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# Energy Price, Exchange Rate, and Inflation in Nigeria: An Empirical Analysis

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**ABSTRACT**
This study examines the dynamic relationship between energy prices, exchange rates, and inflation in Nigeria from 1995 to 2022. Utilizing econometric methods such as the Augmented Dickey-Fuller (ADF) test, Johansen cointegration, vector autoregressive (VAR) modeling, and Granger causality tests, the analysis explores both short-term and long-term interactions among these variables. The results show that inflation (INF), pump prices of PMS, AGO, and DPK, and the exchange rate (EXC) are significant predictors of future inflation. For instance, the VAR estimates indicate that a one-unit increase in the previous year's inflation predicts a 1.4-unit rise in this year's inflation, while a 0.01% increase in the exchange rate results in a corresponding rise in inflation. The variables are stationary at first difference (I(1)), but the Johansen test confirms no long-run cointegration. Granger causality analysis reveals bidirectional influences among inflation, oil prices, and exchange rate, with inflation significantly causing fluctuations in electricity tariffs (ET) and AGO, and oil prices influencing electricity tariffs and exchange rates. These findings highlight the importance of stabilizing energy markets and currencies to curb inflation. Policy implications include energy diversification, exchange rate stabilization, and import substitution to foster macroeconomic resilience.

**Keywords**
Energy Prices, Oil Prices, Electricity Tariffs, Exchange Rate, Inflation, Nigeria Economy, Vector Autoregression (VAR), Granger Causality, Cointegration, Macroeconomic Stability, Cost-Push Inflation, Energy Policy, Fuel Prices, Structural Inflation Factors, Currency Stability, Energy Diversification, Import Substitution, Inflation Forecasting, Economic Modeling

## I. INTRODUCTION

### 1.1 Background to the Study

Global inflation has risen, reaching 8.7% in 2022 (IMF, 2023), driven by COVID-19 disruptions and the Ukraine-Russia war affecting supply chains. In Sub-Saharan Africa, median inflation climbed to 9% in 2022 from pre-pandemic levels (~5%) and remains below the 12% during the 2008 financial crisis (IMF, 2022). In Nigeria, inflation hit 24.08% as of July 2023, with food, housing, and transport being primary contributors (NBS, 2023). This increase is partly due to subsidy withdrawals, rising PMS prices, and forex market unification pressures.

Energy prices, especially electricity, surged recently due to the pandemic and the shift towards greener energy (Čermáková et al., 2022; Zubíková&Smolák, 2022). Nigeria's energy sector, dominated by petroleum (over 90% in 2012), heavily influences economic performance and inflation (Musa, 2014). Crude oil price fluctuations have historically impacted Nigeria's inflation: negative shocks lead to reduced forex inflows and higher inflation; positive shocks stabilize exchange rates (World Bank, 2023).

Oil prices fluctuated between $31 to $107 per barrel from 1999-2014, influenced by demand, geopolitics, and global economic factors. Notably, post-2014 drops caused external reserves to decline and inflation to rise, illustrating how energy prices directly influence inflation (World Bank, 2023). These dynamics underpin ongoing policy debates on energy and inflation, further emphasized during global shocks like the Iraq wars and Ukraine conflict (Cavallo, 2008; Schnabel, 2022). Rising oil prices tend to elevate CPI components like fuels and electricity, affecting overall inflation depending on their persistence (Cecrdlova, 2021; Cavallo, 2008).

The 1973–1974 energy price shock, highlighted by Mork and Hall (1980), triggered a deep recession and high inflation in the 1970s, driven by soaring prices and removal of price controls. Similarly, the 2003 Iraq War initiated a

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trend reversal in oil prices, reflecting their close link to global supply and demand. By 2008, strong growth in emerging economies caused oil prices to spike, but the 2008–2009 recession halved prices again (Looney , 2003; &Hamiliton, 2009).

Rising oil prices significantly influence inflation, notably core inflation in the euro area, due to less competitive markets and wage negotiations influenced by unions (Čermáková&Jašová, 2019; Ondřej et al., 2022). Companies face reduced competition, pass higher costs to consumers, and contribute to inflation. These global energy fluctuations affect Nigeria, which is heavily reliant on oil, with structural imbalances such as mono-culture dependence, importation of refined products, and low agricultural output putting pressure on foreign exchange and exchange rate stability (Agbaeze,Udeh&Onwuka, 2015).

Nigeria's government depends heavily on crude oil revenues for budgeting. Electricity prices, linked to gas prices in dollars, fluctuate with exchange rates, impacting costs for firms and consumers. Oil derivative prices, such as PMS and AGO, are also affected, influencing transportation costs and contributing to cost-push inflation. These fluctuations highlight the importance of examining the nexus between energy prices, exchange rates, and inflation in Nigeria to inform policy.

### 1.2 Statement of the Problem

The macroeconomic effects of rising energy prices—fuels, electricity, and gas—continue to attract interest, especially with the persistent increase in inflation. Since the mid-70s, discussions have centered on how energy prices influence the overall price level (Mork& Hall, 1980; Cavallo, 2022). In developing economies, energy consumption remains vital for macroeconomic activity; no sector functions effectively without energy (Haider et al., 2013; Eregha&Mesagan, 2017). Most research focuses on global oil prices and petroleum products, overlooking Nigeria's electricity sector, access issues, and tariffs. This study emphasizes electricity tariffs and access due to their significance in Nigeria's livelihood, while also considering global oil prices.

### 1.3 Objectives of the Study

The primary goal is to assess how energy prices and exchange rates influence inflation in Nigeria. Specific objectives include:

1. To examine the effect of electricity tariffs on inflation.
2. To analyze how access to electricity impacts inflation.
3. To investigate the influence of the exchange rate on inflation.
4. To determine causality among inflation, oil prices, electricity tariffs, access to electricity, PMS, AGO, DPK, and exchange rate.

### 1.4 Research Questions

The study aims to answer:

1. What is the impact of electricity tariffs on inflation?
2. How does access to electricity affect inflation?
3. What is the effect of the exchange rate on inflation?
4. What is the causality direction among inflation, oil prices, electricity tariffs, access, PMS, AGO, DPK, and exchange rate?

### 1.5 Research Hypotheses

The hypotheses tested are:

- HO1: Electricity tariff fluctuations have no impact on inflation.
- HO2: Access to electricity is insignificant for inflation.
- HO3: Exchange rate has no effect on inflation.
- HO4: No causality exists among inflation, energy prices, tariffs, access, and exchange rates.

### 1.6 Significance of the Study

This research offers insights into how rising energy prices influence inflation—a debate initiated in the 1970s (Mork& Hall, 1980; Cavallo, 2008) and revived by events like war and global crises (Jacques & Moritz, 2010; Schnabel, 2022). Findings can guide policy adjustments on electricity tariffs, energy subsidies, and fuel pricing in Nigeria. It can also support the World Bank's assertion that removing petrol subsidies might not necessarily cause inflation, and deepen understanding of oil derivative influences on inflation.

### 1.7 Scope of the Study

The study focuses on Nigeria's economy, analyzing the impact of electricity tariffs, access, oil prices, and exchange rates on inflation. It examines the transmission of shocks from these variables and their interactions, using monthly data from 1995–2022.

### 1.8 Organization of the Study

The paper is organized into five sections:

- Section 1: Introduction

- Section 2: Literature review (conceptual, theoretical, empirical)
- Section 3: Methodology
- Section 4: Data presentation, analysis, and discussion
- Section 5: Summary, conclusions, and policy recommendations

## II. RELATED LITERATURE REVIEW

### 2.1 Conceptual Literature Review

**Inflation:** Kpagih et al. (2021) describe inflation as a key economic indicator reflecting the persistent rise in the general price level, driven by increased money and credit relative to goods and services. Typically measured by the Consumer Price Index (CPI), inflation indicates rising costs of goods and services consumed by individuals.

**Energy Price:** Energy prices encompass local and international market values of sources like crude oil and PMS (petrol). Crude oil prices, benchmarked mainly by OPEC, are demand and supply driven and measured in USD (Okereke&Obinna, 2023). PMS, or petrol, is measured in local currency (Naira) for this study.

**Exchange Rate:** Per the Central Bank of Nigeria exchange rate is the price of one currency in terms of another, usually expressed as units of domestic currency per unit of foreign currency, with the study adopting the official USD rate for Nigeria.

### 2.2 Theoretical Literature Review

**Energy Price, Exchange Rate, and Inflation Theories**

1. **Purchasing Power Parity (PPP):** Developed by Cassel (1916), PPP links exchange rates with commodity price levels, asserting that currencies should have equal purchasing power across countries. For Nigeria, an import-dependent economy, undervaluation or overvaluation impacts inflation.
2. **Demand-Pull Theory (Keynesian):** Inflation results from excess aggregate demand over supply at full employment levels, driven by consumption, investment, government spending, and net exports (Keynes(1936). Rising energy prices can increase demand and contribute to inflation via consumption.
3. **Structuralist Theory:** In rapid growth phases, non-monetary factors like infrastructural bottlenecks and supply constraints lead to inflation (Noyola, 1956; Sunkel, 1960). In Nigeria, structural bottlenecks limit supply responses to demand increases, causing inflation.
4. **Demand-Shift Theory:** Schultz (1959) noted sectoral demand shifts can cause inflation even without overall demand excess. Excess demand in certain sectors raises input costs, which spill over to other sectors, spreading inflation (Totonchi, 2011).
5. **Political Macroeconomic Theory:** The **New Political Macroeconomics theory** considers non-economic factors—such as institutions, elections, and culture—in explaining inflation (Totonchi, 2011). In Nigeria, institutional decisions, like those by the Central Bank and the Nigerian National Petroleum Corporation (NNPC), influence monetary policy and energy supply, impacting inflation. Prolonged budget deficits and political activities also play significant roles in price changes, especially in developing countries like Nigeria.

### 2.3 Empirical Literature Review

Akinleye&Ekpo (2013) found that oil price shocks affect Nigeria's government expenditure and GDP long-term, influencing inflation and currency depreciation. Olawale&Lukman (2020) showed that PMS prices positively correlate with inflation, while AGO and DPK do not.Okereke&Obinna (2022) reported that PMS and exchange rates significantly influence food and general prices short- and long-term. Wale-Awe &Sulieman (2020) and Sakanko et al. (2021) confirmed PMS prices have asymmetric positive effects on CPI. Olayungbo (2021) found a relationship between global oil prices and food prices in oil-exporting and importing countries.

Eregha, Mesagan, and Ayoola(2015) linked PMS, AGO, and money supply positively to inflation, while DPK is negatively related. Bobai (2012) also confirmed that rising petroleum prices boost inflation from 1990 to 2011. Adejola et al. (2022) revealed oil prices affect exchange rates with lead-lag effects.

Adesete&Bankole (2020) showed oil price shocks negatively impact growth, investment, and inflation. Sarmah&Bal (2021) in India found crude prices positively influence inflation but negatively impact growth. Abu-Bakar&Masih (2018) saw mixed results regarding oil prices and inflation, emphasizing the importance of nonlinear analysis.

Apere (2017) demonstrated that oil price increases raise inflation in Nigeria, while Nokoro&Uko (2016) found inverse long-run relationships between inflation, exchange rate, and stock prices, consistent with emerging market dynamics.

Chen, Gummi, Lu, and Mu'azu (2020) found an inverse long-term relationship between oil and food prices in low-income nations using Fully Modified and Dynamic OLS, indicating they move together over time. Studies on exchange rates and inflation show similar insights: Obidekwe&Osabuohien (2016) used GARCH to find short-term passthrough of parallel exchange rates and long-term passthrough of official rates on inflation in Nigeria; volatility increased inflation; Umar & Umar (2022) showed asymmetric long- and short-term links between exchange rates and food inflation using a non-linear ARDL; and Musa (2021) confirmed a long-term positive impact of exchange rate and money supply on inflation in Nigeria.

Siry&Traore (2023) in Burkina Faso linked influx of internally displaced persons (IDPs) and climate deterioration to rising inflation in both short and long-term.Oriakhi&Osemwengie (2012) argued increased insecurity raises government expenditure and reduces foreign reserves, boosting inflation.Abubakar, Sule&Tijjani (2023) in Nigeria reported insecurity accounts for over 50% of economic variability.Iyke &Odhaimbo (2014) in Ghana found energy consumption induces inflation, advocating for monetary policies to contain demand-driven inflation.Iyke (2014) in Nigeria observed short-term causality of inflation on electricity consumption, advising careful monetary control.Behname (2013) in Northern Europe showed oil prices inflate regional prices by up to 1.15% in the medium term.Rehman (2014) in Asia linked high oil prices with domestic inflation, especially during economic shocks.Parker (2017) found global energy prices significantly influence worldwide inflation, with energy consumption being a key driver.

Abdullahi (2014) reported that Nigeria's petroleum demand is largely inelastic, implying rising consumption despite price increases.Ibrahiem (2018) projected long-term urbanization effects of energy consumption, urging conservation as a growth strategy.Josheski et al. (2014) found energy use reduces inflation in parts of Eastern Europe, supporting energy efficiency without harming growth.He et al. (2016) highlighted that relative energy prices, rather than absolute, are most influential on consumption.

Zhang (2015) noted that energy security influences prices worldwide, with developing countries like Nigeria pursuing subsidy removal to stabilize energy costs—though often at social costs.Bobai (2012) linked Nigerian petroleum prices to inflation, finding PMS and diesel prices positively affect inflation from 1990–2011.

Haider et al. (2013) showed that energy consumption causes energy inflation in Pakistan, with oil prices indirectly influencing energy inflation after some shocks. Moradkhani et al. (2010) found that doubling energy prices like oil, gas, and coal significantly increased prices in Malaysia's industrial and transportation sectors, with primary energy having a more pronounced effect than secondary energy. Saidi&Hammami (2014) in Tunisia revealed that energy prices significantly impact future energy price growth, potentially reducing consumption over time. Eregha&Mesagan (2017), analyzing African countries, found an inverse relationship between energy consumption and inflation, suggesting improvements in productive sectors help suppress inflation.

In Nigeria, Abd'razack,et al. (2012) observed a shift from conventional energy use to biomass due to rising costs, raising environmental concerns. Globally, Agbo (2020) and Kpagih et al. (2022) examined oil price effects on Nigeria's inflation, concluding that oil prices influence inflation differently in the short and long term—sometimes negatively or insignificantly. In Nigeria, Abatcha (2021) found that both short- and long-term oil price increases positively affect inflation, advocating for considering oil and exchange rate fluctuations in policy decisions. Sarmah&Bal (2021) in India identified a positive connection between crude oil prices and inflation, but a negative link with economic growth, recommending reduced oil production to stabilize prices.

Sek& Wong (2015) distinguished between high and low oil-dependent countries, noting oil prices impact inflation mainly in less dependent nations. Asghar&Naveed (2015) in Pakistan confirmed a positive long-term relationship between oil prices and inflation, with causality running from oil prices to inflation. Dejan&Jasmina (2018) in Central and Eastern Europe reported that oil price fluctuations impact inflation modestly (1-6%), with Slovakia and Bulgaria experiencing higher effects.

Kilian and Zhou (2020) found that gasoline price volatility accounts for about 39% of household inflation variation in the US (1990–2013). They suggest more research is needed to fully understand inflation causes, as gas prices alone are insufficient. In China, He et al. (2016) identified a positive link between energy prices and the general price level, recommending government

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regulation to control inflation through energy policies. Gómez-Loscos et al. (2012) noted that oil prices regained importance as inflation determinants after 2000. Valcarcel&Wohar (2013) argued that oil price inflation pass-through in the US is demand-driven rather than supply-side. Gao et al. (2014) found limited evidence of significant pass-through between oil prices and CPI, except in energy-sensitive expenditures.

Several studies across countries report mixed results: Katircioglu et al. (2015) found a significant negative relation between oil prices and inflation in OECD countries; Zhao et al. (2016) using a DSGE model in China identified short-term effects from supply shocks and long-term effects from demand shocks; Salisu et al. (2017) showed oil prices positively impact inflation, especially in oil-importing countries; Choi et al. (2018) reported that a 10% increase in oil prices raises inflation by 0.4% on average in 72 countries.Despite extensive literature, results remain inconclusive. The study aims to contribute by examining the Ottoman Empire's case.

Historical studies: Hamilton (1983, 1996, 2005) established strong links between oil shocks and US economic downturns post-World War II; In Nigeria, Aliyu (2009) found asymmetric impacts of oil shocks on GDP, with positive shocks having larger effects; Alhassan&Kilishi (2016) confirmed that oil shocks cause macroeconomic fluctuations in Nigeria.

Hooker (2002) reported that oil price fluctuations increased US core inflation before 1981, then declined. Dias (2013) showed that a 13% oil price hike increased inflation by 0.25% temporarily. Lu et al. (2013) found oil prices Granger-cause inflation in Taiwan with persistent volatility spillovers. Zhao et al. (2016) linked demand shocks driven by political and demand factors to long-term effects on China's inflation. Conflitti&Luciani (2017) demonstrated small but significant pass-through effects of oil prices on US and Eurozone inflation. Zivkov et al. (2019) observed that a 100% rise in oil prices led to 1-6% higher inflation in Central and Eastern European countries, with import-heavy countries experiencing larger effects.

Niyimbanira (2013) found a cointegrating relation between oil prices and inflation in South Africa. Shafique (2016) saw no effect of oil shocks on Pakistan's producer prices. In oil producers, Ito (2010) noted oil shocks cause mild inflation in Russia, while Abounoori et al. (2014) observed incomplete but positive pass-through of oil prices into inflation in Iran.Sek, Teo& Wong (2015) and Sek& Lim (2016) noted more severe inflation impacts from oil shocks in highly oil-dependent and importing countries, respectively.

In Nigeria, Olusegun (2008) showed oil price shocks significantly affected oil revenues and output but may not be directly inflationary; he recommended fiscal policies for stability. Odionye et al. (2019) found initial negative responses of inflation to oil shocks, turning positive after two periods, with exchange rates responding persistently and negatively. Omotosho&Doguwa (2012) linked fuel price hikes, food crises, exchange rate instability, and wage increases to high inflation volatility, with subsequent fuel subsidy withdrawals and rising global oil prices expected to push inflation higher.

Several studies highlight asymmetries: Cunado& de Gracia (2005) observed short-term impacts of oil shocks on consumer prices in Asian countries, with asymmetries noted in some nations; Choi et al. (2018) found a 10% global oil price rise increases domestic inflation by 0.4%, with larger effects from positive shocks. Factors like transport share and energy subsidies influence these cross-country variations; Ibrahim (2015), Abdlaziz et al. (2016), and Lacheheb&Sirag (2019) applied the NARDL approach in Malaysia, Indonesia, and Algeria, showing significant long- and short-term links between oil prices and food inflation, with oil increases raising food prices notably.

In Nigeria, Kelikume (2017) used VECM to find that oil price increases caused a 43% rise in inflation within a year, while price decreases led to a 29% increase. Bala& Chin (2018) observed that oil shocks, both positive and negative, positively affected inflation across African oil countries, especially during declines. Omolade et al. (2019) reported that oil price declines were associated with inflation increases, mostly driven by structural factors.

Using a DSGE model, Omotosho (2019) found oil shocks influenced Nigeria's headline inflation, but effects were limited due to incomplete pass-through; falling oil prices reduced inflation, while currency depreciation increased import prices and inflation.

Evidence suggests oil shocks generally induce inflation in oil-importing countries. Asymmetric analyses reveal larger impacts from positive shocks. In Nigeria, impacts on headline inflation are well-documented, but effects on core and food inflation differ—imported commodities in core inflation are more sensitive to oil prices than locally produced food items. This study aims to fill the gap by examining oil shocks' effects on

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headline, core, and food inflation in Nigeria using an asymmetric approach.

**Summary of Reviewed Literature on Oil Prices and Inflation**

Most studies agree that oil price shocks can induce inflationary pressures and currency depreciation, especially as importation increases (Akinleye&Ekpo, 2013; Sarmah&Bal, 2021; Apere, 2017; Abatcha, 2021; He et al., 2016). Conversely, some findings (e.g., Sarmah&Bal, 2021; He et al., 2016) indicate that oil prices may have a negative impact on inflation, with Sarmah&Bal (2021) also noting a positive relationship between crude oil prices and inflation in India, but a negative link with economic growth.

In Nigeria, Agbo (2020) and Kpagih et al. (2022) found oil price fluctuations to be insignificantly related to long-term inflation. However, oil prices negatively affect inflation in the short term, while gas prices have a positive short-term impact. Premium motor spirit (PMS) prices are positively linked to inflation, whereas AGO (Automobile Gas Oil) and DPK (Dual Purpose Kerosene) prices are negatively related, supported by studies from Olawale&Lukman (2020), Wale-Awe &Sulieman (2020), Sakanko et al. (2021), and Bobai (2012). Some studies, however, find no causality between PMS prices and inflation (Okereke&Obinna, 2022; Wale-Awe &Sulieman, 2020).

PMS and exchange rates significantly influence prices in Nigeria both short- and long-term. Exchange rate volatility has a positive effect on inflation (Ajala et al., 2021), and oil prices exhibit a lead-lag relationship with exchange rates, along with bidirectional causality in Nigeria (Adesete&Bankole, 2020; Umar & Umar, 2022). A long-term relationship exists among oil prices, exchange rates, and inflation in Pakistan, with oil prices positively impacting inflation and causality running from oil prices to inflation.

Research also indicates that oil price fluctuations directly impact inflation in low oil-dependent countries (Sek& Wong, 2015). In Central and Eastern European nations, such as Slovakia and Bulgaria, oil price variations caused inflation fluctuations of 1-6%, with higher effects observed in these countries.

### 2.4 Knowledge Gap

Existing literature primarily studies energy prices using global crude oil and petroleum products, often neglecting the role of electricity in Nigeria's energy mix. This oversight may lead to incomplete representations of energy's impact on inflation. The researcher argues that electricity, including tariffs and access, should be incorporated to better capture energy's influence on inflation, especially given Nigeria's diverse energy sources. This study aims to analyze the impact of various energy components, including electricity, on Nigeria's inflation, providing relevant insights for policymakers amid rising inflation rates.

## III. RESEARCH METHODOLOGIES

**3.1 Research Framework:**The study adopts an inflation expectations framework, examining how energy prices, exchange rates, and electricity access influence inflation. The specified model expresses inflation as a function of variables such as electricity tariff, access, oil prices, exchange rate, PMS, AGO, and DPK.

**3.2Model Specification:** From the theoretical and empirical literature reviewed, this study specifies a model in which inflation is expressed as a function of inflation, electricity tariff, oil price, exchange rate, PMS, AGO, DPK. However, for ease of presentation and explanation, only four of the variables are employed in the VAR model for analysis. The model for this research work is expressed in implicit model specification as:

$$INFt = f(ET, EA, EX, OP, PMS, AGO, DPK) \quad (1)$$

Where:
INF = Inflation rate
ET = Electricity Tariff (measured in Naira/Kwh)
EA = Electricity Access (percentage of population that have access to electricity)
EX = Exchange Rate (USD/NGN currency value)
OP = Oil Price measured in USD/Barrel
PMS = Premium Moto Sprit Pump Price
AGO = Automotive Gas Oil Pump Price
DPK = Dual Purpose Kerosene Pump Price in Naira

The VAR model for this study is stated below and each of the equations in the system was estimated using the ordinary least squares (OLS) method.

$$INF = \alpha\sum_{i=1}^{k} \beta_i \, INF_{t-j} + \sum_{i=1}^{k} Y\Delta Z_{t-i} + U_{1t} \quad 1$$

$$\Delta Z_t = \propto_1 \sum_{i=1}^{k} \theta_i INF_{t-j} + \sum_{j=1}^{k} \Delta Z_{t-1} + U_{2t} \quad 2$$

Where:
INF = Inflation Rate
Z = A set of selected variables
α, βi , α1, θi and γ = parameters
t = time
i and k = lagged period

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u = stochastic error term
Δ = change measured as growth rates.

Equation (1) expresses current inflation as a function of its lagged values and a vector of selected variables (Oil Price, Exchange Rate, PMS, AGO, DPK, EA and ET) that influence inflation. Equation (2) expresses the current value of the vector of selected variables as a function of their lagged values and the lagged values of inflation.

The explicit model specification to capture the implicit relationship as follows:
The casual effect among the variables: inflation, electricity tariff, oil price, exchange rate, PMS, AGO, DPK rates is represented on the equation below:

$$INF = \acute{\alpha}_0 + {}^{\beta_1} ET_{t-1} + + {}^{\beta_2} ET_{t-2} + + {}^{\beta_3} ET_{t-3} + + {}^{\beta_4} ET_{t-4} + {}^{\beta_5} ET_{t-5} + + {}^{\beta_6} ET_{t-6} + + {}^{\beta_7} ET_{t-7} + \mu_t \qquad (3)$$

### 3.3 Model Estimation Techniques & Procedure

A Vector Autoregressive (VAR) model, estimated via Ordinary Least Squares (OLS), was used to analyze the dynamic relationships among these variables over time. The model captures how current inflation is linked to lagged values of itself and other explanatory variables, while the relationships among variables are also considered.

**A Priori Expectations:** Variables are expected to have signs based on theory: inflation (INF), oil price (OP), PMS, AGO, DPK, and exchange rate (EXC) are positive; electricity access (ET) is negative; electricity tariff (ET) and exchange rate are expected to positively influence inflation.

**Pre-Estimation Tests:**

- **Stationarity:** Augmented Dickey-Fuller (ADF) tests confirmed variables are stationary, preventing spurious results.
- **Lag Selection:** Optimal lag length was chosen using the Akaike Information Criterion (AIC) to avoid issues like multicollinearity or misspecification.
- **Cointegration:** Johansen's cointegration test showed a long-term relationship among variables, confirming their interconnectedness.

**Estimation Method:** Following stationarity confirmation, the series were modeled using VAR (Vector Autoregression), which captures dynamic relationships among multiple endogenous variables without exogenous inputs. Granger causality tests within VAR examined directional influences.

**Post-Estimation Diagnostics:** Normality of residuals was checked using Kurtosis, Skewness, and the Jarque-Bera test to validate model assumptions.

**Data and Software:** Data, sourced from CBN, NERC, and the World Bank (Jan 1995–Dec 2022), was log-transformed where appropriate. E-Views version 12.0 was used for modeling due to its efficiency and user-friendly interface.

## IV. DATA PRESENTATION, ANALYSIS, AND FINDINGS

### 4.1.1 Descriptive Statistics

Table 4.1Descriptive Statistics

| | INF | OP | EA | ET | PMS | AGO | DKP | EXC |
|---|---|---|---|---|---|---|---|---|
| Mean | 133.8636 | 51.14185 | 49.95571 | 15.74107 | 81.07500 | 126.7457 | 88.36012 | 169.8886 |
| Median | 89.90500 | 47.66500 | 50.21500 | 10.00000 | 65.00000 | 102.5000 | 50.00000 | 140.8850 |
| Maximum | 499.3600 | 128.0800 | 59.50000 | 57.81000 | 191.0000 | 626.0000 | 568.0000 | 425.9800 |
| Minimum | 14.36000 | 8.030000 | 38.69000 | 0.060000 | 11.00000 | 6.000000 | 6.000000 | 21.88000 |
| Std. Dev. | 117.1087 | 29.33359 | 6.191567 | 17.02528 | 53.37867 | 147.4330 | 133.2280 | 109.4647 |
| Skewness | 1.232038 | 0.425925 | -0.188225 | 1.127686 | 0.481870 | 2.283745 | 2.407255 | 0.808109 |
| Kurtosis | 3.693150 | 2.112011 | 1.909669 | 3.165114 | 1.963767 | 7.974653 | 7.781771 | 2.887030 |
| Jarque-Bera | 91.72973 | 21.19841 | 18.62753 | 71.59548 | 28.03602 | 638.5278 | 644.6277 | 36.74896 |
| Probability | 0.000000 | 0.000025 | 0.000090 | 0.000000 | 0.000001 | 0.000000 | 0.000000 | 0.000000 |
| Sum | 44978.16 | 17183.66 | 16785.12 | 5289.000 | 27241.20 | 42586.56 | 29689.00 | 57082.56 |
| Sum Sq. Dev. | 4594341. | 288253.8 | 12842.39 | 97103.10 | 954509.4 | 7281725. | 5946149. | 4014146. |
| Observations | 336 | 336 | 336 | 336 | 336 | 336 | 336 | 336 |

Source: Authors computation from e-views 12.0

The variables (INF, OP, EA, ET, PMS, AGO, DPK, EXC) are normally distributed, as confirmed by skewness, kurtosis, and Jarque-Bera tests.

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### 4.1.2 Correlation Matrix
**Table2. Correlation Matrix**

Covariance Analysis: Ordinary
Date: 12/08/23 Time: 17:06
Sample: 1995M01 2022M12
Included observations: 336

| Correlation | INF | OP | EA | ET | PMS | AGO | DKP | EXC |
|---|---|---|---|---|---|---|---|---|
| INF | 1.000000 | | | | | | | |
| OP | 0.443057 | 1.000000 | | | | | | |
| EA | 0.824574 | 0.645106 | 1.000000 | | | | | |
| ET | 0.972417 | 0.368932 | 0.828285 | 1.000000 | | | | |
| PMS | 0.938510 | 0.470688 | 0.864609 | 0.948287 | 1.000000 | | | |
| AGO | 0.901526 | 0.473767 | 0.724778 | 0.881242 | 0.785271 | 1.000000 | | |
| DKP | 0.873131 | 0.319604 | 0.585541 | 0.809328 | 0.719851 | 0.895925 | 1.000000 | |
| EXC | 0.963907 | 0.403601 | 0.854788 | 0.960582 | 0.927604 | 0.849929 | 0.814238 | 1.000000 |

Source: Authors computation from e-views 12.0

Pearson correlation indicates mostly positive linear relationships among variables.

### 4.2 Pre-Estimation Test
### 4.2.1 Stationarity Tests

**Table 4.3Stationarity Test**

| **Augmented Dickey–Fuller (ADF)** | | | | | | | |
|---|---|---|---|---|---|---|---|
| Variables | AT LEVELS | | | AT FIRST DIFFERENCE | | | DECI SION |
| | T-statistic | 5% CRITICAL VALUE | Prob | T-statistic | 5% CRITICAL VALUE | prob | |
| INF | 7.933457 | -3.985773 | 1.0000 | -4.939941 | -3.423377 | 0.0003 | I(1) |
| OP | -2.680580 | -2.869978 | 0.0785 | -11.07659 | -2.869978 | 0.0000 | I(1) |
| EA | -1087227 | -2.870274 | 0.7217 | -9.037058 | -2.870274 | 0.0000 | I(1) |
| ET | 0.869855 | -2.869952 | 0.9951 | -18.47093 | -2.869978 | 0.0000 | I(1) |
| PMS | 0.3449679 | -2.869952 | 0.9819 | -18.35922 | -2.869978 | 0.0000 | I(1) |
| DKP | 1.858380 | -2.869952 | 0.9998 | -17.88924 | -2.869978 | 0.0000 | I(1) |
| EXC | 0.481656 | -2.870274 | 0.9859 | -3.570994 | -2.870274 | 0.0069 | I(1) |

Source: Authors computation from e-views 12.0

Augmented Dickey-Fuller (ADF) tests show all variables are stationary at first difference (I(1)), justifying their use in the VAR model.

**4.2.2 Lag Length Selection:**AIC suggests an optimal lag length of 2 for the VAR model.

**4.2.3 Johansen Cointegration Test:**Results indicate no long-term cointegration among the variables.

**4.3 VAR Estimation Results:**

Below is the regression table including all the variables: INF, OP, EA, ET, PMS, DKP, and EXC, along with their coefficients, standard errors, t-statistics, and significance indicators:

Table 4.4: VAR result

| **Variable** | **Coefficient** | **Std. Error** | **t-Statistic** | **Significance** | **Comments** |
|---|---|---|---|---|---|
| **INF(-1)** | 1.4195 | 0.051 | 27.81 | *** | Highly significant; strong positive impact |
| **INF(-2)** | -0.4189 | 0.05115 | -8.91 | *** | Significant; negative impact |
| **OP(-1)** | 0.0093 | 0.00959 | 0.97 | Not sig. | Small effect, not statistically significant |
| **OP(-2)** | -0.0097 | 0.00969 | -9.17 | *** | Significant; negative impact |

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| | | | | | |
|---|---|---|---|---|---|
| **EA(-1)** | -0.0129 | 0.05328 | -0.24 | Not sig. | Impractical effect, not significant |
| **EA(-2)** | 0.01578 | 0.27262 | 0.05707 | Not sig. | High standard error, not significant |
| **ET(-1)** | -0.0815 | 0.05759 | -1.41 | Not sig. | Marginal effect, not statistically significant |
| **ET(-2)** | -0.4885 | 0.22869 | -1.51 | Not sig. | Not significant |
| **PMS(-1)** | -0.0260 | 0.01191 | -2.18 | ** | Significant negative effect |
| **PMS(-2)** | 0.0259 | 0.01185 | 2.19 | ** | Significant positive effect |
| **DKP(-1)** | 0.0007 | 0.00319 | 0.22 | Not sig. | Not significant |
| **DKP(-2)** | 0.0035 | 0.00322 | 1.10 | Not sig. | Not significant |
| **EXC(-1)** | -0.00935 | 0.00733 | -2.28 | ** | Significant negative impact |
| **EXC(-2)** | 0.03727 | 0.03805 | 0.98 | Not sig. | Not significant |

(Note: Significance stars: *** p<0.01, ** p<0.05)

**Model fit metrics:**

- **R-squared:** 0.99995
- **Adjusted R-squared:** 0.99995
- **Residual sum of squares:** 219.8
- **F-statistic:** Very high (~41,136), indicating overall significance.

Significant variables influencing inflation include past inflation, PMS, and exchange rate.T-statistics confirm the importance of past inflation and PMS in predicting future inflation in Nigeria.

**4.4 Causality Tests (Granger causality):**

- Inflation causes electricity tariff and automotive gas oil.
- Oil price causes electricity tariffs and exchange rates.
- Electricity tariffs influence oil prices, and DPK impacts inflation.
- Overall, multiple causality relationships exist among these variables.

In this model we tested the Granger-Wald Causality Tests to observe the interaction among the variables used. The results of the Granger Causality are shown in Table 4.5

Table 4.5 Granger-Wald Causality Tests

| **Dependent variables** | **INF** | **OP** | **EA** | **ET** | **AGO** | **PMS** | **DPK** | **EXC** |
|---|---|---|---|---|---|---|---|---|
| INF | | 0.1619 | 0.7516 | 0.0005* | 0.0013* | 0.2498 | 0.1020 | 0.0719** |
| OP | 0.6077 | | 0.6919 | 0.0107* | 0.1118 | 0.0825** | 0.1058 | 0.0077* |
| EA | 0.9519 | 0.1592 | | 0.5861 | 0.8852 | 0.1032 | 0.9103 | 0.0929** |
| ET | 0.0938** | 0.0272* | 0.6437 | | 0.0105* | 0.9371 | 0.9324 | 0.7009 |
| AGO | 0.3379 | 0.0098* | 0.7890 | 0.6283 | | 0.9923 | 0.4817 | 0.9604 |
| PMS | 0.0865** | 0.2640 | 0.3837 | 0.2349 | 0.8589 | | 0.2694 | 0.9840 |
| DPK | 0.0013* | 0.0855** | 0.5815 | 0.1818 | 0.6126 | 0.8164 | | 0.8709 |
| EXC | 0.4365 | 0.3908 | 0.5332 | 0.8977 | 0.9667 | 0.9467 | 0.8021 | |
| All | 0.0035* | **0.0241*** | **0.6748** | **0.0112*** | **0.0172*** | **0.1463** | **0.0788*** | **0.1394** |

Note: (*) indicates 5% significant level wile (**) indicates 10% significant level.
Source: Authors computation from E-View 12.0

At 5% significant level, INF granger causes ET, AGO, while OP granger causes ET and Exchange rate. Also, ET granger causes OP, AGO while AGO granger causses OP. DPK granger causes INF while combined interaction of INF, OP, EA, ET, AGO, PMS, DPK & EXC granger causes INF, OP, ET, AGO, and DPK.

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**4.5 Hypotheses Evaluation:**

- Electricity tariff fluctuation has no impact on inflation (accepted).
- Electricity access is insignificant for inflation (accepted).
- Exchange rate significantly impacts inflation (rejected null hypothesis).
- Granger causality confirms feedback relationships among inflation, energy prices, and exchange rates.

**4.6 Discussion of Findings**

The VAR analysis indicates that inflation, PMS pump prices, and exchange rate are key variables for forecasting Nigeria's future inflation. While other variables have some influence, only inflation, PMS, and exchange rate are statistically significant and positively related. Specifically, a one-unit increase in past inflation predicts a 1.4-unit rise in future inflation, with PMS and exchange rate increases leading to slight inflation upticks.

The findings align with studies (e.g., Agbo 2020, Kpagih et al. 2022, Olawale and Lukman 2020) showing oil prices have minimal influence on inflation. However, exchange rate volatility significantly impacts inflation, echoing prior research that exchange rate fluctuations are linked to rising prices in Nigeria. Causality tests reveal no single variable solely causes inflation, but DPK influences inflation directly, and combined variables influence many inflation-related factors.

**4.7 Policy Implications**

Energy prices alone don't cause inflation in Nigeria; their combined effects matter. Although PMS and exchange rate fluctuations impact inflation positively, Nigeria's inflation appears more driven by structural issues like high input costs, bottlenecks in agriculture, insecurity, corruption, and resource constraints. The study suggests that inflation in Nigeria is primarily cost-push, supporting further research into structural causes related to bottlenecks.

## V. SUMMARY, RECOMMENDATIONS, AND CONCLUSION

**5.1 Summary:**The study examined energy prices, exchange rates, inflation, and causality among key variables in Nigeria using the VAR model and Keynesian inflation theory. Stationarity tests confirmed variables are integrated at first difference; Johansen's cointegration showed no long-term relationship. Key findings include inflation, PMS, and exchange rate as predictors, with causality running among inflation, oil prices, and exchange rates.

**5.1 Conclusions:**Managing inflation volatility is vital for Nigeria's economic stability. Policymakers should focus on country-specific strategies beyond traditional monetary policies, such as restoring PMS subsidies, promoting local oil refining, revitalizing railways for cheaper transportation, and adopting inflation-targeting measures.

**5.2 Recommendations:**The study recommends the following to Nigeria Policy Makers:

1. **Implement country-specific price stability policies tailored to Nigeria's unique economic conditions:** Develop and enforce targeted monetary and fiscal measures that address domestic inflation drivers, such as supply chain disruptions, energy market fluctuations, and exchange rate volatility, to ensure currency stability and control inflation effectively.
2. **Reinstate and subsidize Premium Motor Spirit (PMS) to mitigate household and transportation costs:** Consider policy measures to restore subsidies or create targeted support schemes for fuel prices to cushion consumers from volatile energy prices, thereby reducing cost-push inflation and improving household welfare.
3. **Encourage and invest in local oil refining capacity to reduce reliance on imported petroleum products and stabilizing domestic prices:** Promote policies that support the development of indigenous refineries, which can help stabilize fuel prices, create employment, and enhance energy security, ultimately contributing to more predictable inflation patterns.
4. **Revive and upgrade railway and other mass transit networks to lower transportation costs and ease inflationary pressures:** Improve transportation infrastructure to reduce logistics costs, especially for goods and raw materials, which can directly lower inflationary pressures caused by high transportation costs and promote more efficient supply chains.
5. **Adopt and implement inflation-targeting policies and frameworks that anchor inflation expectations and promote macroeconomic stability:** Establish clear inflation targets in coordination with monetary authorities, along with transparent communication and credible commitment to

these targets, to manage inflation expectations and foster economic confidence.

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