Science World Journal Vol. 19(No 2) 2024 https://dx.doi.org/10.4314/swj.v19i2.29
www.scienceworldjournal.org
ISSN: 1597-6343 (Online), ISSN: 2756-391X (Print)
Published by Faculty of Science, Kaduna State University

Full Length Research Article

A STUDY ON THE EFFECT OF THE GROWTH RATE OF GROSS DOMESTIC PRODUCT ON SOME MACROECONOMIC VARIABLES

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ABSTRACT
This study examined the effect of the growth rate of Gross Domestic Product (GDP) on inflation, money supply, and crude oil price using Autoregressive Distributed Lag (ARDL) model. Tests of stationarity and cointegration were carried out, also ARDL and Error Correction models were used to model the relationship among the variables. Quarterly data was extracted from the Central Bank of Nigeria website from 2010 to 2023. The stationarity test indicated no unit root, while the cointegration test indicated the presence of a long-run relationship among the variables. Inflation and crude oil prices have a significant impact on the growth rate of GDP in the long run, while in the short run, the crude oil price has a significant impact on the growth rate of GDP. The Error Correction model indicated a significant relationship between the growth rate of GDP and money supply. The adjustment term was -2.96, which inferred that the model was explosive, and a stabilizing error correction term was used to adjust for the explosiveness. The stabilizing error correction model indicated a significant relationship between the growth rate of GDP, crude oil prices and inflation. The stabilizing error correction model was observed to perform better than the error correction model.

Keywords: GDP, Inflation, Money Supply, Crude Oil, Autoregressive Distributed Lag, Error Correction

1.0 INTRODUCTION

Monetary policy is the particular move made by the Central Bank to direct the amount, worth, and cost of money in the economy with the view to accomplishing the targets of government macroeconomics. The goals of financial strategy are expressed by various nations, which change from one country to another. In general, there are two primary goals that all nations share: price stability and additional macroeconomic goals. The particular target of financial strategy might change depending on the degree of monetary turn of events and the financial fortune of the country. The national bank accomplishes its financial approach objective through the amount of cash provided, which includes narrow cash (M1) and broad cash (M2). Currency in circulation alongside non-bank demand deposits, current accounts, and public money are examples of narrow money, while savings, time deposits, foreign-denominated deposits, and narrow money are all included in broad money. Broad money estimates the volume of cash supply in the economy (National Bank of Nigeria, 2006).

Using a structural VAR model, Mustafa (2013) investigated how monetary policy affects Nigeria's macroeconomic performance in terms of domestic output, the consumer price index, and the balance of payments. He found that monetary policy is effective in maintaining internal balance but incapable of accomplishing external balance. Nayan *et al* (2013) inspected the post-Keynesian endogeneity of money supply utilizing dynamic panel data from 177 nations and found that money supply was endogenous.

Celina (2014) explored the effect of financial policy on the development of Nigeria's economy using VECM. He concluded that monetary policy had no significant impact on Nigeria's economic growth during the period under review because he discovered that only the exchange rate had a significant impact on growth, while the interest rate, money supply, and liquidity ratio did not.

Ayodeji and Oluwole (2018) explored the effect of monetary policy on economic growth in Nigeria utilizing the Vector Error Correction Model (VECM) and found that money supply and exchange rate don't have a huge impact on economic growth, while interest rate and liquidity proportion essentially affect economic growth. Ibrahim V.H. (2019) inspected monetary policy and economic growth in Nigeria utilizing the ARDL model and Granger causality test and found that the monetary policy rate doesn't essentially affect economic growth, yet broad money as a monetary policy instrument fundamentally affected economic growth.

Ama and Ambassador (2019) concentrated on the impact of oil price shocks on monetary policy, utilizing the VECM approach. It was found that the oil price shock doesn't impact financial policy.

Javid et al., (2020) investigated how monetary policy affects the Nigerian economy using the VECM model and discovered that money supply and exchange rate influence gross domestic product while interest rate does not influence gross domestic product.

Najihah (2020) examined the fluctuation of oil prices on gross domestic product in Indonesia using the ARDL model and found that oil price fluctuation has a positive impact on gross domestic product in the short run.

Yeshiwas (2021) inspected the effect of broad money supply on economic growth in Ethiopia utilizing the Vector Autoregressive (VAR) model and found that money supply affects gross domestic product, and the Granger causality test showed that money supply does Granger cause gross domestic product, yet genuine gross domestic product doesn't Granger cause money supply.

Using a structural VAR model, Sarmah and Bal (2021) examined the effect of crude oil prices on India's inflation rate and economic development. It was shown that the oil price has a negative influence on GDP, it has a favourable impact on inflation. Dinh Van (2022) investigated how changes in crude oil prices influenced the economics of South Korea, Indonesia, Malaysia, Japan, the United States, Thailand, China, and Vietnam. With the exception of Indonesia, it was shown that the crude oil price has a negative effect on economic development in each of these nations.

Atigala *et al.* (2022) investigated the effect of inflation on the economic growth of Sri Lanka using the ARDL model and discovered that inflation has a negative influence on economic growth both in the short and long run. Aronu *et al.,* (2022) examined the nexus between some selected macroeconomic variables and GDP in Nigeria using the ARDL model, and observed that inflation rate and money supply influence GDP negatively in the long run

while exchange rate has a positive influence on GDP. In the short run, it was observed that the lag value of money supply was discovered to be insignificant while inflation and exchange rate with their lags have a significant influence on GDP. Algaeed and Algethami (2023) examined the effect of monetary volatility on the dynamics of economic growth in Saudi Arabia using the ARDL model and discovered that money supply and interest rate have a negative influence on the gross domestic product both in the short and long run, while the exchange rate has a positive impact on the gross domestic product in the short run and a negative influence in the long run. Sule-iko and Nwoye (2023) investigated the effect of crude oil prices on Nigeria's GDP using the Panel ARDL model. It was observed that both in the long run and short run, crude oil prices have a positive and significant impact on real GDP in Nigeria. Oyelabu and Oyelabu (2023) examined the effect of crude oil price on economic growth in Nigeria and discovered that crude oil price, real exchange rate, real interest rate, and inflation do not significantly influence GDP both in the long run and in the short run, while gross national expenditure has a positive and significant effect on GDP in the long run and short run.

Abifarin *et al.* (2024) examined stabilizing error correction mechanism in the presence of explosiveness and discovered some explosiveness in the adjustment term of short run model using Monte-Carlo simulation. After correction, the adjustment term responds to deviations from the long-run equilibrium, which prevents excessive overshooting.

Previous studies have examined the effect of GDP on inflation, and money supply using the ARDL model, VAR model, SVAR model, and VECM model, but none have been able to provide detailed information on how GDP affects money supply, inflation, and crude oil prices in Nigeria. The purpose of this research is to examine the effect of the growth rate of GDP on inflation, money supply, and crude oil price in Nigeria and also to apply the stabilizing error correction model in Abifarin *et al.* (2024)

2.0 MATERIALS AND METHODS

ARDL model

The ARDL approach for long-run relationship is examined when the underlying variables are of order I(0), 1(1) or both. A general ARDL (p,q) by Pesaran and Shin (1997) is given as

$$\phi(L)y_t = \alpha_0 + \beta(L)x_t + \varepsilon_t \quad (2.1)$$

$\phi(L) = 1 - \sum_{j=1}^{p} \phi_j L^j$ and $\beta(L) = \sum_{j=0}^{q} \beta_j L^j$

Where α_0 is the constant term, ϕ_j, β_j are coefficients of the response and explanatory variable and y_t and x_t are the response variable and explanatory variables while p, and q are the maximum lag of response and explanatory variables respectively and ε_t is the error term.

In this work, the ARDL model below is fitted to our data and is written as

$$GRGDP_t = \alpha_0 + \sum_{i=1}^{p} \varphi_i\, LGRGDP_{t-i} + \sum_{i=1}^{q} \beta_{1i} LogCOP_{t-1} + \sum_{i=1}^{q} \beta_{2i}\, LogM2_{t-i} + \sum_{i=1}^{q} \beta_{3i} Inf_{t-1} + \varepsilon_t \quad (2.2)$$

Log GRGDP is the log of growth rate of GDP
Log COP is the log of Crude Oil Price
LogInf is the log of inflation
logM_2 is the log of money supply
ε_t is the error term

ARDL cointegration bound test:

Cointegration is utilized to identify the long-term connection between the series with varying integration orders (Pesaran and Shin, 1999, Pesaran et al., 2001). The ARDL bound test can be performed using either 1(1) or 1(0), depending on the underlying order of stationarity. At the point when a single cointegration vector exists between the series, the ARDL error correction representation is suitable. The ARDL cointegration bound test is utilized in this work to investigate the presence of cointegration among the variables

$$.\Delta y_t = \theta_0 + \sum_{i=1}^{p} \alpha_i \Delta y_{t-i} + \sum_{j=1}^{q} \alpha_j \Delta x_{t-j} + \theta_1 X_{t-1} + \theta_2 y_{t-1} + v_t \quad (2.3)$$

Where

Δy_t is the first difference of the response variable, Δx_t is the first difference of the lag of the explanatory variable, α_i and α_j are the short-run dynamic of the model while, θ_1 and θ_2 are the long-run relationship

Error Correction model:

The error correction model is used when the variables are cointegrated. It combines short-term adjustment with long-term balance without losing sight of the long-term information.

According to Pesaran and Smith (1998), the long run model is given by equation (2.4) while the short-run ECM is given by equation (2.5)

The long-run model is given by

$$GRGDP_t = \beta_0 + \beta_1 GRGDP_{t-1} + \beta_2 LogCOP_{t-1} + \beta_2 LogM2_{t-1} + \beta_3\, Inf_{t-1} + \varepsilon_t \quad (2.4)$$

$$\Delta GRGDP_t = \alpha_0 + \sum_{i=1}^{p} \beta_i\, \Delta GRGDP_{t-i} + \sum_{j=0}^{q} \beta_j \Delta LogCOP_{t-j} + \sum_{i=1}^{q} \beta_i\, \Delta logM2_{t-i} + \sum_{j=0}^{q} \beta_j\, \Delta Inf_{t-j} + \lambda ECT_{t-1} + \varepsilon_t \quad (2.5)$$

The short-run dynamic coefficients of the model's adjustment are the α and β's and ECT is the Error Correction Term from the long-run cointegrating regression.

With a negative sign, the speed of adjustment parameter (λ) indicates long-term convergence. In the long-run, a fairly rapid rate of adjustment is suggested by the magnitude of the correction. The error correction term greater than 1 indicates the underlying series are explosive, there is over-correction, and it also implies an oscillatory convergence.

Stabilized Error Correction Mechanism:

According to Abifarin et al. (2024), the stabilized error correction model is given as

$$\Delta GRGDP_t = \alpha_0 + \sum_{i=1}^{p} \beta_i\, \Delta GRGDP_{t-i} + \sum_{j=0}^{q} \beta_j \Delta LogCOP_{t-j} + \sum_{i=1}^{q} \beta_i\, \Delta logM2_{t-i} + \sum_{j=0}^{q} \beta_j\, \Delta Inf_{t-j} + \lambda ECT_{t-1} + \theta SECM + \varepsilon_t \quad (2.6)$$

Where $SECM = ECT_t - ECT_{t-1}$ (2.7)

SECM is called the Stabilization error correction mechanism. It measures the change in the error correction term from one period to the next. It helps to slow down the correction process. By introducing SECM, we allow the model to adjust the speed of correction dynamically based on past adjustments. The Stabilization Error Correction Coefficient of θ determines the extent

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to which SECM affects the adjustment process. It controls the strength of the damping effect. A higher θ value will result in a stronger impact of SECM on the adjustment process, while a lower θ value will weaken this impact.

Model Performance

The AIC, BIC, R^2, Durbin Watson, Sum of Square Regression, and Standard Error of Regression are used to evaluate the model's performance.

The smaller the value of the estimate's standard error, the better the model's fit to the data. The regression standard error is also known as the Root Mean Square Error.

The amount of variation in a data set that is not explained by the regression model is measured using the sum of squares of residuals. The smaller the residual sum of squares, the better the model matches the data set, and vice versa.

Diagnostic Test

Normality test: The model is tested to know if it is normally distributed. The Jarqua Bera (JB) test of normality is used in this research work to test if the model is normally distributed. According to Gujarati (2004), the test statistics is given as:

$$JB = n\left[\frac{S^2}{6} + \frac{(k-3)^2}{24}\right]$$

S is the skewness coefficient, K is the kurtosis coefficient, n is the sample size

The hypothesis is given as

H0: residuals are normally distributed

If the computed value of the JB statistic is lower than the p-value then the null hypothesis is rejected otherwise the null hypothesis cannot be rejected.

Auto-correlation Test

The test was used to examine if the covariance and correlations between different disturbances are all zero, which implies that the error should be independently distributed. When there is a violation of the assumption, the disturbance is said to be pairwise autocorrelated. We shall apply the Breusch-Godfrey test to detect the existence of autocorrelation.

Heteroscedasticity Test:

The heteroscedasticity test is used to examine if all observations come from a distribution with the same variance, which is one of the basic assumptions of the classical regression model

$E(\mu_i^2) = \sigma^2$, i=1,2,...n

A violation of this assumption is called heteroscedasticity.

Breush-Pagan Godfrey test is used in this study to detect the existence of heteroscedasticity.

Data source

Quarterly data on crude oil price, inflation rate, money supply, and Gross Domestic Product (GDP) from 2010 to 2023 were obtained from Central bank website and used for this work.

3.0 RESULTS AND DISCUSSION

Descriptive statistics

Table 3.1: Descriptive statistics for inflation and crude oil

Variable	Mean	Max	Min.	Standard deviation	Skewness	Kurtosis	Sum	Jarque-Bera	Probability
Inflation	13.03	21.93	7.833	3.67	0.507	2.472	690.345	2.885	0.236
COP	78.963	121.23	27.49	26.887	0.0630	1.7212	4185.043	3.646	0.1615
LogCOP	-1.870	-1.439	-2.084	0.1608	0.4696	2.4736	-99.1122	2.5604	0.2780

Table 3.1 represents the descriptive statistics of the inflation rate and crude oil in Nigeria from the first quarter of 2010 to the first quarter of 2023. The highest inflation rate recorded was 21.93 in the first quarter of 2023, while the minimum value was 7.83 in the first quarter of 2014, with a standard deviation of 3.69. The inflation rate was observed to be positively skewed, with a moderate kurtosis of 0.507 and 2.472, respectively. The time plot of inflation is given in Figure 3.1.

The highest crude oil price recorded was $121.23 per barrel in the first quarter of 2012, while the minimum value was $27.49 in the second quarter of 2020 during the COVID, with a standard deviation of 26.867. The crude oil price was observed to be positively skewed, with a low kurtosis of 0.0630 and 1.7212, respectively. The log of crude oil prices was observed to be positively skewed with moderate kurtosis of 0.4696 and 2.4736, respectively. The crude oil price and the log of crude oil were observed to be normally distributed with a probability value greater than 0.05. The time plot of the log of inflation is given in Figure 3.2.

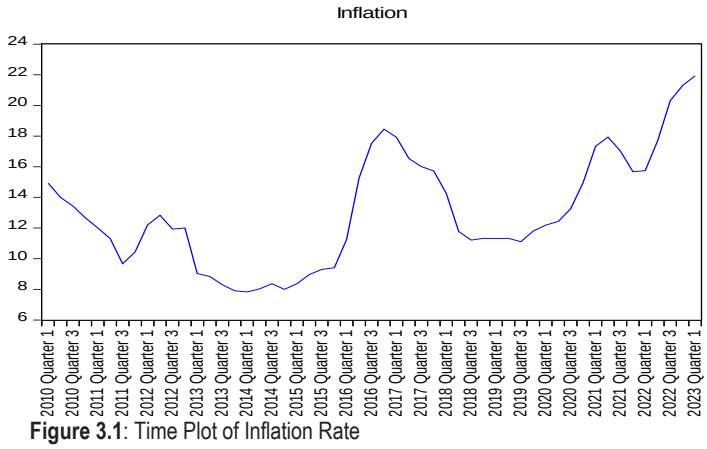

Figure 3.1: Time Plot of Inflation Rate

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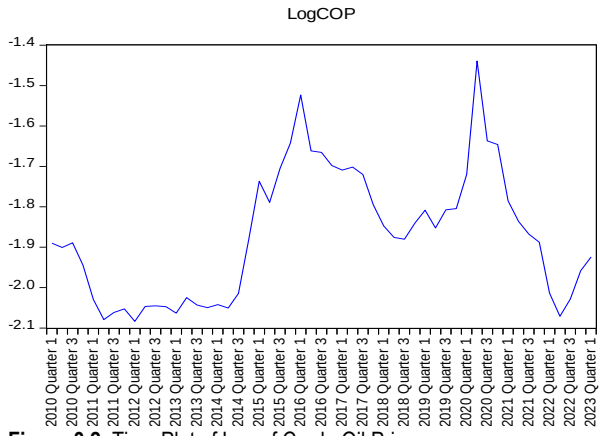

Figure 3.2: Time Plot of Log of Crude Oil Price

Table 3.2: Descriptive statistics for Gross Domestic Product (GDP) and Money supply (M2)

	GDP	Growth of GDP	M2	LogM2
Mean	3140043	-0.039501	24013200	7.319840
Maximum	1.99E+08	0.166184	53314250	7.726843
Minimum	12583478	-0.715265	1075111	6.031453
Standard deviation	25947941	0.122164	11881663	0.263777
Skewness	5.243214	-3.001998	0.832227	-1.999654
Kurtosis	34.46682	19.27854	3.016901	11.84146
Jarque-Berra	2429.445	652.2507	6.118609	207.9496
Probability	0.00000	0.00000	0.046920	0.0000
Sum	1.66E+09	-2.054056	1.27E+09	397.9515

Table 3.2 represents the descriptive statistics of GDP and money supply in Nigeria from the first quarter of 2010 to the first quarter of 2023. The highest GDP recorded was 199336043.8 in the first quarter of 2023, while the minimum value was 12583478 in the first quarter of 2010, with a high standard deviation of 25947941. GDP was observed to be positively skewed, with a high kurtosis of 5.2432 and 34.46682, respectively. The growth rate of GDP was observed to be negatively skewed, with a high kurtosis of -33.001998 and 19.27854, respectively. The growth of GDP was observed to be non-normal, with a probability value less than 0.05. The time plot of the growth of GDP is given in

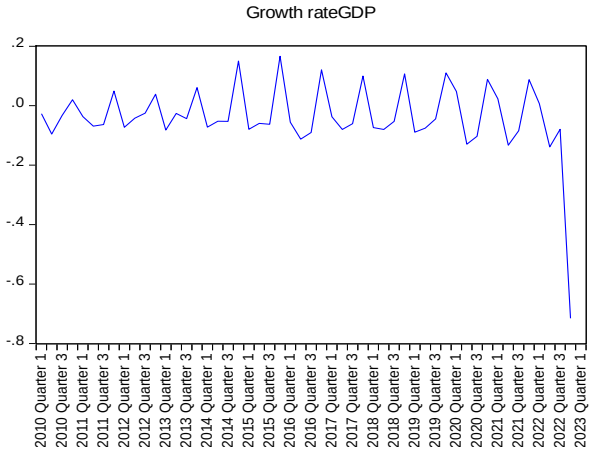

Figure 3.3: Time Plot of Growth Rate of GDP

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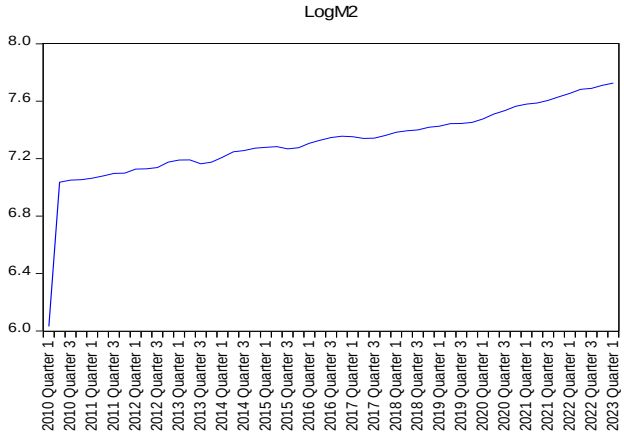

Figure 3.4: Time Plot of Log of M2

Stationarity test

The Augmented Dickey Fuller test was carried out to detect the presence of unit root at three levels: neither trend nor intercept, intercept only, trend, and intercept, as shown in Table 3.3. The table shows that all the variables, for example, growth of GDP, inflation, money supply, and logCOP, all have unit roots that are not stationary at level but are stationary at the first difference. As a result, we conclude that all the variables are stationary at order (1).

Table 3.3: Augmented Dickey Fuller test

Variable	Intercept	P-value	Decision	Trend& Intercept	P-value	Decision	Level None	Pvalue	Decision
GRGDP	-4.4788	0.0007	Stationary	-4.5258	0.0035	Stationary	-3.839	0.0003	Stationary
Infl	-1.7029	0.4238	Unit Root	-2.7312	0.2290	Unit Root	0.1359	0.7211	Unit Root
ΔInf	-3.7527	0.0060	Stationary	-3.8795	0.0201	Stationary	-3.739	0.0004	Stationary
LogCOP	-1.6984	0.4261	Unit root	-1.7316	0.7228	Unit Root	-0.081	0.6509	Unit root
ΔLogCOP	-6.7034	0.0000	Stationary	-6.6435	0.0000	Stationary	-6.772	0.0000	Stationary
LogM2	0.6147	0.9888	Unit Root	-1.6985	0.7373	Unit Root	3.8366	0.9999	Unit Root
ΔLogM2	-5.1861	0.0001	Stationary	-5.4252	0.0003	Stationary	-53.16	0.000	Stationary
Critical value									
1%	-3.5627			-4.1446			-2.6109		
5%	-2.9238			-3.4987			-1.9473		
10%	-2.5973			-3.1786			-1.6127		

Optimal Lag Selection

A maximum lag of 3 was recommended by the AIC, SIC Sequential Modified LR, Hannan-Quinn criteria (HQ), and Final Prediction Error (FPE) results of the optimal lag selection, which are shown in table 3.6 below.

Table 3.4: Optimal Lag selection table

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-43.87555	NA	8.64e-05	1.994814	2.150748	2.05374
1	162.0278	368.9101	3.17e-08	-5.917824	-5.138157*	-5.62319*
2	181.9842	32.42925	2.73e-08	-6.082677	-4.679276	-5.552329
3	201.4920	28.44886*	2.45e-08*	-6.228835*	-4.201700	-5.462778
4	213.7967	15.89356	3.07e-08	-6.074863	-3.423995	-5.073096

ARDL Model for the effect of Crude oil price, inflation and M2 on growth of GDP

The baseline ARDL model in Table 3.5 shows the impact of the growth rate of GDP on crude oil, inflation, and M2. The current growth of GDP is not significantly affected by crude oil prices and the amount of the money supply. The previous growth of GDP has had a negative and significant effect on the current growth of GDP by -0.654233, -0.550763, and -0.757573, respectively,. The current inflation rate adversely affects the current growth of gross domestic product by -0.025402.

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Table 3.5: Baseline ARDL model

Variable	Coefficients	Std. Error	t-Statistic	Prob.
Growth Rate GDP(-1)	-0.654233***	0.248968	-2.627774	0.0122
Growth Rate GDP(-2)	-0.550763***	0.201177	-2.737703	0.0093
Growth Rate GDP(-3)	-0.757573***	0.256855	-2.949416	0.0054
Inflation	-0.025402***	0.006347	-4.002423	0.0003
LogCOP	-0.034129	0.201397	-0.169460	0.8663
LogCOP(-1)	-0.114021	0.267499	0.426248	0.6723
LogCOP(-2)	0.292624	0.265533	1.102024	0.2772
LogCOP(-3)	0.344308	0.221943	1.551334	0.1289
LogM2	-0.062800	0.106617	-0.589022	0.5592
C	1.609054	0.823600	1.953685	0.0579
R-Squared	0.513155			
Adjusted R-Squared	0.400806			
Sun squared residuals	0.368899			
AIC	-1.643011			
BIC	-1.256926			
Durbin-Watson test	1.596156			

***** implies significant at 5%(10%)**

Cointegration test for the effect of Crude oil price, inflation and M2 on GDP

Ho: There is no cointegrating equation

The ARDL cointegration bound test assesses if cointegration exists between the variables by comparing the F-statistics value to the upper 1(1) and lower 1(0) critical bound values, as indicated in table 4.6 below. The F-statistic (10.96523) was found to be greater than 1(1) at the 5%, 10%, and 1% significant levels (3.67, 3.2, and 4.66, respectively). Based on these observations, we draw the conclusion that there is cointegration among the variables. We estimate the Error Correction form because there is a long-term association between the set of variables.

Table 3.6: ARDL Cointegration bound test

Critical value	1(0)	I(1)
1%	3.65	4.66
5%	2.79	3.67
10%	2.37	3.2
F_{cal}=10.96523		
K=3		

Long run Model

Table 3.7 shows the long run impact of the growth rate of GDP on crude oil, money supply, and inflation in Nigeria. The outcomes show that money supply does not have a significant influence on gross domestic product, with a coefficient of -0.021198 and a p-value of 0.5639. This suggests that a unit increase in money supply will decrease the current growth of gross domestic product by 0.021198. The coefficient of inflation on gross domestic product was seen to be -0.008574 with a *P*-value of 0.0024, which suggests that the inflation rate affects the growth of gross domestic product negatively in the long-run. Likewise, the coefficient of the cost of crude oil was seen to be 0.164986 with a *P*-value of 0.0013, which is lower than 0.05. This suggests that the cost of crude oil essentially affects the growth of gross domestic product in the long-run.

Table 3.7: Long run model coefficients

Variable	Coefficients	Std. Error	t-Statistic	Prob.
Inflation	-0.008574***	0.002647	-3.239519	0.0024
LogCOP	0.164986***	0.047651	3.462390	0.0013
LogM2	-0.021198	0.036425	-0.581962	0.5639
C	0.543128	0.29973	1.812042	0.0777

***** implies significant at 5%(10%)**

Short run model

Table 3.8 shows the short run impact of the growth rate of GDP on the inflation rate, money supply, and crude oil price. It was seen that in the short run, past values of the growth rate of gross domestic product affect the current growth of gross domestic product. The current crude oil price has no significant effect on the current growth of gross domestic product, while the past value of the crude oil price adversely affects the growth rate of gross domestic product by -0.636932 and -0.344308. It was also observed that the first quarter of the growth of gross domestic product affects the current growth of gross domestic product by 1.308335, while the second quarter impacts the current growth of gross domestic product by 0.757573. It was further observed that the adjustment term was -2.962568, which infers that the model overshoots and exhibits explosive behaviour. The result is in line with Sarmah and Bal (2021), who observed that the crude oil price has a negative and significant impact on economic growth.

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www.scienceworldjournal.org
ISSN: 1597-6343 (Online), ISSN: 2756-391X (Print)
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Table 3.8: Short run model coefficients

Variable	Coefficients	Std. Error	t-Statistic	Prob.
D(Growth Rate GDP(-1))	1.308335***	0.260350	5.025302	0.0000
D(Growth Rate GDP(-2))	0.757573***	0.186247	4.067577	0.0002
D(LogCOP)	-0.034129	0.175485	-0.194482	0.8468
D(LogCOP(-1))	-0.636932***	0.186134	-3.421899	0.0015
D(LogCOP(-2))	-0.344308***	0.179405	-1.919168	0.0623
CointEq(-1)	-2.962568	0.381042	-7.774916	0.0000
R-Squared	0.653063			
Adjusted R-Squared	0.612722			
Sun squared residuals	0.368899			
AIC	-1.806277			
BIC	-1.574625			
Durbin-Watson test	1.596158			
***** implies significant at 5%(10%)**				

$$\Delta LogGDP_t = 1.308335\ \Delta logGDP_{t-1} + 0.757573\ \Delta logGDP_{t-2} - 0.034129\Delta LogCOP_t - 0.636932\Delta LogCOP_{t-1} - 0.344308\Delta LogCOP_{t-2} - 2.962568ECT_{t-1}$$

Stabilizing Error Correction Model

Table 3.9 shows the stabilizing short-run effect of the growth rate of GDP on the inflation rate, money supply, and crude oil price. It was observed that, in the short-run, inflation and crude oil prices impact the growth rate of the gross domestic product. The current value of crude oil does not have a significant impact on the current growth rate of gross domestic product, while in the second quarter, the price of crude oil has a positive impact on the current growth rate of gross domestic product by 0.295575. It was also observed that the first to third quarter of the growth rate of gross domestic product affects the current growth by - 0.677274, -0.585387, and -0.803836, respectively. An increase in the current inflation rate will diminish the current growth rate of gross domestic product by 0.019757. The ECM term is seen to be -0.0496, while the stabilizing error term is 0.9962. The result is in line with Atigala et al. (2022), who also discovered that inflation has a negative influence on economic growth.

Table 3.9: Stabilizing Error correction model coefficients

Variable	Coefficients	Std. Error	t-Statistic	Prob.
D(Growth Rate GDP(-1))	-0.677274***	0.043966	-15.40463	0.0000
D(Growth Rate GDP(-2))	-0.585387***	0.042009	-13.93494	0.0000
D(Growth Rate GDP(-2))	-0.803836***	0.042706	-18.82246	0..0000
D(LogCOP)	-0.042698	0.053609	-0.796461	0.4307
D(LogCOP(-1))	-0.082116	0.053490	-1.535149	0.1330
D(LogCOP(-2))	0.295575***	0.054490	-5.424401	0.0000
D(Inflation)	-0.019757***	0.003355	-5.889204	0.0000
D(LogM2)	-0.215721	0.228507	-0.944048	0.3511
CointEq(-1)	0.049593	0.087976	-0.563704	0.5763
SECM	0.996200***	0.046358	21.48945	0.0000
R-Squared	0.972172			
Adjusted R-Squared	0.965581			
Sun squared residuals	0.029464			
AIC	-4.141255			
BIC	-3.751421			
Durbin-Watson test	2.082235			
***** implies significant at 5%(10%)**				

MODEL PERFORMANCE

The AIC, BIC, R2, Durbin Watson, Sum of Square Regression, and Standard Error of Regression are used to evaluate the model's performance.

The distance between the average value in the data set and a regression line is calculated using the standard error of regression, which is also known as the Root Mean Square Error. The smaller the value of the estimate's standard error, the better the model's fit to the data; also, the smaller the residual sum of squares, the better the model fits the data set, and vice versa.

Table 3.10 demonstrates that the adjusted model has the lowest AIC and SIC among all models and that it has a smaller standard error of regression and sum-square residual error than the ARDL and ECM.

Science World Journal Vol. 19(No 2) 2024 https://dx.doi.org/10.4314/swj.v19i2.29
www.scienceworldjournal.org
ISSN: 1597-6343 (Online), ISSN: 2756-391X (Print)
Published by Faculty of Science, Kaduna State University

Table 3.10: Model performance

Model	AIC	SIC	R2	Adjusted R2	Durbin Watson	Standard error of Regression	Sum of square of residual
ARDL	-1.643011	-1.256926	0.513155	0.400806	1.596156	0.097257	0.368899
ECM	-1.806277	-1.574625	0.653063	0.612722	1.596158	0.092623	0.368899
SECM Model	**-4.141255**	**-3.751421**	**0.972172**	**0.965581**	**2.082235**	**0.027845**	**0.029464**

Relative Root Mean Square Error

$$Relative\ RMSE = \frac{RMSE\ (Model\ 2)}{RMSE\ (Model\ 1)}$$

When relative RMSE is greater than 1, this implies that model 1 is better but when relative RMSE is less than 1, this implies that model 2 is better

Comparison between SECM model and ARDL model

$$Relative\ RMSE = \frac{0.029464}{0.368899} = 0.07987$$

Since the relative RMSE is less than 1. therefore the SECM model perform better.

Comparison between SECM model and Error correction model

$$Relative\ RMSE = \frac{0.029464}{0.368899} = 0.07987$$

Since the relative RMSE is less than 1, therefore the SECM model perform better

Diagnostic test

Tables 3.11 and 3.12 show that there is no presence of serial autocorrelation among the errors, and furthermore, there is no presence of heteroscedasticity since the F-statistic is greater than 0.05. The normality test in Figure 3.5 shows that the standard errors are normally distributed.

Table 3.11:Breusch-Godfrey test

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	0.144864	Prob. F(2,36)	0.8656
Obs*R-squared	0.383221	Prob. Chi-Square(2)	0.8256

Table 3.12: Heteroscedasticity test

Heteroskedasticity Test: Breusch-Pagan-Godfrey

F-statistic	1.942990	Prob. F(10,37)	0.0700
Obs*R-squared	16.52732	Prob. Chi-Square(10)	0.0855
Scaled explained SS	19.04570	Prob. Chi-Square(10)	0.0397

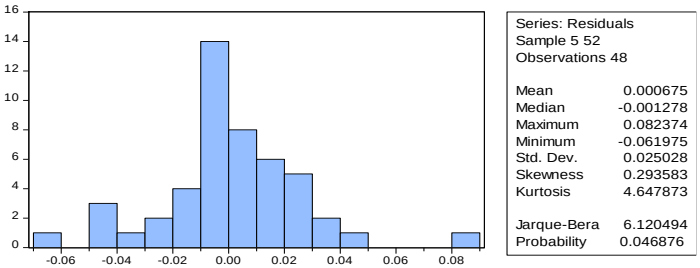

Figure 3.5: Normality graph

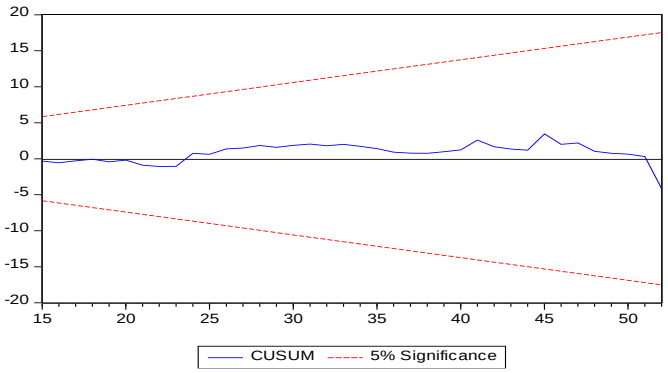

Figure 3.6: Time Plot of Log

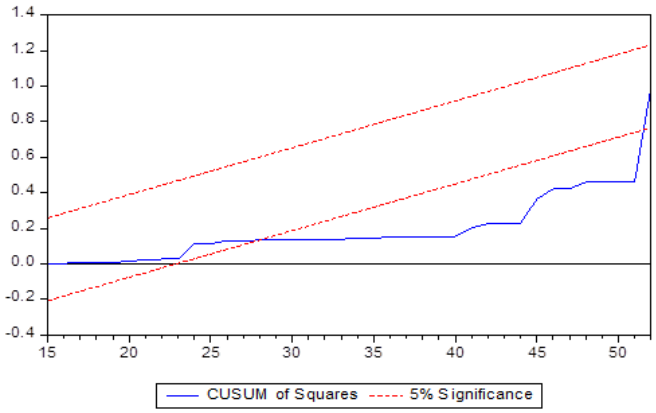

Figure 3.7: Time Plot of Log

Conclusion

Cointegration bound test was performed, and it was discovered that there was cointegration among the variables; therefore, the error correction model was estimated. In the long run, the results show the money supply does not have a significant influence on the growth rate of gross domestic product, and the inflation rate affects the growth rate of gross domestic product negatively in the long-run. The current value of inflation has a significant impact on the current growth of GDP, and the cost of crude oil essentially affects the growth of gross domestic product in the long-run. The past values of the growth rate of gross domestic product affect the current growth of gross domestic product, while the current crude oil price has no significant effect on the current growth rate of gross domestic product, and the past value of the crude oil price adversely affects the growth rate of gross domestic product in the short run. It was also observed that the first quarter of the growth rate of GDP has a positive and significant impact on the current growth, while the second quarter influences the current growth of GDP in the short run. The adjustment term was observed to be explosive; therefore, a stabilizing model was proposed. The result correlated for the error correction term (-0.0495), and the stabilizing coefficient was observed to be 0.9962. Also, it was observed that inflation and money supply influence the growth rate of GDP in the stabilizing error correction model. The impact of the inflation rate was observed to be significantly negative, with a coefficient of 0.019757. The current value of crude oil price does not have significant impacts on the current growth rate of gross domestic product, while in the second quarter, crude oil price has a positive impact on the current growth rate of gross domestic product. The first to third quarters of the growth rate of gross domestic product have a negative influence on the current growth rate of GDP. It is therefore recommended that policymakers act proactively and, in the future, take efforts to control the country's current high level of inflation and implement policies that stimulate constant economic growth.

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