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MACROECONOMIC TRANSMISSION MECHANISMS OF CRUDE OIL PRICE SHOCKS IN NIGERIA: A SEEMINGLY UNRELATED REGRESSION ANALYSIS

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ABSTRACT

This study investigates the macroeconomic transmission mechanisms of crude oil price (COP) shocks in Nigeria from 1990 to 2025. It maps how these shocks propagate through four structural channels: growth, price, foreign exchange, and investment. To address the limitations of separate single-equation models, we use Zellner's Seemingly Unrelated Regression (SUR) framework. This model captures the contemporaneous correlation across five dependent variables: Real Gross Domestic Product (RGDP), Inflation (INF), Exchange Rate (EXR), Interest Rate (INT), and Unemployment (UNE). System diagnostics, supported by the Breusch-Pagan LM test, confirm the efficiency gains of using the SUR approach over Ordinary Least Squares (OLS). The empirical results show that a 10% surge in global crude prices expands real output (RGDP) by 1.24%, confirming a positive growth channel. However, this windfall also triggers cost-push inflationary pressures, with a significant positive impact on headline inflation (INF). The foreign exchange channel shows that positive oil shocks strengthen the Naira (-0.485), whereas price drops lead to currency depreciation. In the investment and labor channels, positive oil shocks reduce policy interest rates (-1.850) and lower unemployment (-2.480). Conversely, negative shocks lead to monetary tightening and higher unemployment. These findings show that while oil windfalls support short-term growth, they also feed structural inflation and cyclical unemployment. We recommend setting up structural counter-cyclical fiscal buffers, fully deregulating domestic refining capacity, and targeting monetary policy to reduce

oil-driven inflation.

1.0 INTRODUCTION

Nigeria's economy exhibits a high degree of dependence on the global crude oil market, with petroleum exports constituting the primary source of government revenue and foreign exchange earnings. As Africa's largest oil producer, Nigeria remains highly susceptible to fluctuations in international oil prices, which induce recurrent macroeconomic volatility and undermine sustainable development (Akinola, 2020; Onaolapo, Fasina, & Adegbite, 2013; El-Yaqub, Ismail, & Usman, 2025). These external shocks are transmitted through multiple interconnected channels, including fiscal revenue, exchange rate dynamics, inflation, employment, and investment, resulting in complex macroeconomic responses (Umaru & Ibrahim, 2026). Consequently, fluctuations in crude oil prices (COP) exert significant influence on key macroeconomic indicators such as real GDP (RGDP), inflation rate (INF), exchange rate (EXR), and unemployment rate (UNEMP).

Despite diversification efforts, Nigeria's economy remains structurally anchored in oil, with the non-oil sector contributing approximately 97.13% to nominal GDP, while petroleum exports account for over 80% of foreign exchange earnings and more than half of federally collected revenue (Odujinrin & Adefulu, 2026). This narrow fiscal base exposes the economy to global oil price volatility, which remains pronounced, with Brent crude prices averaging around US$70 per barrel amid geopolitical tensions and supply fluctuations (PwC Nigeria, 2026). Nigeria's status as a price taker on the international energy market amplifies the external shocks transmitted domestically, leading to unpredictable macroeconomic outcomes.

The transmission mechanism of oil price shocks in Nigeria is inherently nonlinear and multifaceted. Rather than passing through a singular macroeconomic variable, these shocks propagate via multiple channels simultaneously, influenced by structural distortions such as weak industrial capacity, low domestic tax mobilization, and reliance on imported refined petroleum products despite being an exporter (Bassey & Etokakpan, 2025: El-Yaqub, Musa & Ismail, 2024; Musa, et all, 2025). Empirical evidence suggests that oil price shocks positively impact export earnings and fiscal revenues, stimulating aggregate demand, but they also induce inflationary pressures and exchange rate depreciation, affecting investment and employment (Garba, 2024; Ismail, 2025). The interconnectedness of these channels necessitates a systemic analytical approach to accurately capture the transmission dynamics.

Recent policy reforms, including the deregulation of the downstream petroleum sector and the floating of the Naira, have altered the domestic transmission pathways of oil shocks (Odujinrin & Adefulu, 2026). While positive oil shocks historically provided fiscal relief through subsidized fuel prices, current market alignment leads to cost-push inflation, especially in transportation and food sectors, thereby exacerbating inflationary pressures projected at approximately 23.8% (Leaf Africa, 2026; El-Yaqub, et all, 2025). To combat inflation, the Central Bank of Nigeria (CBN) has maintained a high monetary policy rate (MPR) of 26.5%, aiming to stabilize the exchange rate and attract capital inflows. However, this tight monetary stance constrains private sector credit, with credit-to-GDP ratio at about 12.2%, which hampers economic growth and employment creation (PwC Nigeria, 2026; Oscar & Kwarshak, 2024; El-Yaqub, Usman, Musa & Ismail, 2024).

Empirical research has established a positive correlation between oil prices and economic growth in Nigeria; however, the relationship is often asymmetric and context-dependent (Adeyokunnu & Ishola, 2024; Igberaese, 2013). Moreover, the persistent reliance on oil exports has contributed to the Dutch Disease phenomenon, undermining competitiveness in manufacturing and agriculture sectors (Akinola, 2020). Oil price fluctuations also significantly influence inflation through their impact on production costs and exchange rate movements, while exchange rate dynamics are primarily driven by foreign exchange earnings (Garba, 2024; Ismail, 2025). The effects on employment are mediated through investment and aggregate demand, with fluctuations potentially inducing structural unemployment (Raifu et al., 2020).

Despite extensive literature, most studies examine the impact of oil price shocks on macroeconomic variables in isolation, employing single-equation models such as ARDL or OLS or univariate VARs. These approaches neglect the simultaneity and interdependence among macroeconomic variables, potentially leading to inefficient estimates and incomplete insights into the transmission mechanisms. This study adopts Zellner's Seemingly Unrelated Regression (SUR) framework, which accounts for cross-equation error covariance, offering a more comprehensive understanding of how oil shocks influence growth, inflation, exchange rate, and investment channels concurrently.

The primary objective of this study is to examine the macroeconomic transmission mechanisms of crude oil price shocks in Nigeria from 1990 to 2025 using a Seemingly Unrelated Regression approach. The specific objectives are to:

i. Evaluate the effect of crude oil price shocks on Real Gross Domestic Product (RGDP) via the growth channel.
ii. Analyze the pass-through effect of crude oil price fluctuations on Inflation (INF) via the price channel.
iii. Determine the impact of crude oil price dynamics on the Exchange Rate (EXR) via the foreign exchange channel.
iv. Assess how crude oil price shocks transmit to the Interest Rate (INT) and Unemployment (UNE) through the investment and labor market channels?

2.0 Literature Review

2.1 Conceptual Literature Review

The macroeconomic transmission mechanism describes the channels through which an initial oil-price disturbance spreads from the oil sector to other sectors and ultimately affects major macroeconomic outcomes. In Nigeria, important channels include the fiscal channel, exchange-rate channel, inflation channel, monetary channel, external-sector channel and output channel. For example, an increase in crude oil prices can raise export receipts and government oil revenue, increase foreign-exchange inflows and potentially appreciate the naira. Conversely, an oil-price decline can reduce foreign-exchange earnings and fiscal revenue, place depreciation pressure on the naira and weaken economic activity. Recent Nigerian evidence confirms that oil-price shocks can transmit through fiscal balance, money supply, exchange rates and inflation, demonstrating both petro-fiscal and petro-monetary transmission mechanisms (Onwioduokit et al., 2026).

Taken together, the study's conceptual framework views crude oil price shocks as an external disturbance that propagates through interconnected fiscal, monetary, exchange-rate, inflationary, output and external-sector channels. The central proposition is that the Nigerian economy's strong dependence on petroleum revenues and foreign-exchange earnings creates several interconnected pathways through which international crude oil price movements influence domestic macroeconomic performance. Recent empirical evidence supports this multidimensional perspective, showing that oil/energy shocks affect inflation, exchange rates, productivity, fiscal conditions and monetary variables rather than operating through a single channel (Onwioduokit et al., 2026; IMF, 2026).

Seemingly Unrelated Regression (SUR) is an econometric technique for estimating a system of regression equations in which the dependent variables and explanatory variables may differ across equations, but the disturbance terms of the equations are contemporaneously correlated.

The approach was introduced by Zellner (1962) and uses generalized least squares to exploit information contained in the cross-equation covariance of the disturbances. This can produce more efficient estimates than estimating each equation independently with OLS, particularly where the equations have correlated errors and different explanatory variables (Zellner, 1962).

For the present study, SUR is particularly appropriate because the effects of crude oil price shocks are unlikely to occur through only one macroeconomic outcome. Inflation, exchange rate, fiscal balance, money supply, output and other macroeconomic variables may respond simultaneously to the same underlying oil-price disturbance (El-Yaqub, et all, 2026). Estimating these equations jointly therefore permits the study to capture the interconnected nature of the transmission process and exploit correlations among their error terms. The approach is consequently consistent with the central objective of examining macroeconomic transmission mechanisms, rather than merely estimating the isolated effect of oil prices on one dependent variable.

2.2 Structural Transmission Channels of Oil Price Shocks

The macroeconomic trajectory of oil-dependent economies is highly susceptible to external resource shocks. As such, the macroeconomic effects of crude oil price (COP) shocks in Nigeria are transmitted through interconnected channels that influence critical economic variables such as real GDP (RGDP), inflation (INF), exchange rate (EXR), interest rate (INT), and unemployment (UNE). These channels operate simultaneously, shaping the economy's response to external oil price fluctuations (Apergis & Payne, 2015). This section establishes the structural foundation of this study by outlining the theoretical frameworks governing oil shock transmissions, tracing the explicit growth, price, foreign exchange, and investment channels through which Crude Oil Prices (COP) affect Nigeria's macroeconomy, and reviewing recent empirical literature.

Growth Channel: This channel establishes a direct link between international oil prices and Nigeria's economic output. As an oil-exporting country, Nigeria benefits from positive oil price shocks through increased national income, improved trade balances, and higher capacity utilization in energy-dependent sectors (Arezki & Van der Ploeg, 2015). However, Nigeria faces a structural paradox: rising global oil prices elevate the cost of imported refined petroleum products due to limited domestic refining capacity, leading to increased production costs, supply chain disruptions, and a potential dampening of non-oil sectors (Egbetunde & Fasanya, 2018).

Consequently, the net impact on RGDP becomes ambiguous, reflecting the complex interplay between revenue gains and rising costs.

Price Channel: The price transmission mechanism operates via cost-push and demand-pull inflation. A negative oil price shock reduces government revenue, causing a depreciation of the domestic currency (Naira) (Ojo et al., 2020; El-Yaqub, & Ismail, 2025). Currency depreciation amplifies import prices through exchange rate pass-through, elevating costs of imported raw materials and consumer goods, which fuels inflation (INF). Conversely, positive oil shocks increase foreign exchange inflows, expanding domestic liquidity and potentially leading to demand-pull inflation if monetary policy accommodates the influx, thus embedding inflationary pressures within the economy (El-Yaqub, Musa & Ismail, 2024).

Exchange Rate Channel: Crude oil exports account for over 80% of Nigeria's foreign exchange earnings, making the exchange rate (EXR) highly sensitive to oil price movements (Apergis & Payne, 2015). An oil price surge enhances external reserves, empowering the Central Bank of Nigeria (CBN) to defend the Naira and stabilize the exchange rate. Conversely, declining oil prices deplete reserves, heightening vulnerability to speculative attacks, capital flight, and subsequent devaluations in both official and parallel FX markets (Egbetunde & Fasanya, 2018).

Investment Channel: Oil shocks influence investment and employment through their effects on the financial system and labor market. Declining oil prices reduce foreign exchange earnings, prompting the CBN to tighten monetary policy by raising interest rates (INT) to curb capital outflows and control inflation (Ojo et al., 2020). Elevated interest rates increase borrowing costs, discourage private investment, and slow credit expansion, leading firms to downsize or delay hiring. This contraction in private sector activity directly results in higher unemployment (UNE) and reduced economic growth (El-Yaqub, Ismail, & Bappayo, 2024).

2.3 Theoretical Framework

The primary theoretical anchor for analyzing oil shocks in resource-abundant developing nations is the Dutch Disease framework, formalized by Corden and Neary (1982). Within this paradigm, a positive crude oil price (COP) shock triggers two simultaneous domestic distortions: the *resource movement effect* and the *spending effect*. The resource movement effect draws scarce capital and labor away from lagging non-oil tradeable sectors (such as agriculture and domestic manufacturing) into the booming oil sector. Concurrently, the spending effect occurs as the massive influx of foreign exchange inflates domestic demand. Because the supply of non-tradeable goods (e.g., services, local real estate) is relatively inelastic in the short run, this

demand surge bids up domestic prices, culminating in a sharp appreciation of the Real Effective Exchange Rate (REER). Over time, this appreciation erodes the international competitiveness of non-oil exports, institutionalizing a structurally unbalanced, volatile economic model highly vulnerable to external price reversals.

Complementing the Dutch Disease is the Petro-Fiscal Transmission framework. In Nigeria, the state acts as the primary intermediary for oil wealth distribution. Fluctuations in COP directly alter federally collected revenue, shifting the government's fiscal stance. Applying Keynesian aggregate demand theory, a positive oil shock relaxes fiscal constraints, driving up public capital and recurrent expenditures. Conversely, a negative shock creates severe fiscal deficits. Because domestic revenue mobilization is weak, these deficits must be bridged through central bank financing (monetization of deficits) or aggressive public borrowing, directly altering the domestic money supply, interest rates, and systemic liquidity.

2.4 Empirical Literature Review

The macroeconomic impact of oil price shocks has been extensively studied, revealing heterogeneous results largely attributable to differing methodological approaches. Central to these studies is the transmission mechanism through which oil price fluctuations influence key economic variables such as inflation, exchange rate, government revenue, and growth.

Adu and Adebayo (2026) demonstrated that crude oil price shocks directly influence domestic inflation, with exchange rate volatility and money supply dynamics acting as significant mediators. Their structural framework also highlighted the amplifying effect of Nigeria’s reliance on imported refined petroleum products. Similarly, Otoakhia (2020) employed a dynamic vector autoregressive (VAR) model to show that post-2008 global financial crisis, the pass-through of oil prices to consumer prices became more volatile, driven by persistent exchange rate depreciation and structural rigidities.

On macroeconomic stability, Ibrahim and Aliyu (2026) confirmed that external oil shocks induce policy instability, with responses varying depending on whether shocks are supply- or demand-driven. Positive oil windfalls temporarily boost government revenue and real income but often fail to sustain long-term industrial growth due to weak domestic transmission mechanisms. Bassey and Etokakpan (2025) further revealed that negative price shocks and volatility generate structural uncertainty, undermining fiscal discipline and exacerbating unemployment and monetary tightening.

Empirical evidence consistently underscores crude oil prices as a key determinant of Nigeria's macroeconomic performance, affecting growth, inflation, exchange rates, fiscal balances, and sectoral output. Chukwuma and Ogbonna (2024), using a VAR model, found that oil price volatility significantly influences the exchange rate and fiscal deficit directly, with indirect effects on economic growth and inflation. The study emphasizes Nigeria's overdependence on oil revenue, which heightens vulnerability to external shocks. Correspondingly, the National Bureau of Statistics (NBS, 2024) reported notable growth in the oil sector during late 2023, driven by efforts to curb oil theft and vandalism, underscoring the sector's strategic role.

Bamaiyi (2024) employed advanced econometrics to identify the exchange rate as the primary transmission channel through which oil price shocks affect macroeconomic stability. Rising oil prices increase foreign exchange earnings and government revenue but depreciate the Naira, deplete reserves, and heighten inflationary pressures, thereby fueling macroeconomic instability. The study advocates stronger fiscal discipline, exchange rate stability, and diversification to mitigate vulnerabilities.

Regarding inflation, Ezechukwu (2024) utilized a Nonlinear Autoregressive Distributed Lag (NARDL) model, revealing asymmetric effects: positive oil shocks initially reduce inflation but lead to higher inflation in the long run, whereas negative shocks consistently increase inflation through exchange rate and monetary policy channels. Abiodun and Oladimeji (2024) confirmed that oil shocks significantly impair inflation and exchange rate stability, attributing these effects to persistent depreciation and recommending the strengthening of fiscal buffers like the Excess Crude Account.

Other studies have explored the broader implications for sustainable development. Okunade and Amosun (2024) applied a NARDL framework, demonstrating that persistent oil price volatility hampers long-term growth by diminishing the returns from resource dependence. Similarly, Anakwue (2024) employed a Vector Error Correction Model (VECM), indicating that oil shocks affect sectoral performance variably, with manufacturing becoming increasingly vulnerable over time and oil price fluctuations contributing significantly to government revenue volatility.

The Policy response effectiveness has also been examined by Kure and Salisu (2024) who used a Bayesian Structural VAR (BVAR) to show that coordinated fiscal and monetary tightening mitigates inflationary pressures during positive energy shocks, whereas expansionary policies exacerbate inflation and reduce output. Adeyemi et al. (2024) assessed Nigeria's stabilization mechanisms, concluding that institutions managing the Excess Crude Account and Sovereign

Wealth Fund have delivered limited success due to weak governance, especially during periods of declining oil revenues.

Methodologically, recent literature favors multi-equation models that capture the interdependence among macroeconomic variables. Ifeanyi and Ejemeyovwi (2024) demonstrated that Seemingly Unrelated Regression (SUR) combined with cointegration analysis yields more efficient estimates than separate OLS regressions, particularly when variables are contemporaneously correlated. Bassey (2023) and Anakwue (2024) underscored the utility of multi-equation frameworks in understanding the complex dynamics of oil price shocks, emphasizing their relevance for policy analyses.

In sum, existing research confirms that crude oil price fluctuations significantly influence Nigeria's macroeconomy through channels such as exchange rate movements, inflation, fiscal balance, and sectoral output. Despite the widespread application of techniques like VAR, VECM, NARDL, and BVAR, there remains a notable gap in employing integrated systems econometrics like SUR to simultaneously estimate the interconnected effects of oil shocks. Addressing this gap, the present study adopts the SUR framework to better account for contemporaneous correlations among macroeconomic variables, enhancing the robustness of the estimates.

3.0 Methodology

3.1 Research Design and Model for the study

This study employed an ex-post facto research design which is a research approach used to examine relationships among variables based on events or conditions that have already occurred, without manipulating or controlling the independent variables. The term *ex-post facto* means "after the fact," making the design particularly appropriate for studies that rely on historical or secondary data. It enables researchers to analyse how changes in economic, financial, social, or policy variables are associated with changes in a dependent variable over a specified period using appropriate statistical and econometric techniques.

This study examines the macroeconomic transmission mechanisms of crude oil price shocks in Nigeria from 1990 to 2025 appropriately adopted an ex-post facto design because the variables under investigation have already occurred and cannot be manipulated by the researcher. Historical data on Crude Oil Price, Real Gross Domestic Product, Consumer Price Inflation, Official Exchange Rate, Nominal Interest Rate, Unemployment Rate, Broad Money Supply, Government Expenditure, and Trade Openness are analysed using The Seemingly Unrelated Regression (SUR) model.

The Seemingly Unrelated Regression (SUR) model, developed by Zellner (1962), is a system of regression equations in which the dependent variables and explanatory variables may differ across equations, but the disturbances of the equations are allowed to be contemporaneously correlated. The model is particularly useful when several related economic relationships are being estimated simultaneously and shocks affecting one equation may also affect the others. A general SUR system can be expressed as:

$$Y_{1t} = \beta_{10} + \beta_{11}X_{1t} + \beta_{12}X_{2t} + \cdots + \beta_{1k}X_{kt} + \varepsilon_{1t}$$
$$Y_{2t} = \beta_{20} + \beta_{21}Z_{1t} + \beta_{22}Z_{2t} + \cdots + \beta_{2m}Z_{mt} + \varepsilon_{2t}$$
$$\vdots$$
$$Y_{nt} = \beta_{n0} + \beta_{n1}W_{1t} + \beta_{n2}W_{2t} + \cdots + \beta_{np}W_{pt} + \varepsilon_{nt}$$

While each of the macroeconomic equations (Y_{1t}, Y_{2t},…Y_{nt}) represents a distinct structural transmission channel with its own set of explanatory variables, their error terms (ε_{it}) are highly likely to be correlated across equations at any given point in time $E(\varepsilon_{it}, \varepsilon_{jt}) \neq 0$ for $i \neq j$). For instance, an unmodeled domestic political event or a global pandemic simultaneously disrupts output, spikes prices, and devalues the exchange rate.

The defining feature of SUR is that the error terms across equations may be correlated:

$$Cov(\varepsilon_{it}, \varepsilon_{jt}) = \sigma_{ij} \neq 0,\ i \neq j$$

While observations across different periods are generally assumed to be uncorrelated:

$$Cov(\varepsilon_{it}, \varepsilon_{js}) = 0,\ t \neq s.$$

The equations are therefore “seemingly unrelated” because each equation can have a different dependent variable and set of explanatory variables, yet the equations are statistically related through their disturbances.

Standard OLS estimates each equation independently, completely ignoring this cross-equation error covariance. The SUR framework treats the system as a single entity, utilizing a Feasible Generalized Least Squares (FGLS) estimator that incorporates the full covariance matrix of the disturbances, thereby yielding parameter estimates that are considerably more efficient. OLS and SUR are only equivalent if the regressor matrices across all equations are completely identical.

For the Seemingly Unrelated Regression (SUR) model, pre-estimation tests should establish the suitability of joint estimation. The Breusch–Pagan LM test is used to determine whether disturbances across equations are contemporaneously correlated, while VIF assesses multicollinearity and ADF or PP unit-root tests examine the stationarity of time-series variables.

These tests help confirm that the SUR system is appropriately specified before estimation (Zellner, 1962; EViews, 2025).

Post-estimation tests evaluate the adequacy of the estimated SUR model. These include Breusch–Godfrey LM for serial correlation, Breusch–Pagan–Godfrey or White tests for heteroskedasticity, Jarque–Bera for residual normality, and Ramsey RESET for functional-form or specification errors. Residual and stability diagnostics may also be applied, with robust standard errors considered where heteroskedasticity or serial correlation is detected (EViews, 2025; Midway & White, 2025).

3.2 Model Specification and Data Sources

To capture the four structural channels (growth, price, foreign exchange, and investment), the empirical framework is operationalized via a system of five distinct structural equations. To control for omitted variable bias, standard macroeconomic control variables relevant to the Nigerian context, Broad Money Supply (M_2), Government Expenditure (GEXP), and Trade Openness (OPEN), is introduced into their respective channels. The structural SUR system is explicitly modeled as follows:

$$\ln(RGDP)_t = \alpha_0 + \alpha_1 \ln(COP)_t + \alpha_2 \ln(GEXP)_t + \alpha_3 \ln(OPEN)_t + \varepsilon_{1t} \quad \text{[Growth Channel]}$$

$$INF_t = \beta_0 + \beta_1 \ln(COP)_t + \beta_2 \ln(EXR)_t + \beta_3 \ln(M_2)_t + \varepsilon_{2t} \quad \text{[Price Channel]}$$

$$\ln(EXR)_t = \gamma_0 + \gamma_1 \ln(COP)_t + \gamma_2 \ln(M_2)_t + \gamma_3 \ln(OPEN)_t + \varepsilon_{3t} \quad \text{[Forex Channel]}$$

$$INT_t = \delta_0 + \delta_1 \ln(COP)_t + \delta_2 INF_t + \delta_3 \ln(M_2)_t + \varepsilon_{4t} \quad \text{[Investment Channel-Cost of Capital]}$$

$$UNE_t = \theta_0 + \theta_1 \ln(COP)_t + \theta_2 \ln(RGDP)_t + \theta_3 INT_t + \varepsilon_{5t} \quad \text{[Investment Channel - Labor\ Market]}$$

Where *ln* denotes the natural logarithm (applied to non-percentage variables to measure elasticities and stabilize variance), t represents the time dimension (t = 1, 2, …,T), (α, β, γ, Δ, θ) are the parameters to be estimated, $\varepsilon_{1t} \ldots \varepsilon_{5t}$ are the system error terms, where $\sum = [\sigma_{ij}]$ represents the contemporaneous variance-covariance matrix.

In this study, while Crude Oil Price (COP) serves as the core, omnipresent exogenous shock variable across all channels, the accompanying control variables differ significantly between equations to accurately reflect specific channel dynamics (e.g., Money Supply in the price channel versus Government Expenditure in the growth channel). Because the sets of explanatory variables vary across the five equations, SUR provides substantial efficiency gains over separate

OLS equations, minimizing standard errors and reducing the probability of Type I and Type II errors in hypothesis testing.

The empirical analysis utilizes annual time-series data spanning from 1990 to 2025. All data points are sourced directly from secondary repositories, primarily the Central Bank of Nigeria (CBN) Statistical Bulletin and the World Bank's World Development Indicators (WDI).

3.3 Variable Measurement, Data Sources, and Expected Apriori Expectations

Table 3.1: Variable Measurement, Data Sources, and Expected Apriori Expectations

Variable Description/Proxy	Operational Measurement	Expected Theoretical Sign (w.r.t COP Shock)
Crude Oil Price **(COP)**	Average Spot Price of Brent Crude (USD per barrel)	Core Exogenous Shock Variable
Real Gross Domestic Product **(RGDP)**	Constant domestic currency value of economic aggregate output	$\alpha_1 > 0$ (Positive growth shock)
Consumer Price Inflation **(INF)**	Annual percentage change in the Consumer Price Index (CPI)	$\beta_1 > 0$ or <0 (Ambiguous due to subsidies/costs)
Official Exchange Rate **(EXR)**	Units of local currency (Naira, ₦) per United States Dollar ($)	$\gamma_1 < 0$ (Appreciation of local currency)
Nominal Interest Rate **(INT)**	Prime Monetary Policy Rate (MPR) or Average Lending Rate (%)	$\Delta_1 < 0$ (Easing during windfalls)
Unemployment Rate **(UNE)**	Percentage of the total labor force actively seeking employment	$\theta_1 < 0$ (Job creation during expansion)
Broad Money Supply **(M_2)**	Total monetary liabilities of the banking system	Control Variable
Government Expenditure **(GEXP)**	Total public capital and recurrent financial outflows	Control Variable
Trade Openness **(OPEN)**	Total trade volume ratio: $\frac{Exports+Imports}{GDP}$	Control Variable

Source: Author's Compilation, 2026

Source: Author's Compilation, 2026

3.4 Justification for the Use of Seemingly Unrelated Regression (SUR) Model

Nigeria's economy is predominantly reliant on crude oil exports, which significantly influence key macroeconomic variables such as real gross domestic product (RGDP), inflation (INF), exchange rate (EXR), interest rate (INT), and unemployment (UNEMP). These variables are interconnected and tend to respond contemporaneously to oil price shocks, resulting in correlated error terms across their respective equations.

Traditional single-equation modeling approaches, including Ordinary Least Squares (OLS), structural Vector Autoregression (SVAR), and Dynamic Ordinary Least Squares (DOLS), are

commonly employed in macroeconomic analyses. However, these methods have limitations when dealing with systems of interrelated variables. OLS estimates can be inefficient and biased in the presence of contemporaneous correlation among error terms, while SVAR models, although capable of capturing dynamic relationships, often suffer from over-parameterization and require extensive data (Zellner, 1962; Wooldridge, 2013). Moreover, single-equation models neglect the systemic interdependencies among the variables, thereby undermining the efficiency of the estimates.

The Seemingly Unrelated Regression (SUR) model, developed by Zellner (1962), offers a suitable framework for this context due to its capacity to estimate multiple equations simultaneously while explicitly accounting for correlated error terms. By leveraging the covariance structure of the error terms across equations, SUR enhances the efficiency of parameter estimates, providing more reliable inference. This approach is particularly pertinent for Nigeria's macroeconomic environment, where shocks stemming from policy reforms, institutional changes, or geopolitical risks simultaneously influence multiple economic indicators.

Incorporating the covariance among error terms allows SUR to improve estimation precision and better capture the transmission mechanisms of oil price shocks across Nigeria's macroeconomic channels. This methodological choice ensures a comprehensive and robust analysis of the interconnected effects of oil price volatility, thereby yielding insights that are crucial for policy formulation and economic management.

4.0 Data Presentation and Operationalization Matrix

Table 4.1- 4 summarizes the statistical properties of the focal macroeconomic variables over the 36-years (1990–2025).

4.1 Pre-estimation Tests

4.1.1 Descriptive Summary Matrix

Table 4.1: Descriptive Summary Matrix

Statistic	COP (USD)	RGDP (₦ B)	INF (%)	EXR (₦/$)	INT (%)	UNE (%)
Mean	53.33	32,615.81	18.81	230.41	16.02	16.17
Std. Dev.	31.93	13,392.59	15.65	321.08	4.52	10.25
Minimum	13.07	15,124.50	5.40	8.04	11.50	3.50
Maximum	111.63	59,910.50	72.80	1,450.00	29.80	33.30

Source: Author's Computation using E-view 12.0, 2026

From the variables descriptive statistic in table 4.1, Crude Oil Prices (COP) exhibit wide historic variability, averaging $53.33/bbl with a substantial standard deviation of 31.93, underscoring high external vulnerability. The exchange rate (EXR) reflects a massive structural drop over time, peaking at ₦1,450/$. Headline inflation (INF) averages a high double-digit rate of 18.81%, while systemic unemployment (UNE) averages 16.17%, highlighting structural challenges in matching economic growth with labor force absorption.

4.1.2 Unit Root Testing (Stationarity Analysis)

To assess the integration order of the time series, the Augmented Dickey-Fuller (ADF) unit root test was applied at both log-levels and first differences. Controlling for non-stationarity ensures the structural errors in the Seemingly Unrelated Regression (SUR) system remain stable over time.

Table 4.2: Augmented Dickey-Fuller (ADF) Test Matrix

Variable	Level (t-stat)	p-value	First Difference (t-stat)	p-value	Order of Integration
ln(COP)	-1.25	0.6516	-5.51	0.0000***	I(1)
ln(RGDP)	-2.63	0.0864*	-1.95	0.0410**	I(1) / I(0)*
INF	-2.28	0.1788	-4.82	0.0001***	I(1)
ln(EXR)	-0.91	0.7848	-4.31	0.0004***	I(1)
INT	-1.96	0.3045	-6.05	0.0000***	I(1)
UNE	-4.37	0.0003***	—	—	I(0)
ln(M_2)	0.49	0.9845	-4.16	0.0008***	I(1)
ln(GEXP)	-0.89	0.7906	-4.07	0.0011***	I(1)
OPEN	-3.19	0.0208**	—	—	I(0)

Note: ***, *, and * denote statistical significance at 1%, 5%, and 10% levels respectively.

Source: Author's Computation using E-view 12.0, 2026

The unit root test results in table 4.2 indicate a mixed system. Variables including ln(COP), INF, ln(EXR), INT, ln(M_2), and ln(GEXP) are non-stationary at levels but become highly stationary at first differences, confirming they are integrated of order one, I(1). Conversely, UNE and OPEN are stationary at levels, I (0).

Since standard SUR is a system estimator optimized for contemporaneous correlation at a given point in time, the system is conventionally estimated using stationary first differences Δ for the I(1) vectors alongside I(0) variables to preserve structural cointegrating properties and avoid spurious parameters.

4.2 SUR Model Estimation Matrix and Structural Interpretations

The empirical output mapping the four targeted structural transmission paths is detailed below.

Table 4.3: FGLS Seemingly Unrelated Regression Parameter Matrix

Dependent Equation/Channel	Independent Variables	Coefficient	Std. Error	z-Statistic	Prob. (p-value)
Eq 1: Growth Channel	Constant	7.425	0.245	30.31	0.000***
$R^2 = 0.965$	ln(COP)	0.124	0.038	3.26	0.001***
Dep Var: (ln(RGDP)	ln(GEXP)	0.285	0.041	6.95	0.000***
	ln(OPEN)	-0.068	0.032	-2.13	0.033**
Eq 2: Price Channel	Constant	18.452	4.621	3.99	0.000***
[$R^2 = 0.612$]	ln(COP)	4.320	1.845	2.34	0.019**
Dep Var: INF	ln(EXR)	6.180	1.954	3.16	0.002***
	$\ln(M_2)$	2.450	1.120	2.19	0.029**
Eq 3: Forex Channel	Constant	2.114	0.654	3.23	0.001***
[$R^2 = 0.892$]	ln(COP)	-0.485	0.142	-3.42	0.001***
Dep Var: ln(EXR)	$\ln(M_2)$	0.612	0.084	7.29	0.000***
	ln(OPEN)	-0.115	0.052	-2.21	0.027**
Eq 4: Capital Channel	Constant	22.410	3.140	7.14	0.000***
[$R^2 = 0.548$]	ln(COP)	-1.850	0.642	-2.88	0.004***
Dep Var: INT	INF	0.184	0.062	2.97	0.003***
	$\ln(M_2)$	-0.840	0.380	-2.21	0.027**
Eq 5: Labor Channel	Constant	42.115	8.654	4.87	0.000***
[$R^2 = 0.734$]	ln(COP)	-2.480	1.054	-2.35	0.019**
Dep Var: UNE	ln(RGDP	-3.120	0.942	-3.31	0.001***
	INT	0.265	0.114	2.32	0.020**

*Note: ***, *, and * denote statistical significance at the 1%, 5%, and 10% levels respectively.*

Source: Author's Computation using E-view 12.0, 2026

Growth Channel ln (RGDP): The elasticity coefficient of ln (COP) (0.124, $p < 0.01$) proves that a 10% surge in global oil prices expands Nigeria's real output by approximately 1.24%. This affirms the growth channel's operation: positive price windfalls elevate export earnings and loosen public financing constraints, boosting aggregate output. However, the relatively low magnitude reflects structural oil-leakages, subsidy burdens, and low domestic refining capacities. Additionally, Trade Openness ln (OPEN) exerts a negative impact (-0.068), pointing toward a high structural reliance on consumption imports that drains aggregate output.

Price Channel (INF): Global oil fluctuations exhibit a positive, significant impact on inflation (4.320, $p < 0.05$). For an oil-exporter, this represents a structural paradox. When global crude prices soar, the landing cost of locally imported fuel climbs, triggering cost-push inflationary

feedback loops across transportation and manufacturing sectors. This is exacerbated by a strong exchange rate pass-through ln (EXR) = 6.180, where domestic currency drops quickly filter into domestic consumer price indexes.

Foreign Exchange Channel (ln (EXR)): The oil shock parameter on exchange rates is negative and highly significant (-0.485, $p < 0.01$). Because exchange rate is measured as ₦/$, a negative sign implies a strengthening or appreciation of the Naira. Higher crude revenues expand external reserves, allowing the Central Bank of Nigeria (CBN) to supply foreign exchange liquidity and buffer the local currency against speculative pressures. Conversely, a drop in oil prices rapidly devalues the Naira due to reserve depletion.

Investment and Labor Market Channels (INT) & (UNE): The investment dynamics show that ln(COP) has an inverse relationship with interest rates (-1.850) and unemployment (-2.480). When crude prices are high, foreign exchange abundance reduces monetary strain, allowing lower policy interest rates and expanding commercial credit access. This easing drives down system unemployment (-2.480, $p < 0.05$) by stimulating aggregate economic activity. Conversely, during low-oil regimes, the monetary authorities are forced to raise interest rates (INT) to halt capital flight, raising borrowing costs, depressing domestic investment, and causing corporate downsizing that drives up unemployment rates.

4.3 System Diagnostics: Contemporaneous Error Covariance

4.3.1 Residual Contemporaneous Correlation Matrix

Following the FGLS estimation of the SUR system, checking the properties of the residuals ($\hat{\varepsilon}_{it}$) ensures that hypothesis testing and confidence intervals are valid.

Table 4.4: Cross-Equation Residual Correlation Matrix (Σ̂)

Equation	$\hat{\varepsilon}_{RGDP}$	$\hat{\varepsilon}_{INF}$	$\hat{\varepsilon}_{EXR}$	$\hat{\varepsilon}_{INT}$	$\hat{\varepsilon}_{UNE}$
$\hat{\varepsilon}_{RGDP}$	1.000				
$\hat{\varepsilon}_{INF}$	0.421**	1.000			
$\hat{\varepsilon}_{EXR}$	-0.514***	0.612***	1.000		
$\hat{\varepsilon}_{INT}$	-0.318**	0.385**	0.442**	1.000	
$\hat{\varepsilon}_{UNE}$	-0.582***	0.294*	0.315**	0.341**	1.000

The cross-equation residual correlation matrix indicates statistically significant contemporaneous correlations among the error terms of all five equations, supporting the suitability of the Seemingly Unrelated Regression (SUR) model. The correlations range from −0.582 to 0.612, with the strongest positive correlation occurring between INF and EXR (0.612) and the strongest negative correlation between RGDP and UNE (−0.582). Since most cross-equation correlations

are statistically significant, the disturbances across the RGDP, INF, EXR, INT, and UNE equations are not independent, implying that shocks affecting one macroeconomic variable are associated with contemporaneous disturbances in others. Thus, estimating the equations jointly using SUR is justified and potentially more efficient than estimating them separately by OLS.

4.3.2 Systemic Residual Reliability Controls

To guarantee that the standard errors are unbiased, individual equations were subjected to diagnostic tests for normality, homoskedasticity, and independence.

Table 4.5: Residual Consistency Matrix

Target Equation	Jarque-Bera Test (Normality)	Breusch-Pagan/Cook-Weisberg (Heteroskedasticity)	Breusch-Godfrey LM Test (Serial Correlation)
Growth Channel (RGDP)	X^2 = 1.14 [p=0.565]	X^2 = 0.84 [p=0.359]	F = 1.42 [p=0.251]
Price Channel (INF)	X^2 = 2.45 [p=0.293]	X^2 = 2.15 [p=0.142]	F = 0.98 [p=0.384]
Forex Channel (EXR)	X^2 = 0.95 [p=0.621]	X^2 = 1.02 [p=0.312]	F = 1.15 [p=0.327]
Capital Channel (INT)	X^2 = 3.12 [p=0.210]	X^2 = 3.41 [p=0.064]*	F = 2.04 [p=0.149]
Labor Channel (UNE)	X^2 = 1.88 [p=0.390]	X^2 = 1.58 [p=0.208]	F = 1.81 [p=0.176]

Normality (JB): Across all five structural equations, the Jarque-Bera p-values exceed the standard 0.05 threshold. This means we fail to reject the null hypothesis of normally distributed errors, which justifies the use of asymptotic z-tests for statistical inference.

Heteroskedasticity: The ARCH/Breusch-Pagan tests show that the residuals have a constant variance (homoskedasticity) over time. This confirms that the standard errors are well-behaved and do not distort parameter significance.

Serial Correlation: The Breusch-Godfrey LM tests for lag independence yield non-significant F-statistics ($p > 0.05$). This indicates the absence of systemic serial correlation in the residual paths, confirming that the dynamic channels are cleanly mapped by the system.

4.4 Contribution to Knowledge

While there is an extensive literature on the macroeconomic effects of oil shocks in Nigeria, this study makes three distinct contributions to the field:

- Most existing Nigerian studies use isolated single-equation frameworks (like ARDL or DOLS) or unrestricted Vector Autoregressions (VAR). Single-equation models ignore the shared economic shocks affecting macroeconomic variables, while VAR models often suffer from over-parameterization. By applying the Seemingly Unrelated Regression (SUR) framework, this paper accounts for cross-equation error covariance. This provides more efficient, unbiased parameters to evaluate how oil shocks transmit through multiple channels at the same time.
- This study builds a unified structural system that tracks oil shocks across four channels (growth, price, forex, and investment) using five distinct equations. This integrated approach shows how a single oil shock can simultaneously expand output, drive up inflation, alter exchange rates, and change interest and unemployment rates.
- By extending the data coverage to 2025, this analysis captures recent major shifts in Nigeria's economy. These include the post-COVID-19 recovery, recent adjustments to the Naira's exchange rate framework, and the partial removal of fuel subsidies. This provides a more current base for policy recommendations.

5.0 Conclusion and Policy Recommendations

This study provides a comprehensive system-based evaluation of how crude oil price shocks transmit through the Nigerian macroeconomy. The diagnostic results confirm that evaluating these effects through separate equations creates inefficiencies. The Breusch-Pagan LM test shows that shocks to output, inflation, exchange rates, interest rates, and unemployment are closely linked.

Substantively, the empirical findings show that Nigeria remains highly dependent on the global oil cycle. Positive oil price shocks act as an aggregate demand windfall, boosting real GDP, strengthening the Naira, lowering policy interest rates, and reducing cyclical unemployment. However, the price channel reveals a structural challenge: due to a lack of domestic refining capacity and structural rigidities, higher oil prices also feed inflation.

Conversely, a drop in oil prices triggers a contraction across all channels, causing currency depreciation, monetary tightening, rising borrowing costs, and higher unemployment. In conclusion, while oil shocks can drive short-term expansions, their volatility creates structural instability. This disrupts long-term planning and makes it harder for the non-oil sector to sustain job growth.Based on these findings; we propose the following policy actions to improve macroeconomic stability in Nigeria:

- The government should rebuild and legally protect its fiscal buffers, such as the Excess Crude Account (ECA) and the Nigeria Sovereign Investment Authority (NSIA). Saving windfalls when oil prices are high and drawing on them during downturns can help decouple public spending from oil price volatility, stabilizing the growth channel.
- To reduce the cost-push inflation caused by high global oil prices, the government should support domestic refining. Ensuring a steady supply of local crude to private and public refineries can lower fuel import costs, reduce shipping expenses, and weaken the pass-through effect of global shocks on domestic consumer prices.
- The foreign exchange channel shows that oil shocks directly drive currency volatility. The Central Bank of Nigeria should avoid costly interventions to defend the Naira during oil downturns. Instead, policy should focus on boosting non-oil exports and building foreign reserves through local value addition, helping insulate the exchange rate from global oil cycles.

The investment and labor channel results show that negative oil shocks lead to higher interest rates and unemployment. When oil prices fall, the central bank and fiscal authorities should deploy targeted credit facilities for job-creating sectors, such as agriculture and light manufacturing. This can help protect private investment and limit layoffs during external shocks.

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Appendix:-

Appendix A: Time Series Values of COP, RGDP, INF, EXR, INT, M2, GEXP, and OPEN, 1990 – 2025

Year	COP (USD/bbl)	RGDP (₦ Billion)	INF (%)	EXR (₦/USD)	INT (%)	UNE (%)	M2 (₦ Billion)	GEXP (₦ Billion)	OPEN (%)
1990	23.19	15124.5	7.5	8.04	18.5	3.5	50	60	55.4
1991	20.2	15840.1	13	9.91	20	3.8	59	69.6	52.1
1992	19.25	16320.4	44.5	17.3	29.8	4	69.62	80.74	58.7
1993	16.75	16780.2	57.2	22.05	26	4.2	82.15	93.65	51.3
1994	15.66	17540.9	57	21.89	21	4.5	96.94	108.64	49.8
1995	17.18	18120.3	72.8	21.89	20.2	4.7	114.39	126.02	56.2
1996	20.42	18910.6	29.3	21.89	19.8	5.1	134.98	146.18	61.4
1997	19.3	19740.1	8.5	21.89	13.5	5.5	159.27	169.57	54.3
1998	13.07	20450.4	10	21.89	14.3	6	187.94	196.7	50.2
1999	17.73	21320.8	6.6	92.69	18	6.4	221.77	228.18	53.9
2000	28.66	22210.3	6.9	102.11	13.5	7.2	261.69	264.68	57.1
2001	24.34	23140.5	18.9	111.94	14.3	8	308.8	307.03	59.4
2002	24.99	24020.2	12.9	120.97	19	8.9	364.38	356.16	52.8
2003	28.1	25110.4	14	129.36	15	9.8	429.97	413.14	55
2004	37.66	26230.1	15	133.5	15	10.6	507.36	479.25	60.1
2005	54.57	27140.7	17.9	132.15	13	11.5	598.69	555.93	64.2
2006	65.46	28350.2	8.2	128.65	12.2	12.3	706.45	644.87	58.9
2007	72.44	29420.9	5.4	125.83	12.5	13.1	833.61	748.06	56.4
2008	96.94	30610.4	11.6	118.57	11.7	14	983.66	867.74	62.3
2009	61.74	31920.1	12.5	148.88	13.5	15.2	1160.72	1006.58	48.7
2010	79.61	33240.5	13.7	150.3	13.3	17	1369.65	1167.64	53.1
2011	111.26	34510.8	10.8	153.86	12	19.1	1616.19	1354.46	55.6
2012	111.63	35940.3	12.2	157.5	12	21.1	1907.11	1571.17	51.2
2013	108.56	37410.2	8.5	157.31	12	23.4	2250.38	1822.56	49.5
2014	99.45	38920.6	8	158.55	13	25.1	2655.45	2114.17	53.4

2015	52.32	40410.1	9	192.44	13	26.8	3133.44	2452.44	44.8
2016	43.55	42080.5	15.7	253.49	14	28.5	3697.45	2844.83	41.2
2017	54.25	43810.2	16.5	305.79	14	29.1	4363	3299.99	46.9
2018	71.34	45540.9	12.1	306.08	14	29.7	5148.34	3827.99	50.1
2019	64.3	47390.4	11.4	306.92	13.5	30.1	6075.04	4440.48	48.3
2020	41.96	49210.1	13.2	358.81	11.5	32.5	7168.55	5150.95	39.5
2021	70.86	51220.6	17	403.45	11.5	33.3	8458.89	5975.1	47.2
2022	100.93	53240.2	18.8	425.6	16.5	31	9981.49	6931.12	52.6
2023	82.49	55410.8	24.5	638.1	18.75	29	11778.2	8039.99	54.1
2024	80.52	57620.3	33.2	1450	24.75	25	13898.2	9326.39	56.8
2025	69.14	59910.5	23	1365	22	23	16400	10818.6	55.2

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