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Macroeconomic Variables and the Covid-19 Pandemic: Nigerian Evidence from Unrestricted Var Approach

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Abstract
This study, behaviour of macroeconomic variables amidst the COVID-19 pandemic: Nigerian evidence is aimed at examining the behaviour or interactions of the macroeconomic variables during COVID-19 pandemic within the first four months from the day the first index case was recorded in Nigeria. The study employed daily data from February 03, 2020 to June 30, 2020 obtained from Central Bank of Nigeria and National Bureau of Statistics. The following empirical observations were made; VEC Granger Causality/Block Exogeneity Wald Test revealed that all the macroeconomic variables under consideration in this study jointly cause each other, which means they drive each other. Impulse response found that all the variables respond positively to own shocks from first period to last period. They respond positively and negatively, at times fade away slightly to the threshold until the last period among themselves. From the trend analysis to the unrestricted VAR estimates, it was discovered that the behavior of macroeconomic variables are transient within this pandemic (COVID-19). That means the positive or negative shocks from the pandemic can decay with little manipulation. The results validate this study as a compass that informs the economic agents on their activities within this crisis induced by the COVID-19. This is because the macroeconomic variables are system variables. There are always interactions among them, more especially in this global crisis caused by the COVID-19. However, due to the ephemeral fluctuations among the macroeconomic variables, the Federal and various state governments should fashion out measures from time to time to ameliorate the adverse effect that may emanate anytime from the Corona virus pandemic.

Keywords: ***Macroeconomic Variables, COVID-19, Unrestricted VAR, Nigeria***

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I. Introduction

As a follow up to global trend, economic agents started sleeping with their two eyes open the moment the news of the first index case of corona virus (COVID-19) heralded the nooks and crannies of Nigeria on February 27, 2020. Though COVID-19 pandemic as recorded seem not to be the only severe global health crisis since the 1918 Great Influenza (Spanish flu), but is set to become one of the most economically costly pandemics in recent history. Again, Covid-19 differs from previous episodes in several important ways. Notably, the globally synchronized lockdowns and trauma of financial markets reinforce one another into an unprecedented economic sudden stop. For these reasons, the Covid-19 global recession is unique [5]. In the words of Madden [17], there is a projection that as a result of the COVID-19 pandemic, economic growth in sub-Saharan Africa will decline from 2.4 percent in 2019 to between -2.1 percent and -5.1 percent in 2020, depending on the success of measures taken to mitigate the pandemic's effects. In other words, the report predicts that the region will experience its first recession in 25 years and Nigeria is not an exception to the perceived doom days as a result of the pandemic.

However, the performance of any economy is adjudged by the behaviour of the macroeconomic variables such as rate of inflation, exchange rate, interest rates, fiscal position, debt position, real Gross Domestic Product (GDP) growth rate, and many other variables, which can also serve as the major determinants of economic growth [24, 9, 15, 21, 30, 1, 2, 3, 25]. These macroeconomic variables guide business and other activities in the economy. They can be volatile and sensitive and should be handled with care. Any aggressive shock in any of macroeconomic variables is capable of generating adverse effect on the economy. As such its behavior should be closely monitored from time to time; mostly now this novel pandemic is ravishing the world and particularly our nation, Nigeria.

Though many researchers are saying it is too early to starting evaluating the short and long-term economic impact of Covid-19, efforts should made to study the behaviour of the macroeconomic variables in Nigeria. This is because, how the pandemic will end remains highly uncertain and agents' behaviour could change in ways that are hard to predict. Again, macroeconomic variables are system variables. There are always

interactions among them, more especially in this global crisis caused by the COVID-19. In fact, this assertion and thinking aroused the interest of the researchers to examine the response and behavior, as well unravel interactions of the macroeconomic variables amidst the COVID -19 pandemic within the first four months. The remaining sections of this study are structured as follows; section two takes care of review of related literature; section three handles the materials and methods of analysis adopted; section four analyses the data, results and interpretation, while section five addresses conclusion and recommendation.

II. Literature Review

The outbreak of the Corona virus (formerly known as 2019-nCoV) was as a result of the SARS-CoV-2 virus. This outbreak was triggered in December 2019 in Wuhan city in Hubei province of China. The outbreak was formerly named on February 11, 2020 by the World Health Organization (WHO) as the Severe Acute Respiratory Syndrome Corona virus 2 Disease (SARS-CoV-2). The novel COVID-19 continues to spread across the world with many records of pneumonia cases. Initially the epicenter of the outbreak was China with reported cases either in China or travelers from China. This outbreak after thorough examination was declared a Public Health Emergency of International Concern (PHEIC) by the World Health Organization (WHO) on January 30, 2020 [29]. Subsequently, the disease was named the Corona virus disease 2019 with abbreviation; COVID-19 [31, 29, 5].

As a result of the spike in the cases and public health risk COVID-19 poses to the world, the World Health Organization (WHO) has declared a public health emergency of international concern to coordinate international responses to the disease, which is now a global pandemic [28]. Again, United Nations has tagged the COVID-19 pandemic a health, economic and social crisis [27]. In the same vein, UNCTAD [26] sees the COVID-19 as a public health emergency and obvious economic threat.

Apart from the super national institutions, researchers are having sleepless nights to unravel the health, economic, social and political impacts of the pandemic [8, 22, 20]. For instance, Jordà et al [13] studied the long-run effects of a sample of 12 major epidemics in Europe stretching back to the 14th century and found that pandemics were followed by multiple decades of low natural interest rates, due to higher precautionary saving and depressed investment opportunities. Indeed, unlike wars, pandemics do not destroy physical capital, and typically give rise to a long period of excess capital per surviving worker. Also, Correia et al [7] estimate that this pandemic has drastically reduced manufacturing activity and consumption growth in USA by around 20%, while Barro et al [4] with Cross-country panel regressions estimated the adverse effect of the pandemic impact on global GDP to be around 6–8% overall. For the US, the quarterly contraction is expected to be largest in the second quarter. It is also notable that, by the end of 2020, the level of US GDP under these projections would still fall short. It points to cross-country spillovers as an important amplification channel of the Covid-19 shock [7].

Coming down to Nigeria, in a move to combat the spread of the pandemic disease, President Muhammadu Buhari directed the cessation of all movements in Lagos and the Federal Capital Territory (FCT) for an initial period of 14 days, which took effect from 11 pm on Monday, 30th March 2020. The movement restriction, which was extended by another two-week period, was partially put on hold with some businesses commencing operations from May 4, 2020. On April 27th, 2020, Nigeria's President, Muhammadu Buhari declared an overnight curfew from 8 pm to 6 am across the country, as part of new measures to contain the spread of the COVID-19. This came along with the phased and gradual easing of lockdown measures in FCT, Lagos, and Ogun States, which took effect from Saturday, 2nd May 2020, at 9 am. On Monday, 29th June 2020 the federal government extended the second phase of the eased lockdown by 4 weeks and approved interstate movement outside curfew hours with effect from July 1, 2020 [18].

Despite the above measures by the President of Nigeria, President Muhammadu Buhari under the auspices of the Presidential Task Force (PTF) and the National Centre for Disease and Control (NCDC), there is yet increase daily records of new cases of the COVID-19. As at the time of revisiting this work on July 14, 2020, 36 states and FCT had 199016 samples tested, 33616 cases were confirmed, discharged cases were 13792 and total fatalities were 754, while globally from 213 countries and territories had 12964809 confirmed cases and 570288 death [19]. Table 1 and Figure 1 in the appendix are distribution and the trend of confirmed cases, active cases, critical cases, new cases, new death, total death and total recovery computed from table. A close look at the figure 1 in the appendix as computed from table 1 in the appendix shows a persistent increase in all the cases recorded.

III. Methodology

3.1. Data and Method

This study used daily data from February 03, 2020 to June 30, 2020 obtained from Central Bank of Nigeria (CBN) and National Bureau of Statistics (NBS). The variables represented in the collected data are macroeconomic variables; All Share Index (ASI), Exchange Rate (EXCR), Inflation Rate (INFLR), Monetary

Policy Rate (MPR), Oil Prices (OLP) and Saving Rates (SAVR). The choice of these macroeconomic variables is because of the belief that 'interest rate, exchange rate, inflation rate and others are the most important among macroeconomic variables which shape the performance of any economy [11].

Augmented Dickey Fuller (ADF) unit root test is used to check the stationarity of the variables. In testing for multicollinearity and global utility of specified models, the correlation matrix is engaged. Because of the dynamic nature of the variables Vector Autoregressive (VAR) is employed to test the models.

3.2. Description of tools

3.2.1. Unit Root Test

To stem the problem of spurious regression, it is important that the time series properties of the data set employed in the estimation is ascertained. It might be reasonable to test for the presence of unit root in the series using the Augmented Dickey Fuller (ADF) unit root test to test for the stationarity of the variables [6]. Unit root tests are tests for stationarity in a time series. A time series has stationarity if a shift in time doesn't cause a change in the shape of the distribution; unit roots are one cause for non-stationarity. The ADF handles bigger, more complex models. It does have the downside of a fairly high Type I error rate.

Deriving from AR (p) representation, the ADF test involves the following regressions:

No constant, no trend: $\Delta y_t = \gamma y_{t-1} + \nu_t$ (1)

(1)

Constant, no trend: $\Delta y_t = \alpha + \gamma y_{t-1} + \nu_t$ (2)

(2)

Constant and trend: $\Delta y_t = \alpha + \gamma y_{t-1} + \lambda_t + \nu_t$ (3)

(3)

The Augmented Dickey Fuller adds lagged differences to these models:

$$\text{Non constant, no trend: } \Delta y_t = \Upsilon y_{t-1} + \sum_{S=1}^{m} a_s \Delta y_{t-s} + v_t \quad (4)$$

$$\text{Constant, no trend: } \Delta y_t = \alpha + \Upsilon y_{t-1} + \sum_{S=1}^{m} a_s \Delta y_{t-s} + v_t \quad (5)$$

$$\text{Constant and trend: } \Delta y_t = \alpha + \Upsilon y_{t-1} + \lambda_t + \sum_{S=1}^{m} a_s \Delta y_{t-s} + v_t \quad (6)$$

Let Υ_t be a time series.

3.2.2. Co-integration Test

It is often said that co-integration is a means for correctly testing the relationship between two variables having unit roots (integrated order 1). The Johansen's co-integration test was applied to check the co-integration between and among the variables. There are different methods of testing for co-integration but Jung and Seldon [14] stated that Johansen co-integration test is more valid as there is no need of prior knowledge of the co-integration vectors in cases when they are unknown. According to Koirala [16], the Johansen [12] method of testing for the existence of co-integration relationships has become standard in the econometrics literature because of its superiority over other alternatives. As a set of variables Yt is said to be co-integrated of order (d,b) denoted Yt = CI(d,b) if all components of Yt are integrated of order d or b (band d > 0) and there exists a vector $\beta = (\beta_1, \beta_2 \ldots \beta_n)$ such that a linear combination $\beta Y_t = \beta_1 Y_{1t} + \beta_2 Y_{2t} + \ldots\ldots \beta_n Y_{nt}$ is not integrated of order (d,b).

3.2.3. Vector autoregressive models

Vector autoregressive models (VARs) were popularized in econometrics by Sims in 1980 as a natural generalization of univariate autoregressive model. A VAR is a system regression model (i.e. there is more than one dependent variable) that can be considered a kind of hybrid between the univariate time series models and the simultaneous equations models. VARs have often been advocated as an alternative to large-scale simultaneous equations structured models [23, 6].

3.2.4. Impulse responses and variance decomposition

Block F-tests and examination causality in a VAR will suggest which of the variables in the model has statically significant impact on the future values of each of the variables in the system. But F-test results will not, by construction is able to explain the sign of the relationship or how long these effects require to take place. That is, F-test results will not reveal whether changes in the value of a given variable have a positive or negative

effect on other variables in the system, or how long it would take for the effect of that variable to work through the system. Such information will, however, be given by an examination of the VAR's impulse responses and variance decompositions [6].

Impulse responses trace out the responsiveness of the dependent variables in the VAR to shocks to each of the variables. So, for each variable from each equation separately, a unit shock is applied to the error, and the effects upon the VAR system over time are noted. Thus, if there are g variables in a system, a total of g^2 impulse responses could be generated. The way that this is achieved in practice is by expressing the VAR model as a NMA- that is, the vector autoregressive model written as a vector moving average (in the same way as was done for univariate autoregressive models in previous case). Provided that the system is stable, the shock should gradually die away [6].

Variance decompositions offer a slightly different method for examining VAR system dynamics. They give the proportion of the movements in the dependent variables that are due to their 'own' shocks, versus shocks to the other variables. A shock to the i^{th} variable will directly affect that variable of course, but it will also be transmitted to all of the other variables in the system through the dynamic structure of the VAR. Variance decomposition determine how much the *s*-step-ahead forecast error variance of a given variable is explained by innovations to each explanatory variable for s = 1, 2, ... In practice, it is usually observed that own series shocks explain most of the (forecast) error variance of the series in a VAR. To some extent, impulse responses and variance decompositions offer very similar information [6].

For calculating impulse responses and variance decompositions, the ordering of the variables is important. To see why this is the case, recall that the impulse responses refer to a unit shock to the errors of one VAR equation alone. This implies that the error terms of all other equations in the VAR system are held constant. However, this is not realistic since the error terms are likely to be correlated across equations to some extent. Thus, assuming that they are completely independent would lead to a misrepresentation of the system dynamics. In practice, the errors will have a common component that cannot be associated with a single variable alone [6].

3.3. Model Specification

VAR methodology superficially resembles simultaneous equation modeling. The essence of adopting the VAR is that it accommodates forecasting, not estimation, hence lag distribution not static. This is because; this study will inform economic agents about today and tomorrow. Again, it examines several endogenous variables together. In VAR, in case of including exogenous variable, do not lag the exogenous variable. One advantage of VAR modeling is that one does not need to specify which variable is endogenous or exogenous-all are endogenous ([6, 10].

The reduced VAR model, incorporating All Share Index (ASI), Exchange Rate (EXCR), Inflation Rate (INFLR) and Monetary Policy Rate (MPR), Oil Prices (OLP) and Saving Rates (SAVR) is;

$$ASI_t = ASI_t + \alpha_{21}EXCR_{t-1} + \alpha_{31}INFLR_{t-1} + \alpha_{41}MPR_{t-1} + \alpha_{51}OLP_t + \alpha_{61}SAVR_{t-1} + U_{t1} \quad (7)$$

$$EXCR_t = \beta_{02}ASI_t + \beta_{22}EXCR_{t-1} + \beta_{32}INFLR_{t-1} + \beta_{42}MPR_{t-1} + \beta_{52}OLP_t + \alpha_{62}SAVR_{t-1} + U_{t2} \quad (8)$$

$$INFLR_t = \Upsilon_{03}ASI_t + \Upsilon_{23}EXCR_{t-1} + \Upsilon_{33}INFLR_{t-1} + \Upsilon_{43}MPR_{t-1} + \Upsilon_{53}OLP_t + \alpha_{63}SAVR_{t-1} + U_{t3} \quad (9)$$

$$MPR_t = Z_{04} + Z_{14}ASI_t + Z_{24}EXCR_{t-1} + Z_{34}INFLR_{t-1} + Z_{44}MPR_{t-1} + Z_{54}OLP_t + \alpha_{64}SAVR_{t-1} + U_{t4} \quad (10)$$

$$OLP_t = \partial_{05} + \partial_{15}ASI_t + \partial_{25}EXCR_{t-1} + \partial_{35}INFLR_{t-1} + \partial_{45}MPR_{t-1} + \partial_{55}OLP_t + \alpha_{65}SAVR_{t-1} + U_{t5} \quad (11)$$

$$SAVR_t = \partial_{06} + \partial_{16}ASI_t + \partial_{26}EXCR_{t-1} + \partial_{36}INFLR_{t-1} + \partial_{46}MPR_{t-1} + \partial_{56}OLP_t + \alpha_{66}SAVR_{t-1} + U_{t6} \quad (12)$$

Where U_t are white noises that capture the innovations or shocks to the VAR system.

IV. Analysis, Results and Interpretation

4.1. Trend Analysis of Data: ASI, EXCR, INFLR, MPR, OLP and SAVR

First, the time series plot of the data is shown in figure I below,

The figure below 1 shows a frantic trend of the macroeconomic variables under consideration. Starting from ASI; at the beginning of February, 2020, when Nigeria had not recorded any case, ASI was above 23000. It then starting dropping the moment the first index case was announced towards the end of February, 2020. It drastically reduced continuously from March to April, 2020 to as low as almost 20000, as the increase in the cases became progressive. Then gradually increased but did not exceed 26000 at the end of June, 2020. For EXCR, prior to first index case at end of February, 2020 to scanty record of cases, the EXCR to US$1 oscillated between ₦360. It then jumped to above ₦380/ US$1 towards the end of March as well on a progressive record of cases of COVID-19 pandemic. It had peaks and troughs in April, 2020 and fluctuated around ₦380 to ₦390/ US$1 from May to June, 2020. Before, the first index case, INFLR was steady at 12.2%. It then rose to above 12.24% in response to the news of the first index case. It jumped to above 12.3% and maintained a plateau until the end of June, 2020 in response to the measures for curtailing the rise of the pandemic by the Federal and various States government. In the same vein, MPR, prior to the record of the first case in February, 2020 end

was pegged at 14%, then reduced to 13.5% in response to the plight of the economic agents as result of unfriendly measures to mitigating the of upsurge of the pandemic. It was further reduced to 12.5% at the end of May, 2020. OLP trended similarly with the ASI while, SAVR responded inversely with INFLR. SAVR also reduced drastically when the news of the first case heralded the nooks and crannies of the country, Nigeria. In fact, is assumed to be the outcome of the lockdown. SAVR was low at almost 3.3% from April to June, 2020.

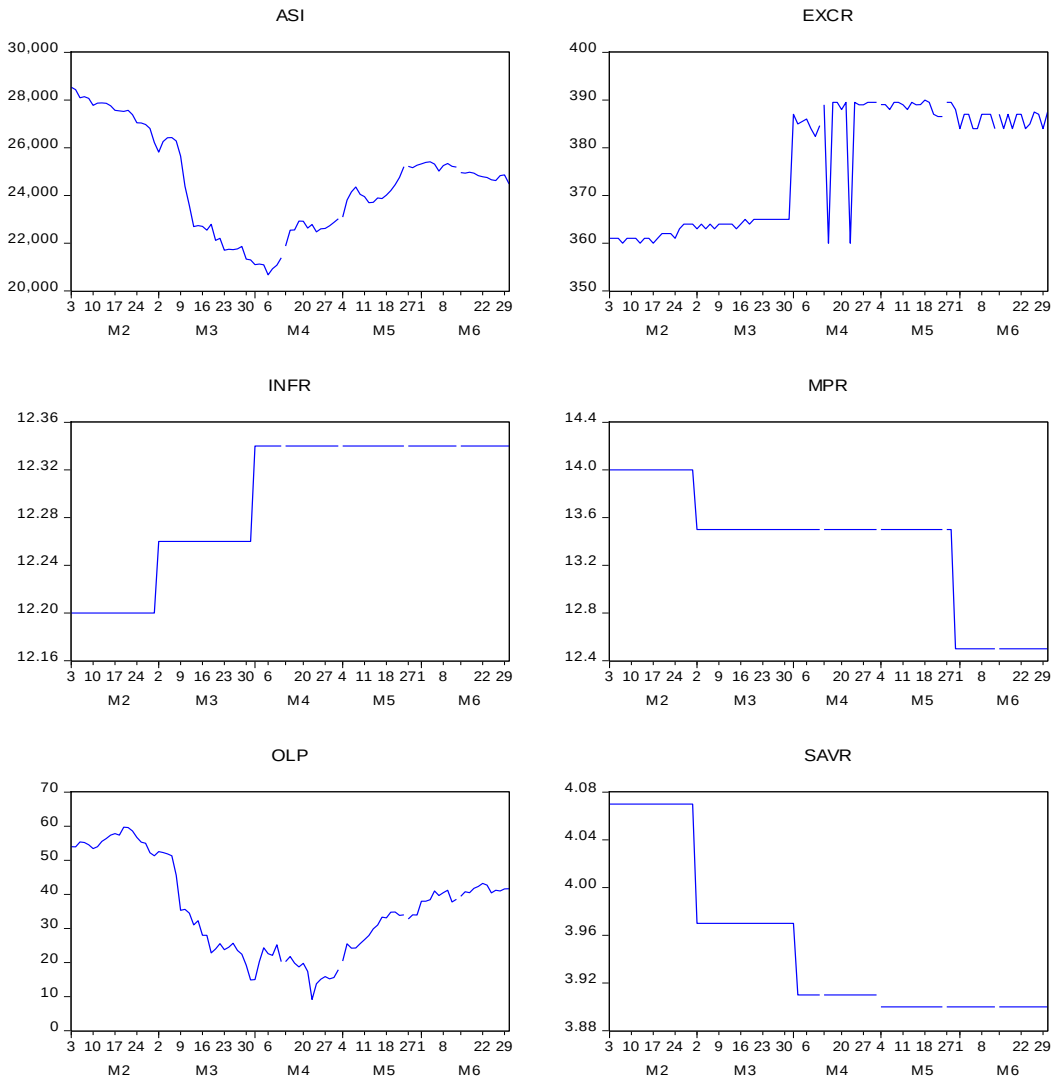

Fig 1. Trend of Variables: ASI, EXCR, INFLR, MPR, OLP and SAV

4.2. Description of Data: ASI, EXCR, INFLR, MPR, OLP and SAVR

Table 1 below shows the summary of statistics that describe the distributional characteristics of all the data. ASI, EXCR, INFLR, MPR, OLP and SAVR recorded following mean; 24454.06, 376.6234, 12.29485, 13.38119, 35.40525 and 3.951485 respectively within the scope of the study. They respectively recorded the following standard deviation; 2108.366, 12.32497, 0.057177, 0.505710, 13.73556 and 0.065183, suggesting ASI has the highest variation followed by OLP while, INFLR parades the least variation. All the variables recorded Kurtosis less than 3, suggesting platykurtic distributions. From Jarque-Bera normality distribution test statistic probability values, with exception of ASI and OLP, the variables have abnormal distribution at 5% significant level.

Table 1: Descriptive Statistics of Data ASI, EXCR, INFLR, MPR, OLP and SAVR

	ASI	EXCR	INFR	MPR	OLP	SAVR
Mean	24454.06	376.6234	12.29485	13.38119	35.40525	3.951485
Median	24625.17	384.0000	12.34000	13.50000	34.45000	3.910000
Maximum	28533.40	389.9670	12.34000	14.00000	59.72000	4.070000

Minimum	20669.38	360.0000	12.20000	12.50000	9.120000	3.900000
Std. Dev.	2108.366	12.32497	0.057177	0.505710	13.73556	0.065183
Skewness	0.155077	-0.240707	-0.675747	-0.793772	0.182764	0.971060
Kurtosis	2.078824	1.153146	1.792145	2.503082	1.884286	2.393890
Jarque-Bera	3.975869	15.32940	13.82626	11.64540	5.800886	17.41913
Probability	0.136978	0.000469	0.000995	0.002960	0.054999	0.000165
Sum	2469860.	38038.96	1241.780	1351.500	3575.930	399.1000
Sum Sq. Dev.	4.45E+08	15190.50	0.326923	25.57426	18866.55	0.424877
Observations	101	101	101	101	101	101

4.3: Multicollinearity Test

Table 2 below shows the summary of correlation of the variables. The correlations between ASI, EXCR, INFLR, MPR, OLP and SAVR range from -0.977815 to 0.918043 suggesting the variables are not linearly correlated. Therefore, the researchers have nothing to worry about presence of multicollinearity in the model.

Table 2 Correlation Matrix for Data; ASI, EXCR, INFLR, MPR, OLP and SAVR

	ASI	EXCR	INFR	MPR	OLP	SAVR
ASI	1.000000	-0.390234	-0.572535	0.180082	0.918043	0.608225
EXCR	-0.390234	1.000000	0.907364	-0.569593	-0.488467	-0.846582
INFR	-0.572535	0.907364	1.000000	-0.671546	-0.645966	-0.977815
MPR	0.180082	-0.569593	-0.671546	1.000000	0.141289	0.703148
OLP	0.918043	-0.488467	-0.645966	0.141289	1.000000	0.659196
SAVR	0.608225	-0.846582	-0.977815	0.703148	0.659196	1.000000

4.4. Stationarity/Unit Root Test:

This is statistical valid procedure in macroeconomics time series analysis that assists to determining the best estimation method for the data. It is due to the peculiarities of time series data. To do this, the popular Augmented Dickey Fuller (ADF) unit root/stationary test is used as shown below in table 3. Table 3 below reveals the summary of stationary test for both level and first difference data. The results show that all the variables; ASI, EXCR, INFLR, MPR, OLP and SAVR are integrated at order one or are differenced once to be stationary at 5%. This validates the choice of VAR model.

Table 3: ADF UNIT TEST

Variables	**Lag Length**	**Level**	**1st Difference**	**Critical Value**		**Remarks**
		ADF Statistics	**ADF Statistics**	**5%**	**10%**	
ASI	0	-	-6.412556 (0.0000)	-2.890926	-2.582514	@1(1)
EXCR	3	-	-9.132404 (0.0000)	-2.891871	-2.583017	@1(1)
INFLR	0	-	-10.04983 (0.0000)	-2.890926	-2.582514	@1(1)
MPR	0	-	-10.03296 (0.0000)	-2.890926	-2.582514	@1(1)
OLP	0	-	-8.783886 (0.0000)	-2.890926	-2.582514	@1(1)
SAVR	0	-	-10.06567 (0.0000)	-2.890926	-2.582514	@1(1)

4.5. Cointegration and Long run Relationship Test:

This is important to know if there exist long run equilibrium relationship between the variables; ASI, EXCR, INFLR, MPR, OLP and SAVR as shown below in Table 4. Table 4 shows that unrestricted rank tests (Trace and Maximum Eigenvalue) record 120.7652 and 52.86429 with probability of values of 0.0003 and 0.0011 respectively at 'None'. That shows one cointegration equations for both at 5% significant level. This is enough evidence to declare that long run relationship exists between the macroeconomic variables; ASI, EXCR, INFLR, MPR, OLP and SAVR.

Table 4 Johansen Cointegration Test

Series: ASI EXCR INFR MPR OLP SAVR				
Panel A: Unrestricted Cointegration Rank Test (Trace)				
Hypothesized		Trace	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.423436	120.7652	95.75366	0.0003
At most 1	0.271341	67.90088	69.81889	0.0704
At most 2	0.201611	37.51216	47.85613	0.3238

At most 3	0.099984	15.89683	29.79707	0.7195
At most 4	0.048733	5.783924	15.49471	0.7209
At most 5	0.010236	0.987713	3.841466	0.3203
Panel B: Unrestricted Cointegration Rank Test (Maximum Eigenvalue)				
Hypothesized		Max-Eigen	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.423436	52.86429	40.07757	0.0011
At most 1	0.271341	30.38872	33.87687	0.1234
At most 2	0.201611	21.61533	27.58434	0.2408
At most 3	0.099984	10.11291	21.13162	0.7340
At most 4	0.048733	4.796211	14.26460	0.7673
At most 5	0.010236	0.987713	3.841466	0.3203

4.6. Unrestricted VAR Analysis

4.6.1. VAR Lag Length Selection:

The first step in estimating the VAR model is to determine the lag length for a parsimonious specification. To achieve this, the researchers engaged all the automatic lag selection criteria as shown in table 5 below. The VAR lag order selection criteria on table 5 shows that lag length of 1 is selected at 5% level based on sequential modified LR test statistic, Final prediction error (FPE), Akaike information criterion (AIC), and Hannan-Quinn information criterion (HQ), indicating that VAR (1) specification is the parsimonious model and the plausible description of the data used. The researchers confidently proceed to estimate a VAR (1) model for the relationship between the macroeconomic variables under consideration in this study.

Table 5 VAR Lag Order Selection Criteria

VAR Lag Order Selection Criteria						
Endogenous variables: ASI EXCR INFR MPR OLP SAVR						
Lag	LogL	LR	FPE	AIC	SC	HQ
0	-1022.192	NA	64.88278	21.19984	21.35910	21.26424
1	-439.7685	1080.786*	0.000831*	9.933371*	11.04819*	10.38415*
2	-410.8073	50.15965	0.000969	10.07850	12.14889	10.91566
3	-389.2599	34.65359	0.001333	10.37649	13.40244	11.60004
4	-357.4842	47.17218	0.001515	10.46359	14.44510	12.07352

4.6.2 Stability check:

To check the coefficient stability of the estimated VAR (1) model, the researchers plot the inverted roots in relation to unit circle. It is statistically known that the estimated VAR model is stable if all the inverted points are inside the unit circle as shown below in fig 2;

Figure 2 below shows the inverse roots of the characteristics AR polynomial. It indicates that all roots fall or lie within the unit imaginery circle (modulus), an indication that VAR (1) model is stable.

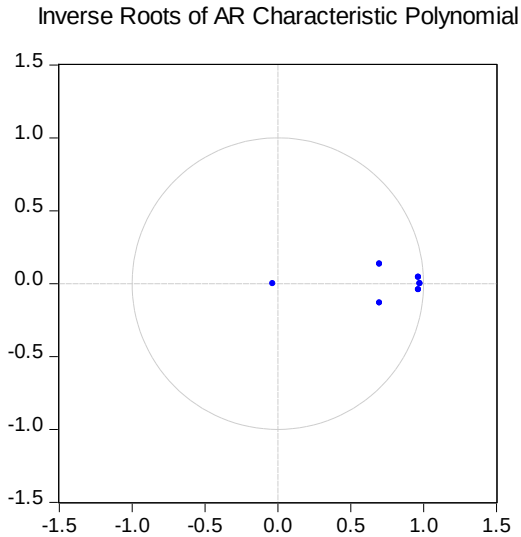

Figure 2: Graphical Representation of Inverse roots of AR Characteristic Polynomial

4.6.3. Residual Checking:

The researchers proceed with residual diagnostic tests; VAR Residual Serial Correlation LM and VAR Residual Heteroscedasticity Test. This is necessary to know if the error in the model is a white noise.

Table 7 below reveals that VAR Residual Serial Correlation LM Tests probability value is 0.9472, which an indication of rejection of the null hypothesis, validating no serial correlation. In the same way, Table 8 shows VAR Residual Heteroscedasticity test probability value is 0.1277, this signposts the model is homoscedastic. This satisfies that the error term is white noise (no serial correlation and no heteroscedasticity).

Table 7: VEC Residual Serial Correlation LM Test

Lag	LRE* stat	df	Prob.	Rao F-stat	Df	Prob.
1	23.46771	36	0.9467	0.636859	(36, 231.1)	0.9472

Table 8: VEC Residual Heteroskedasticity Tests

Chi-sq	df	Prob.
1166.850	1113	0.1277

4.6.4. Short run Causality Test

To examine the short run causality implications of the variables, the researchers adopted VEC Granger Causality/Block Exogeneity Wald Test as shown in table 9 below;

Table 9 below reveals that probability values of 0.0158 and 0.0090 for MPR and OLP respectively. These shows the two macroeconomic variables are significant at 5%, suggesting rejection of null hypothesis of no short run causality flowing from MPR and OLP to ASI. This means the cause themselves in the short run, while other variables do not in the short run. Also in table 9, 'All' macroeconomic variables; ASI, EXCR, INFLR, MPR, OLP and SAVR have probability value of 0.0001, which is significant at 5%. This is confirmed evidence that the macroeconomic variables (ASI, EXCR, INFLR, MPR, OLP and SAVR) jointly cause each other in the long run.

Table 9: VAR Granger Causality/Block Exogeneity Wald Tests

Dependent variable: ASI			
Excluded	Chi-sq	df	Prob.
EXCR	2.434405	1	0.1187
INFR	1.261068	1	0.2614
MPR	5.829924	1	0.0158
OLP	6.818124	1	0.0090
SAVR	0.394151	1	0.5301
All	27.11925	5	0.0001

***4.6.5. Impulse Response and Variance Decomposition of* ASI, EXCR, INFLR, MPR, OLP and SAVR**

This section is basically to examine the response to shock of variations; to check the duration of the shock. The time it takes to decay, the direction of shock, whether negative or positive (impulse response) and contribution of the shock to the variables (variance decomposition). This is achieved with impulse responses and variance decomposition as shown below in figure 3 and figure 4.

In fig 3 below shows the impulse response function of one time shock for all the macroeconomic variables (ASI, EXCR, INFLR, MPR, OLP and SAVR). It shows that the variables respond positively to own shocks from first period to the last period. They respond positively and negatively, at times fade away slightly to the threshold until the last period among themselves.

Figure 4 below looks at the contribution of the shock to the variables. It is found that own shock cause greater variations in the first period and diminished to the last period. That suggests that own shock exerted huge influence in the cause of variation for all the macroeconomic variables (ASI, EXCR, INFLR, MPR, OLP and SAVR) and slightly among themselves, at times diminish to the threshold.

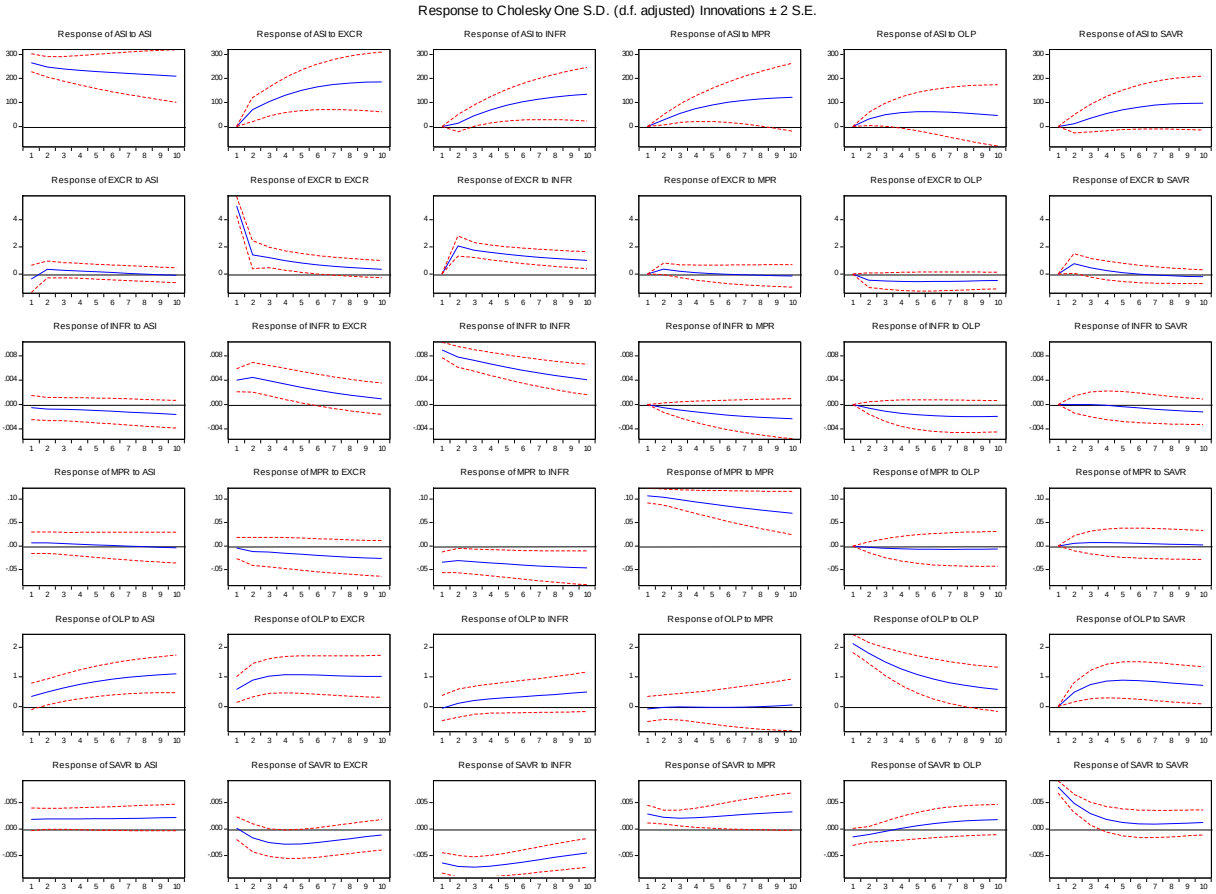

Figure 3: Graph depicting Responses of* ASI, EXCR, INFLR, MPR, OLP and SAVR *to Shocks

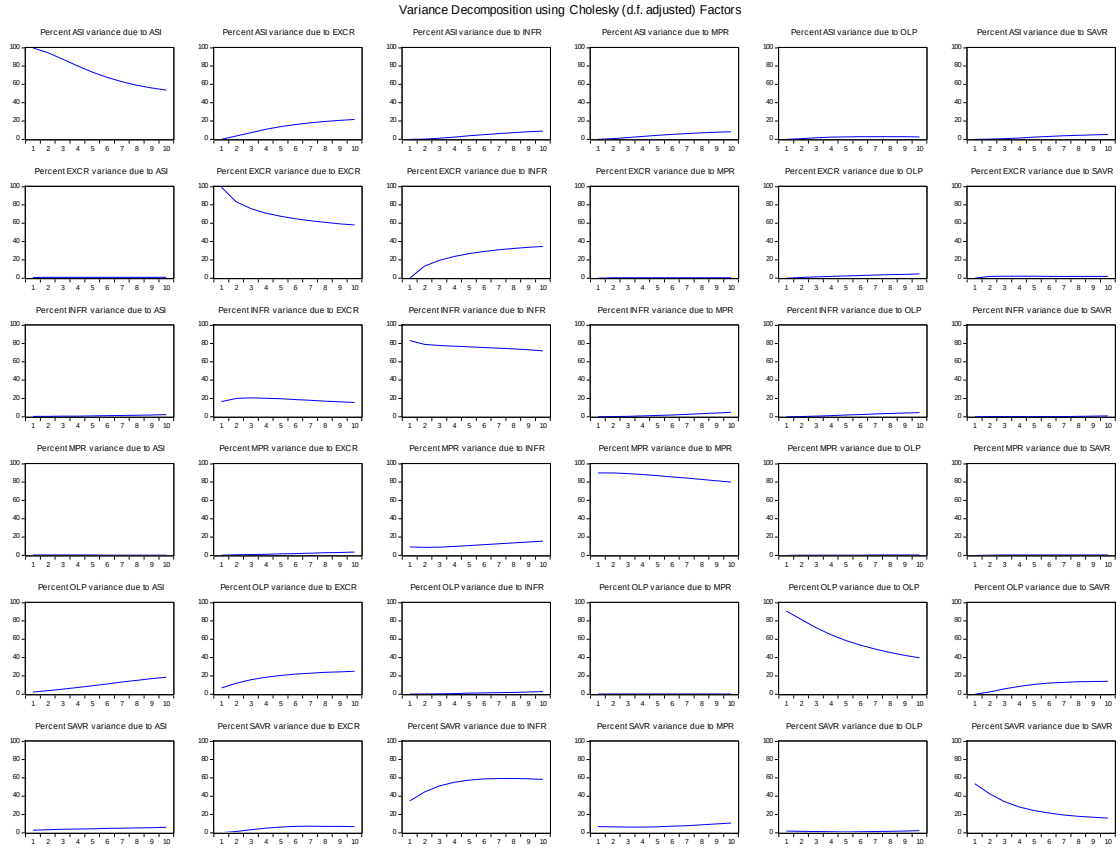

Figure 4: Graph depicting Variance Decomposition* ASI, EXCR, INFLR, MPR, OLP and SAVR *to Shocks

4.6.6. Error Correction and Long run Causality Test

Having established that the variables are cointegrated, there is likelihood of adjustment from short run to long run equilibrium. That is to say that errors encountered in the short run can be corrected or adjusted in the long run. To achieve the consistency, the researchers estimated the model with Vector Error Correction Estimates as shown below in table 10;

The analysis in table 10 below shows that error correction equation (CointEq1) has coefficient of -0.012654 and t-statistic of -2.21220. That shows the error correction parameter is negative and significant, satisfying the apriori expectation (condition), hence, significant. The speed of adjustment is 1.2%. The cointegration already established is confirmed. That means short term errors can be corrected in the long run with annual speed of adjustment 1.2%.

Table 10: Vector Error Correction Estimates

Error Correction:	D(ASI)	D(EXCR)	D(INFR)	D(MPR)	D(OLP)	D(SAVR)
CointEq1	-0.012654	-3.00E-05	-7.14E-07	1.07E-06	-0.000272	7.41E-07
	(0.00572)	(0.00013)	(2.7E-07)	(3.2E-06)	(5.0E-05)	(2.8E-07)
	[-2.21220]	[-0.23496]	[-2.61097]	[0.33354]	[-5.45806]	[2.62602]

V. Conclusion and Recommendation

This paper; behaviour of macroeconomic variables amidst the covid-19 pandemic: Nigerian evidence. From the trend analysis to the unrestricted VAR estimates, it was discovered that the behavior of macroeconomic variables (All Share Index, Exchange Rate, Inflation Rate, Monetary Policy Rate, Oil Prices and Saving Rates) are transient within this pandemic (COVID-19). That means the positive or negative shocks from the pandemic can decay with little manipulation. The results validate this study as a compass that informs the economic agents on their activities within this crisis induced by the COVID-19. This is because the macroeconomic variables are system variables. There are always interactions among them, more especially in this global crisis caused by the COVID-19. However, due to the ephemeral fluctuations among the macroeconomic variables, the Federal and various state governments should fashion out measures from time to time to ameliorate the adverse effect that may emanate anytime from the Corona virus pandemic.

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Appendix

Table 1: ***Confirmed Cases, Active Cases, Critical Cases, New Cases, New Death, Total Death and Total Recovery***

Date	Confirmed case	New cases	Total deaths	New deaths	Total recovery	Active cases	Critical cases
28-Feb-20	1	1	0	0	0	1	0
10-Mar-20	2	0	0	0	0	2	0
17-Mar-20	3	1	0	0	0	3	0
18-Mar-20	8	5	0	0	1	7	0
20-Mar-20	12	4	0	0	1	11	0
21-Mar-20	22	10	0	0	1	21	0
22-Mar-20	30	8	0	0	2	28	0
23-Mar-20	40	10	1	1	2	37	0
24-Mar-20	44	4	1	0	2	41	0
25-Mar-20	51	7	1	0	2	48	0
26-Mar-20	65	14	1	0	2	62	0
27-Mar-20	70	5	1	0	3	66	0
28-Mar-20	89	19	1	0	3	85	0
29-Mar-20	111	22	1	0	3	107	0
30-Mar-20	131	20	2	1	8	121	0
31-Mar-20	139	8	2	0	9	128	0
1-Apr-20	174	35	2	0	9	163	0
2-Apr-20	184	10	2	0	20	162	0
3-Apr-20	209	25	4	2	25	180	0
4-Apr-20	214	5	4	0	25	185	0
5-Apr-20	232	18	5	1	33	194	2
6-Apr-20	238	6	5	0	35	198	2
7-Apr-20	254	16	6	1	44	204	2
8-Apr-20	274	22	6	0	44	226	2
9-Apr-20	288	14	7	1	51	230	2
10-Apr-20	305	17	7	0	58	240	2
11-Apr-20	318	13	10	3	70	238	2
12-Apr-20	323	5	10	0	85	228	2
13-Apr-20	343	20	10	0	91	242	2
14-Apr-20	373	30	11	1	99	263	2
15-Apr-20	407	34	12	1	128	267	2
16-Apr-20	442	35	13	1	152	277	2
17-Apr-20	493	51	18	4	159	317	2
18-Apr-20	541	48	20	2	166	356	2
19-Apr-20	627	86	22	2	170	436	2
20-Apr-20	665	38	23	1	188	466	2
21-Apr-20	782	117	26	3	197	560	2
22-Apr-20	873	91	29	3	197	648	2
23-Apr-20	981	108	32	3	197	753	2
24-Apr-20	1095	114	33	1	208	855	2
25-Apr-20	1182	87	36	3	222	925	2
26-Apr-20	1273	91	41	5	239	994	2
27-Apr-20	1337	64	41	0	255	994	2
28-Apr-20	1532	195	45	4	255	1232	2

29-Apr-20	1728	196	52	7	307	1369	2
30-Apr-20	1932	204	59	7	317	1556	2
1-May-20	2170	238	69	10	351	1751	2
2-May-20	2388	220	86	17	351	1952	2
3-May-20	2558	170	88	2	400	2070	2
4-May-20	2802	245	94	6	417	2291	2
5-May-20	2950	148	99	5	481	2370	4
6-May-20	3145	195	104	5	534	2507	1
7-May-20	3526	381	108	4	601	2818	4
8-May-20	3912	386	118	10	679	3115	4
9-May-20	4151	239	127	11	745	3278	4
10-May-20	4399	248	142	17	778	3479	4
11-May-20	4641	242	152	10	902	3589	4
12-May-20	4787	146	158	6	959	3670	4
13-May-20	4971	184	164	6	1070	3737	4
14-May-20	5162	193	168	3	1180	3815	4
15-May-20	5445	288	171	3	1320	3954	4
16-May-20	5621	176	176	5	1472	3973	7
17-May-20	5959	388	182	6	1594	4183	7
18-May-20	6175	216	191	9	1644	4340	7
19-May-20	6401	226	192	1	1734	4475	7
20-May-20	6677	284	200	8	1840	4637	7
21-May-20	7016	339	211	11	1907	4898	7
22-May-20	7261	245	221	10	2007	5033	7
23-May-20	7526	265	221	0	2174	5131	7
24-May-20	7839	313	226	5	2263	5360	7
25-May-20	8068	229	233	7	2311	5524	7
26-May-20	8344	276	249	16	2385	5710	7
27-May-20	8733	389	254	5	2501	5978	7
28-May-20	8915	182	259	5	2592	6064	7
29-May-20	9302	387	261	2	2697	6344	7
30-May-20	9855	553	273	12	2856	6726	7
31-May-20	10162	307	287	14	3007	6868	7
1-Jun-20	10578	416	299	12	3122	7157	9
2-Jun-20	10819	241	314	15	3239	7266	7
3-Jun-20	11166	348	315	1	3329	7522	7
4-Jun-20	11516	350	323	8	3535	7646	7
5-Jun-20	11844	328	333	10	3696	7815	7
6-Jun-20	12233	389	342	9	3826	8065	7
7-Jun-20	12486	260	354	12	3959	8173	7
8-Jun-20	12801	315	361	7	4040	8400	7
9-Jun-20	13464	663	365	4	4206	8893	7
10-Jun-20	13873	409	382	17	4351	9140	7
11-Jun-20	14554	681	387	5	4494	9673	7
12-Jun-20	15181	627	399	12	4891	9891	7
13-Jun-20	15682	501	407	8	5101	10174	7
14-Jun-20	16085	403	420	13	5220	10445	7
15-Jun-20	16658	573	424	4	5349	10885	7
16-Jun-20	17148	490	455	31	5623	11070	7
17-Jun-20	17735	587	469	14	5967	11299	7
18-Jun-20	18480	745	475	6	6307	11698	7
19-Jun-20	19147	667	487	12	6581	12079	7
20-Jun-20	19808	661	506	19	6718	12584	7
21-Jun-20	20242	436	518	12	6879	12847	7
22-Jun-20	20919	675	525	7	7109	13285	7
23-Jun-20	21371	452	533	8	7338	13500	7
24-Jun-20	22020	649	542	9	7613	13865	7
25-Jun-20	22614	594	549	7	7822	14243	7
26-Jun-20	23298	684	554	5	8253	14491	7
27-Jun-20	24077	779	558	4	8625	14894	7
28-Jun-20	24867	490	565	7	9007	14995	7
29-Jun-20	25133	566	573	8	9402	15158	7
30-Jun-20	25694	561	590	17	9746	15358	7

Source: NCDC, July 1, 2020.

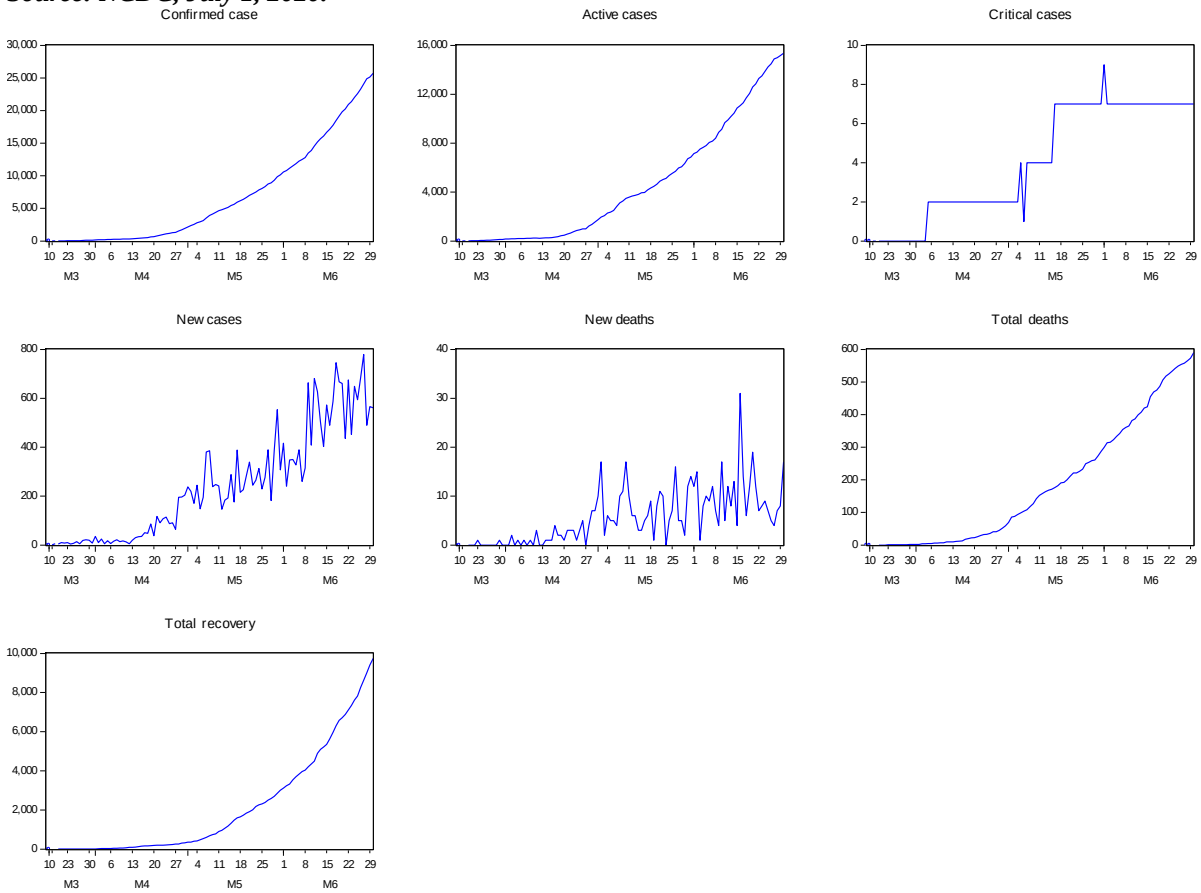

Fig 1: Trend of Confirmed Cases, Active Cases, Critical Cases, New Cases, New Death, Total Death and Total Recovery

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