significance at 5% level, and *** indicate significance at 1% level.

Source: Authors, 2018

Model Estimation

In order to ensure robustness in the analysis of this study and to determine precisely the impact of oil price on agricultural commodity prices in Nigeria and also to account for structural breaks in the model. Asymmetric ARDL (Nonlinear) with structural breaks capturing the dependent variables of maize, wheat and soybeans against the independent of oil price and exchange rate. Just like the result of the unit root test and co-integration test (i. e the Bounds Test) conducted above, both Long Run model and short run Model were estimated for the all the equation except where long there was no long run relationship. The results are presented in table 4.

Short and Long Run Non Linear ARDL with Structural Breaks for maize

In this section, the empirical result of short run and long run nonlinear ARDL is discussed. The results reveal the empirical results and it can be seen from the table that both positive and negative change in oil price have a positive significant relationship with the price of maize in the short run. Observing the effect of changes in exchange rate as to how it affects the price of maize shows that there is a positive relationship that proved to be statistically significant. Whereas, changes in the past prices of maize has a positive significant effect on the price of maize. And a 1% increase in exchange rate increases the price of maize by 0.0.0162%. The result further indicates that for every 1% increase in positive change in oil price, there is 0.2988% increase in the price of maize in the short run. Whereas, a 1% decrease in negative change in oil price reduces the price of maize by 0.3048% in the short run. Also, further investigation revealed that a 1% increase in exchange rate (exchange rate depreciation) increases the price of maize by about 0.0162%. With respect to the five incorporated breaks (1999M11, 2002M09, 2006M10, 2009M08 and 2013M06). Result show that all the breaks are significant in explaining oil prices as it affects the price of maize. The analyses of the break points as to how they affect the price of maize in the short run are the same with the long run behavior

Positive oil price has a positive significant relationship with maize price in the long run and a 1% increase in positive oil price increases maize price by 0.2792. on the other hand, negative oil price shows a positive significant relationship with maize price as well and a 1% decrease in negative oil price reduces maize price by 0.2844% Exchange rate has a positive statistically significant relationship with maize price and a 1% increase in exchange rate increases the maize price by about 0.167%.

The ECM coefficient of -0.1476 indicates an evidence of fast adjustment towards long run equilibrium (i.e. about 14% disequilibrium is corrected on monthly basis by changes in maize price). This implies that in case of distortion in equilibrium, it takes about seven months for equilibrium to be re-established. The result indicates that the overall model is well fitted as the independent variables (oil price and exchange rate and the dummy for break dates) explain about 97% of the variations in the price of maize. The F-statistic being significant at 1% implies that the overall model is valid. Our result is consistent with that of Wu and Li (2013), Du *et al* (2011), etc. where they found evidence of significant relationship between oil and agricultural commodities. That is, oil influences agricultural commodities. In contradiction to our findings is that of Fowowe (2016), Nazlioglu (2013), etc. where they found that the relationship between oil and agricultural commodities are neutral. According to them, there is no relationship between oil and agricultural commodities.

Short and Long Run Non Linear ARDL with Structural Breaks for wheat

Observing the effect of changes in exchange rate as to how it affects the price of wheat shows that there is a positive relationship that proved to be statistically significant. Whereas, changes in the past prices of maize has a positive significant effect on the price of wheat. And a 1% increase in exchange rate increases the price of wheat by 00.167%. The result further indicates that for every 1% increase in positive change in oil price, there is 0.3040% increase in the price of wheat in the short run. Whereas, a 1% decrease in negative change in oil price reduces the price of maize by 0.3083% in the short run. Also, further investigation revealed that a 1% increase in exchange rate (exchange rate depreciation) increases the price of maize by about 0.167%. With respect to the four incorporated breaks (2001M09, 2004M07, 2009M09 and 2013M02). Result show that all the breaks are not significant in explaining oil prices as it affects the price of wheat except the first break (2001M09) The analyses of the break points as to how they affect the price of wheat in the short run are the same with the long run behavior. Positive oil price has a positive significant relationship with wheat price in the long run and a 1% increase in positive oil price increases wheat price by 04806. on the other hand, negative oil price shows a positive significant relationship with maize price as well and a 1% decrease in negative oil price reduces wheat price by 0.5222% Exchange rate has a positive relationship with maize price .

The ECM coefficient of -0.1675 indicates an evidence of fast adjustment towards long run equilibrium (i.e. about 16% disequilibrium is corrected on monthly basis by changes in wheat price). This implies that in case of distortion in equilibrium, it takes about six months for equilibrium to be re-established. The result indicates that the overall model is well fitted as the independent variables (oil price and exchange rate and the dummy for break dates) explain about 96% of the variations in the price of maize. The F-statistic being significant at 1% implies that the overall model is valid. Our result is consistent with that of Wu and Li (2013), Du *et al* (2011), where they found evidence of significant relationship between oil and agricultural commodities. That is, oil influences agricultural commodities. In contradiction to our findings is that of Fowowe (2016), Nazlioglu (2013), etc. where they found that the relationship between oil and agricultural commodities are neutral. According to them, there is no relationship between oil and agricultural commodities.

Short and Long Run Non Linear ARDL with Structural Breaks for soybeans

Observing the effect of changes in exchange rate as to how it affects the price of soybeans shows that there is a positive relationship that proved to be statistically significant. Whereas, changes in the past prices of oil has a positive significant effect on the price of soybean. And a 1% increase in exchange rate increases the price of soybean by 0.051%. The result further indicates that for every 1% increase in positive change in oil price, there is 0.2940% increase in the price of soybean in the short run. Whereas, a 1% decrease in negative change in oil price reduces the price of soybean by 0.2995% in the short run. Also, further investigation revealed that a 1% increase in exchange rate (exchange rate depreciation) increases the price of soybean by about 0.051%. With respect to the three incorporated breaks (2000M06, 2004M08 and 2007M06). Result show that all the breaks are not significant in explaining oil prices as it affects the price of soybean except the second break (2004M08) The analyses of the break points as to how they affect the price of wheat in the short run remains only for the short run as this model does not have long run relationship. The result indicates that the overall model is well fitted as the independent variables (oil price and exchange rate and the dummy for break dates) explain about 96% of the variations in the price of maize. The F-statistic being significant at 1% implies that the overall model is valid.

Our result is consistent with that of Wu and Li (2013), Du *et al* (2011), etc. where they found evidence of significant relationship between oil and agricultural commodities. That is, oil influences agricultural commodities. In contradiction to our findings is that of Fowowe (2016), Nazlioglu (2013), etc. where they found that the relationship between oil and agricultural commodities are neutral. According to them, there is no relationship between oil and agricultural commodities.

Wald Test Result

From the Wald test result in Tables 4.23, 4.24 and 4.25 above, the probability value for the t-statistics and f-statistic are less than 10% significance level for both long run and short run maize, wheat and soybean respectively except in the long run model of soybean with breaks where the significance level is greater than 10%. Hence the hypothesis of symmetries in oil price effect on maize, wheat and soybeans are rejected except in the long run model of soybeans with breaks where there is presence of symmetry. This explains that positive and negative oil prices are important in explaining the variations in agricultural commodity prices of wheat, maize and soybeans leaving the run model of soybeans with structural breaks symmetric which implies that positive and negative are not important in explaining variations in agricultural prices. Oil price as a whole explains variations in agricultural prices of soybeans in the long run model with breaks.

Table 4: Short and Long Run Presentation of NARDL Results with Structural Breaks For maize

Short Run			
Variables	Coefficient	Standard Error	t-stat
Δlop_t^+	0.2792***	0.04898	5.7002
Δlop_t^-	0.2844***	0.0506	5.6196
$\Delta lexr_t$	0.0167***	0.0017	9.8407
$\Delta lrmz_{t-1}$	0.1243***	0.0410	3.0296
Δz_1	0.0724**	0.3006	2.4103
Δz_2	0.1091***	0.0275	3.9591
Δz_3	0.1495***	0.0328	4.5475
Δz_4	0.1711***	0.0342	5.0037
Δz_5	0.0926***	0.0278	3.3272
ECT_{t-1}	-0.1476***	0.0315	-4.6883
Long Run			
Variables	Coefficient	Standard Error	t-stat
lop_t^+	0.0125	0.1179	0.1060
lop_t^-	0.0544	0.1153	0.4716
$lexr_t$	0.0095	0.0026	3.5671
z_1	0.4907*	0.2541	1.9306
z_2	0.7391***	0.2518	2.9349
z_3	1.0123***	0.2683	3.7720
z_4	1.1586***	0.2811	4.1206
z_5	0.6275***	0.2193	2.8610
$cons\tan t$	4.1943***	0.3153	13.3003

* ** *** *indicate significance at 10%, 5% and 1% critical level respectively.*

R^2 = 0.9730 Adj R^2 = 0.9714 F-Stat = 597.9051*** Durbin-Watson Stat = 1.86

Table 5: Short and Long Run Presentation of NARDL Results with Structural Breaks for wheat

Short Run			
Variables	**Coefficient**	**Standard Error**	**t-stat**
Δlop_t^+	0.3040***	0.0542	5.6026
Δlop_t^-	0.3083***	0.0559	5.5089
$\Delta lexr_t$	0.0167***	0.0018	9.1000
$\Delta lrwh_{t-1}$	0.2513***	0.0621	4.0434
Δh_1	0.0504***	0.0183	2.7540
Δh_2	-0.0004	0.0295	-0.0158
Δh_3	-0.0122	0.0340	-0.3600
Δh_4	-0.0279	0.0298	-0.9354
ECT_{t-1}	-0.1675***	0.0351	-4.7682
Long Run			
Variables	Coefficient	Standard Error	t-stat
lop_t^+	0.4806***	0.0930	5.1632
lop_t^-	0.5222***	0.0940	5.5546
$lexr_t$	0.0022	0.0026	0.8503
h_1	0.3011***	0.1115	2.6998
h_2	-0.0027	0.1760	-0.0158
h_3	-0.0732	0.1991	-0.3678
h_4	-0.1666	0.1693	-0.9844
$constant$			

* ** *** *indicate significance at 10%, 5% and 1% critical level respectively.*

$R^2 = 0.9673$ Adj $R^2 = 0.9653$ F-Stat =489.318 *** Durbin-Watson Stat = 1.9

Source: Authors, 2018

Table 6: Short and Long Run Presentation of NARDL Results with Structural Breaks for soybean

Short Run			
Variables	**Coefficient**	**Standard Error**	**t-stat**
Δlop_t^+	0.2940***	0.0606	4.8587
Δlop_t^-	0.2995***	0.0501	5.9769
$\Delta lexr_t$	0.051***	0.0016	9.1258
$\Delta lrsb_{t-1}$	0.2948***	0.06067	4.8587
Δb_1	0.0245	0.0184	1.3268
Δb_2	-0.0597*	0.0312	-1.9135
Δb_3	-0.0201	0.0280	-0.7183
ECT_{t-1}	-0.1617***	0.0338	-4.7862

* ** *** *indicate significance at 10%, 5% and 1% critical level respectively.*

$R^2 = 0.9687$ Adj $R^2 = 0.9670$

F-Stat =558.0611*** Durbin-Watson Stat = 1.94

Source: Authors, 2018

Table 7: Wald Coefficient Restriction Test with consideration of structural breaks

Tests [probability value]	Maize		Wheat		soybean	
	Short run	Long run	Short run	Long run	Short run	Long run
T-Stat	-6.1759[0.0000]	-1.9993[0.0468]	-6.8340[0.0000]	1.7435[0.0827]	-8.0546[0.0000]	-0.9343[0.3512]
F-Stat	38.1424[0.0000]	3.9975[0.0468]	46.7046[0.0000]	3.0399[0.0827]	64.8772[0.0000]	0.8729[0.3512]
Chi-square	38.1424[0.0000]	3.9975[0.0456]	46.7046[0.0000]	3.0399[0.0812]	64.8772[0.0000]	0.8729[0.3512]
Asymmetry?	YES	YES	YES	YES	YES	NO

H0: there is symmetry
H1: there is asymmetry
Source: Authors, 2018

5. Summary and Recommendation

This study examined the effects of oil prices on agricultural commodity prices in Nigeria using monthly data series from 1997M01 to 2016M03. The data were obtained from the international financial statistics (IFS) and Food and Agricultural Organization (FAO). The variables adopted in this study included; oil price and exchange rate which serve as the independent variable while agricultural commodity prices of maize, wheat and soybeans serve as the dependent variable. The estimation procedure was partitioned into three; these include the preliminary analysis, model estimation, and diagnostic tests.

The short run Non-linear ARDL result for maize shows that both positive oil price and negative oil price have same effect on the price of maize and that exchange rate is influential in the analysis of oil-food relationship because it proves statistically significant. The breaks also highlight significant influences in analysis the relationship between oil price and agricultural commodity prices. The same result is evident in the long run.
The relationship between oil price and the price of wheat in the Non-linear ARDL realm shows that in the short run, both the positive and negative oil prices have the same effect on the agricultural commodity under consideration in the short run. So also that only the first break is the only period that statistically affects the price of wheat and so all other breaks should be jettisoned in the considering the relationship between oil price and the agricultural commodity (wheat) under consideration .

Furthermore, the relationship between soybean and oil price appears to be only in the short run from the result. It shows that oil prices have positive and significant effect on the price of soybean. Furthermore, the Wald Coefficient Restriction test was conducted and the result indicates that there is asymmetric effect on the oil price and agricultural commodity prices in Nigeria except for the long run model of soybean with breaks. Hence, oil price is said to have asymmetric effect on agricultural commodity prices in Nigeria.

The partial sum decomposition of oil price into positive and negative has been found to be significant in explaining the movement in agricultural commodity prices over the years. It is also made obvious from the findings that structural breaks in the selected agricultural commodities of wheat, maize and soybean were relevant phenomena that must be captured when examining the asymmetric relationship between oil and food. Based on the foregoing, the following were recommended: first, efforts geared towards developing the oil sector locally as it will bring about positive spillover effect on the agricultural sector thereby making food available at affordable prices. Second, development of the oil sector should diversify into producing relevant inputs for agriculture. This may include the production agrochemicals such as herbicides, insecticide, fungicides e.t.c

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