Vector Autoregressive Modeling of Selected Macroeconomic Variables in Nigeria.

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Abstract- Macroeconomic variables play important role in shaping the economy of every nation. Most times researchers assume that there are interaction among them but not in all cases. This work is an attempt to study if there exist any interaction among prices of copper, maize and oil. Data on these selected variables ranging from April 1971 to July 2024 were carefully extracted from central bank of Nigeria's website (www.cbn.org.ng). Unlike other macroeconomic variables that exhibits interdependence among themselves, this study has demonstrated price independence among copper, maize and oil. Result of the analysis shows stationary series, differencing was done to take care of stochastic disturbance term. Cointegration test was deemed not necessary. The work adopts lag 1 as suggested from the lag selection result output. Table 3 displays VAR estimates result that suggests weak interaction among the prices of copper, maize and oil. Their R-squared and adjusted R-squared show a very weak explanatory power among the three variables. For copper it is 13% and 12% respectively, for maize 7% and 6% respectively and for oil 4% and 3% respectively. These are convincing evidence to say that there is no interaction among the prices of the variables. Table 4 shows VAR residual serial correlation. From the result output, all the probability values are greater than 0.05 at lag 1 so we do not reject Ho. We conclude that there is no serial correlation. Table 5 show VAR residual heteroskedasticity tests, from the result output we observe that the joint chi-square value of 253.2185 with 162 df and P=0.0000 shows significant evidence of homoscedastic. That is, there is no heteroskedasticity. Table 6 shows VAR residual Normality tests, the jarque-Bera test value of 6896.977 is far way greater than the P-values (0.0000) indicating that we do not reject Ho meaning that VAR residuals are normally distributed. Table 7 shows dynamic stability test of the VAR estimates, from the plot it is clearly seen that no root lies outside the unit circle. Hence, VAR satisfies the stability condition. Table 8 shows granger causality/block exogeneity Wald tests. From the result output, there is clearly no variable that granger causes each other because their various chi-square values are greater than 0.05. Copper, maize and oil do not granger cause each other hence there will be no need for impulse response function (IRF) test. In conclusion, as important as these macroeconomic variables are, the researcher recommends that policy makers are to focus more on other variables such as interest rate, unemployment rate, crime rate, inflation, GDP etc to get macroeconomic variables with high interdependence for the purpose of policy formulation for the country.

Keywords: Macroeconomic, Variables, VAR, Stationary, Multivariate, Time Series

I. INTRODUCTION

The work of Christopher .A. Sims on VAR has continued to gain relevance especially when modelling a multivariate time series. When a VAR model is mentioned, we concern ourselves with studying interactions between the selected variables or indicators. A VAR model describes the evolution of a set of k variables, called the endogenous variables over time. Each period of time is numbered t = 1, 2, …T. The variables are collected in a vector, y_t, which is of length k. (Equivalently, this vector might be described as a $(k \times 1)$ matrix). The vector is modelled as a linear function of its previous value. This VAR model is widely applied in macroeconomics, finance and policy analysis. This paper looked at interactions among prices of three selected macroeconomic variables in Nigeria – copper, maize and oil from April 1971 to July 2024. The importance of macroeconomic variables in modeling any nation's economy (both producing and consuming countries) cannot be overemphasized. These commodities influence production costs, trade balances, inflation and overall economic growth. Copper is a vital industrial metal used in construction, electrical wiring and manufacturing. Its price often reflects the level of global economic activity – rising during economic expansion and falling during recessions. For many developing countries like Nigeria copper exports serve as a major source of foreign exchange earnings. Hence, fluctuations in copper prices can significantly affect government revenue and investment levels. Also, Maize (corn) is both a stable food crop and an industrial raw material used for animal feed, biofuel (ethanol), and processed foods. Its availability and price affect food security, inflation and agricultural income. In many economies, especially in Africa and Latin America, maize production contributes substantially to the GDP and rural employment. While Crude Oil is a key energy commodity that powers transportation, manufacturing and electricity generation. Changes in oil prices have widespread macroeconomic effects – rising oil prices tend to increase production costs, inflation and import bills for oil-importing nations, while oil exporting countries benefit through higher export revenues and fiscal surpluses. However, several studies have explored the use of VAR model to analyze Nigerian macroeconomic behavior (Adebiyi & Adenuga 2010), Olomola & Adejumo, 2006). In the face of economic instabilities, policy makers and economists predicts with uncertainty as a result of interventions or shocks. Although they have certain measures to achieve stable series (also called stationary). As oil producing country a decrease in sales of oil may affect the countries revenue. In this paper, I shall ascertain if there is any form of interaction among the prices of copper, maize and oil and which granger causes each other.

II. LITERATURE REVIEW

Gbanador M.A (2024) studied macroeconomic variables and stock price behavior in Nigeria. In his work, he investigated the influence of macroeconomic variables on stock price behaviour in Nigeria. The annual time series data spanning through the period of 1995 to 2021 and historical data research design were adopted for the study. The Augmented Dickey Fuller (ADF) and Phillips-Perron test were used to test for stationarity of the variables. Other econometric tests like Ramsey Reset test, Heteroskedasticity test, Cusum test, Johansen cointegration test, Parsimonious Error Correction model and the fully modified Least Square were used for the data analysis. The findings from the short-run result showed that all the macroeconomic variables adopted for the study have no positive and significant influence on stock price except inflation whose impact is positive and significant. However, the result from the long-run analysis reveals that interest rate and money supply had inverse and insignificant influence on stock price behaviour. Inflation had a positive and insignificant effect while exchange rate had a positive and significant influence on stock price behaviour in Nigeria. The result from the Johansen Cointegration and the fully modified least squares showed evidence of long-run relationship between the Dependent and independent variables. The study therefore suggested that the government through its relevant agencies should formulate good macroeconomic policies in order to enhance stock market performance.

Terfa Williams A. (2012) investigated stock market reaction to selected macroeconomic variables in the Nigerian economy. His study examined the relationship between the stock market and selected macroeconomic variables in Nigeria. The all-share index was used as a proxy for the stock market while inflation, interest and exchange rates were the macroeconomic variables selected. Employing error correction model, it was found that a significant negative short run relationship existed between the stock market and the minimum rediscounting rate (MRR) implying that, a decrease in the MRR, would improve the performance of the Nigerian stock market. It was also found that exchange rate stability in the long run, improved the performance of the stock market. Though the results for Treasury bill and inflation rates were not significant, the results suggested that they were negatively related to the stock market in the short run thus, achieving low inflation rate and keeping the TBR low could improve the performance of the Nigerian stock market. Specifically, the study concluded that, by achieving stable exchange rates and altering the MRR, monetary policy would be effective in improving the performance of the Nigerian stock market.

Winful Christian E. *et al.* (2016) studied macroeconomic variables and stock market performance of emerging countries. Their article seeks to fill the gap of severe data limitations on the link between macroeconomic variables and stock market performance. A panel data of 41 emerging countries for the period 1996 to 2011 were used to estimate the results. The model used by Sangmi and Mubasher (2013) was adopted and modified to determine the effect of macroeconomic variables on stock market capitalization. The four techniques to investigate the effects were robust ordinary least squares (OLS), FGLS, dynamic ordinary least squares (DOLS) and then Newey-West. It was discovered that depreciation in exchange rate in dollars and reduction in consumer price index affects stock market development negatively, while increase in money supply does influence stock market positively. The findings highlighted the significance of macroeconomic factors such as consumer price index, exchange rate, money supply and GDP in explaining the stock market performance in emerging stock economies.

Sims, C.A. (1980) worked on macroeconomics and reality. In his paper he argued that existing strategies for econometric analysis related to macroeconomics are subject to a number of serious objections, some recently formulated, some old. These objections are summarized in his paper, and it is argued that taken together they make it unlikely that macroeconomic models are in fact over identified, as the existing statistical theory usually assumes. The implications of his conclusion were explored, and an example of econometric work in a non-standard style, taking account of the objections to the standard style, is presented. He furthermore criticized standard econometric time series modeling for being detached from economics and introduces the concept of Structural Vector Autoregression (SVAR) as a better approach for macroeconometric modeling. The paper argues that these models should be identified with economic theory rather than relying on naive or mechanically imposed restrictions, highlighting the need for methods that better capture the dynamics and causal relationships within the economy to provide meaningful insights.

Deebom, Z. D (2025) examined the interaction between Global Macroeconomic variables and commodity price movement in Nigeria. In his work, he examined the interplay between global macroeconomic variables and commodity price movements in Nigeria, focusing on data spanning from April 1971 to July 2024. The analysis incorporated key global variables, including the Common Commodity Price Factor (CCPF), Global Factors (GF), and commodity-specific prices – copper (CP), Maize (MP), and oil (OP). By employing a comprehensive econometric framework that includes correlation analysis, cointegration testing, short-term dynamics, Granger causality, impulse response functions, and variance decomposition, the study uncovered both short- and long-term dynamics in the global commodity price relationship. His results provided strong evidence of long-term cointegration between variables, with oil prices exerting a dominant influence on the Common Commodity Price Factor. Meanwhile, Granger Causality tests reveal two-way relationships between global macroeconomic indicators and commodity prices. Oil prices and global factors, in particular, significantly influence Nigeria's commodity price movements, underscoring the country's vulnerability to global shocks. Impulse response and variance analyses further highlighted the evolving influence of global forces over time. His findings underscored the need for strategic policy interventions to mitigate external volatility, enhance resilience, and stabilize commodity markets. His work enhanced the understanding of global economic relations and their impact on emerging markets, offering valuable insights for policymakers in resource-dependent economies, such as Nigeria.

III. METHODOLOGY

3.1. Data source.

The monthly time series data were carefully extracted from the website of the central bank of Nigeria (CBN) www.cbn.org.ng. The data set ranged from April 1971 to July 2024. These macroeconomic data are for copper, maize and oil only.

3.2. VAR MODEL.

Vector autoregression (VAR) is a technique used by macroeconomists to illustrate the joint dynamic behaviour of a collection of variables without requiring strong restrictions as required in the identification of fundamental structural parameters Tuaneh (2018). In a univariate autoregression, a stationary time-series variable y_t can often be modelled as depending on its own lagged values:

$$Y_t = a_0 + a_1 Y_{t-1} + a_2 Y_{t-2} + \cdots + a_{k-1} Y_{k-1} + \varepsilon_t \quad (1)$$

Where,

Y_t = is the series being considered
a_0 = denotes the mean
$a_1 Y_{t-1}$ = denotes AR polynomial of order 1
$a_2 Y_{t-2}$ = denotes AR polynomial of order 2
$a_{k-1} Y_{k-1}$ = denotes AR polynomial of order k
ε_t = the white noise.

When multiple time series is analysed, the natural extension to the autoregressive model is the Vector Autoregressive or VAR, in which a vector of variables is modelled as depending on their own lags and the lags of every other variable in the vector. VAR model (vector autoregressive models) is used for multivariate time series. The structure is that each variable is a linear function of past lags of itself and lags of the other variables. The model adopted in this work is the Vector Auto-Regressive Model (VAR) and a two-variables VAR (2) with lag could be specified as thus:

$$X_t = a_0 + a_1 Y_{t-1} + a_2 X_{t-1} + a_3 Z_{t-1} + a_4 M_{t-1} + \varepsilon_{1t} \quad (2)$$

$$Y_t = b_0 + b_1 Y_{t-1} + b_2 X_{t-1} + b_3 Z_{t-1} + b_4 M_{t-1} + \varepsilon_{2t} \quad (3)$$

Where X_t *and* Y_t represents variable 1 and variable 2 respectively. While the apriori expectation: $a_0, b_0 > 0$, these represent the intercept a_1, *and* b_1= Short-run dynamic coefficients of the model's adjustment long-run equilibrium, $\varepsilon_{i.t}$ = Errors, impulses, shocks or innovations. Each variable is a linear function of the lag 1 values for all variables in the set. In a VAR (2) model, the lag 2 values for all variables are added to the right sides of the equations. Generally, for a VAR (p) model, the first p lags of each variable in the system would be used as regression predictors for each variable. VAR models are a specific case of more general VARMA models. VARMA models for multivariate time series include the VAR structure above along with moving average terms for each variable. Applied macroeconomist use models of this form to both describe macroeconomic data, to perform causal inference and provide policy statement/and or advice.

$$\begin{bmatrix} y_t \\ x_t \\ z_t \end{bmatrix} = \begin{bmatrix} \hat{x} \\ \hat{y} \\ \hat{z} \end{bmatrix} \quad (4)$$

VAR is a multivariate autoregressive linear time series model of the form:

$$P_t = \alpha + \sum_{i=1}^{z} \alpha_i P_{t-i} + \varepsilon_t \quad (5)$$

Where; P_t is the set of series under consideration $P_t = (P_{t1}, P_{t2,\dots,} P_{nt})$ is a $n \times 1$ vector, α_i are full rank $m \times m$ matrix of coefficients, and i= 1, 2, 3, …z. $\varepsilon_t = (\varepsilon_{t1}, \varepsilon_{t2,\dots,} \varepsilon_{nt})$ is an unobservable i.i.d zero mean error term.

The three endogenous variables captured in this paper are copper, maize and oil.

3.3. Stationarity Test.

For every good forecast or policy to be made time series data must be stationary. Consequently all series must be checked to ascertain the stationarity condition before proceeding with the analysis. If stationary, proceed with your analysis otherwise difference the series before proceeding with the analysis.

3.4 Cointegration Test

Cointegration is a statistical method used mainly for testing the correlation between two or more non-stationary time series in the long run or for a specific period. According to Syed (2008), the concept of co-integration between variables was developed by Granger and Engle in 1987. They explained the presence of a long-run relationship between two or more variables. In testing for co-integration, there are several underlying assumptions and this include: all variables are said to be non-stationary; they are all integrated of the same order and where they are not integrated of the same order then will continue with co-integration analysis using multi co-integration.

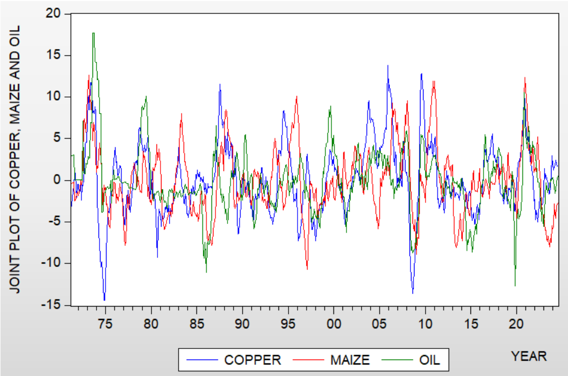
3.5 VAR Lag Order Selection Criteria.

The general approach to this is to fit model with orders N =0, 1, 2…Nmax and choose the value of "N" which minimizes the model selection criteria (Lutkepohl). The VAR lag length is selected using either AIC, SC or HQ.

IV. RESULTS

a. Time Plots

Fig. 1 below shows joint time plot of copper, maize and oil.



4.2. Diagnostic Test Results

Augmented Dickey Fuller test was employed to ascertain the stationarity condition of the series. Table 1 shows the output of the result.

UNIT ROOT TEST RESULTS TABLE (ADF)
Null Hypothesis: the variable has a unit root

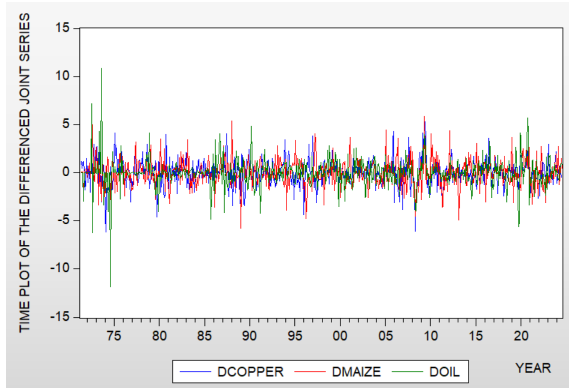
	At Level			
		COPPER	MAIZE	OIL
With Constant	t-Statistic	-5.1078	-4.8868	-5.1869
	Prob.	*0.0000*	*0.0000*	*0.0000*
		***	***	***
With Constant & Trend	t-Statistic	-5.1222	-4.8751	-5.2646
	Prob.	*0.0001*	*0.0004*	*0.0001*
		***	***	***
Without Constant & Trend	t-Statistic	-5.1007	-4.8917	-5.1907
	Prob.	*0.0000*	*0.0000*	*0.0000*
		***	***	***
	At First Difference			
		d(COPPER)	d(MAIZE)	d(OIL)
With Constant	t-Statistic	-12.5844	-9.7222	-10.0377
	Prob.	*0.0000*	*0.0000*	*0.0000*
		***	***	***
With Constant & Trend	t-Statistic	-12.5741	-9.7184	-10.0298
	Prob.	*0.0000*	*0.0000*	*0.0000*
		***	***	***
Without Constant & Trend	t-Statistic	-12.5943	-9.7296	-10.0460
	Prob.	*0.0000*	*0.0000*	*0.0000*
		***	***	***

Notes:
a: (*)Significant at the 10%; (**)Significant at the 5%; (***) Significant at the 1% and (no) Not Significant
b: Lag Length based on SIC
c: Probability based on MacKinnon (1996) one-sided p-values.

From the output, we detect a stationary series.

b. Difference series of Copper, Maize and Oil.

Fig. 2 shows the output of the difference series just in case there exist stochastic disturbance term.



4.3. VAR Lag Order Selection Criteria.

The appropriate lag length for the VAR model was concluded to be at ‘‘Lag 1’’ based on the VAR lag selection result in table 2

VAR Lag Order Selection Criteria
Endogenous variables: DCOPPER DMAIZE DOIL
Exogenous variables: C
Date: 10/17/25 Time: 09:02
Sample: 1971M04 2024M07
Included observations: 631

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-3333.845	NA	7.867487	10.57637	10.59751	10.58458
1	-3262.426	141.9329	6.455272*	10.37853*	10.46310*	10.41138*
2	-3255.827	13.04980	6.504618	10.38614	10.53415	10.44363
3	-3249.583	12.29143	6.561707	10.39487	10.60631	10.47700
4	-3246.123	6.776268	6.678020	10.41244	10.68731	10.51920
5	-3237.427	16.95237	6.684544	10.41340	10.75170	10.54479
6	-3227.534	19.18937*	6.665807	10.41057	10.81231	10.56660
7	-3221.462	11.72058	6.728160	10.41985	10.88502	10.60052
8	-3213.733	14.84567	6.755586	10.42388	10.95248	10.62918

* 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

4.4. VAR ESTIMATES

Table 3 below shows the output of the VAR estimates

DCOPPER(-1)	0.338546 (0.04037) [8.38529]	-0.030905 (0.04332) [-0.71348]	0.129057 (0.04552) [2.83523]
DCOPPER(-2)	-0.047324 (0.04037) [-1.17213]	0.090518 (0.04332) [2.08973]	0.056931 (0.04552) [1.25070]
DMAIZE(-1)	-0.003790 (0.03713) [-0.10209]	0.222210 (0.03983) [5.57877]	-0.039056 (0.04186) [-0.93307]
DMAIZE(-2)	0.046438 (0.03698) [1.25573]	0.012378 (0.03967) [0.31197]	0.035279 (0.04169) [0.84616]
DOIL(-1)	0.101095 (0.03568) [2.83367]	0.101949 (0.03828) [2.66355]	0.139492 (0.04022) [3.46797]
DOIL(-2)	-0.027875 (0.03592) [-0.77610]	0.023798 (0.03853) [0.61760]	-0.047605 (0.04049) [-1.17561]
C	0.003814 (0.05076) [0.07514]	-0.002661 (0.05446) [-0.04887]	-0.004631 (0.05723) [-0.08092]

R-squared	0.131043	0.074858	0.048900
Adj. R-squared	0.122768	0.066047	0.039842
Sum sq. resids	1033.749	1189.864	1314.014
S.E. equation	1.280965	1.374290	1.444208
F-statistic	15.83457	8.496047	5.398440
Log likelihood	-1058.074	-1102.871	-1134.481
Akaike AIC	3.344033	3.484680	3.583927
Schwarz SC	3.393008	3.533655	3.632903
Mean dependent	0.004851	-0.003768	-0.003799
S.D. dependent	1.367666	1.422053	1.473867

Determinant resid covariance (dof adj.)	6.252630
Determinant resid covariance	6.048756
Log likelihood	-3284.845
Akaike information criterion	10.37942
Schwarz criterion	10.52634
Number of coefficients	21

4.5 VAR residual serial correlation.

Table 4 displays the result of VAR residual serial correlation test which usually checks whether residuals are autocorrelated.

H0: No serial correlation

H1: There is serial correlation

VAR Residual Serial Correlation LM Tests
Date: 10/17/25 Time: 11:45
Sample: 1971M04 2024M07
Included observations: 637

Null hypothesis: No serial correlation at lag h

Lag	LRE* stat	df	Prob.	Rao F-stat	df	Prob.
1	12.06359	9	0.2097	1.342627	(9, 1521.2)	0.2097
2	10.73959	9	0.2940	1.194752	(9, 1521.2)	0.2940
3	12.05546	9	0.2102	1.341718	(9, 1521.2)	0.2102

Null hypothesis: No serial correlation at lags 1 to h

Lag	LRE* stat	df	Prob.	Rao F-stat	df	Prob.
1	12.06359	9	0.2097	1.342627	(9, 1521.2)	0.2097
2	18.54183	18	0.4205	1.030836	(18, 1759.8)	0.4205
3	32.27731	27	0.2220	1.197834	(27, 1808.4)	0.2220

*Edgeworth expansion corrected likelihood ratio statistic.

4.6 VAR RESIDUAL HETEROSKEDASTICITY TEST

Table 5 shows the output of the VAR residual heteroskedasticity test

VAR Residual Heteroskedasticity Tests (Includes Cross Terms)
Date: 10/17/25 Time: 11:55
Sample: 1971M04 2024M07
Included observations: 637

Joint test:

Chi-sq	df	Prob.
253.2185	162	0.0000

Individual components:

Dependent	R-squared	F(27,609)	Prob.	Chi-sq(27)	Prob.
res1*res1	0.092347	2.294863	0.0002	58.82506	0.0004
res2*res2	0.044742	1.056446	0.3884	28.50060	0.3855
res3*res3	0.034438	0.804475	0.7486	21.93708	0.7406
res2*res1	0.037214	0.871825	0.6542	23.70528	0.6466
res3*res1	0.063441	1.527879	0.0437	40.41197	0.0469
res3*res2	0.111685	2.835849	0.0000	71.14359	0.0000

4.7 VAR RESIDUAL NORMALITY TEST

Table 6 shows the result output of VAR residual normality test.

Ho: VAR residuals are normally distributed

H1: VAR residuals are not normally distributed

VAR Residual Normality Tests
Orthogonalization: Cholesky (Lutkepohl)
Null Hypothesis: Residuals are multivariate normal
Date: 10/17/25 Time: 12:03
Sample: 1971M04 2024M07
Included observations: 637

Component	Skewness	Chi-sq	df	Prob.*
1	-0.125136	1.662460	1	0.1973
2	0.090362	0.866887	1	0.3518
3	-0.142526	2.156643	1	0.1420
Joint		4.685989	3	0.1963

Component	Kurtosis	Chi-sq	df	Prob.
1	4.901329	95.94947	1	0.0000
2	4.893639	95.17495	1	0.0000
3	18.88953	6701.167	1	0.0000
Joint		6892.291	3	0.0000

Component	Jarque-Bera	df	Prob.
1	97.61193	2	0.0000
2	96.04184	2	0.0000
3	6703.323	2	0.0000
Joint	6896.977	6	0.0000

*Approximate p-values do not account for coefficient estimation

4.8 DYNAMIC STABILITY TEST OF THE VAR ESTIMATES

The table and figure below presents the roots of characteristic polynomial

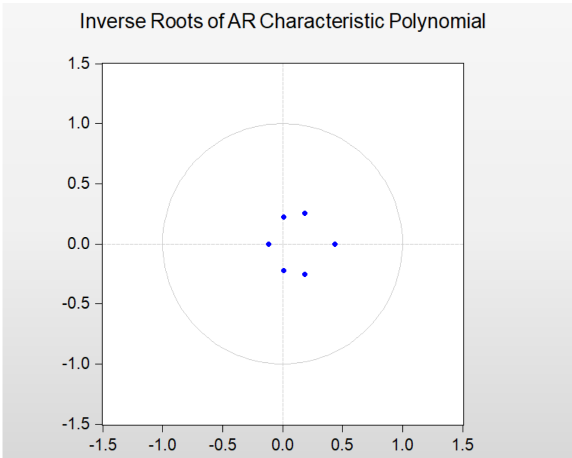
Table 7 below

Roots of Characteristic Polynomial
Endogenous variables: DCOPPER DMAIZE DOIL
Exogenous variables: C
Lag specification: 1 2
Date: 10/17/25 Time: 12:17

Root	Modulus
0.433320	0.433320
0.185446 - 0.257254i	0.317128
0.185446 + 0.257254i	0.317128
0.007025 - 0.225280i	0.225389
0.007025 + 0.225280i	0.225389
-0.118015	0.118015

No root lies outside the unit circle.
VAR satisfies the stability condition.

Figure 3 below



4.9 GRANGER CAUSALITY TEST

Ho: Variable 'C' does not granger cause variable 'M' or 'O'

H1: Variable 'C' granger causes variable 'M' or 'O'

Where C is copper, M is maize and O is oil.

VAR Granger Causality/Block Exogeneity Wald Tests
Date: 10/17/25 Time: 12:28
Sample: 1971M04 2024M07
Included observations: 637

Dependent variable: DCOPPER

Excluded	Chi-sq	df	Prob.
DMAIZE	1.613110	2	0.4464
DOIL	8.219434	2	0.0164
All	9.626834	4	0.0472

Dependent variable: DMAIZE

Excluded	Chi-sq	df	Prob.
DCOPPER	4.374901	2	0.1122
DOIL	7.992627	2	0.0184
All	14.62935	4	0.0055

Dependent variable: DOIL

Excluded	Chi-sq	df	Prob.
DCOPPER	12.90261	2	0.0016
DMAIZE	1.292927	2	0.5239
All	14.22833	4	0.0066

CONCLUSION

This work successfully modelled selected macroeconomic variables in Nigeria – namely copper, maize and oil. The work ascertain that unlike most macroeconomic variables there exist little or no interaction among the selected variables. Fig. 1 shows an up and down movement of the series which by visual inspection suggests possible non stationarity. Also, Table 1 shows the output of Augmented Dickey Fuller Test result which shows that the series are stationary at levels. The t-statistics values of copper, maize and oil are all significant enough to reject the null hypothesis and accept alternative hypothesis that the series are stationary. Fig. 2 displays the time plot of the differenced series to account for stochastic disturbance term. From the plot we observe a more stationary series where all data set falls within zero (0) axis. From the observation so far there will be no need for cointegration test because the series are in stationary form. Table 2 shows VAR lag order selection criteria, from the result output it suggests optimal lag at 1. This short lag structure accounts for sharp and immediate persistence in commodity market. Table 3 shows the output of the VAR estimates, the result shows a very weak interaction among the prices of copper, maize and oil. Their R-squared and adjusted R-squared show a very weak explanatory power among the three variables. For copper it is 13% and 12% respectively, for maize 7% and 6% respectively and for oil 4% and 3% respectively. These are convincing evidence to say that there is no interaction among the prices of the variables. Table 4 shows VAR residual serial correlation. From the result output, all the probability values are greater than 0.05 at lag 1 so we do not reject Ho. We conclude that there is no serial correlation. Table 5 show VAR residual heteroskedasticity tests, from the result output we observe that the joint chi-square value of 253.2185 with 162 df and P=0.0000 shows significant evidence of homoskedastic. That is, there is no heteroskedasticity. Table 6 shows VAR residual Normality tests, the jarque-Bera test value of 6896.977 is far way greater than the P-values (0.0000) indicating that we do not reject Ho. VAR residuals are normally distributed. Table 7 shows dynamic stability test of the VAR estimates, from the plot it is clearly seen that no root lies outside the unit circle. Hence, VAR satisfies the stability condition. Table 8 shows granger causality/block exogeneity Wald tests. From the result output, there is clearly no variable that granger causes each other because their various chi-square values are greater than 0.05. Copper, maize and oil do not granger cause each other hence there will be no need for impulse response function (IRF) test. In conclusion, as important as these macroeconomic variables are, policy makers are advised to focus on other variables such as interest rate, unemployment rate, crime rate, GDP etc to get macroeconomic variables with high interdependence for the purpose of policy formulation for the country.

REFERENCES

[1] Granger, C. W. J. & Engle, R.F. (1987). Co-integration and error correction: representation, estimation and testing. *The Econometric Society,* 55(2), 251-276.

[2] Adebiyi, M. A. & Adenuga, A. O. (2010). *Oil price shocks, exchange rate and stock market behaviour: empirical evidence from Nigeria*. *The Open Economics Journal*, 3(1), 1–15.

[3] Gbaranador, M.A. (2024). Macroeconomic variables and stock price behavior in Nigeria. *Journal of Accounting and Financial Management,* 10(4), 1-16.

[4] Luetkepohl, H. (2011). Vector Autoregressive Models. *EUIECO* ,50(1).

[5] Olomola, P. A. & Adejumo, A. V. (2006). Oil price shock and macroeconomic activities in Nigeria. *International Research Journal of Finance and Economics*, 3(1), 28–34.

[6] Terfa, W. A. (2012): Stock management reaction to selected macroeconomic variables in the Nigerian Economy CBN. *Journal of Applied Statistics,* 2(1), 47-56.

[7] Tuaneh, G. L. (2018). Vector autoregression modeling of the interaction among macroeconomic stability indicators in Nigeria. *Asian Journal of Economics, Business and Accounting,* 9(4), 1-17.

[8] Winful, C. E., Sarpong, D. J. & Sarfo, A. K. (2016). Macroeconomic variables and stock market performance of emerging countries. *Journal of Economics and International Finance*, 8(7), 106-126.

[9] Tuaneh, G. L. (2018). Vector autoregression modeling of the interaction among macroeconomic stability indicators in Nigeria. *Asian Journal of Economics, Business and Accounting,* 9(4), 1-17.

[10] Sims, C.A. (1980). Macroeconomics and Reality: *Econometrica,* 48(1), 1– 48.

[11] Syed, A.B & Westerlund, J. (2008). Panel cointegration and the monetary exchange rate model. *MPRA Paper 10453, University Library of Munich, German.*

[12] Deebom, Z. D. (2025). Granger's causality analysis of the interaction between global macroeconomic variables and commodity price movement in Nigeria. *AVE trends in intelligent management letters.* 1(1), 12-27