

Investigating the Effects of Coronavirus Pandemic on Selected Nigerian Macroeconomic Indicators: An Application of VECM

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ABSTRACT

This research empirically assessed the impacts of CoV-19 on Nigeria's foreign reserves (FR), exchange rate (EXR), and crude oil price (COP) using 593 daily datasets from January 2, 2020 to May 11, 2022. The number of confirmed CoV-19 cases was sourced from World Health Organization, the EXR, FR, and the COP were obtained from Central Bank of Nigeria (CBN). Johansen cointegration test was used and Vector Error Correction Model (VECM) adopted in the research. The variance decomposition result reveals that the CoV-19 exhibits a strong endogeneity in both the short and long run but weakly predicts the economic variables. The estimates of the variables speed of adjustments shows that CoV-19, COP, EXR and FR are significant at lag one. The error correction term, shows an adjustment rate of -0.0658 for the target variable CoV-19. The Granger/Wald causality test shows that there is no short run causality from CoV-19 to COP, EXR, and FR. The long run causal relationship indicates CoV-19, COP, EXR, and FR have long run relationship among the variables. Long run casual outcome indicates that crude oil price and foreign reserve are negative and significant at 5% level due to infected CoV-19 cases. While 5% increase in infected cases of CoV-19 pandemic will lead to 0.001897 increase in exchange rate in the future.

Keywords: CoV-19 Pandemic, Error correction term, Speed of adjustment, Cointegration, Stationarity test

1.0 INTRODUCTION

The new coronavirus has spread rapidly throughout the world. On March 11, 2020, the World Health Organization (WHO) Trusted Source declared CoV-19 a pandemic. The most common way for the virus to spread is via close contact with someone who is infected already. Close contact is defined as being within 6 feet of a trusted source. There's a chance that the novel coronavirus will spread in other ways. CoV-19 is more contagious, and it has already killed more people around the world. After quickly spreading across Europe, North America, and East Asia in early 2020, the CoV-19 outbreak began to affect most countries in Africa and Latin America. It took some time before the pandemic reached Nigeria, which is Africa's largest human population and long-standing travel and commerce linkages in Africa and the rest of the world. The first case detected of the disease in Sub-Sahara Africa was in late February in Nigeria (NCDC, 2020). The virus spread from Lagos to Ogun state, as well as the Federal Capital Territory Abuja. CoV-19 arrival triggered a cascade of governmental responses, including education initiatives and public health, as well as monetary and fiscal regulations. The pandemic's size and unexpected beginning, as well as the governmental responses, are predicted to have substantial economic consequences, although the magnitude of these consequences are still unknown.

In the first quarter of 2020, the overall economic cost of effective mitigation programs became apparent. National GDP dropped by 6.8% year on year in the first quarter. Agricultural businesses encountered logistical challenges during and after the lockdown, including labor and feed shortages, supply issues and insecurity issues caused by Boko haram and armed bandits killing and kidnapping farmers on their farms (NBS, 2020). All affected countries' policymakers are seeking for ways to strike a balance between the favorable public health consequences of strict mitigation regulations and their economic costs. While the research concentrates on Nigeria's macroeconomic variables, which is extremely important to understand. It will help us to evaluate the economic costs of mitigation programs as well as the possible benefits of economic recovery. The analysis has substantial policy implications for Nigeria in terms of stimulating economic growth and ensuring a stable food supply system in late 2021.

1.1 Variables

1.1.1 Foreign Reserve

The external reserves dropped by 6.25 percent in first half (H1) of 2020. In 2021, the data fell by \$2.05 billion, or 5.8%, in the equivalent half-year, a greater decline than this year. As the nation, like others sacrificed the economy to preserve its life, around \$2.4 billion was taken out of the reserves in absolute terms. Which were

all mostly impacted by the world economic shutdown caused by the CoV-19 pandemic.

1.2 Exchange Rate

The question on the lips of every Nigerian is that in the 80s, Nigeria exchanges 80 kobo to 1 dollar and in the first quarter of 2020 it was ₦360 to 1\$ and with the pandemic it skyrocketed to ₦470 to 1\$, what could have been responsible for all these, could it be bad economic policies or our international borrowings? Is it a CoV-19 pandemic?

Because of the worrisome increase in the exchange rate, and its effects on the already precarious Nigerian economy. We empirically want to determine whether CoV-19 had an impact on the nation's currency rate performance.

1.3 Crude Oil Price

Oil-producing nations like Nigeria are confronted with enormous budget deficits, inflation, exchange rate instability, the depletion of foreign reserves, among other economic challenges, as a result of diminishing demand and excess production. Nigeria is experiencing three shocks at once: the pandemic of the CoV-19, local and international shock, and shock from the price of oil.

Oil prices had a historic collapse, from \$61.5 in December 2019 to \$23.2 in March 2020. Due to CoV-19 and the federal government reduced the 2020 budget by 45%. Following the global price crash, crude oil benchmark of \$57 per barrel has been reduced to \$30 per barrel (<http://www.premiumtimes.com>).

$$CoV = F(COP, FR, EXR,)$$

$$\text{Recall; } y_t = K + B_1 y_{t-1} + B_2 y_{t-2} + \dots + B_p y_{t-p} + \mu_t,$$

With cointegration transformation of Equation (2.1), we can get that

$$\Delta y_t = K + \Pi y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + \mu_t, \quad (2.12)$$

where;

Δy_t is the first difference of the variables in vector y

Π is a coefficient matrix of cointegrating relationships

Γ_i is a coefficient matrix of the lags of differenced variables of y

If y_t has cointegration relationship, then $\Pi y_{t-1} \sim I(0)$, and Equation (2.12) can be written as follows:

$$\Delta y_t = K + \alpha \beta' y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + \mu_t, \quad (2.13)$$

where; α is the coefficient of the ECT_{t-1}

$\beta' y_{t-1} = ECT_{t-1}$ is the Error Correction Term (ECT_{t-1}), which reflects long-term equilibrium relationships between variables, and the above Equation can be written as follows:

1.4 Vulnerable Sectors during the Lockdown and Recovery Phases

CoV-19 outbreak has been the most historic economic shock in Nigeria's contemporary times, according to the latest economic data given by the NBS. CoV-19 affected different economic sectors in different ways. A major portion of Nigeria's commercial activity were halted as a result of the lockdowns and other restrictions. As a result of the outbreak, many organizations extended the dates when employees could return to work. The bulk of migrant employees returning home for vacation or leave were imprisoned in their hometowns, resulting in serious labor shortages in many manufacturing and service industries. The number of migrant workers who returned to work decreased. Supply chains and logistics were interrupted across the country, with certain industries being damaged harder than others. Entertainment, travel/tourism, traditional food markets, and restaurants, which rely on physical space and stores, experienced the worst losses.

2.0 DATA AND RESEARCH MODEL SPECIFICATION

2.1 Data Description

The research takes four variables into consideration namely; coronavirus cases, exchange rate, Crude oil price, and foreign reserve. The research is to investigate the impact of the pandemic on Crude oil price, exchange rate, and foreign reserve for the periods considered. The number of variables were limited to daily coronavirus infected cases, Crude oil price, exchange rate, and foreign reserve. The model is given as:

(1)

(2.1)



$$\Delta y_t = K + \alpha ECT_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + \mu_t, \tag{2.14}$$

A set of $I(1)$ variables are cointegrated if a linear combination exists that is $I(0)$. Occasionally it is convenient to consider systems with both $I(0)$ and $I(1)$ variables.

Equation (2.15) gives the VAR econometric form of the model below;

$$CoV_t = \lambda_0 + \lambda_1 COP_t + \lambda_2 EXR_t + \lambda_3 FR_t + \varepsilon_t \tag{2.15}$$

where:

CoV_t = Coronavirus infected cases, COP_t = crude Oil price, EXR_t = Exchange rate, FR_t = Foreign reserve, $\lambda_1, \dots, \lambda_3$ are the coefficients of Independent variables, ε_t is the error term

and t is the time.

Natural logarithmic function is introduced in the model to enhance the assumption of linearity, eliminates the problems of multicollinearity, and heteroscedasticity. Therefore, Equation (3) express the model equation in its natural logarithmic form;

$$\ln CoV = \lambda_0 + \lambda_1 \ln COP_t + \lambda_2 \ln EXR_t + \lambda_3 \ln FR_t + \varepsilon_t \tag{3}$$

where: \ln represents natural log sign, $\ln CoV_t$ denotes natural log of coronavirus infected cases; $\ln COP_t$ denotes natural log of global crude oil price; $\ln EXR_t$ depict natural log of Exchange rate, $\ln FR_t$ is the natural log of Foreign reserve, t is the time and ε_t is the error term.

2.2 Stationarity of the VAR Model

It is always advisable to check if the time series are stationary or not before estimating a VAR model, i.e., to know if their means and variances are constant over time and do not show any trending behavior. A time series in M - dimensions is considered weakly stationary if;

(a) $E(s_t) = \mu$, a constant m -dimensional vector

(b) $Cov(s_t, s_t) = E[(s_t - \mu)(s_t - \mu)'] = \Sigma_s$, a constant $m \times m$ positive-definite matrix.

$Cov(s_t, s_t)$ and $E(s_t)$ respectively represent the covariance matrices and, expectation of the random vector s_t .

Strict stationarity requires that the probability distribution of any random collection of s_t is time invariant. For above two criteria to exists, the mean of s_t must not rely on when the series began. For a system to be stationary, its absolute value must be less than 1.

2.3 Model Specification

Take $y_t = (y_{1t}, y_{2t}, \dots, y_{ut})'$ as a stochastic time series of G – dimension,

$t = 1, 2, \dots, T$ and $y_t \sim I(1)$, each $y_{it} \sim I(1)$, $i=1, 2, \dots, u$ is affected by exogenous time series of Z – dimensional

$x_t = (x_{1t}, x_{2t}, \dots, x_{zt})'$; then VAR model is given as;

$$y_t = K + B_1 y_{t-1} + B_2 y_{t-2} + \dots + B_p y_{t-p} + Cx_t + \mu_t, \tag{4}$$

$$t = 1, 2, \dots, T$$

When y_t is not affected by exogenous time series of Z – dimension $x_t = (x_{1t}, x_{2t}, \dots, x_{zt})'$ then the VAR model of Equation (4) is written as:

$$y_t = K + B_1 y_{t-1} + B_2 y_{t-2} + \dots + B_p y_{t-p} + \mu_t, \tag{5}$$

$$t = 1, 2, \dots, T$$

taking cointegration transformation of Equation (5), we have;

$$\Delta y_t = K + \Pi y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + \mu_t, \quad (6)$$

where;

Γ_i is a coefficient matrix of the lags of differenced variables of y

Δy_t is the first difference of the variables in vector y

Π is a coefficient matrix of cointegrating relationships

whenever y_t has cointegration relationship, then $\Pi y_{t-1} \sim I(0)$, and Equation (6) is given as:

$$\Delta y_t = K + \alpha \beta' y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + \mu_t, \quad (7)$$

where; α is the coefficient of the ECT_{t-1}

$\beta' y_{t-1} = ECT_{t-1}$ is the Error Correction Term (ECT_{t-1}), which reflects long-term equilibrium relationships between variables, and Equation (3.14) is written as below:

$$\Delta y_t = K + \alpha ECT_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + \mu_t, \quad (8)$$

Equation (8) is the VECM, where each equation is an Error Correction Model. The VECM which was presented in equation (8) will now be written in matrix form (taking variables into consideration) is given below;

$$\begin{bmatrix} \Delta \ln CoV_t \\ \Delta \ln COP_t \\ \Delta \ln EXR_t \\ \Delta \ln FR_t \end{bmatrix} = \begin{bmatrix} \lambda_0 \\ \phi_0 \\ \delta_0 \\ \beta_0 \end{bmatrix} + \begin{bmatrix} \alpha_1 \\ \alpha_2 \\ \alpha_3 \\ \alpha_4 \end{bmatrix} (ECT_{t-1}) + \sum_{i=1}^{p-1} \begin{bmatrix} \lambda_{1i} & \lambda_{2i} & \lambda_{3i} & \lambda_{4i} \\ \phi_{1i} & \phi_{2i} & \phi_{3i} & \phi_{4i} \\ \delta_{1i} & \delta_{2i} & \delta_{3i} & \delta_{4i} \\ \beta_{1i} & \beta_{2i} & \beta_{3i} & \beta_{4i} \end{bmatrix} \times \begin{bmatrix} \Delta \ln CoV_{t-1} \\ \Delta \ln COP_{t-1} \\ \Delta \ln EXR_{t-1} \\ \Delta \ln FR_{t-1} \end{bmatrix} + \begin{bmatrix} \mu_{1t} \\ \mu_{2t} \\ \mu_{3t} \\ \mu_{4t} \end{bmatrix} \quad (9)$$

$$\begin{aligned} \Delta \ln CoV_t &= \lambda_0 + \sum_{i=1}^{p-1} \lambda_{1i} \Delta \ln CoV_{t-1} + \sum_{i=1}^{p-1} \lambda_{2i} \Delta \ln COP_{t-1} + \sum_{i=1}^{p-1} \lambda_{3i} \Delta \ln EXR_{t-1} \\ &+ \sum_{i=1}^{p-1} \lambda_{4i} \Delta \ln FR_{t-1} + \alpha_1 (ECT_{t-1}) + \mu_{1t} \end{aligned} \quad (10)$$

$$\begin{aligned} \Delta \ln COP_t &= \phi_0 + \sum_{i=1}^{p-1} \phi_{1i} \Delta \ln CoV_{t-1} + \sum_{i=1}^{p-1} \phi_{2i} \Delta \ln COP_{t-1} + \sum_{i=1}^{p-1} \phi_{3i} \Delta \ln EXR_{t-1} \\ &+ \sum_{i=1}^{p-1} \phi_{4i} \Delta \ln FR_{t-1} + \alpha_2 (ECT_{t-1}) + \mu_{2t} \end{aligned} \quad (11)$$

$$\begin{aligned} \Delta \ln EXR_t &= \delta_0 + \sum_{i=1}^{p-1} \delta_{1i} \Delta \ln CoV_{t-1} + \sum_{i=1}^{p-1} \delta_{2i} \Delta \ln COP_{t-1} + \sum_{i=1}^{p-1} \delta_{3i} \Delta \ln EXR_{t-1} \\ &+ \sum_{i=1}^{p-1} \delta_{4i} \Delta \ln FR_{t-1} + \alpha_3 (ECT_{t-1}) + \mu_{3t} \end{aligned} \quad (12)$$

$$\begin{aligned} \Delta \ln FR_t &= \beta_0 + \sum_{i=1}^{p-1} \beta_{1i} \Delta \ln CoV_{t-1} + \sum_{i=1}^{p-1} \beta_{2i} \Delta \ln COP_{t-1} + \sum_{i=1}^{p-1} \beta_{3i} \Delta \ln EXR_{t-1} \\ &+ \sum_{i=1}^{p-1} \beta_{4i} \Delta \ln FR_{t-1} + \alpha_4 (ECT_{t-1}) + \mu_{4t} \end{aligned} \quad (13)$$

where Δ is the short run parameter, $\lambda_{1t} \dots \lambda_{4t}, \phi_{1t} \dots \phi_{4t}, \delta_{1t} \dots \delta_{4t}$, and $\beta_{1t} \dots \beta_{4t}$ denotes coefficients of the short runs, the error correction term's coefficients are represented by $\alpha_1, \dots, \alpha_4$, r is the maximum lag, t is the time, the homoscedastic disturbance terms are denoted by μ_1, \dots, μ_4 , ECT_{t-1} is the error correction term.

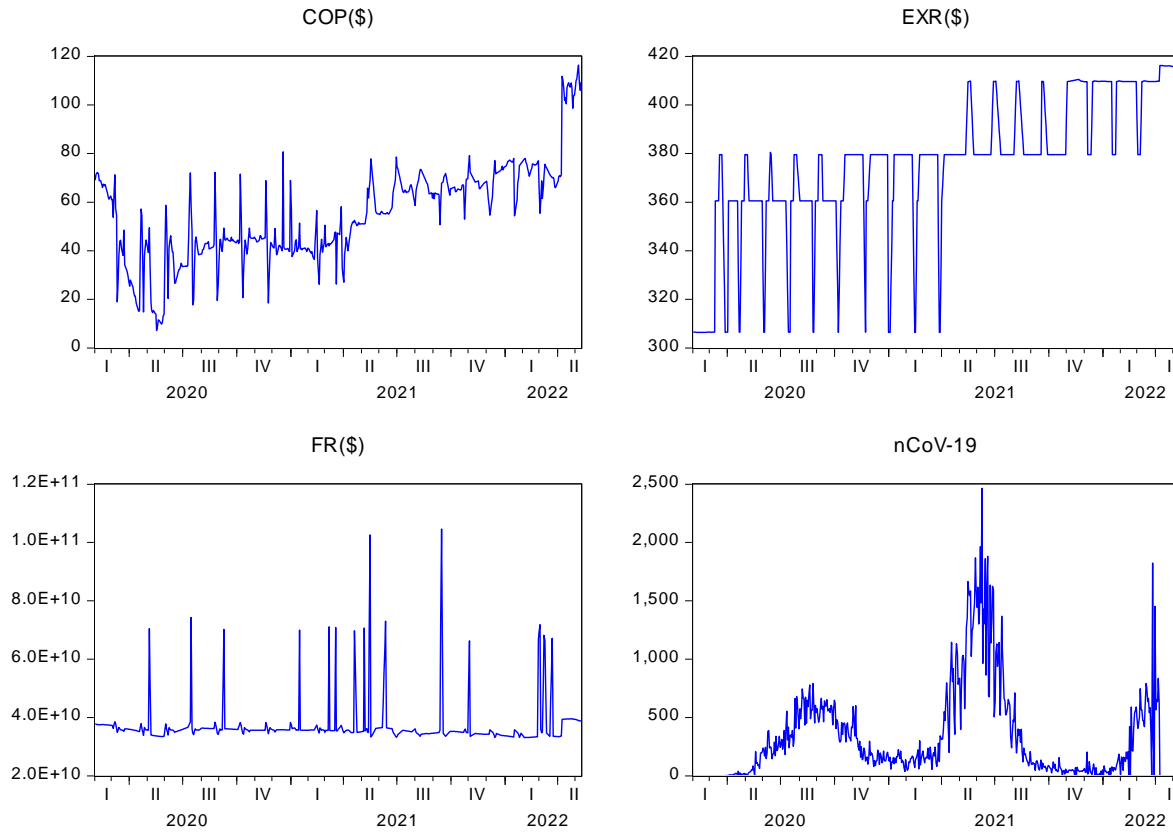


Figure 4.1 Graphical Representation of the Original Data

Interpretation: The graphical representation of the original data above shows that all the variables (LCOP, LEXR, LFR and LCOV_19) are not stationary. However, COP graph which is the crude Oil price shows that in the first quarter of 2020 COP was between 80\$ and 60\$ per barrel which happen to decline slowly and sharply down to 20\$ per barrel between the first quarter and second quarter of 2020 due to the presence of the pandemic. The COP suffered the worst decline in the second quarter of 2020 at a price of less than 20\$ per barrel. The COP also, indicate the presence of seasonal effect between the third quarter and fourth quarter of 2020. A sharp and gradual appreciation in COP was recorded between the first quarter and second quarter of 2022 at almost 120\$ per barrel probably due to the return of economic activities nationally and internationally.

The EXR which is the exchange rate in dollars was between the rate of ₦320 to ₦300 per dollar in the first quarter of 2020 but later recorded a sharp rise to between

₦380 per dollar after the first quarter and steadily fluctuate between second quarter of 2020 to first quarter of 2021 at the rate between ₦300 to ₦380 per dollar. A sudden steady rise and fluctuation was recorded from the second quarter of 2021 up to second quarter of 2022 at the rate between ₦380 to almost ₦420 per dollar.

The FR which is the foreign reserve which is recorded in billions of dollars started almost at \$40 billion in the first quarter of 2020 and continue to fluctuate in decline but later recorded a rise between \$80 billion and \$60 billion towards the second quarter of 2020 after which it dropped down to less than \$40 billion in the second quarter of 2020. The peak of the rise in the foreign reserve was recorded in the second quarter of 2021 and between third quarter and fourth quarter of 2021 at almost \$100 billion. The worst decline was recorded in every second quarter of 2020 and 2021. The Foreign reserve was grossly affected by structural breaks during periods of the pandemic.

CoV which is the pandemic started at zero level between the first and second quarter of 2020 but later recorded a steady rise and increase in daily confirmed infected cases from the second quarter of 2020 with a peak at more than 500 cases in the third quarter of 2020 which later slowly decline in the fourth quarter of 2020. The pandemic

recorded its highest peak Between the second quarter and third quarter of 2021 at almost 2,500 daily infected cases which also later decline in the fourth quarter of 2021 and continue to decline towards the first quarter of 2022. Lastly, the pandemic continues to increase a later with a sharp decline between the first quarter and second quarter of 2022 in the study.

2.4 Stationarity Graph at First Difference

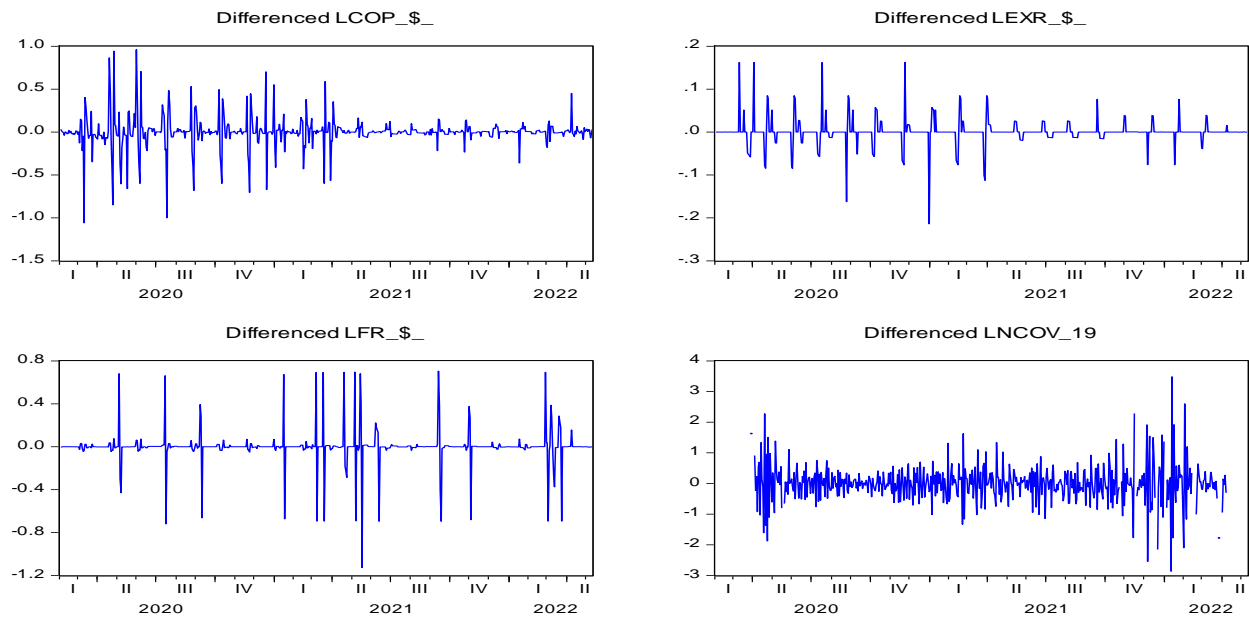


Figure 4.2 Stationarity Graphs at First Difference

The above graph shows the stationarity nature the pandemic and the macroeconomic variables considered during the period of the study. All the variables are stationary at first difference which give us the basis of adopting VECM in the study.

4.0 RESULTS AND DISCUSSIONS

Table 4.1 Optimal Lag Selection Criterion

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-4.393803	NA	1.22e-05	0.037141	0.073545	0.051486
1	1101.535	2187.390	9.81e-08	-4.785553	-4.603532	-4.713825
2	1219.644	231.5144	6.25e-08	-5.237363	-4.909724*	-5.108252
3	1250.576	60.08549	5.85e-08	-5.303435	-4.830180	-5.116942*
4	1278.866	54.45123	5.54e-08	-5.357814	-4.738941	-5.113938
5	1296.580	33.78180	5.50e-08	-5.365398	-4.600908	-5.064139
6	1314.188	33.26921*	5.46e-08*	-5.372515*	-4.462408	-5.013874
7	1323.836	18.05696	5.62e-08	-5.344406	-4.288683	-4.928382
8	1331.579	14.35600	5.83e-08	-5.307872	-4.106532	-4.834466

* Indicates lag order selected by the criterion

Sequential modified Likelihood Ratio (LR) test statistics, FPE (final prediction error),

SC (schwarz information criteria), AIC (Akaike information criteria), HQ (Hanan-Quinn information criteria). From the table above, FPE, AIC and sequential modified LR test statistic indicates lag 6 as the optimal lag. We have selected Akaike information criterion at lag 6. therefore, we proceed using lag 6 to test for the unit root existence in series as below;

HYPOTHESIS A: H_0 : lnCoV is non stationary VS H_1 : lnCoV is stationary

HYPOTHESIS B: H_0 : lnCOP is non stationary VS H_1 : lnCOP is stationary

HYPOTHESIS C: H_0 : lnEXR is non stationary VS H_1 : lnEXR is stationary

HYPOTHESIS D: H_0 : lnFR is non stationary VS H_1 : lnFR is stationary

Despite the data becoming stationary at first difference, evidence from the original and Log-transformed data shows non-stationary but it's an informal conclusion on the stationarity nature of the data. The most formal and technical confirmation of stationarity is to use unit root test and the table below shows the stationary test at levels and first difference of the Log-Transformed variables.

Table 4.2 Unit Root Test (Stationarity Test)

Variables	Level			First Difference			Conclusion at $\text{prob} \leq 0.05$
	Critical Value	t-Statistics	p-Value	Critical Value	t-Statistics	p-Value	
lnCoV(-1)	-2.866254	-1.447791	0.5595	-2.8687	-3.460331	0.0096	ln[CoV(-1)] is stationary
lnCOP(-1)	-2.866237	-2.655227	0.0826	-2.8663	-8.479554	0.0001	lnFR (-1) is stationary
lnEXR(-1)	-2.866267	-1.654258	0.4541	-2.8663	-10.72689	0.0001	lnEXR(-1) is stationary
lnFR(-1)	-2.953972	-2.784858	0.0724	-2.8663	-10.04128	0.0001	lnCOP(-1) is stationary

Decision Rule: if p-values ≤ 0.05 we reject H_0

Interpretation: Using Augmented Dickey-Fuller test from the above stationarity tests at levels; all the P-values are greater than 0.05 and also, the t-statistics are greater than the critical values which shows that all the variables are non-stationarity at levels. A Further analysis conducted at first difference showing all the p-Values less than 0.05 and the t-statistics less than the critical values which indicates the stationarity of the series at first difference. Therefore, we conclude that the series are stationary at first difference. Johansen cointegration test is adopted for the test of cointegration.

Table 4.3 Johansen Cointegration Test

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Max-Eigen Statistic	0.05 Critical Value
None *	0.150962	149.1405(0.0001**)	47.85613	75.11610(0.0001**)	27.58434
At most 1 *	0.097100	74.02436(0.0001**)	29.79707	46.88378(0.0001**)	21.13162
At most 2 *	0.034825	27.14058(0.0006**)	15.49471	16.26963(0.0238**)	14.26460
At most 3 *	0.023406	10.87095(0.0010**)	3.841466	10.87095(0.0010**)	3.841466

* Indicates rejection of H_0 at the 0.05 level
** p-values

H_0 : there is no cointegrating equation (no error term) VS H_1 : There is cointegrating equation (there is error term).

Decision Rule: Reject H_0 if trace statistics is greater than critical value at 5% or reject H_0 when p-value < 0.05 .

Also, reject H_0 if max-eigen statistic is greater than critical value at 5% or reject H_0 when p-value < 0.05 .

Conclusion: From the above trace and maximum eigenvalue rank test for Johansen cointegration tests shows that all the p-values of the variables considered are less than 5%, therefore we conclude that all the variables are cointegrated. Interestingly, as all the four variables are cointegrated we can now run the VEC Model.

Table 4:4 Vector Error Correction Model

Cointegrating Eq:	CointEq1			
lnCoV(-1)	1.000000			
lnCOP_\$(-1)	-10.65796 (1.72443) [-6.18055]			
lnEXR_\$(-1)	70.51161 (10.9809) [6.42132]			
lnFR_\$(-1)	-26.54113 (4.68564) [-5.66436]			
C	263.7577			
Error Correction:	D(lCoV)	D(lnCOP_\$)	D(lnEXR_\$)	D(lnFR_\$)
CointEq1	-0.06580 (0.00626) [1.05148]	0.011809 (0.00198) [5.97303]	-0.001964 (0.00031) [-6.24610]	0.009694 (0.00191) [5.07930]
D(lCoV(-1))	-0.762948 (0.04774) [-15.9800]	-0.002707 (0.01508) [-0.17948]	-0.000960 (0.00240) [-0.40017]	0.003440 (0.01456) [0.23627]
D(lCoV(-2))	-0.518840 (0.05936) [-8.74043]	-0.013815 (0.01875) [-0.73665]	0.003752 (0.00298) [1.25754]	0.007825 (0.01810) [0.43226]
D(lCoV(-3))	-0.368070 (0.06266) [-5.87391]	0.019278 (0.01980) [0.97380]	0.002451 (0.00315) [0.77810]	0.019185 (0.01911) [1.00391]
D(lCoV(-4))	-0.238566 (0.05986) [-3.98530]	0.034437 (0.01891) [1.82088]	0.000636 (0.00301) [0.21130]	0.009077 (0.01826) [0.49721]
D(lCoV(-5))	-0.153572 (0.04737) [-3.24166]	0.032707 (0.01497) [2.18522]	-0.002103 (0.00238) [-0.88338]	-0.003352 (0.01445) [-0.23201]
D(lnCOP_\$(-1))	-0.002801 (0.17010) [-0.01647]	0.008237 (0.05374) [0.15328]	-0.011591 (0.00855) [-1.35580]	0.100887 (0.05188) [1.94479]
D(lnCOP_\$(-2))	-0.157617 (0.16831) [-0.93644]	-0.005913 (0.05318) [-0.11120]	-0.007628 (0.00846) [-0.90170]	0.053145 (0.05133) [1.03533]
D(lnCOP_\$(-3))	-0.096117 (0.16087) [-0.59749]	-0.157069 (0.05082) [-3.09050]	0.023091 (0.00809) [2.85599]	0.096735 (0.04906) [1.97175]
D(lnCOP_\$(-4))	0.061534 (0.15531) [0.39619]	-0.062178 (0.04907) [-1.26717]	-0.012215 (0.00781) [-1.56480]	0.064159 (0.04737) [1.35452]
D(lnCOP_\$(-5))	-0.294691 (0.15074) [-1.95499]	0.006295 (0.04762) [0.13219]	-0.012707 (0.00758) [-1.67730]	0.048317 (0.04597) [1.05103]
D(lnEXR_\$(-1))	1.380768 (1.01506) [1.36028]	-0.349158 (0.32069) [-1.08877]	0.377989 (0.05102) [7.40904]	-0.439708 (0.30957) [-1.42039]
D(lnEXR_\$(-2))	-1.687593 (1.07723)	0.764008 (0.34033)	-0.006053 (0.05414)	-0.644114 (0.32853)

	[-1.56660]	[2.24488]	[-0.11180]	[-1.96060]
D(lnEXR_\$_(-3))	1.021284 (1.07324)	0.790770 (0.33907)	-0.093173 (0.05394)	-0.189672 (0.32731)
D(lnEXR_\$_(-4))	[0.95159] 1.388927 (1.08195)	[2.33215] -0.517754 (0.34182)	[-1.72729] 0.059756 (0.05438)	[-0.57948] -0.094109 (0.32997)
D(lnEXR_\$_(-5))	[1.28373] -1.042091 (1.05966)	[-1.51468] -0.382876 (0.33478)	[1.09887] -0.139216 (0.05326)	[-0.28521] -0.677352 (0.32317)
D(lnFR_\$_(-1))	[-0.98342] 0.132122 (0.19849)	[-1.14366] 0.202661 (0.06271)	[-2.61396] -0.058337 (0.00998)	[-2.09597] -0.155088 (0.06054)
D(lnFR_\$_(-2))	[0.66562] 0.234870 (0.19229)	[3.23167] 0.136709 (0.06075)	[-5.84752] -0.032698 (0.00966)	[-2.56193] -0.211827 (0.05864)
D(lnFR_\$_(-3))	[1.22141] -0.046109 (0.17958)	[2.25028] 0.123532 (0.05674)	[-3.38323] -0.031013 (0.00903)	[-3.61204] -0.236852 (0.05477)
D(lnFR_\$_(-4))	[-0.25675] 0.115878 (0.16906)	[2.17729] 0.137116 (0.05341)	[-3.43597] -0.020215 (0.00850)	[-4.32461] -0.163848 (0.05156)
D(lnFR_\$_(-5))	[0.68542] 0.188987 (0.15984)	[2.56711] 0.054548 (0.05050)	[-2.37902] -0.006206 (0.00803)	[-3.17782] -0.154331 (0.04875)
C	[1.18235] 0.029480 (0.02254)	[1.08018] 0.002591 (0.00712)	[-0.77248] 0.000143 (0.00113)	[-3.16595] -0.002003 (0.00687)
	[1.30814]	[0.36398]	[0.12664]	[-0.29137]

Table 4.5 Variable Speeds of Adjustment Table

Variable	Coefficient in ECT	Coefficient of ECT where variable is dependent variable	Product = speed of adjustment
lnCoV(-1)	1.000000	-0.06580	-0.06580
lnCOP(-1)	-10.65796	0.011809	-0.1258598
lnEXR(-1)	70.51161	-0.001964	-0.1384848
lnFR(-1)	-26.54113	0.009694	-0.2572897

Ideally, every speed of adjustment is -0.05 or less (more negative, e.g., -0.10) which means it is significant at the 5% level. However, from the above table it shows that lnCoV-19, lnCOP(-1), lnEXR(-1) and lnFR(-1) are significant.

Table 4.6 Long Run Causal Relationship

Variable	Coefficient	Std. Error	t-Statistic	Prob.	RELATIONSHIP At $\alpha \leq 0.05$
$ECT_{t-1} = C(1)$	-0.06580	0.006258	1.051483	0.0029	long run relationship exists among the variables
$\Delta \ln COP_t = C(23)$	-0.010892	0.002010	5.418082	0.0001	long run relationship exists among the variables
$\Delta \ln EXR_t = C(45)$	0.001897	0.000308	-6.155878	0.0001	long run relationship exists among the variables
$\Delta \ln FR_t = C(67)$	-0.009558	0.001867	5.119022	0.0001	long run relationship exists among the variables

Sources: Authors computation using EViews 9

Looking at the long run casual outcome in the above table, it indicates that crude oil price and foreign reserve have negative coefficients and significant at 5% level. Meaning that 5% increase in infected cases of COVID-19 pandemic is associated with -1.0892 and -0.9558 decreases in crude oil price and foreign reserve respectively in the long run period. While 5% increase in daily



infected cases of the pandemic will be associated with 0.001897 increase in exchange rate in the future. Which implies that infected cases of the virus will have positive relationship with exchange rate in future.

The ECT_{t-1} -0.0658 is Statistically significant which satisfied the econometrics requirements of negative value. Now, to check for lnFR, lnEXR, and lnCOP short run causality. Here we employ the Wald statistic test.

Table 4.7 Wald Test Short Run Causality

Variable	Test statistic	Value	DF	Probability	Conclusion
lnCOP	Chi-square	4.603038	5	0.4662	No short run causality from lCoV to lnCOP
lnEXR	Chi-square	6.217063	5	0.2857	No short run causality from lCoV to lnEXR
lnFR	Chi-square	3.719137	5	0.5905	No short run causality from lCoV to lnFR

Short Run Causality for lnCOP Using Wald Test

H_0 : $C(7) = C(8) = C(9) = C(10) = C(11) = 0$ implies no short run causality running from lnCoV to lnCOP.

H_1 : $C(7) \neq C(8) \neq C(9) \neq C(10) \neq C(11) \neq 0$ implies short run causality running from lnCoV to lnCOP.

Decision Rule: using the Chi-square, reject H_0 if P-Value < 5% and conclude on H_1 otherwise fail to reject H_0 .

Conclusion: The P-Value = 0.4662 (46%) > 5%, we therefore fail to reject H_0 and conclude there is no short run causality from lnFR to lnCoV.

Short Run Causality for lnEXR

H_0 : $C(12) = C(13) = C(14) = C(15) = C(16) = 0$ Vs H_1 : $C(12) \neq C(13) \neq C(14) \neq C(15) \neq C(16) \neq 0$

Conclusion: The P-Value = 0.2857 > 0.05, we therefore fail to reject H_0 and conclude there is no short run causality from lnCoV to lnEXR.

Short Run Causality for lnFR

H_0 : $C(17) = C(18) = C(19) = C(20) = C(21) = 0$ Vs H_1 : $C(17) \neq C(18) \neq C(19) \neq C(20) \neq C(21) \neq 0$

Conclusion: The P-Value = 0.5905 > 0.05, H_0 is retained and conclude that there is no short run causality from lnCoV to lnCOP.

Variance Decomposition: Variance decomposition was applied to analyze the influence of each variable’s update on other variables, which shows relative effects. Variance decomposition results are obtained using Eviews 9 software, as shown below in table 4.8 and figure 4.3

Table 4.8 Variance Decomposition Percentage Values

Periods	S.E	lCoV	LCOP	LEXR	LFR
Short Run	0.522300	98.69226	0.642824	0.618460	0.046457
Long Run	3.922117	97.31465	2.330246	0.308533	0.046567

In the Short Run (i.e., a period where the pandemic is fixed and the economic variables varies), the shock to CoV account for 0.64% variation fluctuation in crude oil price while the shock to CoV account for 0.62% variation fluctuation in exchange rate also the shock to CoV account for 0.05% variation fluctuation in foreign reserve while the shock to CoV account for 98.7% variation fluctuation in CoV (own shock)

In long run (i.e., a period where the pandemic and economic variables change), the shock or innovation to CoV account for 2.33% variation fluctuation on crude oil price, whereas the shock to CoV account for 0.31% variation fluctuation in exchange rate also the shock to CoV account for 0.05% variation fluctuation in foreign exchange and the own shock is 97.3%.

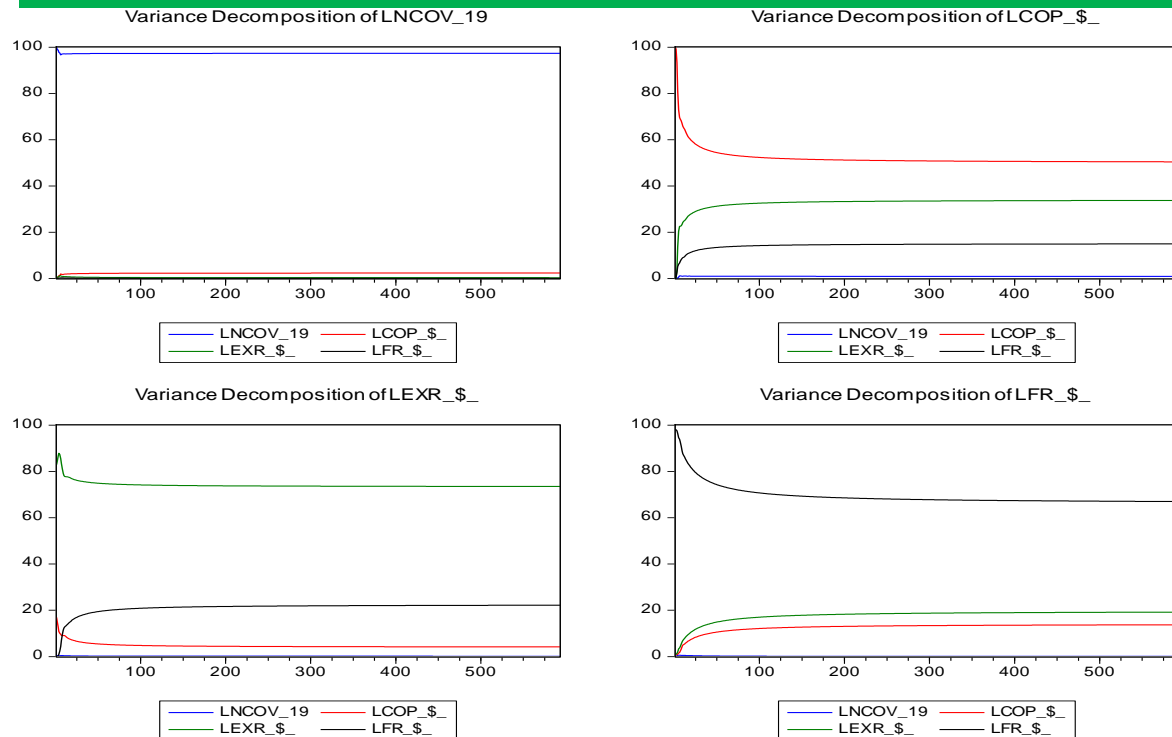


Figure 4.3 Variance Decomposition of CoV-19

5.0 SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Summary

The research utilized a VEC model to analyze the influence of the CoV-19 pandemic on key factors such as crude oil price, foreign reserve and exchange rate within Nigeria context. Additionally, the study employed Johansen cointegration test to examine whether cointegrating relationship exists among these variables. This study also describes both the relative impacts of the pandemic on the variables. The estimates of the cointegrating equation coefficients and p-values reveals that the variables under study do not have short run causality to CoV-19. The estimates of variable speeds of adjustment shows that CoV-19, exchange rate, crude oil price and foreign reserve are all significant. The long run causality outcome indicates that crude oil price and foreign reserve have negative coefficients and significant at 5% level which implies 5% increase in infected cases of COVID-19 pandemic will be associated with -1.09 and -0.96 decreases in crude oil price and foreign reserve respectively in the long run period. While 5% increase in daily pandemic cases will be associated with 0.0018 increase in exchange rate in the future which indicates that infected cases of the virus will share positive relationship with exchange rate. The coefficient of ECT_{t-1} shows that COVID-19 pandemic is statistically significant. The variance decomposition result reveals that the CoV-19 exhibits a

strong endogeneity in both the short and long run but weakly predicts the economic variables.

5.2 Conclusion

This research empirically assessed the impacts of CoV-19 on Nigeria's foreign reserves, exchange rate, and crude oil price from January 2, 2020 to May 11, 2022. The Granger/Wald causality test shows that there is no short run causality from lnCoV to lnCOP, lnEXR, and FR. The long run causal relationship indicates that CoV-19 will continue to have impact on the economic variables in the future. The research concludes that the pandemic has significant impact on the macroeconomic variables considered. Nigerian government should put more effort in local drug manufacturing and also fiscal and monetary policies should be targeted to direct liquidity to strategic sectors, SMEs, and households. This study can be extended by adding a larger number of macroeconomic variables and examining their volatility from this pandemic.

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Appendix**DUMMY VECTOR ERROR CORRECTION MODEL**

The result of the covid-19 dummy data VECM analysis on the economic variables shows that it is significant with adjustment speed of -0.100516 at 5% level which justifies the inclusion of the covid-19 daily data in the research. As shown in the table below;

Standard errors in () & t-statistics in []

Cointegrating Eq:	CointEq1			
NCOV(-1)	1.000000			
COP(-1)	0.004043 (0.01666) [0.24273]			
EXR(-1)	-0.012452 (0.01176) [-1.05860]			
FR(-1)	5.66E-10 (5.1E-11) [11.1315]			
C	-17.48018			
Error Correction:	D(NCOV)	D(COP)	D(EXR)	D(FR)
CointEq1	-0.100516 (0.00087) [0.59609]	-0.149185 (0.09159) [-1.62877]	0.160698 (0.12839) [1.25166]	-1.12E+09 (1.0E+08) [-11.0796]
D(NCOV(-1))	-0.001883 (0.04302) [-0.04378]	2.993842 (4.55120) [0.65781]	1.660407 (6.37946) [0.26027]	2.27E+09 (5.0E+09) [0.45287]
D(NCOV(-2))	-0.001765 (0.04297) [-0.04107]	3.910957 (4.54628) [0.86025]	-0.440545 (6.37257) [-0.06913]	-12735814 (5.0E+09) [-0.00254]
D(NCOV(-3))	7.35E-05 (0.04295) [0.00171]	-8.624308 (4.54389) [-1.89800]	6.186662 (6.36922) [0.97134]	1.51E+09 (5.0E+09) [0.30099]
D(COP(-1))	-4.38E-05 (0.00042) [-0.10343]	-0.091175 (0.04485) [-2.03302]	0.046397 (0.06286) [0.73808]	43037956 (4.9E+07) [0.87162]
D(COP(-2))	-5.40E-05 (0.00041) [-0.13177]	-0.119335 (0.04338) [-2.75068]	0.000981 (0.06081) [0.01613]	-37367913 (4.8E+07) [-0.78231]
D(COP(-3))	3.15E-06 (0.00040) [0.00787]	-0.247225 (0.04233) [-5.84036]	0.291656 (0.05934) [4.91541]	43805502 (4.7E+07) [0.93990]

D(EXR(-1))	-1.79E-05 (0.00030) [-0.05988]	0.008524 (0.03162) [0.26956]	0.294557 (0.04433) [6.64497]	4569627. (3.5E+07) [0.13124]
D(EXR(-2))	-1.09E-05 (0.00031) [-0.03500]	0.114243 (0.03286) [3.47623]	-0.052493 (0.04607) [-1.13953]	-22274553 (3.6E+07) [-0.61560]
D(EXR(-3))	2.35E-05 (0.00030) [0.07756]	0.102531 (0.03205) [3.19862]	-0.106053 (0.04493) [-2.36033]	9223522. (3.5E+07) [0.26134]
D(FR(-1))	-1.92E-13 (4.5E-13) [-0.42303]	2.77E-11 (4.8E-11) [0.57856]	-1.69E-10 (6.7E-11) [-2.51263]	0.138189 (0.05276) [2.61935]
D(FR(-2))	-1.48E-13 (4.0E-13) [-0.36683]	2.18E-11 (4.3E-11) [0.51006]	-4.94E-11 (6.0E-11) [-0.82648]	0.033884 (0.04700) [0.72099]
D(FR(-3))	-1.08E-13 (3.6E-13) [-0.29772]	1.19E-11 (3.8E-11) [0.30840]	-4.34E-11 (5.4E-11) [-0.80552]	-0.018326 (0.04234) [-0.43282]
C	7.60E-06 (0.00243) [0.00313]	0.054016 (0.25725) [0.20997]	0.134720 (0.36059) [0.37361]	-308999.4 (2.8E+08) [-0.00109]

ESTIMATE OF P-VALUES AND THEIR COEFFICIENTS

Dependent Variable: D(NCOV)

$$D(NCOV) = C(1) * (NCOV(-1) + 0.00404307441981 * COP(-1) - 0.0124523042238 * EXR(-1) + 5.65694832477E-10 * FR(-1) - 17.4801784247) + C(2) * D(NCOV(-1)) + C(3) * D(NCOV(-2)) + C(4) * D(NCOV(-3)) + C(5) * D(COP(-1)) + C(6) * D(COP(-2)) + C(7) * D(COP(-3)) + C(8) * D(EXR(-1)) + C(9) * D(EXR(-2)) + C(10) * D(EXR(-3)) + C(11) * D(FR(-1)) + C(12) * D(FR(-2)) + C(13) * D(FR(-3)) + C(14)$$

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-0.100516	0.000866	0.596094	0.5513
C(2)	-0.001883	0.043017	-0.043785	0.9651
C(3)	-0.001765	0.042971	-0.041072	0.9673
C(4)	7.35E-05	0.042948	0.001712	0.9986
C(5)	-4.38E-05	0.000424	-0.103434	0.9177
C(6)	-5.40E-05	0.000410	-0.131773	0.8952
C(7)	3.15E-06	0.000400	0.007867	0.9937
C(8)	-1.79E-05	0.000299	-0.059884	0.9523
C(9)	-1.09E-05	0.000311	-0.034996	0.9721
C(10)	2.35E-05	0.000303	0.077563	0.9382
C(11)	-1.92E-13	4.53E-13	-0.423028	0.6724
C(12)	-1.48E-13	4.03E-13	-0.366829	0.7139
C(13)	-1.08E-13	3.63E-13	-0.297717	0.7660
C(14)	7.60E-06	0.002432	0.003127	0.9975