

MODELLING THE RELATIONSHIP BETWEEN MONTHLY EXCHANGE RATE AND AVERAGE PRICE OF PETROL (APP) (2019 – 2023)

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Authors' contributions

This study was a collaborative effort among all authors. Each author reviewed and approved the final version of the manuscript for publication.

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ABSTRACT

This work aims to model the relationship between Nigeria's exchange rate (NGN/USD) and the monthly average price of petrol (APP). The source of data collection is the secondary method and data obtained from www.statista.com/statistics and the Central Bank of Nigeria Statistical Bulletin. The data were analyzed with the aid of SPSS 29. The result showed that there is a significant positive relationship between the exchange rate and the monthly average price of petrol. On the nature of the relationship, six (6) models were fitted to the bivariate data and the polynomial of order 2 (quadratic) model was found to be the best model as it had the highest \bar{R}^2 and Adjusted \bar{R}^2 of 0.762 and 0.752, respectively. Based on this, conclusions it was recommended that Government should look critically at ways to control the fall of the Naira to the US Dollar.

Keywords: NGN/USD, rate, petrol, relationship, quadratic

INTRODUCTION

The exchange rate (NGN/USD) functions as a vital variable for countries importing and exporting oil because it establishes relationships with factors including current account deficit and inflation rate and interest rate. The earliest study in the Scopus database that links the variables (oil prices and exchange rate) was conducted by Amano and Van Norden (1998a). They explored the relationship between Japan, Germany, and the United States. Similarly, in one more study, the authors emphasised the role of energy prices in determining the exchange rate movement (Amano and Van Norden, 1998b). Research on the connection between oil prices and exchange rates becomes vital because of unpredictable factors including COVID-19 and geopolitical changes along with their impact on price impulsiveness. A significant number of studies have established the relationship between these two variables. However, they are different in various aspects, such as long and short-run relationships, time-varying, extreme dependence, volatility spillover, frequency domain, etc. (Das, 2021; Long et al., 2021; Raju et al., 2021; Bedin et al., 2021). The linkages also vary based on oil-exporting and importing countries, the size of the economy, and the recent shift towards renewable energy sources in mobility (Eryiğit, 2012). Alssadek and Benhin (2021) examined the dependence between oil prices and exchange rates in oil-rich countries. Further, Long et al. (2021) investigated the relationship between the Chinese RMB and oil prices. In recent COVID-19

pandemic has dominated the economic policy and financial decisions landscape; therefore the research in the context of a crisis. In pursuance of covid COVID-related impact on the relationship, Atif et al. (2022) analyzed the relationship between the oil prices and exchange rates in emerging economies, during the pre and post-COVID-19 Covid-19 Pandemic. The exchange rate is an important macroeconomic variable in any economy because it maintains international competitiveness (Jhingan, 2002). This variable's importance can be recognized because it plays a major role in trimming domestic price level (Mordi, 2006), but also harms international trade and capital flows (Abrams, 1980; Hilton, 1984). On the same way, exchange rate volatility has Ahmed et al. 123 become an imperative issue between developing countries because it creates hurdles to achieve two main policymakers' objectives: price stability and economic growth. Most of the traders produce goods and services and sell them internationally. They measure their benefits and costs in term of the US Dollar. Similarly, all the developing countries receive funds, assistances and grants in term of dollars and they reimburse their money in the same currency. So, US dollar is acceptable in all over the world when transactions are made internationally. Normally, central bank of a country decides whether the exchange regime should be fixed or floating. It is important to clear here the scenario behind the exchange rate in nominal and real term. The real exchange rate can be distinguished from nominal through the value of county's product in terms of another; while the price of a currency in term of another is termed as nominal exchange rate. Asset pricing fluctuations alongside portfolio optimization and risk management uncertainty constitute the essence of volatility as a phenomenon. Volatility tends to increase if elasticity of demand and supply is high and vice versa (Obadan, 2006). Exchange rate volatility is linked with flexible exchange rate. Variability in itself is not a critical problem. If variability is predicable then volatility has not significant undesirable effect on international trade and capital flows. An economy's development process depends heavily on the Real Exchange Rate (RER) because both its stabilized level and stability contribute to enhanced export trade and private investment opportunities. Globally, the price of oil has been a significant determinant of the level of economic performance. The magnitude of the direct effect of a given oil price increase depends on the share of the cost of oil in national income, the degree of dependence on imported oil and the ability of end-users to reduce their consumption and switch away from oil (Marzieh, 2006). Oil serves as the economic foundation of Nigeria so its market value determines how well the country's economy performs. Since 1974 the price of oil has displayed significant price changes. During 2002 the price of oil fell between \$17 and \$26 per barrel yet reached \$53 in October 2004 according to Philip and Akintaye (2006). Between January 2000 and July 2008 oil prices surged beyond six times their initial level when they started at \$23 per barrel then reached their all-time peak at \$146 per barrel before plunging to \$42 by December 2008. The annual average price for oil reached \$61.73 per barrel during 2009 according to Hassan and Zamid (2011). Oil prices keep rising because of political turmoil in the Middle East notably after uprisings in Tunisia, Egypt, Libya, Yemen and Syria alongside Iran's nuclear crisis which prompted American and European sanctions on Iranian oil imports and Tehran's retaliatory threats. Through both supply and demand channels the RER experiences fluctuations from changes in oil prices. Because crude oil functions as a primary production factor the price increase directly influences non-tradable product costs in manufacturing. As non-tradable goods prices rise an appreciation occurs in the RER. Indirect RER changes stem from its links to available disposable income. Rising oil prices diminish the spending capability of buyers. A decrease in non-tradable goods demand will result in lower market prices. This will depreciate the RER. The Nigerian oil sector can be categorized into three segments- upstream, downstream and gas. However, the downstream sector provided the most challenge. The incessant crisis in supply of petroleum products culminated in the government's decision to deregulate the downstream sub-sector. Oil production by the Joint Venture companies accounts for about 95% of Nigeria's crude oil production. Shell which operates the largest joint venture with 55% government interest, through the Nigerian National Petroleum Corporation, NNPC) produces about 50% of Nigeria's crude oil, Exxon Mobil, Chevron Texaco, ENI.AGIP and Total final Elf operated the other Joint Ventures (Gbadebo, 2007). The Nigerian petroleum product prices elevated because fuel subsidy elimination followed Naira's decline against the US Dollar in foreign exchange markets. Because oil represents more than ninety percent of the Nigerian government revenue the country remains vulnerable to oil price fluctuations. Oil price shocks deliver such intense impacts that Nigerian budgets explicitly acknowledge a designated crude oil price standard while budget adjustments require oil price shifts during global financial crises. Nigeria faces intensified exposure to varying oil prices because it imports substantial refined petroleum products despite operating four refineries. Nigeria maintains its status as both oil exporter and refined product importer which creates susceptibility to crude oil price fluctuations. Recent changes have failed to boost fuel pricing although a model to understand their connection remains crucial. The findings from this research would help policy makers and economic researchers together with the Nigerian government fight price inflation while maintaining economic stability in Nigeria through the questions; Exchange rate movements show an association with petroleum product prices. What pattern connects the movements of currency exchange rates to petroleum product prices in the market? The research looks for a suitable model which describes the connection between exchange rate movements and petroleum product price changes. With an objectives of; examining how petroleum product prices react to exchange rate movements with the goal of determining exchange rate influences on petroleum price change in Nigeria and investigate the relationship dynamic between exchange rates and petroleum product prices across Nigeria.

Exchange rate movements show an association with petroleum product prices. What pattern connects the movements of currency exchange rates to petroleum product prices in the market?

Research hypothesis

H₀: Price volatility of petroleum products does not coincide with exchange rate changes in any meaningful manner.

H₁: The analysis confirms a statistically meaningful connection between currency exchange rates and petroleum product pricing.

METHODOLOGY

In this study, the cross-sectional descriptive survey design was employed. The population of the study consists of the data on exchange rate fluctuations and price of petroleum products price of petroleum products from 1960 to date. A sample of twenty-three (23) months was selected conveniently for both variables. In order to check that the data met the basic assumptions, exploratory data analysis was carried out before they were fully analyzed with the aid of SPSS 29. The data was collected from www.statista.com/statistics. In modeling the relationship between the exchange rate fluctuations and price of petroleum products, the scatter diagram was plotted with the means (average) of the variable as reference lines and the pattern observed. A linear relationship would be fitted if the pattern shows a straight line; otherwise, nonlinear models would be fitted. The best model was determined using the \bar{R}^2 and the adjusted \bar{R}^2 .

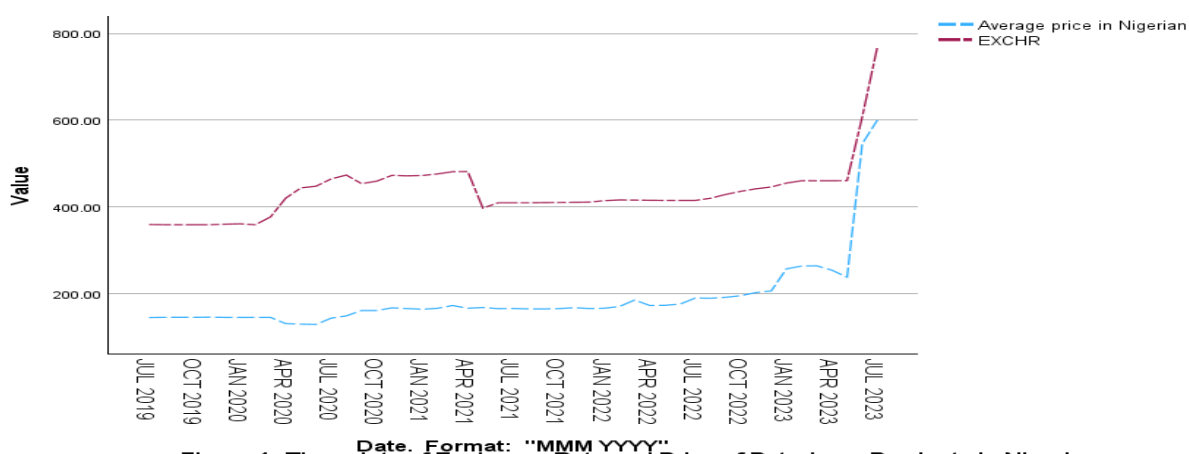


Figure 1: Time plots of Exchange Rate and Price of Petroleum Products in Nigeria

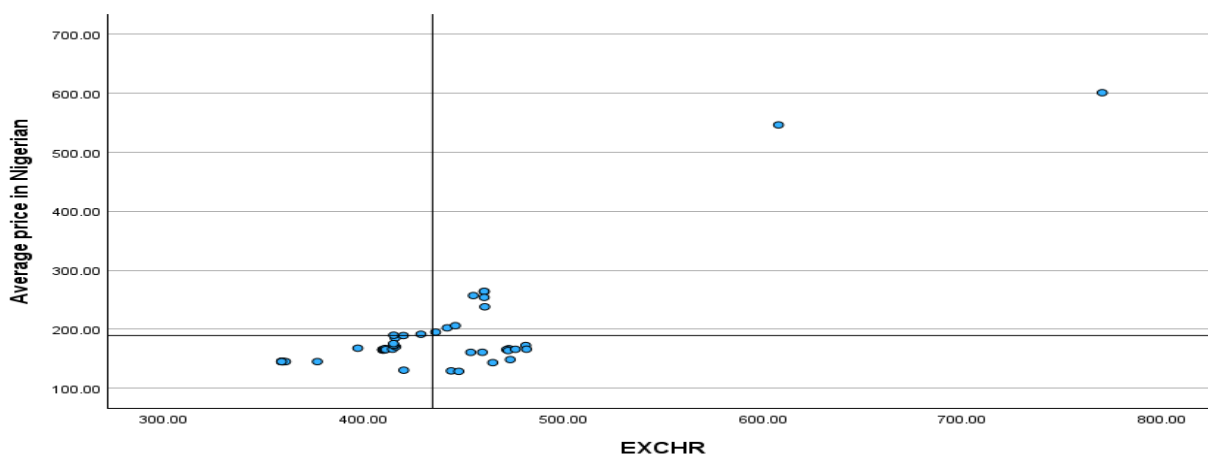


Figure 2: Scatter plot of Price of Petroleum vs Exchange Rate

The scatter plot enables us to visualize the pattern of the relationship existing in the variables. From the plot in figure 2, there is a positive relationship between EXCHR and APP and a closer look at the scatter plot showed that the relationship exhibits some curves and this is an indication that the relationship may not be linear. A confirmation would be obtained from further analyses with results. Table 1 showed the correlation between EXCHR and APP. From the results in the table, there is a very high significant positive relationship between the variables with a correlation coefficient of 0.83. This is evident in the current situation where prices of commodities have skyrocketed as a result of the increase in the prices of petrol.

Table 1: Correlations

		Average price in Nigerian	EXCHR
Average price in Nigerian	Pearson Correlation	--	
	N	49	
EXCHR	Pearson Correlation	.834**	--
	Sig. (2-tailed)	<.001	
	N	49	49

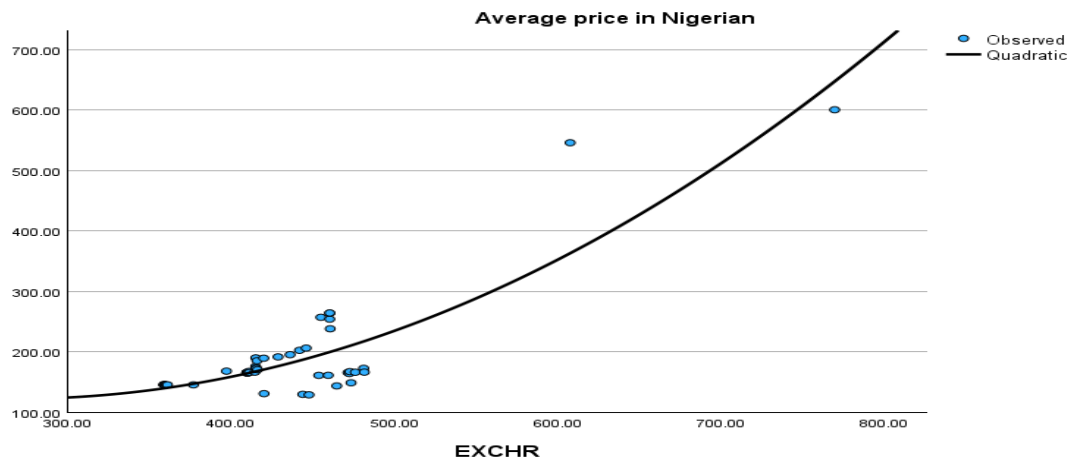
** . Correlation is significant at the 0.01 level (2-tailed).

In modeling the relationship between EXCHR and APP, Six (6) models were fitted with the aid of SPSS 29 and the results are displayed in table 2 below. From the results, the Quadratic model was judged the best model to explain the systematic fluctuation in the dependent variable (see figure 3). It had an \bar{R}^2 and Adjusted \bar{R}^2 of 0.762 and 0.752 respectively.

Table 2: Results from Estimated Models

Model	Model Name	Model type	Estimated Equation	\bar{R}^2 (Adjusted \bar{R}^2)	F-Stats	T-stat
1	Linear Regression	Linear	APP= -278.18 + 1.08EXCHR	0.695 (0.689)	107.23	10.35 (<0.001)
2	logarithmic	Non linear	APP=-2853.48+501.76 LN(EXCHR)	0.611 (0.603)	73.78	8.59 (<0.001)
3	Inverse	Nonlinear	APP=692.35-214613.98 (1/EXCHR)	0.511 (0.501)	49.15	-7.01 (<0.001)
4	Quadratic	Nonlinear	APP = 271.47-1.11EXCHR + 0.002EXCHR ²	0.762 (0.752)	73.80	-1.813 (<0.076) 3.605 (<0.001)
5	Cubic	Nonlinear	APP= 68.399 + 0.00EXCHR ² + 0.0000011EXCHR ³	0.756 (0.746)	71.416	0.195 (<0.846) 1.439 (<0.157)
6	Power	Nonlinear	APP = 0.007 + 1.68 LN(EXCHR)	0.575 (0.566)	63.571	7.973 (<0.001)

Source: Author's Computation

**Figure 3: Fitted Quadratic model for the relationship**

RESULTS AND DISCUSSION

The results obtained from the analysis carried out are presented in the section. The data were analyzed using both the descriptive and inferential statistics. The results are presented in graphs and tables with text discussion. In figure 1 below, the plot showed that the EXCHR maintained a steady rise in February 2020 to March 2021 and dropped in April 2021. It then maintained another rise in May 2021 to April 2023 from which it took a sharp rise in May 2023. On the price of petroleum product, the pattern is similar to that of exchange rate except for March to July 2020 where it dropped in price and from December 2022 to April 2023 where it rose. In Nigeria, unarguably, the prices of petroleum product tend to be more responsive in reaction to the fluctuations in the exchange rate as this product is being imported.

CONCLUSION

The Exchange rate is one indicator whose fluctuations greatly affect the economy of Nigeria as it is needed in most transactions that takes place in Nigeria from importation of goods and payment for international services. This change in price of petroleum product is a response to a stimulus from the fluctuations in the exchange rate especially to the US Dollar. Hence, the need to model the relationship between the variables which in turn will aid in forecasting and policy making. In this study, there is a very high positive and significant relationship between Exchange rate and APP which was modeled and found to be nonlinear and specifically of the quadratic form (a polynomial of order 2).

RECOMMENDATION

On the basis of the results from this study, the following recommendations are made;

1. Government should look critically at ways to control the fall of the Naira to the US Dollar.
2. Government should make it possible for the refining of crude in Nigeria.
3. Government should have a control over the foreign exchange market.

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APPENDIX 1: Data used for the study

Month /year	Average price in Nigerian naira per liter	Exchange Rate NGN/USD	Month /year	Average price in Nigerian naira per liter	Exchange Rate NGN/USD
Jul-19	145.03	359.43	Apr-22	172.61	415.40
Aug-19	145.48	359.00	May-22	173.08	415.08
Sep-19	145.53	359.00	Jun-22	175.89	415.02
Oct-19	145.48	359.00	Jul-22	190.01	415.11
Nov-19	145.94	359.00	Aug-22	189.46	419.97
Dec-19	145.35	360.25	Sep-22	191.65	428.75
Jan-20	145.37	361.00	Oct-22	195.29	436.12
Feb-20	145.41	359.00	Nov-22	202.48	441.88
Mar-20	145.4	376.89	Dec-22	206.19	445.97
Apr-20	130.84	420.15	Jan-23	257.12	454.97
May-20	129.67	443.89	Feb-23	263.76	460.43
Jun-20	128.88	447.71	Mar-23	264.29	460.43
Jul-20	143.63	464.71	Apr-23	254.06	460.42
Aug-20	148.78	473.48	May-23	238.11	460.70
Sep-20	161.06	453.68	Jun-23	545.83	607.75
Oct-20	161.17	459.50	Jul-23	600.35	769.82
Nov-20	167.27	472.74			
Dec-20	165.7	471.62			
Jan-21	164.09	472.40			
Feb-21	166.24	476.05			
Mar-21	172.68	481.21			
Apr-21	166.38	481.60			
May-21	168.06	397.15			
Jun-21	165.61	409.66			
Jul-21	165.91	409.63			
Aug-21	164.91	409.65			
Sep-21	164.85	410.02			
Oct-21	165.6	410.41			
Nov-21	167.6	410.81			
Dec-21	165.77	411.13			
Jan-22	166.4	414.54			
Feb-22	170.42	416.15			
Mar-22	185.3	415.83			

Source: www.statista.com/statistics