EVALUATING THE LINEAR ASSOCIATION BETWEEN CRUDE PRICE CHANGES AND NIGERIA'S FOREIGN RESERVES, 2008-2023

Abstract

The study investigated the correlational association between crude price and foreign reserves using the Nigerian economy as the jurisdiction of interest. The study covered the period 2008 to 2023 representing a 25year period. Bivariate pairwise correlational matrix was used to find that a highly significant positive linear association exists between crude price and foreign reserves**.** Following the findings arising from this study, it is recommended that the country should take advantage of crude price movement in building its foreign reserves given that increase in crude price will likely lead to a rise in revenue from crude sale.A high foreign reserve can act as stabilization fund for exchange rate, debt management and other shocks from international financial flows. Building foreign reserves can be beneficial in managing such exposures to the advantage of the Nigerian economy.

Keywords: Crude Price, Foreign Reserves, Linear Association and Nigeria.

1.1 Introduction

Nigeria's economy has experienced significant fluctuations in crude prices and foreign reserves from 2013 to 2022. Crude is Nigeria's main export commodity, and changes in its price have a substantial impact on the country's foreign reserves. The period saw a decline in crude prices, leading to a depletion of foreign reserves.Nigeria's foreign reserves are heavily influenced by crude price changes, as the country relies on crude exports for about 90% of its foreign exchange earnings [1]. When crude prices rise, external reserves increase, and vice versa. The relationship between crude prices and foreign reserves is significant, with even a 1% increase in Brent crude price causing a 5.663% reduction in external reserves. Nigeria, Africa's largest crude producer, has faced significant fluctuations in its foreign reserves due to changes in global crude prices and domestic economic factors. Between 2013 and 2022, Nigeria's foreign reserves experienced substantial volatility,

due to the volatility of the international crude market, there has been widespread concern that Nigeria's economy has become overly dependent on crude prices. As Nigeria's economy is heavily dependent on crude, the fluctuation in crude prices adversely affects the country. The volatility of crude prices can be attributed to a number of factors, including macroeconomic instability and uncertainty. Based on the research of Aigheyisi (2018), macroeconomic volatility adversely impacts both investing and growth. Nigeria's economy is negatively impacted by these changes in crude prices in virtually all sectors. Crude prices have fluctuated greatly since the 1970s. Philip & Akintoye (2006) reported that, in 2002, the price

of crudefluctuated between $17 and $26 a barrel, rose to $53 in 2004 and reached $60 in 2005, according to Okoli, Tewari, &Oluwafisayomi (2017). There was a 70-per-barrel crude price in 2007; however, there was a $145-per-barrel price in 2008. As of August 2010, the price of crude averaged $75 per barrel, down from $61.73 per barrel in 2009. A study conducted by this author found that crude prices have fluctuated since 2010, reaching $95% in December 2010 and $117.1 by the end of 2011. There was a decline in 2012 to $114.49 and a rise in 2013 to $112.29. From 2014 to 2015, crude prices declined dramatically to $63 and $37.8 per barrel. It should also be noted that in 2016, 2017, and 2018, the crude price was $53.48, $65.11, and $62 per barrel, respectively. Crudeprices were $68.56 per barrel at the end of 2019 and $42.7 per barrel at the end of 2020. At the end of 2021, crude prices had reached $76.25 per barrel (CBN, 2021). In March and July 2021, crudeprices had reached $62.48 and $67.37 per barrel, respectively. Crude prices in 2022 began at $80.07 per barrel and fluctuated during the period, ultimately ending at $86.3 per barrel. According to the CBN (2023), the price per barrel was $74.75 at the end of May 2023.

- **Crude Price Changes have to do with but are not limited to:**

- Geopolitical tensions: Conflicts, sanctions, or political instability in crude-producing countries can disrupt supply chains, leading to price fluctuations. (e.g., the Russia-Ukraine conflict)
- Brent crude prices: A benchmark for global crude prices, Brent crude has fluctuated between $60-$120 per barrel in recent years.
- OPEC+ production decisions: The Organization of the Petroleum Exporting Countries (OPEC) and its allies (OPEC+) adjust crude production levels to balance global supply and demand, impacting prices.

In the event of an increase in crude prices, crude exporting nations' exchange rates are likely to appreciate as a result of an increase in their foreign exchange earnings and foreign exchange reserves. A depreciation of the exchange rate is likely to occur in crude-importing nations, according to Büetzer, Habib, &Stracca (2012). Foreign reserves increase as crude prices rise, resulting in a favorable trade balance and an appreciation of the exchange rate. It is, however, important to note that low crude prices, resulting from international events, may cause the exchange rate to depreciate and the foreign exchange reserves to deplete, resulting in a deficit in the budget, reduced foreign exchange flows, and slower growth of the economy (Olayungbo, 2019).).As reported by Musa, Maijama'a, Shaibu, & Muhammad (2019), crude prices have fluctuated due to concerns regarding looming imbalances in supply and demand.

Crudeexporting countries, such as Nigeria, may experience a loss of profits or even revenue if crude prices decline.

- **Impact on Nigeria's Foreign Reserves include but not limited to:**
- Direct impact: Nigeria's foreign reserves are directly affected by crude price changes.
- Rising crude prices:
- Export earnings increase: Higher prices mean more revenue from crude exports.
- Foreign reserves grow: Increased export earnings lead to higher foreign reserves.
- Naira (NGN) strengthens: A stronger naira results from increased foreign reserves.
- Falling crude prices:
- Export earnings decrease: Lower prices mean less revenue from crude exports.
- Foreign reserves decline: Decreased export earnings lead to lower foreign reserves.
- Naira (NGN) weakens: A weaker naira results from decreased foreign reserves.

Nigeria's foreign reserves are heavily impacted by volatile global crude prices, leading to economic instability, reduced ability to import essential goods, difficulty servicing foreign debts, and a weakened naira, resulting in higher import costs and inflation, due to factors such as geopolitical tensions, supply chain disruptions, OPEC+ production decisions, global demand fluctuations, low crude production, crude theft and vandalism, and reduced export earnings. In other words, the volatility in crude prices has led to instability in Nigeria's foreign reserves, affecting the country's economic growth and development.

The main aim of this study is to understand the impact of global crude price fluctuations on Nigeria's foreign reserves and economy. The study will focus on Nigeria's foreign reserves and crude prices from 2013 to 2022, using data from reputable sources such as the Central Bank of Nigeria and international energy agencies.The study will provide insights into the impact of crude price volatility on Nigeria's foreign reserves, informing policy decisions on foreign reserves management.The findings will contribute to the existing body of knowledge on the relationship between crude prices and foreign reserves in Nigeria.The study will serve as a reference for future research on the topic and provide recommendations for stakeholders in the energy and financial sectors.

The rest of the study is organised as follows: section two is literature review, three presents the methodology, section four shows the results while the conclusion is contained in section 5.

2. Literatures Review

Price inflation is defined as an increase in the price of a standardized commodity or service or a basket of goods or services over a certain period (usually one year). When the price of goods and services rises, this is referred to as inflation. When price increases are persistent and exceed the stated benchmark, this is referred to be inflation. For example, an increase in the money supply can quickly lead to a rise in the price level. There are several varieties of inflation described in the literature, including Demand-pull inflation occurs when aggregate demand grows without a matching increase in supply; supply push or cost-push inflation occurs when supply falls due to an increase in the cost/price of the product supplied (Anochiwa& Maduka,2015). It can also be structural inflation, which occurs as a result of monetary policy changes. This sort of inflation is commonly known as built-in inflation. Inflation can be hyper, extremely high, chronic, high, moderate, or low within these categories (Umaru & Zubairu, 2012).

Foreign exchange is the exchange of one currency for another or the conversion of one currency into another currency. It also refers to the global market where currencies are traded virtually around the clock. According to McDonald (1990) defines exchange rate as "the price of foreign currency that clears the foreign exchange market." As a result, a currency's exchange rate is the relationship between local and international prices of products and services. Furthermore, Mordi (2006) defines exchange rate as the price of one currency in terms of another. The price at which one currency may be purchased with another currency or gold, according to Economics Dictionary (2019). According to the Investment Dictionary (2014), an exchange rate is the price of one nation's currency represented in the currency of another country. In other words, the exchange rate at which one currency may be converted into another. According to Fahrettin (2001), an exchange rate, defined as the price of one country's currency in terms of another's, is one of the most essential prices in an open economy. It has an impact on the movement of goods, services, and capital inside a nation, as well as the balance of payments, inflation, and other macroeconomic indicators.

The crude industry dominates the economy of Africa's crude-producing countries, with Nigeria at the forefront; the economies of these countries rely heavily on the extremely unpredictable crude rent, rendering them vulnerable to crude market volatility (Omolade, 2019). Crude price shocks are a key cause of macroeconomic variations, with a spike having a contractionary effect on global demand and GDP in the short term. This is because growing energy prices boost the cost of production, depending on labor market flexibility and manufacturers' capacity to pass on rising costs to customers in the form of higher pricing-higher crude prices generate inflation (Akpan, 2009) & (Omolade, 2019). Other else being

equal, a continuous rise in the price of crude has a large beneficial influence on the economies of crude-exporting countries while having a negative impact on the economies of crude-importing countries. In the event of a drop in crude prices, the reverse occurs.

2.2 Theoretical Framework

The key underpinning theory for this study is the Dutch Disease theory which explains how a country's economy can be negatively impacted when it experiences a sudden surge in wealth, typically due to a natural resource discovery or export boom. This theory was first used to describe the Netherlands' economic challenges after discovering natural gas in the 1960s.The Dutch disease idea first appeared in the Netherlands in the 1950s.The key aspects of the Dutch Disease theory include but are not limited to: Appreciation of the Real Exchange Rate: The increased wealth leads to a stronger currency, making exports more expensive and less competitive. A Shift from Manufacturing to Resource Extraction: The booming resource sector attracts labour and capital, causing other industries, like manufacturing, to decline. Volatility and Dependence on a Single Resource: The economy becomes vulnerable to fluctuations in global commodity prices, leading to economic instability and Neglect of other Industries: The focus on the booming resource sector leads to neglect of other industries, causing a lack of diversification and economic stagnation. Below are the two steps to employ when analyzing the impact of crude price changes and Nigeria’s foreign reserves

Nigeria's economy has exhibited symptoms of Dutch Disease due to its dependence on crude exports. Due to the country's over-reliance on crude exports has led to neglect of other sectors, such as agriculture and manufacturing, vulnerability to crude price fluctuations has caused economic instability and volatility, stronger currency (Naira) has made non-crude exports less competitive, Lack of economic diversification has hindered sustainable economic growth.Mitigating Dutch Disease in Nigeria will have to diversify the economy by investing in other sectors, like agriculture, manufacturing, and services.Implement fiscal policies to manage crude revenues and reduce dependence on crude exports, promote non-crude exports through incentives and investments in infrastructure and encourage foreign investment in non-crude sectors to stimulate economic growth.It clearly explains the impact of low crude prices; it is based on the negative consequences of the natural resource boom on the nation's other important sectors owing to their abandonment (Salawu, Oyebayo, Obafemi, Oyeleye and Olaniwun, 2021). Natural resource income have resulted in a fall in economic growth owing to corruption, mismanagement, and inflation, reducing competitiveness and profitability. Natural resources may become a burden for crude-producing countries, making

other industries unreliable and stifling economic progress. The idea is pertinent to the research because, following the commercial discovery of crude, there has been no substantial influence on the lives of citizens or the economy, and no historic development has resulted from crude earnings.

2.3 Empirical Literature

Okeke, *et al.* (2024) examined the effect of crude price shock on inflation and exchange rate in Nigeria. The study adopted an ex-post facto research design, covering the period between 1990 and 2022. Secondary data were extracted from the CBN Statistical Bulletin and World Development Indicators. Multiple regression technique was used for test of hypotheses. The findings revealed a noteworthy adverse effect of crude price shocks on Nigeria's inflation rate, indicated by a probability value of 0.0180. Additionally, the impact of crude price shocks on exchange rates in Nigeria was also adverse and statistically significant, as reflected by a probability value of 0.047. Moreover, these findings align with established economic theory. The negative effect of crude price shocks on the exchange rate can be explained by the consistent devaluation of the Naira relative to the US Dollar in response to abrupt, particularly negative, changes in crude prices.

Nwagu, *et al.* (2023) examined the transmission effect of crude prices on Nigeria's exchange rate. E-GARCH (Exponential GARCH) model is employed in this study. Approach/Methodology/Design: We used Augmented Dickey Fuller to determine a unit root, integrating exchange rates, crude prices, external reserves, GDP, inflation, and interest rates to one I(1) and zero I(0). We used Johansen Cointegration to determine long-term relationships. Interest rates, inflation, and crude prices all correlated positively with each other. Findings: A statistically insignificant result is shown by the variance equation, indicating there is no correlation between crude prices and exchange rates. The Nigerian exchange rate is not affected by volatility transmission or leverage due to fluctuations in crude prices.

According to Karel & Quang (2022) based on quarter-by-quarter data from 2001 to 2021. According to the study, a positive change in crude prices leads to a reduction in the value of the dollar, but the opposite is not true, a decline in crude prices leads to an appreciation of the dollar. Also, Zhang, Zhang, Gao, Li & Yang (2022) looked at the effects of three types of crude shocks on exchange rates: crude supply changes, crude demand changes, and crude risk shocks. The largest impacts of crude price changes on the exchange rate were on crude demand, according to this study. A certain periodicity can be observed in short-term time variations of the crude price and exchange rate market. In Saudi Arabia, Suliman & Abid

(2020) found that the price of crude is closely related to the real exchange rate based on monthly data fromJanuary 1986 to March 2019. The long-run equilibrium relationship between variables was examined using the Autoregressive distributed lag model and error correction model. A strong cointegration can be observed over the long run in the study, and the same relationship can also be observed in the ARDL. It should also be noted that short-term results suggest that crude price and exchange rate have a unidirectional causal relationship. It was investigated in a study which was done by Qiang, Lin, Zhao, Liu, and Liu (2019) how fluctuations in international crude prices affect the exchange rates of crude-importing countries.

In Nigeria, Omolade, Nwosa, &Ngalawa (2019) investigated whether crude price shocks are transmitted through monetary channels. In the study, crude prices are associated with longterm appreciation of exchange rates. Asymmetrical responses to crude price shocks are found in Saudi Arabia's money demand according to Alsamara, Mrabet, Dombrecht, and Barkat (2016). A linear autoregressive approach was replaced with an ARDL approach in the study. It appears that crude price shocks and money demand are positively related over the long run, but the effects are asymmetric. Crude price shocks that increase positively have a greater impact than those that decrease positively. It is possible to say the same of Ebrahim, Inderwidi, & Kind (2014), who studied the macroeconomic effects of crude price volatility between 1980 and 2012. The volatility of crude prices constitutes a fundamental obstacle to economic growth due to its damaging and destabilizing effects on the macroeconomy. The volatility of crude prices has a negative effect on aggregate consumption, inflation, unemployment, investment, and industrial production in non-OECD countries.

According to Olayungbo (2019) investigated the relative Granger causal effects of crude price on exchange rate, trade balance, and foreign reserve in Nigeria. We used seasonally adjusted quarterly data from 1986Q4 to 2018Q1 to remove predictable changes in the series. Given the non-stationarity of our variables, we found cointegration to exist only between crude price and foreign reserve. The presence of cointegration implied the existence of long run relationship between the variables. The Granger causality result showed that crude price strongly Granger caused foreign reserve in the short period. However, no Granger causal relationships were found between crude price and trade balance and for crude price and exchange rate. The implication of the result is that Nigerian government should not rely solely on crude price to sustain her reserve but to diversify the economy towards non-resource production and export for foreign exchange generation.

According to Broni-Bediako, *et al*.(2018) Nigeria's dependence on oil revenue has been a cause for concern, especially as oil is an internationally traded commodity whose price is subject to unpredictable changes. The volatility in price of oil has various implications for both oil importing and exporting countries alike. However, oil export revenue dependent nations are more prone to the consequences, especially during periods of negative volatility. Nigeria's economy is highly dependent on M a n crude oil export revenue, hence, fluctuations in oil prices affects Nigeria's macroeconomics. This study empirically investigated the economic effects of oil price volatility on Nigeria's economy using some macroeconomic indicators such as gross domestic product (GDP), exchange rate (EXR), interest rate (INR), Foreign Direct Investment (FDI), and balance of payment (BOP). Ordinary Least Square (OLS) estimation was used to assess the impact of oil price fluctuation (independent variable) on the macroeconomic indicators listed above (dependent variables). The result of the study shows that the macroeconomic variables respond to changes in the price of oil (volatility), although at varying extent/degrees

Obi, Awujola, and Ogwuche (2016) used annual data from 1979 to 2014 to analyze the effects of crude price shocks on Nigerian macroeconomic performance. This study's theoretical foundation is based on Sims' unconstrained Vector Auto Regression model (1980). The models are used to estimate the link between changes in crude prices, the inflation rate, the GDP, and the real exchange rate.Unit root tests, Johansen co-integration technique, variance decomposition test, granger casualty test, and Vector Auto Regression Mechanism were used to investigate the speed with which variables shift from short run dynamics to long run dynamics. It was discovered that a proportionate change in crude price causes a more than proportionate change in Nigeria's real exchange rate, interest rate, and GDP.

The researcher reviewed a large amount of literature and found that other studies have explored the relationship between crude price changes and foreign reserves in Nigeria not with empirical data as recent as the one done by this study. With the aid of recent Nigerian data, this studyexamines the transmission effect between changes in crude prices and foreign reserves in Nigeriaas well as the long-term relationship between the two important indices in the Nigerian economy.

3. METHODOLOGY

This study was designed to appraise the fundamental relationship between crude price changes and foreign reserves in Nigeria from 2008 - 2023. The dataset for the study is drawn

from the Central Bank of Nigeria Statistical Bulletin. The datasets are time series as they are arranged according to a natural frequency and are fully quantitative.

The variables of interest are the foreign reserves of the country over the investigated period and the crude price over the set period.

The analytical framework for the study follows four steps. First, the data sets are described following the basic descriptive statistics of measures of central tendency, dispersion and normality.

Secondly, there is a test for the linear association between the crude price over time and the foreign reserves over the period. This is with the aim of determining the degree and direction of the such a relationship. The model for the test is of the form presented below:

The test for linear association following the bivariate pairwise correlation matrix of the form stated below:

$$\frac{N\Sigma xy - (\Sigma x)(\Sigma y)}{\sqrt{[N\Sigma x2 - (\Sigma x)2][N\Sigma Y2 - (\Sigma Y)2]}}$$

Where:

N = Number of Pairs;

Σxy = Sum of the Product of the pairs;

Σx = Sum of the x scores (crude price)

Σy = Sum of the y scores; (foreign reserves)

Σx2 = Sum of the squares of x scores and (crude price)

Σy2 = Sum of the squares of y scores (foreign reserves)

Thirdly, using the results from the estimation tool, inferences were made which formed the outcome of the study. The decision rule in this study is based on 5% degree of significance and conclusions were drawn based on this decision rule.

4. Results & discussion :

First, the basic descriptive statistics of the crude price and foreign reserves over the studied period are presented in table 1.

Table 1: Summary of Basic Descriptive Statistics

Variables	Mean	Median	Std. Dev.	Skewness	Kurtosis	Jarque-Bera	Prob	CV	Obs
Reserves	4.39	4.46	0.31	-0.17	3.70	0.22	0.89	0.07	25
Crude Price	1.57	1.79	1.63	0.23	3.41	2.84	0.24	1.03	25

Source: Computed by the author using Eviews.

In Table 1 above, measures of central tendency dispersion, symmetrical features of the series, and degree of peakness of the distribution are clearly indicated. Foreign reserves reported a higher aggregative average of 4.39billion over the period while crude price has 1.57. crude price is found to be more dispersed with a higher standard deviation of 1.63 and a coefficient of variation of 103%. This shows that crude price exhibited a higher swing relative to its mean over foreign reserves over the investigated 25years of the Nigerian economy. Skewness measures the degree of symmetry or departure from symmetry of the distribution whereas kurtosis measures the degree of peakness of the distribution. The distribution is normal if skewness is zero (0) and kurtosis is three (3). Also, the distribution is leptokurtic (statistical distribution with kurtosis greater than three) if kurtosis is > 3, platykurtic (statistical distribution with kurtosis less than three) if kurtosis is < 3, mesokurtic if it is = 3.

This leads to the conclusion that both foreign reserves and crude price exhibit is Leptokurtic features.This is largely consistent with the behaviour of financial and economics time series (See Brooks 2019)

Second, the linear association between crude price and foreign reserves which is the core investigative interest of this study is shown in table 2.

Table 2: Bivariate correlational matrix

VARIABLES	Crude Price	Reserves
Crude Price	1.00	

Reserves	R = 0.52	1.00
	{2.96}	-----
	[0.00]	-----

R=correlational coefficient; {} = t-stat; [] = probability of t-statistics.
Source: Extracted from E-views 10

The results show that crude price share a positive and significant linear association with foreign reserves. The correlation coefficient of 52% is evidence in favour of the fact that as crude price rises foreign reserves rises by 52%. This coefficient is found to be significant as the t-statistics is greater than 2.5(rule of thumb) while the probability value is greater than

0.05. Following these empirical results, it is concluded that a positively significant linear association exists between crude price and foreign reserves suggesting that as crude price rises, Nigeria as country will have a greater proclivity to increase its foreign reserves.

5.Conclusion

This study is set to find out the correlation between foreign reserves and crude price with the economy of Nigeria as the jurisdiction of interest. The temporal dimension is 25years covering the period 2008 to 2023. Nigeria as a country is one of the largest crude exporting country yet it grapples with oscillating degree of foreign reserves. This stimulated the question on whether or not any form of correlation can be established between crude price and foreign reserves. Using a bivariate pairwise correlational analyses, the study found a positively significant correlation between crude price and the Nigeria's foreign reserves.

Following the findings arising from this study, it is recommended that the country should take advantage of crude price movement in building its foreign reserves given that increase in crude price will likely lead to a rise in revenue from crude sale.A high foreign reserves can act as stabilization fund for exchange rate, debt management and other shocks from international financial flows. Building foreign reserves can be beneficial in managing such exposures to the advantage of the Nigerian economy.

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