THE NEXUS BETWEEN OIL PRICES AND EXCHANGE RATE: EVIDENCE FROM NIGERIA

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Abstract

This study investigated the relationship between oil price changes and exchange rates in Nigeria from 1982 to 2023. The study also analyzed the direction of causality between oil price and exchange rates. To achieve these objectives, a Vector Autoregression model was employed and granger causality test was carried out. Results showed that oil price fluctuations had significant short and long run effects on exchange rates. In the long run, a 1% increase in oil price resulted in a 0.02875% change in the exchange rate. Interestingly, Granger causality tests revealed a unidirectional relationship from exchange rates to oil prices. The study concludes by recommending that the Nigerian government should properly manage its foreign exchange reserves and promote diversification of the economy into non-oil sectors to mitigate vulnerabilities associated with oil price changes.

Keywords: Exchange Rate, Granger Causality, Oil Price, Oil Revenue, Vector Autoregression, Gross Domestic Product

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1. Introduction

Oil has been one of the most significant natural resources in the world economy since its discovery in 1800 and also it has been adding relevance for oil-exporting developing countries, which already recorded more than half of the world's total oil consumption (Narayan et al, 2015). Similarly, for oil-exporting countries, since the early 1970s, a significant part of their gross domestic product (GDP) and export earnings can be evidenced through oil (Nasir et al, 2023). Oil products are the largest traded single commodity in the world whether measured in value or volume. As expected, shifts in global oil prices have clear-cut consequences for both importers and exporters. For importers, the rise in oil prices translates into increased production costs, higher inflation, and trade imbalances due to elevated import expenditures, particularly for energy-related goods. This poses challenges to economic growth and currency stability. Conversely, exporting nations typically welcome higher oil prices, leading to high export revenues, more reserves that will strengthen currency position, trade surpluses, and positive economic growth (Buetzer, Habib, & Stracca, 2012).

The main argument for the oil price–exchange rate interplay is based on the fact that oil is quoted in US dollars (USD) and, therefore, variations in oil price do shape the exchange rate behaviour of trading countries through the reference currency which is the US dollar. Krugman (1983) argue that higher oil prices will transfer wealth from the oil-importing countries to oil-exporting countries. This implies that when the price of oil goes up, countries that export oil may see their exchange rates appreciate, leading to a positive balance of payments and overall economic growth. On the other hand, countries that import oil may witness a depreciation in their exchange rates, resulting in a negative balance of payments and a decline in economic growth.

Nigeria is recognized not only for its significant oil production but also as a net exporter of oil. Consequently, shifts in oil prices have profound consequences on the macroeconomic landscape of Nigeria. Given that roughly 90% of the nation's total annual foreign revenue is derived from crude oil, any changes in oil prices directly affect Nigeria's economic stability and the welfare of its citizens (Adeyemi & Oluwatomisin, 2013).

While other oil-exporting countries are recording tremendous economic advantages from the rising oil prices, the reverse is the case for Nigeria. For instance, Saudi Aramco, the government-owned oil and gas company in Saudi Arabia, declared a 124 percent increase in profit to US$110 billion in 2021, reflecting the level of inflows (EIA, 2021).

Most recently, the global oil market has exhibited a persistent upward trend for the year 2023, the average price of Brent crude oil was $83 per barrel, down from $101/b in 2022, influenced by changes in trade dynamics and global crude oil demand falling short of expectations. The EU import ban on Russia's crude oil, interest rate hikes, and inflation concerns led to price fluctuations in the first half of the year. Despite increased volatility in the second half due to geopolitical tensions, Brent crude oil prices ended the year at $78/b. OPEC+ members extended production cuts through 2024, and Saudi Arabia implemented voluntary cuts. Various events, including the Israel-Hamas conflict, influenced oil prices, with

Brent reaching $98/b in September. Prices fluctuated, settling at $74/b in December but rising to $78/b by the year-end due to heightened geopolitical tensions affecting shipping routes.

Empirical studies suggest a negative relationship between real exchange rates and crude oil prices in net oil-exporting countries like Nigeria, driven by cases where high prices bring more foreign currency into the country (Krugman, 1983).

In Nigeria's economic landscape, the relationship between oil prices and the exchange rate of the Naira presents a persistent challenge that demands rigorous investigation. Despite experiencing periods of booming oil prices, Nigeria has not witnessed a significant corresponding appreciation of its local currency, the Naira. Historical data from the Central Bank of Nigeria (CBN) reveals a disconnect between global crude oil price fluctuations and the exchange rate of the Naira. For instance, between 1999 and 2003, average crude oil prices stood at $22.84 per barrel, while the average dollar-to-Naira exchange rate was ₦112.24 per dollar. Similarly, from 2014 to 2021, the average oil price stood at $54.70 per barrel, and the Naira's exchange rate remained volatile, with an average rate of ₦287.48 per dollar (CBN, 2021).

Moreover, fluctuations in oil prices have exacerbated negative impacts on the Nigerian economy. For instance, in 2017, the Nigerian economy plunged into recession due to sudden declines in crude oil prices, accumulated government deficits, and depleting foreign reserves. During this period, the real growth rate slumped by -0.36% and -2.06% in the first and second quarter of 2017 respectively, following a marginal real GDP growth of 0.55% (CBN, 2021).

In response to these challenges, the Central Bank of Nigeria (CBN) has adopted various exchange rate systems, including fixed, floating, and managed floating regimes, alongside intermittent interventions aimed at achieving extended market stability. However, despite these efforts, empirical evidence falls short in validating the achievement of exchange rate stability objectives (James, 2019).

In light of these developments, it becomes imperative to delve into the intricate relationship between oil prices and exchange rates and its cascading effects on external reserves, inflation rate, government revenue, and economic growth. This study aims to contribute to a nuanced understanding of the nexus between the volatile interplay between oil prices and exchange rates in Nigeria, offering insights that can inform strategic policies and interventions for sustainable economic development in Nigeria in the year 2024 and beyond.

The problem statement above has prompted the following research questions:

1. What is the relationship between oil prices and the exchange rate in Nigeria?
2. What is the impact of oil prices on exchange rate in the short run and long run in Nigeria?
3. What is the direction of causality between oil prices and the exchange rate in Nigeria?

The primary aim of this study is to investigate the relationship between oil price and exchange rate in Nigeria. The specific objectives are as follows: To determine the impact of oil price changes on the exchange rate in Nigeria, to ascertain the direction of causality of oil prices and exchange rates in Nigeria and,

to investigate the potential feedback effects between exchange rate movement and other macroeconomic variables like GDP, external reserves and total exports in Nigeria.

Given the dynamic nature of the global oil market, there is a notable gap in understanding how current economic trends impact this nexus. This study aims to fill this gap by leveraging recent data to provide insights into the contemporary dynamics between oil prices and exchange rates in Nigeria.

Following the introduction in Section 1, the rest of this paper is arranged as follows: Section 2 takes a look at the literature review while Section 3 discusses the methodology. Results are presented in Section 4 and Section 5 concludes the study.

2. Literature Review

This section reviews existing related literature to this study. It looks into the conceptual framework related to the study, a theoretical review, and an empirical literature review by different authors, and concludes with a summary and gap analysis of the review literature.

2.1 Conceptual framework

2.1.1 Crude oil price

The fluctuation of crude oil prices is a cornerstone of global economic dynamics, profoundly impacting industries, economies, and consumers worldwide. The price of crude oil, determined by supply and demand fundamentals, geopolitical tensions, and market speculation, is closely monitored as a barometer of economic health and stability. In recent years, the volatility of crude oil prices has been particularly notable, driven by a myriad of factors including geopolitical events, technological advancements, and shifts in global energy demand.

2.1.2 Exchange rate

Exchange rates play a critical role in the relationship between oil prices and the economy of Nigeria, as they influence various aspects such as trade balance, inflation, and overall economic stability. Exchange rates refer to the value of one currency relative to another currency, determining the rate at which currencies are exchanged in the foreign exchange market. In the context of Nigeria, exchange rates are particularly significant due to the country's heavy reliance on oil exports. Fluctuations in global oil prices directly impact Nigeria's foreign exchange earnings, which, in turn, affect the value of the Nigerian currency, the Naira, relative to other currencies.

2.2 Theoretical Review

The theoretical underpinning of the linkage between crude oil price and exchange rates is based on the following theories:

2.2.1 The Purchasing Power Parity Theory (PPP).

Purchasing Power Parity (PPP), a theory pioneered by Swedish economist Gustav Cassel in the aftermath of World War I remains a cornerstone in understanding exchange rate dynamics. The concept asserts that exchange rates between two

countries should adjust to equalize the prices of identical goods and services, ensuring parity in purchasing power. This principle is exemplified by the hypothetical scenario where, if US $4 buys one bushel of wheat in the United States and the exchange rate is 120 Japanese yen for US $1, then the price of a bushel of wheat in Japan should be 480 yen (4 × 120), thus demonstrating PPP in action.

2.2.2 Dutch Disease.

The term "Dutch disease" was first coined by The Economist in 1977 to describe the decline in the manufacturing sector in the Netherlands following the discovery of the Groningen natural gas field in 1959. The mechanism underlying Dutch disease is relatively straightforward. With increased revenues in the booming sector, the country's currency is appreciated relative to foreign currencies, as evidenced by changes in the exchange rate. Consequently, exports from other sectors become more expensive for foreign buyers, while imports become cheaper for domestic consumers, rendering those sectors less competitive on the global market. The real exchange rate was significantly affected by Dutch disease. As demand for non-traded goods (services) increased, their prices rose. However, prices in the traded goods sector, such as commodities, remain set internationally and cannot adjust accordingly. Consequently, there was an upward pressure on the real exchange rate, which affected the overall competitiveness of the economy.

2.3 Empirical Review

2.3.1 Evidence from Around the World

Nandelenga and Simpasa (2019) focused on exploring the bivariate dependence between exchange rates and crude oil prices, as well as volatility spillover, in selected emerging and low-income countries. The analysis utilized a two-pronged approach, employing elliptic copula models and the Hafner and Herwartz framework, using daily data spanning from January 2000 to December 2018. The study identified evidence of heterogeneous dependence patterns for both net oil exporters and net oil importers, as well as variations based on the type of exchange rate and country classification. The study's findings confirm previous research indicating that an increase (decrease) in oil prices in net oil-exporting (importing) countries correlates with appreciation (depreciation) of the domestic currency against the US dollar.

Komain (2015) investigated the relationship between oil price volatility and the real effective exchange rate in Thailand over the period from July 1997 to December 2013. Utilizing monthly data on real effective exchange rate index and real oil price, the study employs various time series analysis techniques to analyze the relationship between these variables. The findings reveal that there is no long-term relationship between real oil prices and real effective exchange rates in Thailand. Despite the absence of a direct causal link between real oil price and real effective exchange rate, the study finds that an increase in oil price volatility leads to an increase in exchange rate volatility. This implies that uncertainty in oil prices can contribute to fluctuations in the foreign exchange market, potentially affecting the country's trade balance.

Ahmed et al. (2016) investigated the nexus between exchange rate volatility and oil price fluctuations in Pakistan. Spanning from the first quarter of 1983 to the second quarter of 2014, the study employed various econometric techniques, including Johansen Cointegration and Vector Error Correction Model (VECM), to conduct both short-run and long-run analyses. The empirical findings of the study shed light on the determinants of the exchange rate in Pakistan, revealing that factors such as productivity differential, real foreign exchange reserves, interest rate differential, real exports, and oil prices play significant roles in shaping exchange rate dynamics.

2.3.2 Evidence from Nigeria

Nasir et al (2023) investigated the effect of oil prices on exchange rate in Nigeria from 1980 to 2018 and utilized both linear and non-linear Autoregressive Distributed Lag (ARDL) models. The results from the linear ARDL models demonstrated a positive and significant impact of oil prices on the exchange rate in both the short and long run. Similarly, the non-linear ARDL model indicated that both rising and falling oil prices exert an increasing impact on the exchange rate. The findings of the study highlighted the asymmetric nature of the relationship between oil prices and exchange rates in Nigeria. The authors advocated maintaining constant exchange rates during stable oil price periods to exert pressure on foreign currency, thereby enhancing the impact of oil prices on the exchange rate.

Umunna et al. (2023) examined the transmission effect of oil prices on Nigeria's exchange rate over the period 1980-2022. Utilizing the Exponential growth (EGARCH) model, the authors aimed to discern the volatility transmission effect between oil prices and exchange rates in Nigeria. The study concluded that the Nigerian exchange rate is not substantially influenced by volatility transmission stemming from fluctuations in crude oil prices.

Meanwhile, Adejola et al. (2022) delved into the relationship between oil prices and exchange rates in Nigeria. The study challenged the proposition that there is no significant relationship between oil prices and exchange rates, employing wavelet analysis to examine monthly data from January 1980 to December 2020. Through their analysis, Adejola et al. (2022) uncovered a mixed relationship between oil prices and exchange rates during the study period. Notably, they observed a lead-lag effect of oil prices on exchange rates in the long run, suggesting a time-varying effect of oil prices on exchange rates over extended periods. Furthermore, the study revealed evidence of unidirectional causality from oil prices to exchange rates in the short and medium terms, contrasting with bidirectional causality observed in the long run. This finding underscores the dynamic nature of the relationship between oil prices and exchange rates, with oil prices emerging as a key determinant of exchange rates in the short and medium terms but not in the long term.

Sanusi et al. (2022) contributes to this body of literature by assessing the relationship between oil price volatility and exchange rates in Nigeria using monthly time series data for the period 1999-2021. The Generalized Autoregressive Conditional Heteroscedasticity (GARCH) model was used to measure oil price volatility and the Autoregressive Distributed Lag (ARDL) model to examine both short-run and long-run relationships. The study finds a significant positive

relationship between oil price volatility and exchange rates in Nigeria. This suggests that fluctuations in oil prices exert a notable influence on the Nigerian exchange rate, impacting economic stability and performance.

Musa et al. (2020) analyzed the impact of crude oil prices on the exchange rate in Nigeria using an autoregressive distributed lag (ARDL) model. They found evidence regarding the impact of crude oil prices on exchange rates in Nigeria. The results revealed a negative and significant impact of crude oil prices on exchange rates in both the long and short run.

Attahir (2019) examined the dynamics of the relationship between oil prices and exchange rates in Nigeria using monthly data spanning from January 1986 to June 2018. The primary focus of the study was to determine whether there were any asymmetries in this relationship and to analyze the effect of oil price shocks on the exchange rate. Various econometric models, including Threshold Autoregressive (TAR), Momentum Threshold Autoregressive (MTAR), and Structural Vector Autoregressive (SVAR) models were employed to analyze the data. The empirical findings from the TAR and MTAR models indicated the absence of asymmetric cointegration, suggesting that there were no significant asymmetries in the relationship between oil prices and exchange rates in Nigeria. Additionally, the SVAR model revealed that following positive shocks to oil prices, there was a gradual appreciation of the Nigerian naira, albeit with some time lag.

3. Research Methodology

3.1 Nature and Data Sources

Time series data was used. Exchange rate was sourced from the World Bank Indicators, Brent oil prices from the US Energy Information Administration (EIA), while Gross Domestic Product (GDP), external reserves and total exports data were sourced from the Central Bank of Nigeria (CBN). The dataset was collected over 42 years from 1982 to 2023, with records available yearly.

3.2 Model specification

This study adapted Umunna et al. (2023) model with modification. The modified model in its general form is stated as:

EXR = f(OLP, ER, GDP, TEX)……(1)

The above model implies that Nigeria's exchange rate is collectively determined by oil price (OLP), external reserves (ER), gross domestic product (GDP), and total exports (TEX). The variables included were based on economic theory and empirical literature.

Including the error term, the model becomes:

$EXR_t = \beta_0 + \beta_1 OLP_t + \beta_2 ER_t + \beta_3 GDP_t + \beta_4 TEX_t + U_t$ ……..(2)

Where;

EXR = Exchange rate

OLP = Oil price

ER = External reserves

GDP = Gross domestic product

TEX = Total export

t = Period

β_0 = Intercept of the exchange rate
β_1 - β_4 = Coefficient of regressors (independent variables)
U_t = Time series error term

The decision to exclude the "inflation" and "interest rate" variables from the primary model was driven by concerns over multicollinearity, as these variables often demonstrate high correlation with other predictors, potentially leading to instability or inflated standard errors in regression analysis. Also, the inclusion of the "total export" variable aligns with economic theory that emphasizes the significant impact of trade balances on exchange rates. According to the balance of payments model, countries with higher export levels typically experience stronger demand for their currency, resulting in appreciation. By incorporating total export into the model, the analysis not only adheres to theoretical underpinnings but also captures a critical determinant of exchange rate dynamics.

Table 3.1 Data Description

Variables	**Description**	**Source of Data**
Exchange rate (EXR)	**Exchange rates represent the value of one currency in terms of another.**	**World Bank Indicators**
Oil Price (OLP)	Oil prices refer to the market price of crude oil, and is measured using benchmark crude oil prices such as Brent crude	US Energy Information Administration (EIA)
Gross domestic product (GDP)	GDP represents the total monetary value of all goods and services produced within a country's borders over a specific period.	Central Bank of Nigeria (CBN)
External reserves (ER)	External reserves refer to a country's holdings of foreign currencies and other liquid assets, typically held by its central bank.	Central Bank of Nigeria (CBN)
Total export (TEX)	Total exports represent the total monetary value of goods and services sold by a country to foreign markets.	Central Bank of Nigeria (CBN)

Source: Author's computation, 2024

3.3 Estimation Techniques

3.3.1 Vector Autoregression

In the realm of econometrics, Vector Autoregression (VAR) stands out as a powerful tool for analyzing the dynamic interdependencies among multiple time series variables. Unlike traditional regression models that focus on estimating the conditional mean function of a single variable, VAR allows researchers to explore the joint behaviour of several variables over time.

At its core, VAR treats each variable in the system as a function of its past values and the past values of all other variables in the system. This approach acknowledges the mutual influences and feedback mechanisms that exist among the variables, thereby providing a more comprehensive understanding of their relationships.

In the context of this study on the nexus between oil prices and exchange rates in Nigeria, VAR emerges as a suitable estimation technique due to its ability to capture the dynamic interactions between these key macroeconomic variables. By

employing VAR, we aim to unravel the relationship between oil prices and exchange rates, shedding light on their mutual influences and implications for the Nigerian economy.

The VAR model included the following variables; Exchange rate, Oil price, External reserves, GDP, and Total exports. Each variable has been carefully selected based on its relevance to the research question and its potential to contribute to the understanding of the nexus between oil prices and exchange rates in Nigeria. The VAR model was estimated using the appropriate technique. The lag length of the VAR model was determined using the Akaike Information Criterion (AIC) to ensure optimal model specification.

Diagnostic tests were conducted to assess the adequacy of the estimated VAR model. These tests include examining residuals for serial correlation, heteroscedasticity, and normality. By employing VAR as the estimation technique, this study aims to provide a comprehensive understanding of the nexus between oil prices and exchange rates in Nigeria.

While investigating the dynamic relationship, the regression model is as follows:

$$\mathrm{EXR_t} = \alpha_1 + \beta_{11}\mathrm{EXR_{t-1}} + \beta_{12}\mathrm{OLP_{t-1}} + \beta_{13}\mathrm{ER_{t-1}} + \beta_{14}\mathrm{GDP_{t-1}} + \beta_{15}\mathrm{TEX_{t-1}} + U_{1t}$$

$$\mathrm{OLP_t} = \alpha_2 + \beta_{21}\mathrm{EXR_{t-1}} + \beta_{22}\mathrm{OLP_{t-1}} + \beta_{23}\mathrm{ER_{t-1}} + \beta_{24}\mathrm{GDP_{t-1}} + \beta_{25}\mathrm{TEX_{t-1}} + U_{2t}$$

$$\mathrm{ER_t} = \alpha_3 + \beta_{31}\mathrm{EXR_{t-1}} + \beta_{32}\mathrm{OLP_{t-1}} + \beta_{33}\mathrm{ER_{t-1}} + \beta_{34}\mathrm{GDP_{t-1}} + \beta_{35}\mathrm{TEX_{t-1}} + U_{3t}$$

$$\mathrm{GDP_t} = \alpha_4 + \beta_{41}\mathrm{EXR_{t-1}} + \beta_{42}\mathrm{OLP_{t-1}} + \beta_{43}\mathrm{ER_{t-1}} + \beta_{44}\mathrm{GDP_{t-1}} + \beta_{45}\mathrm{TEX_{t-1}} + U_{4t}$$

$$\mathrm{TEX_t} = \alpha_5 + \beta_{51}\mathrm{EXR_{t-1}} + \beta_{52}\mathrm{OLP_{t-1}} + \beta_{53}\mathrm{ER_{t-1}} + \beta_{54}\mathrm{GDP_{t-1}} + \beta_{55}\mathrm{TEX_{t-1}} + U_{5t}$$

Where $\mathrm{EXR_t}$, $\mathrm{OLP_t}$, $\mathrm{ER_t}$, $\mathrm{GDP_t}$ and $\mathrm{TEX_t}$ represent exchange rate, oil price, external reserve, Gross Domestic Product and total exports at time t respectively.
$\mathrm{EXR_{t-1}}$, $\mathrm{OLP_{t-1}}$, $\mathrm{ER_{t-1}}$, $\mathrm{GDP_{t-1}}$, and $\mathrm{TEX_{t-1}}$ are the lagged values of the variables,

3.3.2 Estimation Technique Procedure

The Augmented Dickey-Fuller (ADF) unit root test was conducted to ascertain the stationarity of each variable in the time series data. Following this, a test was carried out to determine the optimal lag order (p) for the VAR model, employing criteria such as the Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC). This step was crucial in capturing the appropriate temporal dependencies within the data. The VAR model was specified, incorporating the determined lag order. This resulted in a system of equations where each variable is regressed on its lagged values and the lagged values of other variables in the

system. In order to achieve the research objectives the dynamic effects of shocks to one variable on all variables in the VAR system over time was observed. This provided insight into the short-term and long-term responses of each variable to exogenous shocks. Granger causality tests were also employed to investigate the direction of causality between the variables in the system.

Next, the presence of cointegration among the variables was examined using the Johansen cointegration test. Johansen cointegration test helps to determine if there are long-term relationships among the variables. This test helps us determine the number of relationships and whether they have lasting impacts over time. Through hypothesis testing and interpretation of test statistics, the number of cointegrating vectors and the existence of cointegrating relationships among the variables will be identified.

Finally, the estimation, overall fit and performance of the VAR model, as well as the cointegration relationships, will be rigorously evaluated in the statistical software package, EView and the findings from the model estimation, cointegration test, and causality tests will be interpreted in the context of the research objectives using. Conclusions will be drawn regarding the relationships among the variables and their implications.

4. Result and Discussion

This Section presents our findings together with a discussion of the results.

Table 4.1: Descriptive statistics of Variables

	EXR	OLP	GDP	ER	TEX
Mean	130.7656	46.54496	39979.89	19828.61	7083882.
Maximum	635.2360	111.6500	77936.10	58472.88	35962392
Minimum	0.673461	12.78000	16048.31	456.6417	7502.500
Std. Dev.	142.2405	31.34849	21490.38	17585.87	8504945.
Observations	42	42	42	42	42

Source: Author's computation, 2024.

The table 4.1 presents the descriptive statistics of the variables in this study for 42 observations. The variables include Exchange Rate (EXR), Oil Price (OLP), Gross Domestic Product (GDP), External Reserves (ER), and Total Export (TEX). The statistical measures reported are mean, maximum, minimum, and standard deviation. The average exchange rate is 130.7656, with a wide range from a minimum of 0.673461 to a maximum of 635.2360. The high standard deviation of 142.2405 confirms the substantial variability in EXR, implying the exchange rate in Nigeria was not stable during the period analyzed.

The mean oil price (OLP) of 46.54496 represents the average oil price over the sample period with values ranging from 12.78000 to 111.6500, suggesting that oil prices experienced both low and high values, with a wide gap between the minimum and maximum. The standard deviation of 31.34849 indicates moderate variability, but less than the exchange rate.

4.1 Unit root test

The Augmented Dickey-Fuller (ADF) and Philip-Perron (PP) tests were utilized to determine whether each variable in the study possesses a unit root, which would indicate non-stationarity. The result of the unit root conducted was presented in table 4.2 below.

Table 4.2: Unit root test

Variables	ADF Test	PP Test	Critical values	Stationarity Status
EXR	-4.181369	-4.110723	-3.610453 (1%) -2.938987 (5%) -2.607932 (10%)	I(1)
OLP	-5.260493	-5.124017	-4.211868 (1%) -3.529758 (5%) -3.196411 (10%)	I(1)
ER	-4.864747	-4.343973	-3.605593 (1%) -2.936942 (5%) -2.606857 (10%)	I(1)
GDP	-2.538098	-3.583971	-3.605593(1%) -2.936942 (5%) -2.606857(10%)	I(1)
TEX	-3.952669	-3.418067	-3.610453 (1%) -2.938987 (5%) -2.607932 (10%)	I(1)

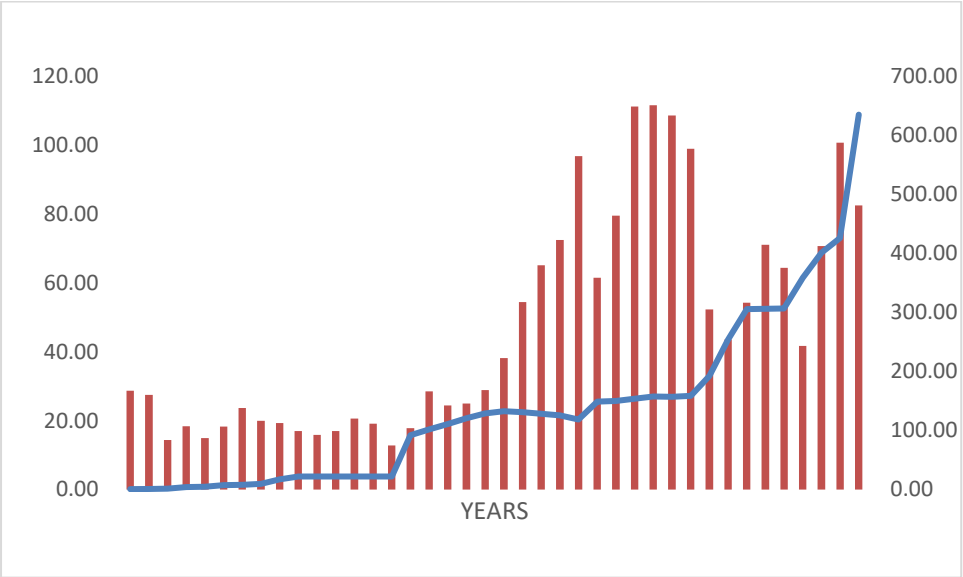
Source: Author's computation, 2024

The tests were conducted at significance levels of 1%, 5%, and 10%. The results show that all variables are non-stationary at their levels but become stationary after first differencing, denoted as I(1). Thus, the time series data for these variables are integrated of order one, I(1), which is crucial for subsequent analyses like Vector Autoregression (VAR) models and cointegration test, allowing for a deeper exploration of the relationships between these economic indicators.

The trend analysis of oil prices (OLP) and exchange rates (EXR) in Nigeria from 1982 to 2023 reveals significant fluctuations in both variables over the observed period. The annual oil prices, measured in USD per barrel, showed notable periods of change, including a sharp decline in the mid-1980s, substantial increases in the mid-2000s, and marked fluctuations during the 2010s. These variations in oil prices reflect global economic conditions, geopolitical events, and shifts in the global oil market.

The exchange rates, recorded in Nigerian Naira (NGN) per USD, also exhibited substantial changes, particularly during periods of economic instability and policy adjustments in Nigeria. The exchange rate trends show pronounced depreciation during 1980's, aligning with economic crises and policy shifts that impacted Nigeria's foreign exchange market.

Figure 4.1 Trend Analysis for Oil price And Exchange Rate in Nigeria between 1982 - 2023



Source: Author's computation, 2024

It can therefore visually be observed that co-movements between oil prices and exchange rates in Nigeria exist.

Table 4.3 Lag Selection Criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-1845.571	NA	1.13e+35	94.90107	95.11434	94.97759
1	-1641.910	344.6565*	1.20e+31*	85.73898*	87.01864*	86.19811*
2	-1622.022	28.55678	1.67e+31	86.00115	88.34720	86.84289
3	-1595.176	31.66501	1.81e+31	85.90646	89.31889	87.13081

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

Based on the lag selection criteria analysis presented in Table 4.3, several indicators were used to determine the appropriate lag order for the VAR (Vector Autoregression) model. The results of the lag order selection process indicate that the optimal lag length is 1, as unanimously suggested by the LR, FPE, AIC, SC, and HQ information criteria. This means that the current values of the variables are influenced by their own lagged values from the previous period (lag 1).

Table 4.4: VAR Estimation

Vector Autoregression Estimates
Sample (adjusted): 1983 2023
Included observations: 41 after adjustments
Standard errors in ( ) & t-statistics in [ ]

	EXR	**OLP**	**GDP**	**ER**	**TEX**
EXR(-1)	1.017186	0.177563	22.57659	66.65030	48186.95
	(0.15635)	(0.07485)	(5.79652)	(30.4459)	(11587.2)
	[6.50581]	[2.37223]	[3.89485]	[2.18914]	[4.15865]
OLP(-1)	-0.427483	1.029463	64.88868	172.7994	51611.15
	(0.49328)	(0.23615)	(18.2877)	(96.0551)	(36556.8)
	[-0.86662]	[4.35935]	[3.54822]	[1.79896]	[1.41181]
GDP(-1)	-0.000298	-0.000321	0.890546	-0.071016	-106.1747
	(0.00085)	(0.00041)	(0.03140)	(0.16494)	(62.7732)
	[-0.35132]	[-0.79196]	[28.3590]	[-0.43056]	[-1.69140]
ER(-1)	-0.000807	0.000273	0.053900	0.820368	-34.63292
	(0.00068)	(0.00032)	(0.02510)	(0.13181)	(50.1658)
	[-1.19232]	[0.84180]	[2.14780]	[6.22370]	[-0.69037]
TEX(-1)	6.45E-06	-2.61E-06	-0.000303	-0.001160	0.570941
	(3.1E-06)	(1.5E-06)	(0.00011)	(0.00060)	(0.22914)
	[2.08672]	[-1.76371]	[-2.64103]	[-1.92687]	[2.49163]
C	19.16466	2.703925	973.5145	-1323.977	370813.3
	(18.4374)	(8.82670)	(683.547)	(3590.29)	(1366400)
	[1.03945]	[0.30633]	[1.42421]	[-0.36877]	[0.27138]
R-squared	0.962012	0.823675	0.997702	0.905019	0.941855
Adj. R-squared	0.956585	0.798485	0.997373	0.891450	0.933549
Sum sq. resids	30853.45	7071.337	42407393	1.17E+09	1.69E+14
S.E. equation	29.69052	14.21401	1100.745	5781.602	2200373.
F-statistic	177.2688	32.69933	3038.496	66.69905	113.3894
Log likelihood	-193.9568	-163.7563	-342.0863	-410.0928	-653.7025
Akaike AIC	9.753992	8.280793	16.97982	20.29721	32.18061
Schwarz SC	10.00476	8.531559	17.23059	20.54797	32.43138
Mean dependent	133.9386	46.87533	40510.64	20287.18	7256459.
S.D. dependent	142.4947	31.66382	21476.86	17548.26	8535824.
Determinant resid covariance (dof adj.)		7.69E+30			
Determinant resid covariance		3.49E+30			
Log likelihood		-1732.580			
Akaike information criterion		85.97951			
Schwarz criterion		87.23334			

Source: Authors computation, 2024

The VAR estimation results presented in Table 4.4 offer valuable insights into the dynamic relationships between the variables in the model. The lagged exchange rate (EXR(-1)) has a positive and statistically significant impact on the current exchange rate, with a coefficient of 1.017186, indicating that a one-unit increase in the lagged exchange rate is associated with a 1.017186-unit increase in the current exchange rate, holding all other variables constant. The lagged oil price (OLP(-1)) has a negative but insignificant effect on the exchange rate, with a coefficient of -0.427483.

In the oil price equation, the lagged oil price (OLP(-1)) has a positive and statistically significant impact on the current oil price, with a coefficient of 1.029463, suggesting that a one-unit increase in the lagged oil price leads to a 1.029463-unit increase in the current oil price, ceteris paribus. The lagged exchange rate (EXR(-1)) has a positive and significant effect on the oil price, with a coefficient of 0.177563.

Concerning gross domestic product (GDP), the lagged GDP positively influences the current GDP, with a one-unit increase in the former associated with a 0.890546-unit increase in the latter. Moreover, both the lagged exchange rate (EXR(-1)) and oil price (OLP(-1)) exert positive and significant effects on GDP.

In the exchange rate equation, the lag external reserve (ER(-1)) has a positive and statistically significant impact on the current exchange rate, with a coefficient of 0.820368, suggesting that a one-unit increase in the lagged exchange rate leads to a 0.820368-unit increase in the current exchange rate, ceteris paribus. The lagged GDP (GDP(-1)) has a negative but insignificant effect on the exchange rate, with a coefficient of -0.071016.

Lastly, in the total exports (TEX) equation, the lagged total exports (TEX(-1)) exerts a positive and statistically significant influence on the current total exports, with a coefficient of 0.570941. This suggests that a one-unit increase in the lagged total exports corresponds to a 0.570941-unit increase in the current total exports, with other variables held constant. Furthermore, the lagged exchange rate (EXR(-1)) demonstrates a positive and significant effect on total exports, with a coefficient of 48186.95.

Table 4.5 Casualty Test

Pairwise Granger Causality Tests
Sample: 1982 2023
Lags: 1

Null Hypothesis:	Obs	F-Statistic	Prob.
OLP does not Granger Cause EXR	41	0.18623	0.6685
EXR does not Granger Cause OLP		5.07458	0.0301
GDP does not Granger Cause EXR	41	0.61771	0.4368
EXR does not Granger Cause GDP		0.40313	0.5293
ER does not Granger Cause EXR	41	1.70839	0.1990
EXR does not Granger Cause ER		1.56098	0.2192
TEX does not Granger Cause EXR	41	0.42339	0.5192
EXR does not Granger Cause TEX		20.0931	7.E-05
GDP does not Granger Cause OLP	41	2.87533	0.0981
OLP does not Granger Cause GDP		9.94325	0.0031
ER does not Granger Cause OLP	41	3.31012	0.0767
OLP does not Granger Cause ER		0.06348	0.8024
TEX does not Granger Cause OLP	41	1.59182	0.2148
OLP does not Granger Cause TEX		5.74319	0.0216
ER does not Granger Cause GDP	41	13.6149	0.0007
GDP does not Granger Cause ER		0.65264	0.4242
TEX does not Granger Cause GDP	41	2.30227	0.1375
GDP does not Granger Cause TEX		0.38516	0.5386
TEX does not Granger Cause ER	41	0.13032	0.7201

ER does not Granger Cause TEX	1.55235	0.2204

Source: Author's computation, 2024

The pairwise Granger causality tests presented in Table 4.5 assess the causal relationships between the variables, including oil price (OLP), exchange rate (EXR), gross domestic product (GDP), and total exports (TEX) over the sample period from 1982 to 2023, with one lag considered in the analysis. When analyzing the OLP versus EXR relationship, surprisingly, the test results indicate that OLP does not Granger-cause EXR, with a probability value of 0.6685. This suggests that past values of oil price do not contain significant information to predict future values of exchange rate. In other words, historical oil prices do not appear to have a causal influence on the exchange rate. However, the test reveals a unidirectional causal relationship in the opposite direction, as EXR is found to Granger-cause OLP, with a probability value of 0.0301. This finding suggests that past values of the exchange rate provide valuable information for forecasting future oil prices, implying that movements in the exchange rate can help predict changes in oil prices.

Table 4.6 Variance Decomposition

Variance Decomposition of EXR:						
Period	S.E.	EXR	OLP	GDP	ER	TEX
1	29.69052	100.0000	0.000000	0.000000	0.000000	0.000000
2	48.68863	95.08210	0.402490	0.096005	0.759806	3.659597
3	72.38494	88.94016	1.047378	0.178916	2.072899	7.760643
4	104.1851	83.97836	1.586259	0.217184	3.425176	10.79302
5	147.6585	80.47059	1.907273	0.225758	4.581189	12.81519
Variance Decomposition of OLP:						
Period	S.E.	EXR	OLP	GDP	ER	TEX
1	14.21401	17.43536	82.56464	0.000000	0.000000	0.000000
2	17.80182	12.97557	81.53520	0.331860	0.675290	4.482075
3	19.82594	10.46147	77.70996	0.753600	1.855137	9.219832
4	21.13070	9.967318	73.83801	1.085947	3.018541	12.09018
5	22.10283	11.71599	70.26176	1.277612	3.779190	12.96544
Variance Decomposition of GDP:						
Period	S.E.	EXR	OLP	GDP	ER	TEX
1	1100.745	0.274310	7.138126	92.58756	0.000000	0.000000
2	1647.280	0.123723	22.58318	67.46782	2.786300	7.038973
3	2240.824	0.616850	32.08893	45.03253	6.855516	15.40618
4	2876.885	2.809649	36.21193	30.42973	10.13197	20.41672
5	3542.787	7.688741	37.45065	21.31273	11.91527	21.63262
Variance Decomposition of ER:						
Period	S.E.	EXR	OLP	GDP	ER	TEX
1	5781.602	17.04631	13.15153	2.861178	66.94098	0.000000
2	7701.424	13.03621	14.58590	3.519480	64.12927	4.729131
3	9017.793	10.23750	14.53760	3.856297	61.24588	10.12272
4	9971.327	8.466088	14.06034	4.002367	59.21320	14.25800
5	10660.57	7.410303	13.59698	4.044253	57.93082	17.01764
Variance Decomposition of TEX:						

Period	S.E.	EXR	OLP	GDP	ER	TEX
1	2200373.	2.775617	53.55967	0.530976	0.090131	43.04361
2	3127610.	22.05897	48.96715	0.264526	0.459858	28.24950
3	4335463.	45.31983	35.04355	0.141097	1.135049	18.36047
4	6090035.	62.13749	22.15055	0.071695	2.090368	13.54989
5	8615606.	71.06709	13.44599	0.047577	3.184247	12.25509

Cholesky Ordering: EXR OLP GDP ER TEX

Variance decomposition in a Vector Autoregression (VAR) model provides insight into how much of the forecast error variance of each variable is attributed to shocks in each of the variables within the system. Here, we focus on the relationship between Exchange Rate (EXR) and Oil Price (OLP) in Nigeria, from 1982 to 2023, while providing a brief summary of the other variables (GDP, ER, and TEX). The variance decomposition analysis reveals a dynamic relationship between Exchange Rate (EXR) and Oil Price (OLP) over both short and long-term horizons. In the short term, the forecast error variance of EXR is increasingly influenced by OLP, with OLP's contribution rising from 0.40% in the 2nd period to 1.91% in the 5th period. This suggests that oil price fluctuations play a growing role in explaining exchange rate movements in the near future. Conversely, in the short term, OLP is significantly impacted by EXR, with EXR accounting for 17.44% of the forecast error variance in the 1st period, decreasing to 11.72% in the 5th period. This highlights the immediate influence of exchange rate changes on oil prices.

Table 4.7 Johansen Cointegration Test

Sample (adjusted): 1982 2023
Included observations: 40 after adjustments
Trend assumption: Linear deterministic trend
Series: EXR OLP GDP ER TEX
Lags interval (in first differences): 1 to 1

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.492275	72.69660	69.81889	0.0289
At most 1	0.413672	45.58398	47.85613	0.0805
At most 2	0.328986	24.22891	29.79707	0.1909
At most 3	0.175513	8.270307	15.49471	0.4370
At most 4	0.013670	0.550565	3.841466	0.4581

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None	0.492275	27.11263	33.87687	0.2574
At most 1	0.413672	21.35507	27.58434	0.2553
At most 2	0.328986	15.95860	21.13162	0.2273
At most 3	0.175513	7.719742	14.26460	0.4079
At most 4	0.013670	0.550565	3.841466	0.4581

Max-eigenvalue test indicates no cointegration at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Table 4.7 provides the result for the Johansen cointegration test. This test is used to determine whether two or more time series are cointegrated, meaning they share a long-term relationship. The test is applied to the relationship between oil price (OLP) and exchange rate (EXR) in Nigeria, along with other variables such as gross domestic product (GDP), external reserve (ER) and total export (TEX).

The cointegration test results indicate that there is one cointegrating equation at the 0.05 level, suggesting that the oil price and exchange rate are cointegrated. The normalized cointegrating coefficients suggest that the oil price and exchange rate are positively related, with a coefficient of 0.028750 for the oil price and 1.000000 for the exchange rate. This indicates that a 1% change in oil price leads to a 0.02875% change in the exchange rate. The adjustment coefficients indicate the speed at which the variables adjust to their long-term equilibrium. For example, the adjustment coefficient for the exchange rate is 0.321367, suggesting that the exchange rate adjusts to its long-term equilibrium at a rate of 32.13% per period.

The cointegration test results suggest that there is a long-term relationship between the oil price and exchange rate in Nigeria. The positive coefficient of the oil price indicates that an increase in oil price leads to an increase in the exchange rate. The adjustment coefficients suggest that the exchange rate adjusts to its long-term equilibrium at a relatively slow rate. This implies that the exchange rate may not immediately adjust to changes in the oil price, leading to potential deviations from its long-term equilibrium.

4.2 Post Estimation Techniques

Post-estimation techniques are analytical methods used to evaluate and validate the results obtained from statistical models. After running a model, these techniques help diagnose the model's performance, check the validity of assumptions, and understand the results' robustness and reliability.

Table 4.2.1 VAR Residual Serial Correlation LM Tests

VAR Residual Serial Correlation LM Tests
Null Hypothesis: no serial correlation at lag order h
Sample: 1 43
Included observations: 41

Lags	LM-Stat	Prob
1	27.08331	0.3517

Probs from chi-square with 25 df.

Table 4.2.2 Heteroskedasticity Test: Breusch-Pagan-Godfrey

Heteroskedasticity Test: Breusch-Pagan-Godfrey			
F-statistic	2.346074	Prob. F(4,37)	0.0724
Obs*R-squared	8.497281	Prob. Chi-Square(4)	0.0750
Scaled explained SS	4.794665	Prob. Chi-Square(4)	0.3090

Figure 4.2 Normality Test

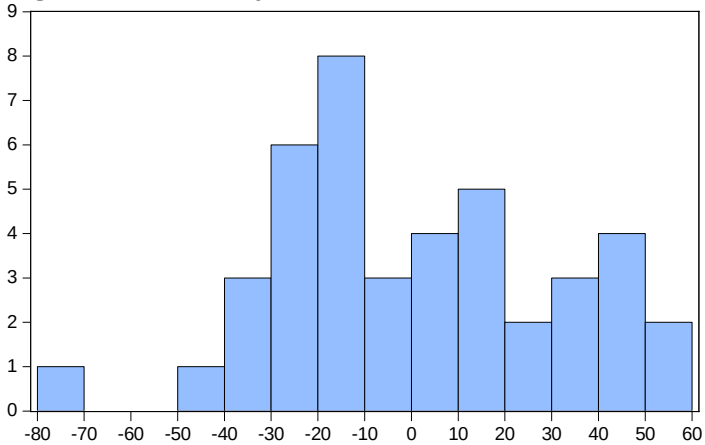
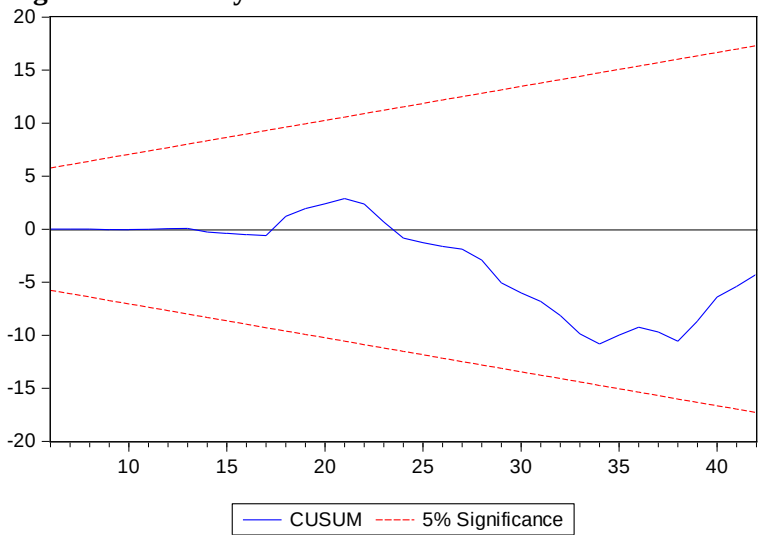


Figure 4.3 Stability Test



5. Conclusion and Policy Implication

This study investigated the relationship between oil price and exchange rates in Nigeria. The first objective was to assess the short-run and long-run impact of Oil Price changes on the Exchange Rate in Nigeria. In the short run, the results revealed that an increase in oil price leads to an immediate increase in the exchange rate. However, this effect gradually diminishes over time, indicating that the initial impact of the oil price shock on the exchange rate is strong but not enduring. This suggests that while oil price fluctuations significantly influence the exchange rate in the immediate term, the exchange rate tends to revert to its equilibrium level in the long run.

Furthermore, the variance decomposition analysis showed that the forecast error variance of the exchange rate is increasingly explained by oil price

fluctuations. Specifically, the contribution of oil price to the forecast error variance of exchange rate rises from 0.40% in the second period to 1.91% in the fifth period. This growing influence marks the importance of oil price movements in shaping exchange rate variations in the near future.

In the long run, the Johansen cointegration test results provide compelling evidence of a sustained relationship between oil prices and exchange rates in Nigeria. The existence of one cointegrating equation at the 0.05 level indicates a long-term equilibrium relationship between these variables. The normalized cointegrating coefficients further reveal a positive relationship, with a coefficient of 0.028750 for the oil price. This coefficient implies that a 1% increase in oil price results in a 0.02875% change in the exchange rate. This long-term positive correlation aligns with economic theory, which posits that higher oil prices negatively affect foreign exchange earnings of oil importing countries, leading to its currency depreciation. These findings are in line with Igbinovia et al. (2021) and Nasir et al. (2023)**.**

The second objective was to identify the direction of causality between Oil Prices and Exchange. The result showed that oil price does not cause exchange rate, but exchange rates cause oil price. This relationship might be driven by several factors such as market perceptions and speculation, as exchange rates reflect broader market perceptions and investor confidence. Movements in the exchange rate could influence speculators' and traders' expectations regarding future oil prices, thereby impacting the actual prices. Secondly, economic policies and foreign exchange reserves play a role, as exchange rate fluctuations often lead to adjustments in economic policies and foreign exchange reserves management. Such adjustments can impact oil-related transactions and contracts, thereby influencing future oil prices. Lastly, the cost of imports and exports is a factor, as changes in the exchange rate affect the cost of importing goods and services, including those related to oil production and export. An appreciating Naira might reduce the cost of imported goods and vice versa. This research findings is found to be contrast to the findings of Adejola et al. (2022) and Narayan et al. (2015). However the findings from the similar studies carried by Olayungbo (2019), Umunna et al. (2023) and Ahmad et al. (2013) are found to be similar.

The third objective was to assess the response of other macroeconomic variables to exchange rate movement. The analysis revealed interesting feedback effects between the exchange rate and other key macroeconomic variables in Nigeria, including GDP, external reserves, and total exports. A shock to GDP initially leads to a negative response of the exchange rate in the first period, i.e. appreciation of the Naira. However, this effect becomes positive(depreciation) by period 3 and continues to increase over the forecast horizon. This suggests that an unexpected increase in GDP has an initial dampening effect on the exchange rate, but as the economy adjusts, the exchange rate continues to increase in response to the GDP shock. This finding is consistent with the theoretical expectation that higher economic growth, as measured by GDP, should lead to an appreciation of the domestic currency. As the economy expands, the demand for the local currency increases, putting downward pressure on the exchange rate.

A shock to external reserves causes a large negative impact on the exchange rate in the impact period. However, this effect diminishes over time and eventually becomes positive by period 5. This indicates that an unanticipated change in the external reserves has a significant and persistent effect on the exchange rate, with the initial negative impact gradually fading and turning positive in the long run. The negative response of the exchange rate(appreciation) to a shock in external reserves in the short term can be attributed to the stabilizing role of external reserves in managing exchange rate volatility. When external reserves increase, the central bank may intervene in the foreign exchange market to prevent excessive appreciation of the domestic currency. However, in the long run, the positive impact of higher external reserves on the exchange rate prevails, as it signals the country's ability to meet its foreign currency obligations and maintain a stable exchange rate.

In contrast to the GDP and external reserve shocks, a shock to total exports results in a positive response of the exchange rate (depreciation), with the impact increasing over the forecast period. This implies that an unexpected shock in total exports leads to depreciation of the exchange rate, as the increased demand for foreign currency puts downward pressure on its value. This finding aligns with the theoretical norms that higher exports should lead to an appreciation of the domestic currency and vice versa. When a country's exports increase, the demand for its currency rises, as foreign buyers need to purchase the local currency to pay for the exported goods.

The policy implication of these results is that Government should increase and effectively manage foreign exchange reserves to provide a buffer against external shocks and enhance the Central Bank's ability to intervene in the foreign exchange market. Higher external reserves stabilize the exchange rate during periods of volatility. The Government should also ensure macroeconomic stability through sound fiscal and monetary policies, including maintaining a stable inflation rate and reducing public debt because stable economic fundamentals correlate with a more resilient exchange rate. Also, government should promote the growth of other sectors such as agriculture, manufacturing, and technology to reduce reliance on oil revenues. Diversified economies are less vulnerable to oil market fluctuations.

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