Time Series Analysis of Macroeconomic Variables in Nigeria: A Study Before COVID-19 Pandemic

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Abstract

This paper examines the effect of Money Supply, GDP Growth, Oil Price, REER and Official exchange rate on Consumer Price Index in Nigeria during the period 1980 to 2019. Empirical estimation proceeds with tests for stationary and co-integration. The finding of Johansson among the variables leads to estimation of the hypothesized relationships with a vector error-correction model.

First, to check trend in our analysis we use unit root test ADF and Phillip Peron then apply Johnson co-integration approach to test our variables for long run as well as short run. The results of Johansen co-integration show, that Money Supply and CPI are co-integrated, as there is a long run relationship between the two. Further, we also found that GDP Growth, World Oil Price have positive and significant effect on CPI.

1. Introduction

Consumer Price Index is the weighted average of prices of consumer goods and services. It is calculated by taking changes in prices for each item and then averaging them. Consumer price index is a proxy of inflation, which means continuous increase in prices of the economy. Money is losing its value while price index is increasing in a process. Due to higher inflation, prices of the goods and services increases so people carry more money as its value has been declined. Pondering such adversarial impacts of expansion on the economy, there is an understanding among the world's national banks that worth robustness should be the practical objective of cash related game plan. Subsequently, the upkeep of significant worth steadfastness continues being the supplanting objective of cash related methodology in Nigeria. The complement given to esteem adequacy in the direct of cash related technique is with the ultimate objective of progressing viable money related advancement and improvement similarly as bracing the securing impact of the private money, among others. Right now, extraordinary appreciation of the parts driving extension is required.

To address these problems in this study we examined the effect of Money Supply, GDP Growth, Oil Price, REER and Official exchange rate on Consumer Price Index in Nigeria by using ARDL approach. Therefore, it is standard that the determinants of inflationary loads in Nigeria are multi-dimensional. There was, in any case, even now no concurrence concerning its complete source, be it money related or helper factors. In development, a couple of makers have evaluated the size of expanding inertness in order to give a prevalent guide, on how much, past expansion impacts on choosing its present level. In Nigeria, (Papi and Lim 1997).

First, to check pattern in our paper we use unit root test ADF and Phillip Peron at that point apply Johnson co-mix way to deal with test our factors for long as well as short run. The aftereffects of Johansen co-integration appear, we will use ARDL for results and conclusion.

Consumer Price Index (CPI) in Nigeria, January 1995 - January 2021: For that indicator, we provide data for Nigeria from January 1995 to January 2021. The average value for Nigeria during that period was 112.47 index points with a minimum of 14.36 index points in January 1995 and a maximum of 361.23 index points in January 2021. Click on the following link to see the values of Consumer Price Index (CPI) around the world.

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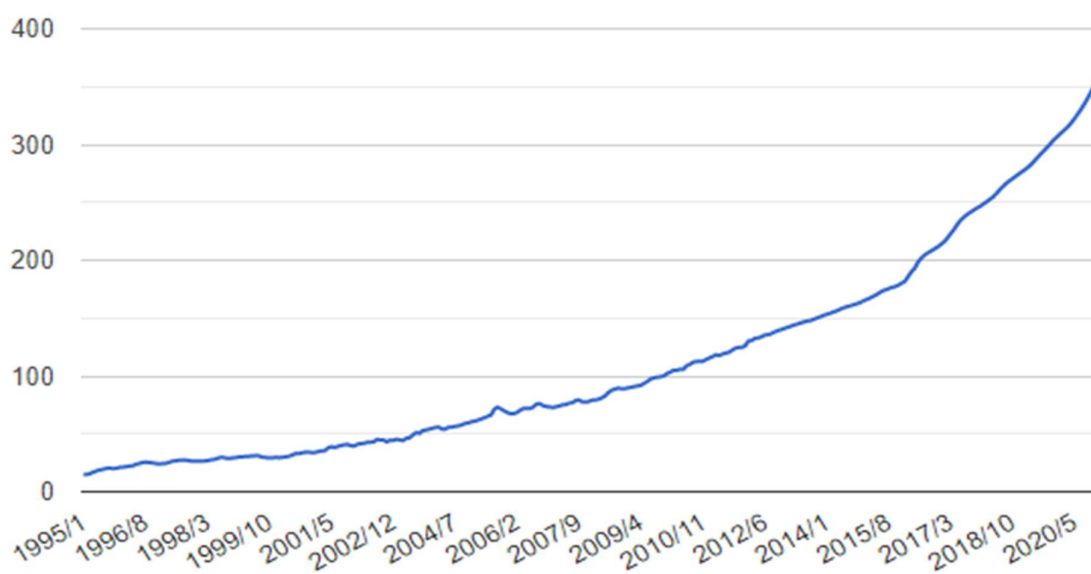
2. Literature Review

This study examined effect of macroeconomic variables on performance of manufacturing sector in Nigeria a thirty-six year (39) period spanning from 1981-2019. Specifically, this study investigated how macroeconomic variables such as real interest rate, exchange rate and inflation rate relate with performance of manufacturing sector measured by output contribution ratio to real gross domestic product and average capacity utilization. In pursuance of the objectives of this study, four hypotheses were formulated and tested using secondary data obtained from the Central Bank of Nigeria and National Bureau of Statistics Statistical Bulletins. This study is based on time series data. The Augmented Dickey Fuller was used to test the time series data for stationarity. Simple linear regression was employed in the analysis of the data. The findings of this study revealed that macroeconomic variables significantly relate with performance at 5% significant level. Based on the findings, it was recommended among others that nominal interest rate should be lowered to increase the level of investment. An increase in investment will lead to an increase in overall performance of manufacturing firms in Nigeria and economic growth at large.

This section has revealed the effect of various studies on the determinants of CPI in many countries (developing &developed) including Nigeria. (Jones and Khilji 1988) analyzed the impact of inflationary process in Brazil for the time 1968 to 1985. In this study, the author prescribes that if there is an increase in the money growth or Oil-Price, inflation increases overall. Furthermore, he explained that if the devaluation of the exchange rate increases, inflation increases while it decreases when growth output goes up.

Qayyum (2006) investigate the effect of Money Supply on CPI in Pakistan between 1960 to 2005 by using vector autoregressive analysis, it shows that there is stable correlation exist between the growth of the money supply and the rate of the inflation. The analysis of the determinants of inflation also examined in Nigeria by (Tabi and Ondoa 2011) by using error correction model from 1970 to 2010 which predict that lagged inflation and money supply determine the inflation significantly.

Bandara (2011) studied the impact of GDP growth on Consumer price index in low and high inflation countries; he describes the significant relationship between the GDP growth and

inflation (CPI) in 2011 by using the vector auto regression model. (Hassan, Islam et al. 2016) explained the negative relation between GDP and inflation in Pakistan.

Ndidi (2013)studied the impact of REER with CPI by using sample of 93 developing countries over 16-19 years and propose that negative effect is stronger than positive effect on growth of the economy. Aguirre and Calderon (2005) also conduct a study on REER and inflation for more than 60 developing countries for the period 1983-2015 and reveal that there is negative correlation exist on GDP growth.

Abdullahi et al. (2016) examined the official exchange rate impact on CPI for the period 1986-2007 by using VECM model in Nigeria and found that exchange rate was low for the selected time period which ultimately lowers the price chain; on the other hand, exchange rate is normally high in developing countries rather than developed and found negative correlation among them.

3. Data Source and Methodology

The detail of research methodology and data source for achieving the aim of this study is given below. The aim of this research study is to find the Broad Money, Oil Price, GDP Per Capita and REER Impact on consumer Price Index for achieving this aim, an appropriate methodology is adopted. The detail of which is as below.

Data are taken for the country of Nigeria for the period of 1980 to 2019. The data on all variables such as per capita gross domestic product, Broad Money, REER, Oil Price, Official Exchange Rate and CPI have been collected from World Development Indicators (WDI).

This study has conceptualized the following functional model:

$LnCPI_t = \beta_0 + \beta_1 \ lnLBM \ 1 + \beta_2 lnGDPPC \ 2 + \beta_3 \ lnREER \ 3 + \beta_4 lnLOEXR \ 4 + \beta_5 \ lnOIL + e$

Proposed data analysis techniques

We will get data by descriptive statistics, doing correlation study to find interdependence of variables. For stationary of data, we apply unit root tests ADF and PP test is employed to find out the integrating order. Using vector autoregressive (VAR) analysis, particular attention is given to testing for the existence and direction of Granger-causality among the variables. For co-integration (ARDL) Autoregressive distribution lag Johnson, co-integration approach is used for short run and long. Finally do descriptive statistics.

Transformation approach and variable construct

Variable name	variable representation	variable proxy	Transformation of the variable	Data Source
Consumer Price Index	LNCPI	Inflation ,Consumer Price	Ln Inflation ,Consumer Price	WDI 1980-2019
Broad Money	LNBM	Broad Money as share of GDP	Ln Broad Money constant LCU/ GDP	WDI 1980-2019
GDP Per Capita	LnGDPPC	GDP Per Capita	Ln GDP Per Capita	WDI 1980-2019
Official Exchange Rate	LnOEXR	Official Exchange Rate	Ln Official Exchange Rate	WDI 1980-2019
Oil Price	LnOIL	Oil rents (% of GDP)	ln Oil rents (% of GDP)	WDI 1980-2019
Real Effective Exchange Rate	LnREER	Real Effective Exchange Rate	LnReal Effective Exchange Rate	WDI 1980-2019

4. Results and Discussions

Table : 1 Descriptive statistics					
	LNCPI	LNBM	LNGDPPC	LNOIL	LNREER
Mean	2.673587	16.71361	12.46111	2.318672	7.430505
Median	2.502892	16.58259	12.37879	2.551599	4.610383
Maximum	4.288204	17.64619	12.8619	3.274506	106.6936
Minimum	1.683102	15.926	12.20126	0.413011	3.915382
Std. Dev.	0.694971	0.567739	0.237055	0.672169	16.32518
Skewness	0.881561	0.428439	0.46297	-0.95014	5.988217
Kurtosis	2.862922	1.722303	1.616901	1.26484	36.91712
Jarque-Bera	5.082012	3.845966	4.501784	5.982004	2102.434
Probability	0.078787	0.14617	0.105305	0.150237	0.0000
Sum	104.2699	651.8309	485.9832	90.42819	289.7897
Sum Sq. Dev.	18.35343	12.24844	2.135421	17.16884	10127.44
Observations	39	39	39	39	39

In the descriptive Statistics, the study is based on 39 observations from 1980 to 2019; the descriptive result is displaying the mean, median, maximum and minimum values of observation, standard deviation, and Jarque-Bera test statistics values of each individual variable. TheJarque-Bera Probability value is greater than 0.1 then we accept the Ho and reject the H1. There is broad money, GDP per Capita and oil showing the normality in the above table, so we say that data of our series normally distributed. Moreover, CPI and real effective exchange rate is not normally distributed and we accept the alternative Hypothesis.

In order to check the issue of multi co-linearity, we have developed a correlation matrix among all the variables and then with help of correlation matrix we have developed a table of Variance inflation factor, which says that the VIF value among independent variables, should be less than 10 otherwise they will report an evidence of multi co-linearity. Table 2 present the coefficient of correlation among the variables, correlation among the variables tells us about the direction and strength of variables to move together in the same or opposite direction.

The strength of relationship among all variables is less than 0.75 or 75%. Table 3 is reporting the values of VIF which has been calculated with the help of VIF formula such as $1 / 1 - (r^2)$ where r is the correlation between the variables for each pair, in order to report the evidence of multi co-linearity between the variables if any. Table 3 reports that VIF value between each pair of variables is less than 10 hence concluded that there is no evidence of multi o-linearity among the independent variables.

Table 2: Coefficient of Correlation Matrices					
	LNCPI	**LNBM**	**LNGDPPC**	**LNOIL**	**LNREER**
LNCPI	1	-0.26414	-0.30853	0.227524	-0.04911
LNBM	-0.26414	1	0.893317	-0.02311	0.256594
LNGDPPC	-0.30853	0.893317	1	-0.17105	0.224129
LNOIL	0.227524	-0.02311	-0.17105	1	-0.21633
LNREER	-0.04911	0.256594	0.224129	-0.21633	1

Table 3: Variance Inflation Factor Matrices					
	LNCPI	**LNBM**	**LNGDPPC**	**LNOIL**	**LNREER**
LNCPI	1	1.075002	1.105202	1.054593	1.002418
LNBM	1.075002	1	4.950878	1.000534	1.070481
LNGDPPC	1.105202	4.950878	1	1.03014	1.052891
LNOIL	1.054593	1.000534	1.03014	1	1.049098
LNREER	1.002418	1.070481	1.052891	1.049098	1

According to the Lag order, selection criteria among the variable we select lowest value of the given select criteria at specific lag order in which we skip the three-lag period at AIC which most the lowest value for the optimal lag order.

VAR Lag Order Selection Criteria
Endogenous variables: LNCPI LNBM LNGDPPC LNOEXR LNOIL LNREER
Exogenous variables: C
Date: 02/09/20 Time: 15:06
Sample: 1980 2018
Included observations: 36

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-256.555	NA	0.08709	14.58636	14.85028	14.67848
1	-72.7899	296.0653	2.44E-05	6.377217	8.224656	7.022023
2	-23.9692	62.38197	1.43e-05*	5.664957	9.095915	6.862453
3	15.42876	37.20922	1.96E-05	5.476180*	10.49066	7.226367

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

Table4: ADF Unit Root Test

ADF Unit root at level			At First difference			Decision at Level	Decision at 1st Diff.
Variables	**t-statistics**	**p-value**	**Variables**	**t-statistics**	**p-value**		
LNCPI	-3.781229	0.0066	**LNCPI**	-6.400835	0	Stationary	Stationary
LNBM	-0.839551	0.7958	**LNBM**	-7.955023	0	Non-Stationary	Stationary
LNGDPPC	-1.221542	0.6544	**LNGDPPC**	-4.212094	0.0021	Non-Stationary	Stationary
LNOIL	-3.13505	0.1323	**LNOIL**	-7.926805	0	Non-Stationary	Stationary
LNREER	-0.363372	0.9054	**LNREER**	-0.2647	0.9207	Non-Stationary	Stationary

Table5: PP Unit Root Test							
PP Unit root at level			**At First difference**			**Decision at Level**	**Decision at 1ˢᵗDiff.**
Variables	**t-statistics**			**t-statistics**	**p-value**		
LNCPI	-3.338242	0.02	**LNCPI**	-13.86345	0	Stationary	Stationary
LNBM	-0.621315	0.8539	**LNBM**	-10.3532	0	Non-Stationary	Stationary
LNGDPPC	-0.82912	0.7992	**LNGDPPC**	-4.265918	0.0018	Non-Stationary	Stationary
LNOIL	-3.13505	0.0323	**LNOIL**	-8.496219	0	Non-Stationary	Stationary
LNREER	-0.363372	0.9054	**LNREER**	-0.2647	0.9207	Non-Stationary	Stationary

In order to check the order of integration of variables and evidence of unit root problem, we have applied Augmented Dickey-Fuller (ADF) test and Phillips-Perron (PP) unit root tests. According to ADF test, the order of integration is mixed because LnCP is stationary at level whereas variables LNBM, LNGDPPC, LNREER and LNOIL are non-stationary at level, whereas all the variables comes stationary at first difference. Hence concluded on the base of ADF test there is an evidence of mix order of integration. As per PP test, the order integration again comes mixed because variables LnCPI comes stationary at level while variables LNBM, LNGDPPC, LNREER and LNOIL comes non-stationary at level, whereas all the variables come stationary at first difference. So, PP is also providing an evidence of mixed order of integration. Therefore, two test of unit root test ADF and PP have provided an evidence of mixed order of integration. Therefore, on based of this two-test justification, ARDL approaches become appropriate but we want check through Johansson Co-integration approach to apply for the regression results.

Johnson Co-Integration Trace test and Max-Eigen Value Statistics
Johnson Co-integration through two types of test Trace test and Max-Eigen Value Statistics, if the Trace statistics greater then critical value then we can say that long run Co-integration exist and also we say that Max-Eigen Value greater then critical value then we can say that long run Co-integration exist. Therefore, in our results we can see that in Trace Statistics, test indicates that 2 Co-integration exist at 0.05 level of significance trace value is 91.285 and 50.36348 greater the critical values 69.81889, 47.85613 and shows that co-integrationexists. In addition, Max-Eigen value40.921, 27.895 is greater than the critical value at 0.05 level of significance.

Table 6: Trace Test and Max-Eigen Value Statistics

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Date: 02/09/20   Time: 18:09
Sample (adjusted): 1982 2018
Included observations: 37 after adjustments
Trend assumption: Linear deterministic trend
Series: LNCPI LNBM LNGDPPC LNOIL LNREER
Lags interval (in first differences): 1 to 1
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Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.669117	91.28508	69.81889	0.0004
At most 1 *	0.529485	50.36348	47.85613	0.0285
At most 2	0.356198	22.46817	29.79707	0.2732
At most 3	0.151025	6.174690	15.49471	0.6749
At most 4	0.003152	0.116823	3.841466	0.7325

Trace test indicates 2 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.669117	40.92160	33.87687	0.0061
At most 1 *	0.529485	27.89532	27.58434	0.0456
At most 2	0.356198	16.29348	21.13162	0.2082
At most 3	0.151025	6.057866	14.26460	0.6058
At most 4	0.003152	0.116823	3.841466	0.7325

Max-eigenvalue test indicates 2 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

By identifying Trace statistics, we depicted that there are two co-integrating equations exist. One on the None as their Trace test value 91.28 is greater than critical value, which is 69.81;it is the case at (At most 1).
On the other hand, in max Eigen test also have two co-integration equations one on None and one on (At most 1) as their calculated value is greater than critical value.

Table 6: Error Correction Representation for the Selected ARDL Model

ARDL(1,0,1,1,1) selected
****
****
 Dependent variable is
dLNCPI
 38 observations used for estimation from 1981 to 2018
****

Regressor	Coefficient	Standard Error	T-Ratio[Prob]
dLNBM	.036729	.39389	.093248[.926]
dLNGDPPC	-6.5650	2.1425	-3.0641[.004]
dLNOIL	-.030231	.21785	-.13877[.891]
dLNREER	-.0025252	.0054786	-.46092[.648]
ecm(-1)	**-.65178**	**.14152**	**-4.6054[.000]**

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Estimated Long Run Coefficients using the ARDL Approach
ARDL(1,0,1,1,1) selected
****

Dependent variable is LNCPI

38 observations used for estimation from 1981 to 2018
****

Regressor	Coefficient	Standard Error	T-Ratio[Prob]
LNBM	.056351	.60850	.092607[.927]
LNGDPPC	-1.4774	1.4497	-1.0191[.317]
LNOIL	-.27602	.36441	-.75743[.455]
LNREER	-1.1526	.36317	-3.1736[.004]
C	26.3897	11.5204	2.2907[.029]

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As in this test, the value of F-statistic 9.8022 is greater than upper critical bound 4.6055 that shows that there is co-integration exist. It is the case with W test value, which is greater than upper critical bound, which reveal the existence of co-integration among dependent and its independent variables.

As the above test's P-value is greater than 0.1 so we will conclude that our model is following normal distribution, have no serial correlation, homoscedastic and functional form of the variance is specified.

5. Conclusion and Policy Implications

This study aims to investigate the relationship of money supply, GDP per capita, Real exchange rate, oil price and official exchange rate on CPI for Nigeria for the period of 1980 to 2019.

The study uses ADF and Phillip Peron to check the stationary of data. Similarly, this will decide whether to apply co-integration or not. The study applies Johnson co-integration test for short run and long run relationship of variables.

As inflation is one of the determinant to use the economic situation and ups & downs of the economy and it play very important role for the development and growth of country. To check the stationary and non-stationary of data we use two-unit root test ADF and Philip Peron then apply Johnson co-integration approach to test our variables for long run as well as short run. The results of Johansen co-integration show, that money supply and consumer price index are co-integrated, as there is a long run relationship between the two.

Further, there is a need to control the stability of exchange rate movements, which not only helps in economic growth but also contributes to economic development of the country. GDP per capita, oil price and money supply have significant with CPI but official exchange rate is negative and insignificant with economic growth for long run, labor force and trade are insignificant and, real exchange rate and CPI are significant and negative impact and cannot influence on economic growth.

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