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Crude oil price and exchange rate: An econometric analysis on commodity price in Nigeria

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Abstract

This study empirically examined the effects of crude oil price and exchange rate on commodity price in Nigeria from 1990 to 2022 employing Autoregressive Distributed Lag (ARDL) testing procedures. Commodity price index is utilised to proxy commodity price while the adopted independent variables are crude oil price and exchange rate, with government capital expenditure and interest rate employed as control variables. The study utilized time series data sourced from Central Bank of Nigeria (CBN) statistical bulletin and World Development Indicators (WDIs) of the World Bank. Diagnosis for unit roots in the time series data were conducted employing the Augmented Dickey Fuller method and the upshots suggested mixture of I(0) order and I(1) order of integration, with the Bounds cointegration estimate showing long-run relationship. The ARDL upshots showed that crude oil price contributed long-run direct and substantial effects on commodity price index in Nigeria but negatively in the short-run while rise in official exchange rate positively and substantially contributed to long-run and short-run CPI effects. The study therefore concluded that upsurge in crude oil price and exchange rate are major determinants of commodity price level in Nigeria. It is thus recommended among others that Nigeria's heavy earnings from crude oil exports which is vulnerable to fluctuations in global oil prices should be supported with strengthening the non-oil sector to stabilize commodity prices in the long-run. Also, the CBN should ensure real non-oil sector friendly revaluation of the Naira relative to the US Dollar as this will strengthen the domestic economy and curb future inflationary pressures.

Keywords: Crude Oil Price Per Barrel, Official Exchange Rate, Commodity Price Index, ARDL Testing Procedure and Nigeria.

INTRODUCTION

Energy is a strategic fulcrum and stimulant for the global advancement of human civilization, industrial innovations, economic diversification, and sustainable development. This energy is accessible to consumers at a reasonable price, as expressed in the unit of Joule (J) and other physical quantities of energy, comprising barrels for crude petroleum, for gas it is cubic feet, but petrol (fuel) and diesel oil are measured in litres, likewise kilowatt-hours (kWh) for electric energy. It is impossible to overstate the economic and developmental influence of energy on the development of human capital by creating jobs to reduce poverty and inequality in both developed and emerging economies. The foreign earnings generated from energy exports are indicative of the overall growth in a variety of economic and fiscal operations and business activities (Prince, Ogbodo, Callistus & Samuel, 2021).

Renewable and non-renewable energy sources are distinct categories of energy. Renewable energy encompasses solar, wind, hydro, biomass, tidal, and geothermal sources, while non-renewables comprise natural gas, coal, nuclear, electrical power, and oil or petroleum. Nigeria is the most substantial oil-producing nation in Africa. The hydrocarbon export is the primary source of revenue for the Nigerian economy, accounting for over 95% of export earnings and 70% of total government revenue. Nigeria exports more than 80% of its crude petroleum and imports more than 70% of its refined products to satisfy domestic demand, as the country's refineries are unable to accommodate the increasing demand. Sambo (2017) and the International Energy Agency (2020) reported that petroleum products were the most frequently consumed energy source in 2019, with a consumption rate of approximately 36% after biomass. Nevertheless, petroleum oil is an indispensable component of the production and transportation of numerous commodities, rendering it inextricably linked to commodity price fluctuations. Crude oil's outcome on commodity prices is evident in a variety of sectors, i.e. energy, transportation, manufacturing, and agriculture. In the production of electricity, transportation fuels, and heating, crude petroleum is a primary energy source. The implication of fluctuations in crude petroleum price is direct on cost of energy, which in turn affect the production, transportation, and distribution of commodities. The cost of production for energy-intensive industries, i.e. manufacturing and transportation, increases as crude oil prices rise, resulting in increased prices for goods and services (Ifeonyemetalu & Ogu, 2020). Furthermore, Mamdouh and Mohamed (2021) asserted that crude oil is utilised as a feedstock in the production of petrochemicals and plastics, which are utilised in a diverse array of industrial and consumer products. The prices of products i.e., plastics, fertilisers, and synthetic fibers increase as an upshot of the increased production costs for petrochemical manufacturers due to upward price movement of crude petroleum. This indirectly influence other commodities prices that rely on petrochemicals as inputs. Additionally, petroleum oil prices have a substantial influence overall effect on inflation rate, as energy costs affect the prices of products and services across the economy. Inflation typically rises when crude oil prices rise, as businesses pass on increased production and transportation costs to consumers. This has the potential to diminish real incomes and erode purchasing power, particularly for households with restricted fiscal resources (Ighosewe, Akan & Agbogun, 2021).

Conversely, fluctuations in crude oil prices can also influence exchange rates by influencing investor perceptions and capital flows. Countries that are substantial oil exporters experience an upsurge in foreign exchange earnings when crude oil prices increase, which upshots in upward pressure on their currencies. This can lead to currency appreciation, which can lower the cost of imports and exert downward pressure on commodity prices. In contrast, countries that are net importers of oil may experience currency depreciation, which upshots in increased

commodity prices and increases the cost of imports. Therefore, exchange rates are essential in determining the prices of commodities, as they influence the cost of imports and exports. The outcome of alterations in exchange rates on production costs, trade flows, and market dynamics can affect commodity prices. Fluctuations in exchange rates directly affect the cost of imported items, since variations in exchange rates modify the pricing of commodities denominated in foreign currencies. When the home currency depreciates against foreign currencies, the expense of importing commodities rises, resulting in elevated prices for imported items. This may outcome many commodities, encompassing consumer items, raw resources, and intermediate inputs utilised in manufacturing (Ademola, Ditimi & Johnson, 2022).

Ademola, Ditimi, and Johnson (2022) empirically shown that natural gas prices, crude oil prices, and electricity tariffs are co-integrated, indicating a long-run link; nevertheless, no substantial causal influence exists among them. Mamdouh and Mohamed (2021) found that fluctuations in crude petroleum price, are contrasting in terms of effects on crude petroleum exporting and importing nations; specifically, oil price variations positively influence exporters while volatility negatively affects them. Furthermore, Sunday (2019) discovered that oil price volatility and currency rate fluctuations negatively influence infrastructure expansion while positively affecting inflation.

Crude oil is an incontrovertible factor input contributing to the socio-economic growth dynamics of resource-rich nations. While its availability does not inherently resolve the social and economic challenges confronting developing nations i.e. Nigeria, the volatility of its price substantially hampers foreign exchange inflow to Nigeria, a net importer of numerous essential commodities, comprising food, machinery, and consumer goods. When crude oil prices escalate or the exchange rate declines, the expense of importing these goods surges. The upsurge in import costs upshots in elevated domestic inflation, hence raising the cost of products and services for consumers. The inflationary effect is especially substantial for food products, given Nigeria's substantial reliance on imports to satisfy its food requirements. Moreover, variations in crude oil prices and currency rates mostly result in cost-push inflation, particularly in sectors dependent on imported inputs and raw materials. As manufacturing costs rise owing to elevated import expenses or a depreciated exchange rate, companies transfer these increased costs to consumers via elevated pricing for locally produced products and services.

The fluctuations in crude oil prices and currency rates have eroded consumer and company confidence, resulting in less spending, investment, and economic activity in Nigeria. Ambiguity over future commodity prices, inflation, and currency rate fluctuations mostly suppresses consumer sentiment, leading families in Nigeria to defer discretionary expenditures and increase savings as a conservative strategy. Conversely, exchange rate depreciation may directly affect commodity prices by elevating the expenses associated with imported goods and services. As the Nigerian Naira declines in value relative to major foreign currencies, the costs of imported goods, i.e. petroleum, food, equipment, and consumer items increase. This upshots in increased manufacturing expenses for local companies, which are then transferred to consumers as elevated prices. The exchange rate pass-through outcome exacerbates inflationary pressures and diminishes buying power, especially for low-income families who allocate a substantial percentage of their income to necessary goods. This research aimed to empirically assess the outcome of crude oil prices and currency rates on commodities price levels in Nigeria, in line with the highlighted issue. The research specifically attempts to investigate the empirical impacts of crude oil prices and the official currency rate, with government capital expenditure and interest rates as control variables, on Nigeria’s commodities price index.

RELATED LITERATURE REVIEWS

Asymmetric Price Transmission (APT) Theory

This research is based, in part, on the Asymmetric Price Transmission (APT) theory. The theory focusses on the Rocket and Feather Effect (RFE) and how alterations in the price of energy supplies like crude oil may translate to alterations in the price of gasoline as an upshot of alterations in other input prices, as often credited to (Bacon, 1991). The Rocket and Feather Effect (RFE), as attested by Ojeyinka and Olayungbo (2021), demonstrates that as input costs rise, prices rise sharply and fall sharply, respectively. Put mathematically, as in Equation 2.1, for a two-variable model with y directly related to q and k set as a constant;

$$y = k\ q \qquad (2.1)$$

We get the following in a three-variable model with a constant k and direct relationships between y and q and z:

$$y = kqz \qquad (2.2)$$

In an ideal market structure, an APT can adapt to alterations in the prices of cross-elasticity-demanded, homogenous goods. For instance, as long as all other variables stay the same, the rocket and feather theory states that the prices of natural gas and crude oil have an asymmetrical effect on each other and the power tariff. Additionally, certain market players are at a disadvantage when prices change, and Asane-Otoo and Schneider (2015) contended that this is because of the Asymmetric Price Transmission effect, which impacts consumer welfare inequalities related to the rate of price adjustment in response to alterations in input costs.

As attested by Jhingan (2011), market structure focusses on the aggregate features of an economy, i.e. its producers and consumers, while APT theory highlights how prices move in a perfectly competitive market. Theories of supply and demand that result in pricing and price equilibrium, as stated by Makwe, Akinwale, and Atoyebi (2012), also have an impact:

$$Qd = Qs = (P_t) \qquad (2.3)$$

What makes a competitive market special is the way prices work, which is owing to the idea that the relationship between producer profit and consumer utility ultimately leads to the social welfare function, which is defined as:

$$P = CS\ (pt) + PS\ (pt) = SW \qquad (2.4)$$

Energy costs are comprised of three components: the electricity tariff, natural gas, and crude petroleum prices (Zhang, 2015). Consequently, a number of other factors, both structural and market-oriented, have direct and indirect impacts on energy costs respectively. In congruent with Iwayemi and Fowowe (2010), crude petroleum and natural gas prices wield substantial implication on the economic performance of Nigeria, particularly when it comes to the payment of the government's fiscal obligations, which in turn affects the cost of other products and services. This is similar to the situation in other countries that use energy imports and exports as their primary source of energy.

Purchasing Power Parity (PPP) Theory

In 1918, Swedish economist Professor Gustav Cassel proposed the Purchasing Power Parity (PPP) idea. One of the earliest theories of exchange rates, also called the inflation theory of exchange rates, postulates that two countries' currencies are equal at any given time if and only if the ratio of the two countries' exchange rates to the price levels of a fixed quantity of goods and services is equal (Cassel, 1918, in Mordi, 2014). So as to revive the PPP, this postulate is owing to the law of one price, which states that as prices rise in an economy, the value of the currency falls. With the same currency, the competitive market will match the pricing of commodities in two nations, providing there are no transit costs or other channels. To be valid, the assumption of a price-level playing field in both nations, the free flow of commodities between them, and the lack of transportation costs and other associated expenses must all be satisfied. Employing the degree of divergence from linear trend coding to capture

misalignment leads to erroneous conclusions. Absolute and relative PPP are the two varieties. As attested by absolute PPP, the state of the products market is balance, and the solution is to merge the local and international markets into one. However, relative PPP argues that the difference between two nations' exchange rates is the best way to determine a currency's appreciation rate, which in turn increases inflation. Mordi (2014).

Related Empirical Review

There are a number of literatures that include pertinent empirical research. Still, in order to gather the empirical leads needed for our investigation, we perused a multitude of publications that addressed Nigeria or other nations. So, Ademola, Ditimi, and Johnson (2022) looked at how natural gas and crude petroleum oil prices correlated with Nigeria's power tariff. We take time series data from 1980 to 2021 and run the ARDL, VAR, and pairwise causality tests on it. In spite of the lack of a clear causal link, the prices of crude oil, natural gas, and electricity are all substantially correlated and therefore affect each other. Using data from 1984 to 2018, Ighosewe, Akan, and Agbogun (2021) looked at how changing crude oil prices affected Nigeria's GDP. At least in the near term, the Nigerian economy benefited greatly from fluctuations in oil prices per barrel (FOBP), in congruent with secondary data examined using an ARDL Model. Gylych, Jibrin, Celik, and Isik (2020) looked at how oil prices influenced Nigeria's monetary variables from 1995 to 2018. The researchers found that oil prices had a unidirectional effect on exchange rates at the 10% significance level, that CPIs responded simultaneously to alterations in interest and exchange rates, and that CPIs were granger causally connected to oil prices, interest rates, and CPIs. Examining how alterations in oil prices outcome GDP growth in Nigeria, Ifeonyemetalu and Ogu (2020) carried out their study using the GARCH (1,1) model for estimate. For this, they consulted OPEC's database likewise the Statistical Bulletin, a quarterly publication from the CBN that spanned 1984–2017. In addition, the data showed that oil prices substantially boosted GDP growth in Nigeria. Using an ARDL model, Musa, Maijama'a, Shaibu, and Muhammad (2019) examined data from 1982-2018 for the consequence of crude oil prices and currency rates on the growth of the Nigerian economy. The results demonstrated that these fundamentals significantly influenced long and short-term development. As an example, Sunday (2019) used an error correction technique to analyse data from 1981 to 2016 on Nigeria's infrastructure development and found that oil price volatility and inflation were detrimental to infrastructure investment, while actual exchange rates had the opposite effect.

In examining how fluctuating oil prices exerts on the Nigeria's economy, the measures COP, GDP, currency rates, unemployment rates, and government spending were looked at for the period of 1997 to 2015 (Okonkwo and Ogbonna, 2018). Studies show that changes in the COP, currency values, and unemployment rates have a direct and linear effect on the Nigerian economy. Drawing on statistics spanning 1980–2016, Charles and Oguntade (2018) determined the impact of oil prices on GDP growth in Nigeria. The results showed that after applying the ordinary least squares (OLS) method to the long-term relationship between oil price changes and GDP growth, there was a positive and statistically significant link. Over the period from 1981 to 2015, Ergin and Abdullahi (2018) investigated influence of crude petroleum oil prices changes on GDP growth of Nigeria. The results obtained by using the Vector Error Correction approach reveal that, although economic growth is favourably correlated with both variables, government expenditure is negatively correlated with inflation and positively correlated with oil price and real effective exchange rate. The Granger causality model applies the oil price to explain economic growth and exchange rates, in contrast to the inflationary model's reliance on the exchange rate. Following the variance decomposition, crude price's impact on growth of GDP and currency rates is the most significant, followed by that of changes in exchange rates on inflation rates, and finally, the impact of changes in oil prices on inflation rates ranks third. By using method of error correction, how fluctuating oil

prices exerted on Nigeria's economy, in the period (1970 to 2013) was examined (Ogbonna & Orlu, 2017). When considering GDI, PMS price, LIR, and LEMP (labour employment policy), among other things. There was a little but negative impact on the Nigerian economy from changes in PMS prices. Using data collected in Nigeria from 1990 to 2015, Chikwe, Ujah, and Uzoma (2016) analysed how critical macroeconomic indices are dependent on crude petroleum price. Applying multiple regression analysis, the researchers discovered a positive and statistically significant correlation between the unemployment rate and COP. But the interest rate crushed crude oil prices. Evidence also suggested that real GDP, inflation, and exchange rates were not significant determinants of COP. For their 2016 research, Pere and Eniekezimene analysed GDP growth in Nigeria from 1981 to 2013 and found that COP had an effect. Changes in oil prices have a major impact on Nigeria's economic growth, according to the results of the VAR and OLS models. Oil prices are positively correlated with GDP according to the conventional least squares approach, although GDP declines in agreement with prices of petroleum black gold, but GDP and volatility in currency rate of exchange exhibited inverse correlation.

In their study from 2021, Mamdouh and Mohamed analysed how price of crude petroleum oil, as unstable affected MENA nations' GDP development. In conclusion, countries that gain from oil price variations but are also vulnerable to volatility are those that export oil, while countries that import oil see the flip relationship: oil price fluctuations lessen volatility but heighten oil price fluctuations. Quantiles also show distinct patterns in how uncertainty and fluctuations in oil prices affect them. Additionally, data suggests that oil price fluctuations outcome GDP growth in several ways. Researchers Jahangir and Dural (2018) looked at how the availability of petroleum and natural gas influenced the development of the Caspian Sea region's economy. The ordinary least squares method's upshots showed that natural gas and crude oil had a major effect on regional GDP growth. Although the Granger causation between gross domestic product and (unidirectional) export and COP is correct, these variables do not outcome GDP projections. This is not the way GDP and natural gas will evolve, despite widespread perception to the contrary. For the purpose of demonstrating how alterations in the price of petrol affect inflation and GDP growth in developing nations that rely on imports, Meyer (2018) employed South Africa as an example. This analysis made use of quantitative data collected between 2001 and 2018. The econometric methods employed included Johansen cointegration and Granger causality, and established evidence of long-term and short-run factor interdependence as analysed. Shahbaz, Sarwar, Chen, and Malik (2017) found that oil prices and economic growth are positively and reciprocally related. From 1960 to 2014, the research monitored the gross domestic product, power consumption, oil prices, labour force, and capital of OECD nations using panel data. Utilising trials that employed Pool Mean Party, long-run parameter estimation, and panel cointegration, we quantified the degree of correlation between the variables.

Perceived Literature Gaps

As part of our research, we have compiled a selection of relevant theoretical and empirical literature reviews. The empirical excursions in particular have helped to fill in certain gaps in the literature. To begin, very little research has looked at how alterations in the price of crude oil and the value of the naira affect commodities prices in Nigeria. No research has regressed the real nature of the link among price of crude oil, currency rate, and inflation on commodity prices in Nigeria, even if there is no universal agreement about this matter. "Secondly, most of the prior research in this area has had limited data samples; however, the present study fills this void by focusing on the effects of crude oil and exchange rates on commodity prices from 1990 to 2022, a time frame that more closely tracks current events.

METHODOLOGY

Research Design

This research makes use of the ex-post-facto methodology. This relies on the researcher being able to access preexisting data so as to objectively test hypotheses or answer study research questions. The data utilised in this research came only from secondary sources. This analysis specifically utilised yearly data spanning from 1990 to 2022. Both the World Bank's World Development Indicators (WDI) and the CBN's statistics bulletin (2023) provided the original data for this analysis.

Model Specification

Both the Asymmetric Price Transmission (APT) and the Purchasing Power Parity (PPP) theories provide the theoretical foundation for this investigation, which follows previous theoretical expositions on the relationships between commodities prices, exchange rates, and crude oil prices. The study's variables form the basis for the multiple regression model's specification. In particular, the model is slightly modified to align with that of Kenny (2019). So, this is the model that represents the functional connection of the variables:

$$CPI = f((COP, OER, GCE, INR) \quad (3.1)$$

The assumption of exactness in the connection among the variables in Equation (3.1) necessitates the introduction of the disturbance factor in the econometric version, which helps to explain the less-than-perfect relationship. Therefore, it is defined as:

$$CPI_t = \beta_0 + \beta_1 COP_t + \beta_2 OER_t + \beta_3 GCE_t + \beta_4 INR_t + \mu_t \quad (3.2)$$

Finally, the following is the specification of the model in its partial log form:

$$CPI_t = \beta_0 + \beta_1 InCOP_t + \beta_2 OER_t + \beta_3 InGCE_t + \beta_4 INR_t + \mu_t \quad (3.3)$$

A Priori Expectation: $\beta_1 > 0, \beta_2 > 0, \beta_3 < 0, \beta_4 > 0.$

Where: CPI = Commodity price index, COP = Crude oil price, OER = Official exchange rate, GCE = Government capital expenditure, INR = Interest rate, f = Functional sign, β_0 = The intercept/constant variable, β_1, β_2, β_3, β_4 = parameters of COP, OER, GCE and INR respectively. In addition, β_1, β_2, β_3, β_4 denote the rate of change in CPI for each unit change in COP, OER, GCE and INR correspondingly; t = time, *In* = log linear and μ_t = disturbance term.

Variable Description

The variables utilized in the model of this study are classified as dependent variable and independent variables, which compiled and described in Table 1 below.

Table 1
Variables and Descriptions

Dependent Variable			
Variables	**Measurements**	**Sources**	**Descriptions**
Commodity Price	Commodity price index (CPI) utilised as average annual indices.	CBN (2023)	It is a measure that tracks the average price movements of a basket of commodities over time. It provides a benchmark for evaluating alterations in the broad-based index covering multiple commodities.
Independent Variables			
Crude Oil Price	Yearly average crude oil prices (COP) in ($/Barrel)	WDI (2023)	This is the international market value of a barrel of crude oil, which is mainly influenced by factors i.e. global oil supply and demand.
Exchange Rate	Official Exchange Rate (OER)	CBN	It refers to the official rate at which the Nigeria's currency exchanged for

	as annual average in N/$	(2023)	the US-Dollar within the study period covered as determined by the CBN.
Government Capital Expenditures	Yearly total capital expenditures (GCE) in N'billion, employed as fiscal policy support variable	CBN (2023)	This denotes funds allocated by the Nigerian government for investment in infrastructure projects aimed at enhancing productive economic activities
Interest Rate	Monetary policy rate as the annual percentage benchmark interest rate (INR), employed as monetary policy control variable	CBN (2023)	This is the baseline interest rate by which the CBN influences cost of borrowing and lending in the economy.

Source: Author's Compilation

Model Estimation Techniques

To empirically test the specified model, the summary statistics analysis for checking the variables for normality was conducted relying on the Jarque-Bera statistics. Following this in principle is the unit root test of the individual variables, which is for ascertaining their orders of integration by applying the ADF test at 5% (Dickey & Fuller, 1981). The general ADF model for unit root estimation is specified as follows:

$$\Delta Y_t = \lambda_0 + \lambda_1 + \delta Y_{t-1} + \sum_{i=1}^{n} \lambda_1 \Delta Y_{t-i} + \mu_t \qquad (3.4)$$

Where Y represents the time series variables under consideration, t denotes the linear time trend, Δ is the first difference operator, λ_0 is the constant term, n indicates the optimum number of lags on the dependent variables, μ_t represents the stochastic error term.

Pesaran, Shin, and Smith (2001) also noted that the ARDL Bounds cointegration test is utilised to determine whether the variables in question are cointegrating. Use it when you find a mixed order of integration employing *I(0)* and *I(1)* from the unit root analysis. When the computed F-statistic value is above the upper limit *I(1),* below the lower bound *I(0),* or in between the *lower I(0)* and the higher *I(1)* bounds, three possible outcomes are considered by this method: the presence of cointegrating relationships, the absence of cointegrating connections, and inconclusive relationships. Modelling the ARDL Bounds cointegration often entails:

$$Y_t = \Delta_t Y_{t-1} + \ldots \Delta_p Y_{t-p} + \delta R_t + U_t \qquad (3.5)$$

Where the time series variables under consideration in time t is denoted by Y_t , the cointegrating equations estimates *i*s represented as Y_{t-1} and Y_{t-p} , the First difference operator is denoted by Δ denotes and U_t stands for the stochastic error term.

Following the ARDL limits test for cointegration, the long-run and short-run dynamic estimates models are created to examine the statistical and theoretical significance of the relationship between the dependent and independent variables in the model. Hence, Equation 3.6 following presents the specifications of the ARDL model's short-run and long-run forms;

Where Δ represents the difference operator and denotes the optimal lag, β_1 to β_5 correspond to the short-run dynamic co-efficient, while α_1 to α_5 represent the long-run co-efficient. The term ε_{1i} is a serially uncorrelated stochastic error with a mean of zero and constant variance. Additionally, ECM_{t-1} signifies the error correction term derived from the short-run analysis, with Ω acting as its co-efficient. This coefficient represents the yearly rate of system adjustment from prior period's disequilibrium to long-run equilibrium. There will likely be a statistically substantial negative ECM coefficient. However, a key limitation of this method is its inapplicability when all variables are stationary at their first differences.

$$\Delta(CPI_t) = \beta_0 + \sum_{t=1}^{p} \beta_{1i}\Delta(CPI) + \sum_{t=1}^{q} \beta_{2i}\Delta 1n(COP_{t-1}) + \sum_{t=1}^{q} \beta_{3i}\Delta(OER_{t-1}) + \sum_{t=1}^{P} \beta_{4i}\Delta 1n(GCE_{t-1}) + \sum_{t=1}^{P} \beta_{5i}\Delta(INR_{t-1}) + \alpha_{1i}\Delta(CPI_{t-1}) + \alpha_{2i}\Delta\ln(COP_{t-1}) + \alpha_{3i}\Delta(OER_{t-1}) + \alpha_{4i}\Delta\ln(GCE_{t-1}) + \alpha_{5i}\Delta(INR_{t-1}) + \Omega ECM_{t-1} + \varepsilon_{1i} \quad (3.6)$$

Furthermore, post diagnostic tests i.e.: the Ramsey RESET test shall be conducted on the model for correctness of the specified model, the Jarque-Bera normality statistic test to ascertain if all variables are jointly normally distributed, the serial correlation **test** to know whether the residuals are serially independent, the heteroscedasticity test to check for homoscedasticity and the CUSUM stability test to test whether the estimated regression result is stable.

RESULTS AND DISCUSSIONS

This section is utilised to capture presentation and interpretation of upshots to facilitate the study's concluding remarks and policy recommendations as generated from this study.

Descriptive Analysis

The upshots of the descriptive analysis are presented as follow:

From 1990 to 2022, Table 2 below shows the descriptive statistics of the following variables: interest rate (INR), government capital expenditure (GCE), official exchange rate (OER), commodity price index (CPI), and crude oil price (COP) in Nigeria. The table shows that the CPI had a low degree of dispersion from the mean with a standard deviation of 109.03 and a range of values from 2.40 to 421.1 per year, with an average value of 105.0. To continue, the average price of crude oil (COP) was 49.29 USD, with a range of 109.45 USD to 12.28 USD. Still, with a standard deviation of 31.36, it shows a fair amount of variation around the mean. Furthermore, the official exchange rate (OER) ranged from a low of 8.04 to a high of 425.98, with a mean value of 146.65. There is a quite large degree of dispersion from the mean, however, since its standard deviation is 116.56. Additionally, government capital expenditures ranged from a low of 24.05 to a high of 3133.82, with a standard deviation of 753.28 indicating a much-dispersed distribution. The mean value was 778.51. Finally, the interest rate had a mean of 18.210, a range of 29.8 to 11.48, and a standard deviation of 3.71, which means that there is not a lot of variation around the mean.

Table 2

Descriptive Statistics

	CPI	**COP**	**OER**	**GCE**	**INR**
Mean	105.0061	49.29273	146.6518	778.5094	18.21030
Median	66.40000	41.47000	129.3600	552.3900	17.95000
Maximum	421.1000	109.4500	425.9800	3133.820	29.80000
Minimum	2.400000	12.28000	8.040000	24.05000	11.48000
Std. Dev.	109.0261	31.36349	116.5638	753.2825	3.705118
Skewness	1.328264	0.570909	0.837470	1.490247	0.893975
Kurtosis	3.976648	2.024009	2.932355	4.864863	4.813051
Jarque-Bera	11.01511	3.102424	3.863745	16.99646	8.915389
Probability	0.004056	0.211991	0.144877	0.000204	0.011589
Sum	3465.200	1626.660	4839.510	25690.81	600.9400
Sum Sq. Dev.	380374.0	31477.39	434787.6	18157906	439.2927
Observations	33	33	33	33	33

Source: Computation carried out by author, 2024.

Unit Root Tests' Results

The data representing each variable in this study were subjected to testing for presence or absence of unit root employing ADF. The upshots are summarized in the Table 3 below:

Table 3
Augmented Dickey-Fuller (ADF) Test upshots

Variables	At Levels		At First Difference		Stationarity Remark	Order of Integration
	ADF	Mackinnon Critical Value @ 5%	ADF	Mackinnon Critical Value @ 5%		
CPI_t	-3.122901	-2.963972	-	-	At Level	I(0)
$InCOP_t$	-0.943879	-2.957110	-5.108471	-2.963972	At 1st Difference	I(1)
OER_t	1.966267	-2.957110	-3.905486	-2.960411	At 1st Difference	I(1)
$InGCE_t$	-1.832610	-2.957110	-6.631017	-2.960411	At 1st Difference	I(1)
INR_t	-3.661348	-2.957110	-	-	At Level	I(0)

Source: Computation carried out by author, 2024.

Unit Root test upshots in Table 3 confirm that, at a 5% level of significance, the ADF test statistics for INR and commodities price index (CPI) are larger in absolute values than their respective critical values. Both variables are level-stationary and integrated at the zeroth order, or I(0), in congruent with this. The ADF technique attests that the test data for crude oil price (COP), official exchange rate (OER), and government capital expenditure (GCE) are greater than their critical thresholds when stated as absolute values. This suggests that the variables are stationary at first difference and integrated at order one (I(1)). By using the bound cointegration method, we may ascertain if the equation's variables are cointegrating or not, supposing that they are stationary at mixed integration orders of zero [I(0)] and one [I(1)].

ARDL Bounds Cointegration Analysis Results

The test upshots of the Bounds cointegration is presented in Table 4 below:

Table 4
Bounds Cointegration Test

Null Hypothesis: No Long-Run Relationships Exist				
Critical Value Bounds				
T-statistic	Value	Significance	I(0)	I(1)
F-statistic	7.137060	10%	2.2	3.09
K	4	5%	2.56	3.49
		2.5%	2.88	3.87
		1%	3.29	4.37

Source: Computation carried out by author, 2024.

Table 4 shows that, at the 5% level of significance, the calculated F-statistic (7.137060) is higher than the upper limit critical value (3.49). There is statistical evidence that the commodity price index (CPI), crude oil price (COP), official exchange rate (OER), government capital expenditure (GCE), and interest rate (INR) are all cointegrating over the long term. To fit the ARDL model, one must assume the presence of long-run relationships and mixed orders of stationarity. Scientists thus estimated the ARDL specification to determine the short- and long-run co-efficient.

Discussion of Model's Estimates

Using the ARDL approach, we evaluate the long-run and short-run dynamic implications of the COP and currency rate on commodities prices in Nigeria. Below, in Table 5, you can see the upshots:

Table 5 below indicates that the COP had a positive (0.954379) and substantial (0.0125 < 0.05) relationship with the CPI in the long term, but it had a negative (-5.664471) and

substantial (0.0009 < 0.05) effect in the short term. The implication is that the long-run upsurge in the CPI was approximately 95.4% as the price of crude oil increased by one dollar per barrel. Nevertheless, the short-run outcome suggests that the regressor experienced a substantial decreasing effect over the sampled period as an upshot of a one-dollar upsurge in the price of crude oil per barrel. This implies that the economy did not promptly experience a rise in commodity prices as an outcome of the increased revenue from petroleum oil sales. This outcome was consistent with Sunday's (2019) assertion that the consumer price index in Nigeria is substantially and positively influenced by the price of crude oil.

Additionally, the investigation demonstrated that the official exchange rate had a positive outcome on the CPI (1.346860 and 0.821013) and a substantial outcome (0.0149 < 0.05 and 0.0001 < 0.05) in both the long-run and short-run, respectively. The upshots suggest that the CPI will be exacerbated by 134.7% and 82.1% in the long-run and short-run, respectively, if the official exchange rate is revalued by one Naira against the US Dollar. The upshots corroborate the upshots of Gylych, Jibrin, Celik, and Isik (2020), who discovered evidence of a correlation between inflation and the actual effective exchange rate in Nigeria.

Table 5
Result of Long-Run ARDL Co-efficient

Long-Run ARDL upshots				
Dependent Variable = CPI_t				
Variable	**Co-efficient**	**Std. Error**	**t-Statistic**	**Prob.****
$InCOP_t$	0.954379	0.336643	2.834985	0.0125
OER_t	1.346860	0.490061	2.748351	0.0149
$InGCE_t$	-0.655268	0.416096	-1.574800	0.1362
INR_t	0.126144	0.053740	2.347292	0.0331
C	1.111336	2.788116	0.398598	0.6958
Short-Run ARDL upshots				
D(CPI(-1))	0.700733	0.076723	9.133330	0.0000
$DIn(COP_t)$	-5.664471	1.467534	-3.859856	0.0009
$D(OER_t)$	0.821013	0.172196	4.767900	0.0001
D(OER(-1))	0.629085	0.177840	3.537358	0.0020
DLOG(GCE)	-5.664471	2.112113	-2.681897	0.0140
D(INR)	-0.821013	0.226735	-3.621030	0.0016
D(INR(-1))	0.629085	0.222405	2.828560	0.0101
CointEqM(-1)	-0.013015	0.001787	-7.281357	0.0000
Adjusted R-squared = 0.974464; Durbin-Watson stat = 1.773115				

Source: Computation carried out by author, 2024.

GCEin Nigeria had negative (-0.655268) and insubstantial (0.1362 > 0.05) effects on the CPI in the long-run for the policy support variables. However, in the short-run, this regressor had substantial (0.0140 < 0.05) and negative (-5.664471) effects. These upshots indicate that the CPI was reduced by approximately 65.5% and 566.4% in the long and short term, respectively, as an upshot of an additional one billion Naira in spending on production-driven capital projects. This discovery is consistent with the upshots of Mamdouh and Mohamed (2021), who also discovered that GCEhas a detrimental effect on price stability volatility in Nigeria. Finally, the long-run outcome of INR on the CPI was both substantial (0.0331 < 0.05) and positive (0.126144). However, this control variable had negative (-0.821013) and substantial (0.0016 < 0.05) impacts on the CPI in Nigeria during the current period. However, it had positive (0.629085) and substantial (0.0101 < 0.05) one-year delayed effects. This suggests that a one percent upsurge in the monetary policy (interest) rate resulted in a 12.6% upsurge in commodity prices over the long term, while a one percent upsurge in the INR will result in a 62.9% a year delayed rise in the CPI over the short term. This outcome is

comparable to that of Ademola, Ditimi, and Johnson (2022), who determined that the INR had a substantial and positive outcome on the CPI in the Nigerian economy.

The ARDL error correction term's CointEq(-1)** coefficient, which is -0.013015, further indicates that, taking into consideration any departures from the present period's long-run equilibrium, the yearly rate of adjustment is 1.3%. As a result, alterations in COP, the official currency rate, government capital spending, and INR have a little outcome on the CPI". Finally, using an Adjusted R-squared (Adj. R2) value of 0.974464, we may deduce that INR, COP, official exchange rates, government capital expenditures, and official exchange rates comprise 97% of the short-run systematic variation in the CPI. For the other 3% of fluctuation, we may thank the error term, which captures all of the model's uncertainties.

Post-Diagnostic Tests' results

The diagnostic tests are implemented to evaluate the model's robustness, which must adhere to the standard assumptions of OLS, comprising serial correlation, functional form, normality, heteroscedasticity, and so forth. Subsequently, Table 6 illustrates the outcomes of these assessments:

Table 6

ARDL Model Diagnostic Test upshots

Test	Statistics	P-Value	Null Hypothesis	Decision
A. Serial Correlation	0.223661	0.8017	**H_0:** No serial correlation	H_0 Accepted
B. Functional Form	2.879347	0.1155	**H_0:** Correctly specified	H_0 Accepted
C. Jarque Bera Normality	1.230152	0.5406	**H_0:** Normally Distributed	H_0 Accepted
D. Heteroskedasticity	1.455938	0.2279	**H_0:** Homoscedasticity	H_0 Accepted

Source: Computation carried out by author, 2024.

As shown by the post-estimate tests that are provided in Table 6 above, the diagnostic criteria were satisfied by the Lagrange multiplier test of residual serial correlation, Ramsey's RESET test, Jarque Bera normalcy test, and Heteroscedasticity test. Overall, the upshots of these tests were satisfactory. There is no substantial difference between the separate p-values of these tests, as shown by the fact that the Table has a value that is more than 0.05. That it has a genuine functional form, that its residuals are serially uncorrelated, that they are normally distributed, and that the model residuals are homoscedastic are all further implications of this.

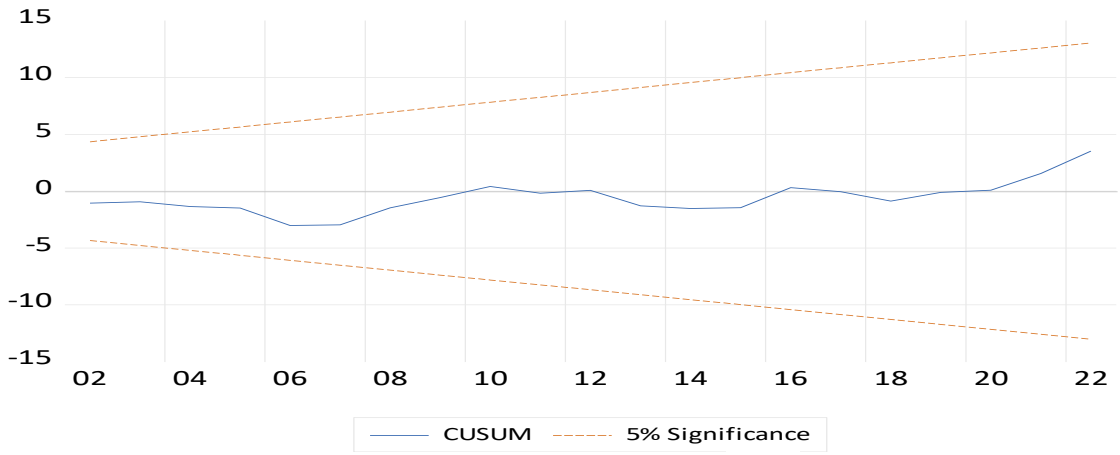

Figure 1: CUSUM Stability Graph

The objective of the cumulative sum, also known as CUSUM, was to assess the consistency of the long-run coefficient in respect to the short-run dynamics. Figure 4.1 presents the upshots of the stability test, which show that the CUSUM line stayed within the critical parameters of 5 percent, and that none of the CUSUM lines passed the critical line of 5 percent. The fact that this is the case suggests that the estimates of the long-run co-efficient of

the regressors in the CPI model are stable, which makes them suitable for reaching conclusions and suggestions about policy.

CONCLUSION AND RECOMMENDATIONS

Conclusion

This study employed the ARDL method to empirically examine the effects of crude oil and exchange rate fluctuations on the pricing of a range of Nigerian goods from 1990 to 2022. The research uses a CPI as a stand-in for actual commodity prices, with the official exchange rate (Naira to USD) and COP (per barrel) employed as inputs. Fiscal and monetary policies serve as control tools for government capital spending and INR. Secondary time series research data were gathered from Development Indicators of World Bank source and Nigeria's apex bank's statistical bulletin. With exception of COP, which had short-run inverse effect and long-run positive implication, the ARDL specification indicated that official exchange rate had positive and substantial effects on Nigeria's CPI in both the short-run and long-run. In congruent with the study's revelations, rise in commodity prices in Nigeria is partly blamable on the currency rate and the price of crude petroleum, as other possible factors are not captured in this research.

Recommendations

This investigation's conclusions and upshots necessitate the subsequent remedial suggestions:

Following the ascertained empirical effect of crude petroleum price on CPI, it is suggestive for government to ensure that earnings from crude oil exports which is susceptible to the vagaries of international prices should be supported by prioritizing economic diversification to let free the wheels of non-oil sectors production, which will in the long-run moderate CPI in Nigeria.

i. In terms of the found effect of official exchange rate on CPI in Nigeria in the sampled period, the CBN should ensure real non-oil sector friendly revaluation of the Naira relative to the US Dollar as this will strengthen the domestic economy and curb future inflationary pressures.

ii. Government and policymakers should prioritize fiscal discipline, transparency, and accountability in public spending, ensuring that capital projects are effectively implemented to support productive activities, even as the apex monetary institution should fix the monetary policy rate at level that should ensure market friendly cost of credit, both of which in the long term will enhance price stability.

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