UNIZIK Journal of Agricultural Economics and Extension (UJAEE) Vol. 1 No. 1 (2024): 172-180
A Journal of the Department of Agricultural Economics and Extension, Nnamdi Azikiwe University, Nigeria
Available at: https://journals.unizik.edu.ng/ujaee

Asymmetric Impact of Crude Oil Price on Domestic Price of Goods in Nigeria

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KEYWORDS:
Asymmetry, Domestic prices, Crude oil price, Shocks

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ABSTRACT

This study investigated the asymmetric impact of crude oil price on domestic price of goods in Nigeria. Using a quarterly data covering 1999Q1 to 2023Q4, a Non-Linear Autoregressive Distributed Lag (NARDL) method was used for the analysis. Results from the estimate indicated that an increase in crude oil prices caused increases in Nigeria's petroleum product prices, manufacturing food prices, and primary food prices as measures of domestic pricing. However, a drop in the price of crude oil led to a slow decline in petroleum product prices, manufacturing food prices, and primary food and the drop in the marginal cost of production, which eventually led to a moderating of domestic prices. Additionally, when exchange rate is excluded from the models, negative oil price shocks resulted in higher domestic prices in Nigeria, showing the passed through effect of exchange rate and its absorbed effects of crude oil price shocks. Additionally, a manufacturing food pricing reacts to rising crude oil prices more than primary food prices. The study therefore, recommend that the Central Bank of Nigeria should concentrate its monetary policy rate efforts by reducing the rate of borrowing by this sectors on containing manufacturing food prices during periods of significant increases in crude oil price. Similarly, the monetary authority should step up its efforts to ensure domestic sustainability and boost food production through its manufacturing and agricultural sectors intervention programs to further reduce the impact of crude oil prices on domestic prices.

INTRODUCTION

In the past seven decades, oil has been the primary source of energy across the globe, with its by-products providing power to homes, businesses, transportation, and aviation (Abounoor, 2014). Consequently, one of the most significant shocks to the world economies is the unexpected disruption of oil supplies and the quick rise in its price. Since oil has continued to be a key commodity that powers global economic activity, changes in the price of oil have a significant impact on the macroeconomic performance of many nations (Alhassan & Kilishi, 2016).

An increase in crude oil prices has several effects on the economy activities, including the transfer of income from oil importing economies to an oil exporting country. An increase in the cost of producing goods and services in an economy due to an increase in the relative price of energy inputs will lead to a decrease in the economy's productive capacity as a result of producers using less oil and capital due to the increasing crude oil prices. Furthermore, uncertainty in investment decisions made by households which could be direct and indirect impacts on financial markets and the incentive for providers of energy to increase production and investment (Blanchard & Gali, 2007;

DePratto *et al.*, 2009; Bataa, 2010; Alvarez *et al.*, 2011; Trang *et al.*, 2017; Bala & Chin, 2018). The magnitude and direction of its impact, however, differ between industrial and developing countries as well as between oil producing and consuming economies (International Monetary Fund [IMF], 2020).

This conflict of results has left much gap in literature and has created some vacuum which this study intends to fill.

The objective of this study is to analyse how consumer goods price in Nigeria is affected by fluctuations in crude oil prices. However, because the majority of the food consumed is produced locally, its prices are mostly immune from oil price-induced inflation and may be more affected by oil price increases than the core measure of inflation for food. In light of this, we break down inflation into its petroleum price, Manufacture food price and primary food prices components in order to analyze how changes in the price of crude oil affect each of these inflation categories. The study adds to the discussion on which measure of inflation should be taken into account when determining how to respond with monetary policy during spikes in crude oil prices. We adopt a Nonlinear Autoregressive Distributed Lag (NARDL) model advanced by Shin, Yu and Greenwood-Nimmo (2014) as it allows for the evaluation of the potential long-run and short-run asymmetries in the relationship between crude oil prices and the three components of inflation.

This study adopted the Rocket and Feather (RF) hypothesis proposed by Bacon (1991) for its model as it best explains the intent of this work. The (RF) hypothesis model based on the assumption that domestic product prices increase faster to an increase in international oil prices like "rockets", while its decrease slowly like "feather" when there is a fall in the price of crude oil, and the monetarist Model based on access money in circulation lead to raise in domestic price of goods and services in an open market. The relationship has been described as the "asymmetry" behavior of crude oil price sensitivity to domestic price of goods and services changes.

The RF hypothesis believes that domestic price of goods and services increase faster to an increase in crude oil price and decrease slowly when there is a fall in crude oil price which is described as asymmetry effect. The theory proves to be better and fit to Nigeria given the potential impact of crude oil prices on stabilizing domestic price of goods, investment, balance of payments and interest rate.

Akarara and Baker (2023) studied the asymmetry of shocks in crude oil price in Nigeria; they implicitly assumed that oil price changes are symmetrical without specifically testing for asymmetry. This study concentrated on the shock asymmetries and crude oil price volatility in Nigeria. Used time series data for the years 1981 to 2022 from the Statistical Bulletin of the Central Bank of Nigeria and the World Bank. The data were analyzed using the Exponential Generalized Autoregressive Conditional Heteroskedasticity (EGARCH) model, and the findings showed that there is a general tendency for oil price shocks to be around 1.83 percent bigger in declining oil prices than in rising prices. The asymmetric shocks to the price of oil completely dominate positive leverage. In order to minimize the economies reliance on crude oil exports as its main export (and source of revenue), measures for export promotion and diversification should be put in place. However, Akarara and Baker study failed to analysis the channel of transmission effect of crude oil price in Nigeria.

Bello and Sanusi (2021). Studied the asymmetric effect of oil price on exchange rate and stock price using the nonlinear autoregressive distributive lag (NARDL) technique on the time-series data spanning from January 1996 to September 2020. The multivariate cointegration test showed evidence of a longrun relationship among the stock price, exchange rate, and oil price. The linear Granger causality test showed that stock price is granger caused by oil price and exchange rate, and

oil price is granger cause by stock price and exchange rate. The result from the nonlinear ARDL revealed that change in oil price impacted asymmetrically on the exchange rate and stock price both in the short-run and long-run. The study recommends that the revenue generated from increasing oil price should be used for developing and reinstalling decayed infrastructure and oil-exporting countries should develop mechanisms and strategies that will ensure fair stability in the capital markets irrespective of the shocks in oil price.

Bawa, Abdullahi, Tukur, Sani, and Yusuf (2020). Studied the asymmetric impact of crude oil Price on Inflation in Nigeria. A Non Linear Autoregressive Distributed Lag (NARDL) approach was applied on quarterly data spanning 1999Q1 to 2018Q4. Results showed that oil price increases led to increase in measures of inflation in Nigeria. However, a decline in oil price resulted in a decline in the marginal cost of production and culminated in moderation of domestic inflation. Also, core inflation tends to respond more to oil price increases than food inflation. These results were robust to changes in econometric specifications and sample period. The study recommends that monetary policy actions of the Central Bank of Nigeria should focus on taming core inflation in periods of substantial oil price increases while strengthening its efforts at ensuring domestic sustainability in food production.

Adediji, Adeniji, and Timilehin (2022). Studied the response of the Nigerian economy to symmetric crude oil price shock. It made use of annual data that spanned 1960 to 2021. A Structural Vector Error Correction Model (SVECM) and Autoregressive Distributed Lag (ARDL) techniques were employed. The results from both the SVECM and the ARDL suggest that real GDP will initially respond positively to oil price shock symmetrically but later decreases sharply, with the potential to lapse the Nigerian economy into a long time recession if not properly managed. The study therefore recommended that the productive base of the Nigerian economy should be diversified to other sectors. Also, security arrangements in the key oil- producing areas should be improved in order to avoid negative oil price shocks that could destabilize and plunge the economy.

Adenekan, Hilili, and Okereke (2022) examined the nexus among oil price, exchange rate and stock market performance, using the VAR based technique. The Johansen cointegration test revealed the absence of long-run relationship among the variables.. Shocks to crude oil market had a positive impact on shares in the first two periods, but very minimal beyond these periods. The findings imply that there are inherent structural or institutional rigidity in the transmission mechanism of oil price and exchange rate developments to the stock market. In examining the nexus among oil price, exchange rate and stock market performance and the cointegration test revealed the a short-run relationship among the variables and the Granger causality tests showed a unidirectional relationship. The used of VAR is inappropriate and will not adequately analysis the exert adjustment speed of the variables in the long-run in Nigeria; the vector error correction model would have been better fit for this study.

Olusegun (2018) had shown that crude oil price shocks significantly contributed to variations in oil revenues and national output in Nigeria. However, he opined that oil price shocks may not necessarily be inflationary, using Structural VAR model; the study recommended the application of fiscal policy measures in restoring stability in the domestic economy in the aftermath of an oil shock. Similarly, Odionye *et al.* (2019) had shown that the response of inflation to crude oil price shocks was negative at the initial instance, before turning positive after two periods. However, the exchange rate's response to crude oil price shocks was negative and persistent. Omotosho and Doguwa (2012) found that the announcement of fuel price hikes, food crises, exchange rate instability and upward review of wages of public sector employees were the major factors that caused high inflation volatility in Nigeria. Thus, subsequent withdrawal of fuel subsidies in Nigeria

and increases in the international prices of crude oil would culminate in higher domestic fuel prices and inflationary pressures in the country.

METHODOLOGY

For the analysis in this study, quarterly data from 1999Q1 to 2023Q4 were used. The study disaggregated the domestic price in to three measures of petroleum price, manufactured foods prices, and primary food prices as well as the broad money supply, real GDP, nominal exchange rates and average rainfall were all taken from the 2022 edition of the Central Bank of Nigeria's Statistical Bulletin and Statistics database. For crude oil prices, Brent crude prices in US$ were used, and were sourced from the commodity prices database (the pink sheet) of the World Bank. The Hodrick-Prescott (HP) filter was used to estimate the output gap.

Model Specification

Bawa *et al.* (2020) adopted the New Keynesian Phillips Curve (NKPC) methodology to arrive on a hybrid model of consumer price for Nigeria. Therefore, these studies were based on RF framework reported by Bello and Sanusi (2021) and adopting both models in analyzing the impact of crude oil price on domestic prices in Nigeria. The model is specified as follows:

$$\pi_t = \alpha_0 + \beta_1\pi_{t-1} + \beta_2 m_{t-1} + \beta_3 (y_t - y_t^*) + \beta_4 X_t + \mu_t \quad (1)$$

Where π_t is the aggregated domestic price at time t and represents the three measures of petroleum product prices, Manufacture foods prices and primary food prices, $(y_t - y_t^*)$ is output gap, which is the difference between petroleum product prices, Manufacture foods prices and primary food prices respectively, π_{t-1} is one period lag of prices, $m_{t-1}$is one period lag of money potential output both measured in it Naira, X_t is other control variables that impact on domestic price in Nigeria and μ_t is the error term. α_0 and β_i are the parameters to be estimated while α_0 is the intercept and β_1, β_2, β_3 and β_4 are the respective parameters of the explanatory variables included in their model.

Therefore, in keeping with Bawa *et al*. (2020) model, the study disaggregated domestic prices into petroleum product prices, manufacture foods process and primary food prices and incorporates two control variables to reduce the bias caused by omitted variables, nominal exchange rates and average rainfall. Given the effect of currency rate pass-through on consumer pricing, nominal exchange rate was taken into account. Rainfall's impact on food prices, which account for a sizeable portion of Nigeria's domestic prices, justifies the model's inclusion. This makes it possible for the study to look at how Nigerian domestic price is affected by crude oil price shocks. Thus, the linear model is as follows:

$$\pi_t = \alpha_0 + \beta_1\pi_{t-1} + \beta_2 m_{t-1} + \beta_3 (y_t - y_t^*) + \beta_4 er_t + \beta_5 oilp_t + \beta_6 rain_t + \mu_t \quad (2)$$

Where er_t is the nominal exchange rate measured in US$, $oilp_t$ is the average Brent crude oil prices measured in US$ and $rain_t$ is the average rainfall in Nigeria measured in percentage. To capture the asymmetric impact of crude oil price shocks on domestic price of goods, we specify a non-linear model by decomposing the variable $oilp_t$ into positive and negative shocks as follows:

$$oilp_t = oilp_{0_t} + oilp_t^+ + oilp^- \quad (3)$$

Where $oilp_0$ is the constant term and $oilp_t^+$ and $oilp^-$ *are* the partial sums of the positive and negative changes in $oilp_t$, and are defined as follows: Following Shin *et al.* (2014), we replace $oilp_t$ in equation 3 with $oilp^+$ and $oilp^-$ to arrive at a non-linear ARDL model as stated below:

$$\pi t = \alpha 0 + \beta 1 \pi_{t-1} + \beta_2 m_{t-1} + \beta_3 (y_t - y_t^*) + \beta_4 er_t + \beta_5 oil\ p_t^+ + \beta_6 oil\ p_t^- + \beta_7 rain_t + \mu_t \quad (4)$$

According to equation 4, there is a positive correlation between historical domestic prices and current prices. Similar to this, since the money supply and domestic prices have a positive relationship, rising money supply will always result in rising domestic prices. Higher rainfall would unavoidably result in higher food production and a drop in food prices, which would ultimately result in a decline in domestic prices. Additionally, it is anticipated that positive output gap and currency rate depreciation will both have a positive effect on domestic prices.

To also capture the various impacts of crude oil price shocks on the disaggregated domestic price of goods (πt), we specify a model by decomposing the variable πt into petroleum product prices, Manufacture foods prices and primary food prices as follows:

$$\text{lncpipp} = \alpha 0 + \beta 1 \pi_{t-1} + \beta_2 m_{t-1} + \beta_3 (y_t - y_t^*) + \beta_4 er_t + \beta_5 oil_t p^+ + \beta_6 oil\ p_t^- + \beta_7 rain_t + \mu_t \quad (5)$$

$$\text{lncpimf} = \alpha 0 + \beta 1 \pi_{t-1} + \beta_2 m_{t-1} + \beta_3 (y_t - y_t^*) + \beta_4 er_t + \beta_5 oil\ p_t^+ + \beta_6 oil\ p_t^- + \beta_7 rain_t + \mu_t \quad (6)$$

$$\text{lncpipf} = \alpha 0 + \beta 1 \pi_{t-1} + \beta_2 m_{t-1} + \beta_3 (y_t - y_t^*) + \beta_4 er_t + \beta_5 oil\ p_t^+ + \beta_6 oil\ p_t^- + \beta_7 rain_t + \mu_t \quad (7)$$

Where lncpipp is the long run consumer price index (CPI) of petroleum products prices, lncpimf is the long run CPI of Manufacture food prices and lncpipf CPI of Primary food prices in Nigeria. The positive which represents the link between growing crude oil prices and domestic price of goods, is represented. This suggests that stronger domestic pressures naturally result from rising crude oil prices on the global market. The relationship between falling crude oil prices and domestic price is likewise represented by equation (4) and is predicted to be positive, indicating that falling oil prices result in lower production costs and a drop in domestic price. However, declining crude oil prices reduce the foreign exchange revenues of import dependent oil exporting nations, which manifests in the devaluation of the domestic currency and leads to an increase in domestic prices and higher import prices (Bala & Chin, 2018; Omotosho, 2019). Consequently, β_6 can be negative in Nigeria.

RESULTS AND DISCUSSIONS

It is a requirement of the NARDL bounds testing method that no variable integrated of order 2, or I (2), be used in the analysis. Therefore, using both the Augmented Dickey-Fuller (ADF), we first conduct unit root tests for all variables to ascertain the degree of stationarity, with the findings shown in Table 1.

Table 1: Unit Root Test Result.

Variables	ADF	5% Critical Level	Order of Integration
ln(cpipp)	-4.464268	-3.447383	I (1)
ln(cpimf)	-4.860416	-3.447383	I (1)
ln(cpipf)	-5.651307	-3.447383	I(1)
ln(m)	-4.193100	-2.885249	I (1)
Qgap	-3.864366	-3.447383	I (0)
ln(er)	-6.362838	-1.702304	I (1)
ln(oilp)	-7.052838	-2.253402	I (1)
ln(rain)	-6.093772	-2.753343	I (1)

Author's Computation E-Views 9.0

The results of the ADF test show that most of the variables have unit root at level and became stationary after first difference I(I) with the exception of output gap (qgap) which is stationary at level. This is established by comparing the ADF value with their respective critical value at 5% level of significant, which show that all the variable of the ADF statistic value are greater than their respective critical value at 5% level. Judging by the order of integration I(0) and I(1) its suggest that there may be existence of long-run relationship between the variables.

Bounds Test for Cointegration

The results of the NARDL bounds test for the three models are shown in Table 2.

Table 2: NARDL Bounds Test for Cointegration

ARDL Bounds Test	F-Statistic	Critical Value Bounds @ 5%	
	6.0435	Lower Bound I(0)	Upper Bound I(1)
		2.27	3.28

Author's Computation E-Views 9.0

The bounds test results for model demonstrate that the six variables co-move over time. In the estimated F-statistic of 6.0435 is higher than the upper bound at 5% levels, indicating the existence of a cointegrating relationship between the variables. The relevant F statistics are over the upper bound critical values under the models, supporting the rejection of the hypotheses that there is no cointegration among the variables in models 2 and 3.

Estimation Results of NARDL

We evaluate domestic price dynamics and look at the effects of both positive and negative changes in crude oil prices on domestic price in Nigeria after finding evidence of a cointegration relationship in the models. So, using a maximum lag length of 3, this study evaluated both the long-run and short-run models.

Table 3: Estimated Long-run NARDL Model

Dependent Variable	**ln(cpipp) at 1%**	**ln(cpimf) at 5%**	**ln(cpipf) at 10%**
Variable	Model 1	Model 2	Model 3
C	-2.0244***	-0.9301	-2.0896**
	(0.7044)	(1.4776)	(0.9270)
ln(oilp) pos	_0.1244**	0.2052*	0.1165*
	(0.0508)	(0.1040)	(0.0666)
ln(oilp) neg	_0.0499	0.0607	0.0260
	(0.0405)	(0.0859)	(0.0527)

*, ** and *** indicate significance at 10 percent, 5 percent and 1 percent levels. Standard errors are in brackets. ***Author's Computation E-Views 10.0***

The models demonstrate that the effects of rising crude oil prices on petroleum products prices, manufacturing food prices and primary food prices in Nigeria are as expected to be positive and considerable. The findings from the three models show that a 1% increase in crude oil prices resulted in increases in petroleum product prices, manufacturing food prices and primary food

prices of 12 %, 21% and 12%, respectively. The increase in domestic price pressure brought on by an increase in the price of crude oil is largely the result of global prices spreading to domestic price, an economic boom during periods of high crude oil prices in oil exporting nations like Nigeria, and an increase in the money supply as a result of a higher inflow of oil proceeds, among other factors. These findings concur with those of Kelikume (2017) and Bala and Chin (2018), who discovered that positive oil price shocks in Nigeria, caused domestic price increase. Similar findings were made by Choi *et al*. (2018) and Lacheheb and Sirag (2019), who found that positive oil price shocks, had a greater and more substantial impact than negative ones and culminated in inflationary pressures.

In addition, crude oil price increases tend to have a higher impact on manufacturing foods prices than primary food prices in Nigeria during the period. This is so because most of the primary food consumed is usually produced in the country and thus, its prices are largely immune from crude oil price induced. As shown by the coefficient of the negative shocks of crude oil price, indicating a 1% drop in crude oil prices will lead to 0.5%, 0.6% and 0.2% declines in petroleum products prices, manufacturing food prices and primary food prices respectively. This is confirming with the RF hypothesis adapted by the study and this association may exist because of the common occurrence of moderated marginal costs of production in many nations when oil prices decrease. A decrease in the marginal cost of production in other nations would lower import prices and thus reduce domestic price pressures in Nigeria given that the country imports a sizable volume of consumer and capital goods.

The findings also confirmed with the research of Alhassan and Kilishi (2016) who have also shown that crude oil price shocks led to macroeconomic fluctuations in Nigeria, Adediji *et al*. (2022) whose findings suggest that real GDP will initially respond positively to oil price shock symmetrically but later decreases sharply. Akarara and Baker (2023) in their study the asymmetry of shocks in crude oil price in Nigeria and the findings showing that there is a general tendency for oil price shocks to be around 1.83 percent bigger in declining oil prices than in rising prices. The asymmetric shocks to the price of oil completely dominate positive leverage.

Also the rocket and feather effect shows the responds of the shocks in the increase and decrease of crude oil price on domestic prices.

Table 4: Estimated Short-run NARDL Model

Variable	Model 1	Model 2	Model 3
Δln(oilp) pos	0.0412**	0.0555*	0.0456
	(0.0192)	(0.0304)	(0.0289)
Δln(oilp) neg	0.0165	0.0164	0.0102
	(0.0138)	(0.0247)	(0.0205)
ecm(-1)	-0.3314***	-0.2704***	-0.3918***
	(0.0578)	(0.0718)	(0.0778)
RESET	2.6041	0.7563	0.4509
	(0.112)	(0.388)	(0.833)

*, ** and *** indicate significance at 10 percent, 5 percent and 1 percent levels. Standard errors are in brackets. ***Author's Computation E-Views 10.0***

The short-run result suggests that a percentage increase in crude oil price (oil) pos will resulted to 0.4% , 0.5% and 0.4% rise in the price of petroleum (cpipp), manufacturing foods prices (cpimf) and primary food prices (cpipf) while a percentage fall in crude oil price (oil) neg will lead to a 0.1%, 0.1% and 0.1% reduction in the price of petroleum products (cpipp), manufacturing foods prices (cpimf) and primary food prices (cpipf) respectively. The difference between the positive and the negative shocks (increase and decrease) of crude oil price on domestic price is associated with rocket and feather hypothesis. This is in line with our a-priori expectation and the rocket and feather hypothesis of the study and also confirm with findings of Akarara and Baker (2023) which revealed that there is a general tendency for oil price shocks to be around 1.83 percent bigger in declining oil prices than in rising prices. The asymmetric shocks to the price of oil completely dominate positive leverage.

CONCLUSION AND RECOMMENDATIONS

The findings of the study indicated that during the study period, rises in crude oil prices had a greater favorable influence on manufacturing food prices than increases in primary food prices and petroleum product prices. This is because only around 26% of the food CPI is imported, with the majority of food consumed being grown domestically. Consequently, the consequences of global crude oil price induced manufacturing foods prices are mainly shielded from passing through to food prices. This is confirmed by the 2023 Nigeria inflation rate, out of the country 28.92% inflation rate, 13.27% increase rate is on the primary foods and food & non-alcoholic beverages while 15.65% is on manufacture items, housing & utilities and health.

The main models' domestic prices also response favorably to falling crude oil prices, indicating that lower crude oil prices cause weaker and slow decline in domestic price than its responds to an increase in crude oil price in Nigeria. Reduced production costs in many nations, as well as reduced oil earnings and government income in Nigeria, are typically associated with falling crude oil prices and help to control domestic prices. These is also confirmed by Brent Crude Oil price averaged USD 88.95 per barrel in October, down 4.0% from September's price in 2023. The commodity traded at USD 87.54 per barrel, 8.2% lower than on the same day of the previous month. Also at the same vain the Nigeria's annual inflation rate swiftly increase to 27.3% in October 2023, the highest since August 2005, up from 26.7% in the prior month. Likewise in 2020, when the price of crude oil is $39.68 per barrel, the inflation rate only decline from 13.25% to 11.40% in 2020 which is an average of 1.85% decrease within the same year.

Additionally, in order to support the monetary authorities' attempts to moderate domestic prices, it is important to ensure that the fiscal policy stance is not overly pro-cyclical during periods of rising crude oil prices. Additionally, it is advised that the nation be sure to save any extra oil revenue and create external reserve buffers for times when crude oil prices are on the rise. Savings of excess revenues would prevent the economy from overheating due to larger inflows, hence reducing the pressures caused by increasing crude oil prices. However, during drops in the price of crude oil, external reserve buffers would assist in reducing excessive demand and achieving a steady exchange rate on the foreign exchange market

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