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Econometric Modelling of Macroeconomic Interdependencies and the Impact on Nigeria's Economic Growth Amidst the Covid-19 Pandemic

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ABSTRACT

This paper dwelt on the investigation of the impact of COVID-19 on economic growth of Nigeria with reference to crude oil price, crude oil export and naira/dollar exchange rate as macroeconomic indicators. The pre and during COVID-19 periods were represented by dummy variables (0, 1). Six years of monthly data ranging between 2016 and 2021 were obtained from the CBN and NBS bulletin. The ARDL model was calculated using the e-view programme. The findings revealed a long-term cointegration between the variables under consideration. There was a significant association established in the short term between the lagged dependent variable, exchange rate, and dummy variable at a 1% level of significance. However, the crude oil price had no significant impact on the model over the study period. According to these findings, the government should diversify its focus by investing more in non-traditional sectors, particularly the service and agricultural sectors. Over-reliance on crude oil exports should be decreased, as the pandemic has highlighted the importance of being prepared for unexpected events and having a resilient economy. Nigeria can reduce its vulnerability to external shocks and boost economic growth by researching and developing in other areas. The epidemic acts as a wake-up call to prioritise diversification and resilience in the face of future uncertainties.

INTRODUCTION

An unprecedented global crisis brought about by the COVID-19 epidemic has disrupted markets all across the world and made it difficult for nations to travel through unfamiliar terrain. One of the biggest economies in Africa, Nigeria, has not been exempt from the pandemic's widespread effects. With major effects on numerous industries and macroeconomic indices, the virus has put a tremendous amount of strain on Nigeria's economy.

Nigeria's economic growth trajectory has been negatively impacted by the COVID-19 pandemic, which has reduced GDP and disrupted several important industries. Nigeria's real GDP decreased by 1.8% in 2020, according to the World Bank, demonstrating the heavy toll the pandemic had on economic activity (World Bank, 2021). Lockdown measures, travel restrictions, and interruptions in global supply chains brought on by the pandemic have hindered manufacturing, decreased consumer demand, and decreased economic activity (Sariakin *et al.*, 2023).

Nigeria's economy, which is heavily dependent on oil, has been particularly affected. Nigeria, a country that exports oil, has had to contend with both falling oil prices and a decline in global demand. According to the International Monetary Fund (IMF), the decrease in oil prices caused Nigeria's oil sector to experience a significant contraction, which exacerbated the country's economic crisis (IMF, 2021). Government finances are under pressure due to the downturn in oil revenue, which has an effect on budgetary allocations and the execution of important development projects.

In Nigeria, the pandemic has also had an impact on jobs and standard of living. According to the International

Labour Organisation (ILO), unemployment rates in Nigeria increased significantly, with an alarmingly high number of people without jobs (ILO, 2021). The pandemic has severely affected the informal sector, which makes up a sizeable percentage of Nigeria's economy, resulting in widespread job losses and decreased incomes for millions of Nigerians.

The pandemic has also increased Nigeria's inflationary pressures. Rising production costs, broken supply chains, and currency devaluation have all contributed to higher prices for products and services. Inflation increased, above the target range of 6-9%, according to the Central Bank of Nigeria (CBN) (CBN, 2021). High inflation reduces purchasing power and has a detrimental impact on living standards, especially for society's most disadvantaged groups.

The Government implemented a number of measures to lessen the burden on the economy in response to the economic difficulties brought on by the pandemic. These consist of monetary policy adjustments, fiscal stimulus plans, and specialised aid for vulnerable groups. The impact of these actions in fostering economic recovery and reestablishing sustainable growth is still being researched.

The COVID-19 crisis has had a considerable influence on the Nigerian economy, causing GDP to decrease, disruptions in numerous sectors, and challenges in macroeconomic statistics. Several existing literature studies have analysed Nigeria's economic growth in the midst of the COVID-19 pandemic and contributed significantly to our understanding of the subject. Bala and Owolabi (2021) use a Vector Autoregression (VAR) model to investigate the economic impact of

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the pandemic in Nigeria. Their findings show that there are considerable negative effects on economic growth, emphasising the importance of effective policy responses to offset the consequences. They also emphasise the significance of tackling the issues that important sectors such as agriculture, industry, and services are facing in order to encourage recovery.

Jibrin and Mubaraq (2021) also look into the link between the pandemic, oil price shocks, and macroeconomic indicators. They observe negative effects on economic growth, inflation, and currency rates using an Autoregressive Distributed Lag (ARDL) model. The study emphasises the significance of economic diversification in increasing resilience to external shocks. They also emphasise the importance of fiscal and monetary policy cooperation in order to stabilise the economy and alleviate the negative consequences of the crisis.

In addition, Nasiru and Muazu (2021) use a Vector Error Correction Model (VECM) to assess the economic impact of the pandemic. Their study emphasises the negative consequences on GDP growth, unemployment, and inflation, emphasising the importance of focused policy actions to foster recovery and stability. They also emphasise the importance of structural changes, vital sector investment, and social protection measures in promoting equitable and sustainable growth. Similarly, Mohammed and Asongu (2021) uses a Generalised Method of Moments (GMM) estimator to investigate how the pandemic and oil price shocks affect Nigeria's economic performance. Their research uncovers important implications on GDP growth, inflation, and fiscal performance, emphasising the significance of long-term economic diversity for resilience. They further advocate for policies that foster economic diversification, improve governance, and promote technological advancement to mitigate the vulnerabilities exposed by the crisis.

Tella, Oyewole, and Adeyemi (2020) utilise an aggregated structural model to estimate the macroeconomic impact of the pandemic. Their research demonstrates that the effects on economic growth, employment, fiscal policy, and monetary policy are all negative. The report emphasises the importance of focused policy initiatives and policies to support economic recovery and resilience. They also emphasise on the importance of investing in infrastructure, human capital, and digital technologies in order to boost Nigeria's competitiveness and assure long-term growth.

Despite scholars' excellent efforts and contributions, a full assessment of the effects of crude oil price, export, and currency rate on GDP before and after the COVID-19 regime is still lacking. While multiple studies have looked into various facets of Nigeria's economic growth in the midst of the epidemic, the specific influence of these factors on GDP dynamics has to be investigated further. As a result, the goal of this study.

METHODOLOGY

This study employed a quantitative research design to effectively address its objectives. Using time series data, the analysis covered a six-year period (January 2016 to October 2021). Because of the mixed order of integration I(1) and I(0) seen in the unit root test for both endogenous and exogenous variables, the Autoregressive Distributed Lag (ARDL) model was adopted. Data were gathered from the Central Bank of Nigeria's (CBN) 2021 statistics bulletin and the National Bureau of Statistics (NBS). The variables studied were GDP, crude oil production, crude oil exports, and the exchange rate.

This is stated as follows:

$$\Delta A_t = C_0 + C_1 A_{(t-1)} + \sum_{i=1}^p C_i \Delta A_{(t-i)} + k_t \quad (1)$$

The optimum lag was selected with the lowest SBIC (Schwartz Bayesian Information Criterion).

Estimation Technique

Equation 1 can be rewritten to describe an ARDL equation for determining whether the variables have a long run relationship. The relationship can be expressed as:

$$\Delta \ln GDP_t = \gamma_0 + \sum_{i=1}^p \gamma_1 \Delta \ln(GDP)_{(t-i)} + \sum_{i=0}^p \gamma_2 \Delta \ln(COP)_{(t-i)} + \sum_{i=0}^p \gamma_3 \Delta \ln(CRDEXPT)_{(t-i)} + \sum_{i=0}^p \gamma_4 \Delta \ln(EXRT)_{(t-i)} + \sum_{i=0}^p \gamma_5 \Delta \ln(DUMY)_{(t-i)} + k_t \quad (2)$$

Where

GDP = Gross Domestic Product

COP = Crude Oil Price; CRDEXPT = Crude Oil Export;

EXRT = Exchange Rate

DUMY = (0 for before Covid 19, 1 for during Covid 19)

$\gamma_0, \gamma_1, \gamma_2, \gamma_3, \gamma_4$ and γ_5 are coefficient to be evaluated.

k_t random error term ($k_t \sim \text{IID}(0, \sigma^2)$)

To affirm the existence of a long-run relationship, we test the hypothesis:

$$H_0: \eta_{iM} = \dots = \eta_{iM} \text{ (for } i=1, 2, 3, 4)$$

The rejection of H_0 indicates integration,

$$\ln GDP_t = \gamma_0 + \sum_{i=0}^p \gamma_{1i} \ln(GDP)_{(t-i)} + \sum_{i=0}^p \alpha_{1i} \ln(COP)_{(t-i)} + \sum_{i=0}^p \theta_{1i} \ln(CRDEXPT)_{(t-i)} + \sum_{i=0}^p \Theta_{1i} \ln(EXRT)_{(t-i)} + \sum_{i=0}^p \vartheta_{1i} (DUMY)_{(t-i)} + k_t \quad (3)$$

$$\ln GDP_t = \gamma_0 + \sum_{i=0}^p \gamma_{2i} \ln(GDP)_{(t-i)} + \sum_{i=0}^p \alpha_{2i} \ln(COP)_{(t-i)} + \sum_{i=0}^p \theta_{2i} \ln(CRDEXPT)_{(t-i)} + \sum_{i=0}^p \Theta_{2i} \ln(EXRT)_{(t-i)} + \sum_{i=0}^p \vartheta_{2i} (DUMY)_{(t-i)} + \mu_t \quad (4)$$

Equation (3) represents the coefficients in the long run at 'm' optimal lag with GDP as a response variable.

In addition, (4) represents the ARDL short run specification, in which error correction model (ECM) can be derived from (Rasheed, 2023).

Equation (5), on the other hand, indicates the ECM's speed of recovery from deviation.

$$ECM_{(t-1)} = \ln GDP_t - \gamma_1 - \sum_{i=0}^p \gamma_{1i} \ln(GDP)_{(t-i)} - \sum_{i=0}^p \alpha_{1i} \ln(COP)_{(t-i)} - \sum_{i=0}^p \theta_{1i} \ln(CRDEXPT)_{(t-i)} - \sum_{i=0}^p \Theta_{1i} \ln(EXRT)_{(t-i)} - \sum_{i=0}^p \vartheta_{1i} \Delta(DUMY)_{(t-i)} \quad (5)$$

Coefficient of determination (R^2) was utilised to confirm how good the fitted model is. For the sake of robustness, this describes how well the line describe the data. This can be expressed as:

$$R^2 = 1 - (SSR)/SST \quad (6)$$

SSR represents square regression and SST represents sum of square total.

RESULTS

Table 1 examined the joint description of measurement variables. The test results show that the exchange rate and GDP have non-normal distribution patterns over

time, with a significant p-value of 0.05. The minimum and maximum values of the predictors as well as their variance were also recorded throughout time.

Table 1: Descriptive Statistics

	COP	CRDEXPT	EXRT	GDP
Mean	56.65	1.41	268.39	9033461
Median	59.10	1.48	199.8	6347146
Maximum	79.59	2.00	396.00	14521335
Minimum	14.28	0.97	169.68	5265989
Std. Dev.	13.72	0.20	81.56	3577591
Skewness	-0.58	0.18	0.34	0.21
Kurtosis	3.01	3.20	1.40	1.24
Jarque-Bera	3.89	0.52	8.62	9.39
Probability	0.14	0.76	0.01	0.009

Source: Researchers' Computations, 2022

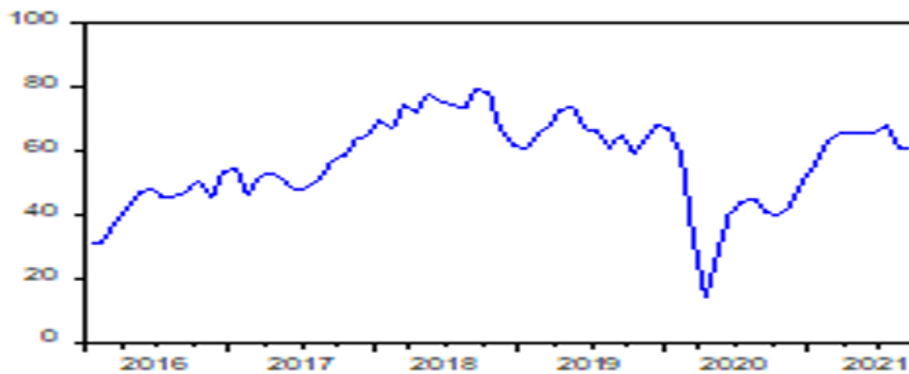


Figure 1: Time plot of GDP

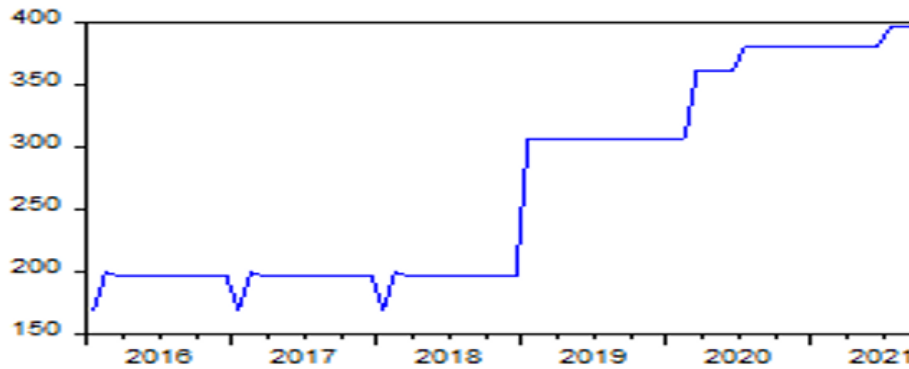


Figure 2: Time plot of CRDEXRT

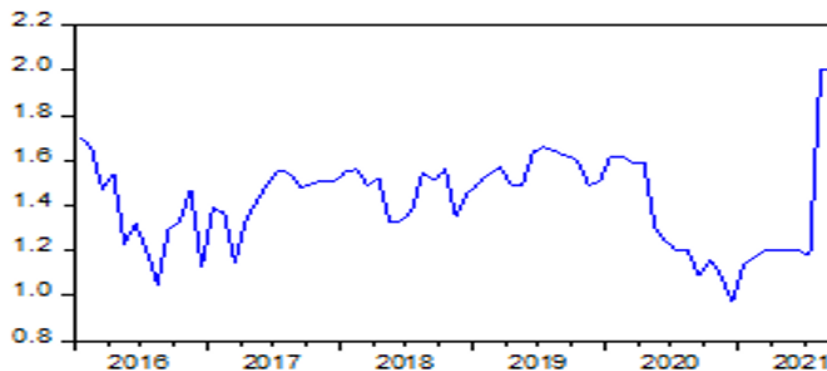


Figure 3: Time plot of COP

Table 2: ADF Stationarity Test Results

Variables	Levels	Critical Values @5%	1 st Diff.	Critical Values @ 5%	Remark
COP	-3.0221	-2.9055 (0.0379)*	-	-	I(0)
CRDEXPT	-2.8219	-2.9048 (0.0605)	-9.6041	-2.9055 (0.000)**	I(1)
EXRT	-0.5555	-2.94848 (0.8728)*	-9.4070	-2.9055 (0.000)**	I(1)
GDP	-0.8443	-2.9048 (0.7997)	-8.2507	-2.9055 (0.000)**	I(1)

Note: values represented by *, ** signifies level of significance @ 5% and 1% respectively
 Source: Researchers' Computations, 2022

Table 2 shows the variables' integration qualities, labelled as I(1) and I(0), signifying mixed orders of integration of 1 and 0, respectively. The ADF test findings for COP indicate that the variable is integrated at the zero-order. This implies that the selected macroeconomic indicators are appropriate in modeling Nigeria economic growth via the ARDL methodology as there exist mix order of integration.

Confirmatory analysis of the PP test in Table 3 also indicated that EXRT is of I(0) as compared to the ADF test. This confirms the robustness of the PP methodology in testing for stationarity of variables for model identification.

The AIC was used to propose the largest lag structure for endogenous and exogenous variables to lag order 1, as indicated in table 4.

Table 3: Philips Perron (PP) Unit Root Results

Variables	Levels	Critical Values @5%	1 st Diff.	Critical Values @ 5%	Remark
COP	-3.1421	-2.7175 (0.0289)*	-	-	I(0)
CRDEXPT	-2.9829	-2.3048 (0.0615)	-8.2135	-2.9165 (0.000)**	I(1)
EXRT	-3.7143	-5.9218 (0.0234)*	-	-	I(0)
GDP	-0.5555	-2.9446 (0.8385)	-9.4482	-2.9385 (0.000)**	I(1)

Note: values represented by *, ** signifies level of significance @ 5% and 1% respectively
 Source: Researchers' Computations, 2022

Table 4: Lag Selection Criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	75.8006	NA	1.20e-06	-2.2793	-2.1433	-2.2258
1	262.47	343.72*	5.34e-09*	-7.6976*	-7.0172*	-7.4300*

* implies lag order chosen by several criterion
 Source: Researchers' Computations, 2022

Table 5: Result for Dynamic Regressors (ARDL)

Variables	Coefficient	Std. Error	t-Value	Pr(> t)
ln(GDP) _(t-1)	0.7734	0.0704	10.9768	0.000
ln(COP) _t	0.0408	0.0242	1.68490	0.100
ln(CRDEXPT) _t	-0.0355	0.0460	-0.7713	0.444
ln(EXRT) _t	0.8907	0.0918	9.7015	0.000
ln(EXRT) _(t-1)	-0.4912	0.1184	-4.1460	0.000
Dummy (0,1)	-0.0736	0.0263	-2.7920	0.007
Constant	1.2693	0.6019	2.1086	0.039

R² = 0.985; Adj. R² = 0.984; MSE = 0.051; RMSE = 0.225; AIC = -3.0263; F-value = 697.510, (sig-value = 0.000)
 Source: Researchers' Computations, 2022

Hence;

$$\Delta \ln(GDP) = 1.2693 - 0.7734 \ln(GDP)_{(t-1)} + 0.0408 \ln(COP)_t - 0.0355 \ln(CRDEXPT)_t + 0.8907 \ln(EXRT)_t - 0.4912 \ln(EXRT)_{(t-1)} - 0.0736 DUMMY \quad (7)$$

According to the R-squared value of 0.985, the combined effects of crude oil price, exchange rate, and export account for roughly 98.5% of the variation in economic

development throughout the examined years. The updated R-squared value of 0.984 implies that new variables will continue to account for around 98.4% of the variation in economic growth. With a p-value less than 0.05, the F-statistic of 697.51 implies that model is adequate enough in predicting the dynamic impact of economic growth with reference to the selected macroeconomic indicators.

Furthermore, the study finds that a 1% increase in GDP in the following year equates to a large 77.3% increase in present economic growth. Furthermore, both the crude oil price (COP) and EXRT contribute to a rise in economic growth of 4.1% and 89.1%, respectively. Assuming all other variables remain constant, a 1% increase in exports (EXPT) and a one-period lag in the exchange rate result in a 3.6% and 49.1% drop in economic growth, respectively. The study also discovers that lagged variables have a major influence on Nigeria's economic growth over this time span.

The research demonstrates that the variables crude oil price (COP) and export (EXPT) make insignificant contributions to the model, implying that they have a limited impact on economic growth. The study, however, emphasises the significance of lag 1 of the exchange rate (EXRT) as a statistically significant variable, demonstrating its impact on economic growth the following year. Furthermore, the analysis shows that the exchange rate at lag 0 contributes considerably to economic growth throughout the study period, as indicated by a p-value less than 0.05.

A detailed analysis using dummy variables demonstrates

a considerable negative influence on economic growth between the pre-COVID-19 period (represented by 0) and the post-COVID-19 period (represented by 1). This effect is significant, accounting for 7.4% of the observed impact, and the related p-value is less than the usually accepted statistical significance threshold of 0.05. These data highlight the considerable impact of COVID-19 on the country's economic collapse, which may be linked to a number of variables, including a combination of low crude oil prices and a high naira/dollar exchange rate, as well as lower export levels.

According to the supplied critical bounds values, the estimated F-statistic (3.9687) for the cointegration limits test exceeds the upper bound critical values of 2.79, 3.67, 2.37, and 3.20 for significance levels of $p = 0.01, 0.05,$ and 0.10 . As a result, the null hypothesis of no cointegration is rejected, and it is conceivable to conclude that there is a long-term cointegrating link. According to the findings, Nigeria's non-oil export statistics demonstrate a long-term relationship between the identified exogenous variables and economic growth in both pre-COVID-19 and COVID-19 era. In selecting an ARDL (1, 0, 0, 1) model, the Akaike Information Criterion (AIC) was utilised.

Table 6: Error Correction Regression Model

Response variable = $\Delta \ln \text{GDP}$				
Var.	Coef.	SE	t-Stat.	Prob.
C	1.2693	0.6019	2.1086	0.039
$\ln(\text{GDP}(-1))$	-0.2265	0.0704	-3.2144	0.002
$\ln(\text{COP})$	0.0408	0.0242	1.6849	0.097
$\ln(\text{CRDEXPT})$	-0.0355	0.0460	-0.7713	0.443
$\ln(\text{EXRT}(-1))$	0.3995	0.1036	3.8537	0.000
$\ln(\text{EXRT})$	0.8907	0.0918	9.7015	0.000
DUMMY	-0.0736	0.0263	-2.7920	0.007
$\text{ECM}_{(t-1)}$	-0.2265	0.0492	-4.5983	0.000

$R^2 = 0.618$; $Adj. R^2 = 0.606$; $DW\ stat = 1.9001$

Source: Researchers' Computations, 2022

The ARDL co-integration analysis, at a significance level of 5%, reveals a substantial long-term influence between current economic growth and economic growth in the previous year. However, impact of crude oil price on economic growth is statistically insignificant ($p\text{-value} > 0.05$), with a 4.1% incremental change in economic growth per percentage shift in crude oil price. In contrast, export shows a long run negative contribution to economic growth, insignificant at the 5% level ($p\text{-value} 0.4435 > 0.05$), while import contributes positively at 3.6%. Exchange rate at lags 0 and 1 also exhibit long-term co-integration effects on economic growth, with incremental rates of 89.7% and 40%, respectively. This suggests that changes in exchange rate before and during the COVID-19 period will result in approximately 90% increase in the unemployment rate in the current year and a 40% rate of increment of economic growth in

the previous year. The coefficient of current domestic output displays elasticity in response to economic growth. Furthermore, the long-term effect of the pre and post COVID-19 era dummy variable indicates a negative multiplier effect of 7.4% on Nigerian economic growth. The statistically significant ($p\text{-value} 0.000 = 0.05$ level of significance) -0.2265 $\text{ECM}(t-1)$ coefficient demonstrates the presence of a long-term equilibrium among economic factors. The error correction model (ECM) system's coefficients provide insight into the short-term adjustment process towards long-run equilibrium. With a significant value of -0.226509 , the ECM shows that approximately 22.7% of the disparity in the determinants of economic growth from the previous era has been addressed in the present period to restore equilibrium. As a result, returning to the equilibrium condition would take around one calendar year.

Table 7: Screening test

Chi-square _{heteroskedasticity} (1) = 1.2352 [0.2969]	Chi-square _{serial correlation} (2) = 0.0485 [0.9527]
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p-values is quoted in []

Source: Researchers' Computations, 2022

Table 7 summarises the results of the portmanteau tests performed on the ARDL model residuals. These tests show that the residuals are free of heteroskedasticity and serial correlation.

Furthermore, the adjusted R-squared of the short-run ARDL model, which is around 61.8%, shows that the model effectively passes the autocorrelation and heteroscedasticity diagnostic tests.

The AR inverse roots of the characteristic polynomial were examined to determine stability and stationarity. It indicated that the root modulus is smaller than one and lies within the unit circle. This verifies the ARDL (1, 0, 0, 1) model stability and invertibility.

The CUSUM test was used on the model residuals to

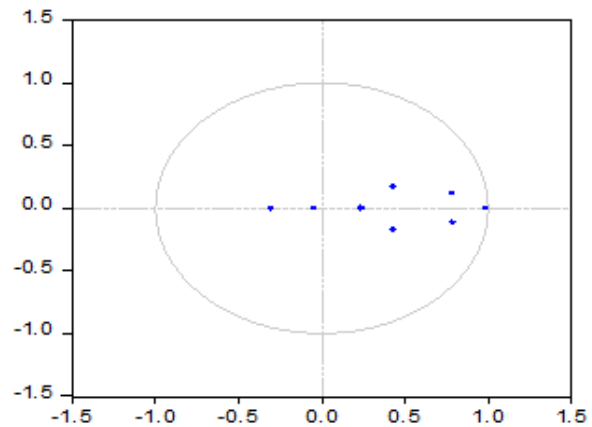


Figure 4: Inverse root of the selected ARDL

ensure its stability. The test results showed that the CUSUM test statistic is still within the critical parameters of the 5% level. This implies that the model estimated parameters are consistent throughout the study period.

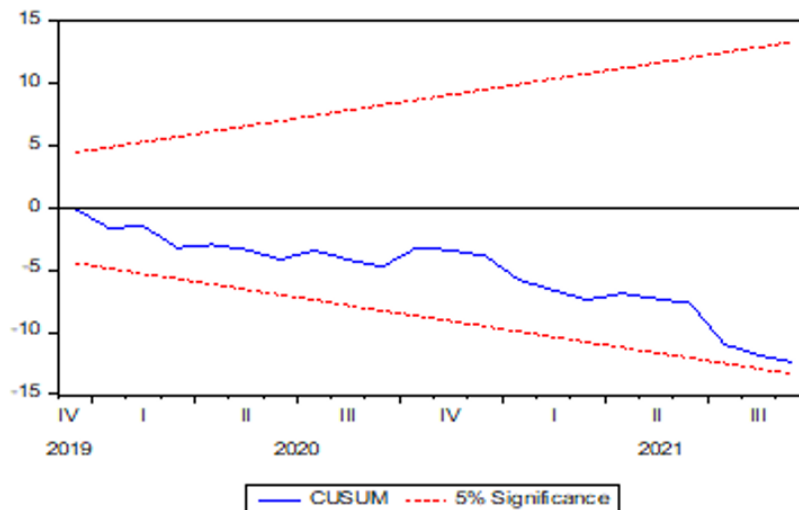


Figure 5: Cumulative Sum of Recursive Residuals plot for Coefficients of ARDL model

CONCLUSION

From the findings of study's predefined objectives, it has been discovered that the selected macroeconomic factors have significant links with Nigeria's economic growth. The exchange rate is a significant and influential component that plays an important impact in economic growth. It is useful in understanding differences in economic growth by using the current rate as a factor. Furthermore, examining previous GDP growth rates is critical for gaining a better understanding relationship existing between exchange rate and Nigeria economic growth.

While crude oil prices had no substantial impact on economic development, they did show a positive trend throughout the study period, particularly during the difficult period of the COVID-19 pandemic. This suggests that, despite the lack of statistical significance, the crude oil price had a favourable affect throughout the time period studied.

In assessing the consequence of the pandemic on economic growth, the introduction of a dummy variable to distinguish between the pre-COVID-19 and COVID-19 eras generated statistically significant results. The dummy variable's negative contribution suggests that the COVID-19 epidemic has considerably led to a major fall in Nigeria's GDP, resulting in an economic downturn and sufferings for the populace. This can be linked to the country's high reliance on imports as opposed to exports, as the exportation variable did not contribute much to economic growth during this time period.

It is advised that the government dedicate additional resources to sectors such as services and agriculture, diversifying the economy beyond crude oil exportation, to reduce the negative effects and support economic recovery. Furthermore, encouraging consumer expenditure on goods and services, particularly in areas such as home development, construction, and allied

industries, can help to GDP growth and, ultimately, strengthen the naira in the global market.

By implementing these steps, Nigeria will be able to gradually overcome the pandemic's obstacles, drive economic growth, and strengthen its position in the international economic scene.

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