

Comparison of Autoregressive Distributed Lag Model and Vector Error Correction Model Analysis on The Effect of Some Macroeconomic Variables on GDP in Nigeria

¹Abbas Usman and ^{2*}Adenomom Monday Osagie

¹Department of Statistics, College of Agriculture Science and Technology Lafia, (COASTL)
Nasarawa State Nigeria

²Department of Statistics, Nasarawa State University Keffi (NSUK) Nasarawa State, Nigeria
Corresponding Author; *adenomonmo@nsuk.edu.ng, abbaslokousman@gmail.com

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Abstract

This research work employed Autoregressive distributed lag (ARDL) and Bound Test for co-integration with Vector Error Correction (VEC) Models for estimation of long run and short run effect on Gross Domestic Product (GDP) in Nigeria. In order to achieve this, annual data on GDP, Unemployment, Exchange, and Interest rate from 1980-2017 The Augmented Dickey Fuller (ADF) Test revealed that the variables are stationary at first difference. ARDL and bound test for co-integration revealed that the decision whether to accept or reject either of the hypotheses is inconclusive. Johansen confirmed the existence of long run relationship between the variables. VECM long run estimate indicated that there is positive and significant effect of Exchange rate and Unemployment rate on GDP while Interest rate had negative significance effect on GDP. ARDL long run estimate indicated that only Unemployment rate had significant effect on GDP. ARDL short run estimate among the variables revealed that the coefficient of the ECM(-1) had a correct sign and statistically significant at 5% level which also indicated that the system corrects its previous period at the speed of adjustment by 46% per annum, it was also revealed that interest rate was positive and statistically significant in the short run. While VEC short run estimate revealed that no any variable has significant effect on GDP and that the coefficient of the ECM(-1) had a correct sign and was statistically not significant at 5% level which also indicated that the system had its previous period correct at the speed of adjustment by 12% per annum. The models were stable for forecasting, no serial correlation, multicollinearity, heteroskedasticity and the residuals are normally distributed.

Keywords; ARDL, VECM, GDP, Unemployment rate, Interest rate, Exchange rate .

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1. Introduction

Basically Nigeria economy has been affected by some factors, among of these are unemployment, interest, exchange, and GDP. In this research work we shall identify factors affecting GDP and the relationship between them in Nigeria, where some of which may show negative relationship while other factors may show positive relationship.

Gross Domestic Product (GDP) is one of the basic indicators used to measure the improvement of national economy. According to World Bank definition, Gross Domestic Product (GDP) is the sum of gross value added by all resident producers in economy plus any product taxes and minus any subsidies not included in the value of the products. Gross Domestic Product is used to determine if an economy is growing fast or slow. GDP is calculated without making deduction for depreciation of natural resources. Economic performance has not been impressive in Nigeria due to high Interest rate, high Exchange rate and increase in population but low employment. According to Njoku and Ihugba(2012) stated that unemployment contributed to low GDP and leads to increase in crime and violence, psychological effect, adverse effect on health and political instability. Rodrik(2008) proved that GDP is affected by exchange rate of any country. Udoka and Roland(2012) stated that the interest rate is one of the determinant of economic growth.

1.2 Statement of the problem

Nigeria economic growth has been poor for a numbers of decades because, economic crises in Nigeria is reflected in level of unemployment, high interest rate, exchange rate distortions to mention a few. The main purpose of this study is to identify the effect of interest, unemployment, and exchange rate on gross domestic product (GDP) in Nigeria. It can be seen that from 1980 to 2017 Nigeria economic growth has been growing but not as it is expected. Foo-Zor (2009) stated that slow economic growth which may be due to expansionary monetary policy via a relatively high interest rate regime can lead to a fall in the economic growth. Redrik (2008) found that there is a relationship between exchange rates with economic growth to form positive relationship. Many studies have proved the existent of conflicting relationship between economic growth and unemployment with some showing positive while other showing negative relationship this include the work of Lee (2000) and Fuad (2011) to mention a few.

2. Literature Review

2.1. Concept of GDP

The measures of national income and output for a given country's economy at a given period of time are called GDP. The definition of GDP is based on the total market value of all goods and services produced within the country in a given period of time Alex (2015). Gross Domestic Product (GDP) is one of the most common measures on the state of the economic for any nation. Another issue is that GDP is about outcomes, rather than processes. Most of us do care about how we got the goods and services we consume as well as what we consume. Ruffin (1998) also said that Gross Domestic Product is the broadcast measure of the total output of the economy. Samuelson (2005) explained Gross Domestic Product as the name given to the total

market value of the final goods and services produced cost of pollution, other disamenities modern urbanization and some other adjustment.

2.2. Concept of Unemployment Rate

According to Balami (2006) Unemployment is conceptualized as a situation where by a worker is or workers are involuntarily out of work. This means that people are willing to work but cannot find any work.

Jhingan (2001) posited that unemployment can be conceived as the number of people who are unemployed in an economy often given as a percentage of the labour force.

According to Aminu and Anono(2012) Unemployment can be conceptualized as total number of people who are willing and able to work, and make themselves available for job at the prevailing wage but no work for them. This therefore implies that unemployment is a state of joblessness in the country.

2.3. Concept of Interest Rate

Jhingan (2001) stated that interest rate play the following role in any economy. It measures the opportunity cost of various productive channels and thus helps allocation of saving among them. Interest induces people to save from their incomes and provide capital for productive uses. It has been widely recognized as a powerful weapon to be used by the monetary authorities to control deflation, capital Movement, inflation, etc. It regulates the flow of investible funds and thereby influences the growth and direction of business and industrial actively.

2.4. Concept of Exchange Rate

Mordi(2006) defined exchange rate as the prices of one currency in terms of another. According to Azeez et al(2012) noted that when there is deviation of this rate over a period of time from the benchmark or equilibrium exchange rate is called exchange rate volatility.

Adenomon et al (2019) in the study recommends that savings and savings culture should be encourage in Nigeria since economic theory states that savings and investment are related in any economic development, the study applied ARDL model to examine the contributions of commercial banks to GDP growth in Nigeria, the annual data from 1981-2015 for loans and advance savings, lending rate and GDP of financial institution were collected from CBN bulletin.

Adenomon et al (2018) employed the fully modified ordinary least squares (FMOLS) and the error connection model (ECM) to investigate the unemployment rate in Nigeria. The ADF test shows that the microeconomic variables are stationary at first differences while the co-integration test shows that the variables are co-integrated using unemployment rate as dependent variables. The FMOLS model revealed that exchange rate and population growth are positively significantly related to unemployment, interest and inflation rate were negatively related to unemployment but only interest rate was significant the short run relationship revealed that the co-efficient of the ECM(-1) is negative and statistically significant at 5% level indicating that the system corrects its previous period disequilibrium at the speed of 48.9% yearly. This study concludes that high exchange rate and population growth can lead to increase

in unemployment rate in Nigeria while the government should develop the industrial sector and non-oil section in order to generate employment and boost export in Nigeria.

Rao et al (2010) Investigated the impact of financial development and trade openness on GDP growth in Pakistan, by employing bound testing approach, the analysis demonstrates that in the long – run, trade openness and financial development both increases economic growth, while in the short run, the results indicate directional causality between trade openness (Top) to granger – caused economics growth (GDP) and M2 granger – caused GDP. It is manifest that economic growth is sensitive to changes both trade and financial liberalization policies. Therefore the government should realize effective macroeconomic policies along with momentous improvements in the structure and financial liberazation reforms.

Akutson et al(2018) examined the relationship and effect between unemployment and economic growth in Nigeria, the studies employed ARDL and parsimonies error correction model to analyses the relationship and effect respectively the finding shows that there is no long run relationship among the variable and the short run indicate that 1% increase in unemployment 20.6% of increase in output in the third period performance.

Olawunmi and Adedayo(2017) investigated the impact of unemployment on economic growth in Nigeria using vector autoregressive (VAR) approach it aim was to analyze the variations using difference method such as ADF, johansen co-integration test, VAR model, impulse response test and variance decomposition test when employed to analyze the data. The study recommends increase in government expenditure towards the enhancement of individual skill in order to reduce unemployment and inflation.

Sultan (2010) examined the short run and long run characteristic of gasoline in the transport sector Mauritius. The result indicates that the co-integration and the long run income and price elasticity of gasoline demand are estimated to be 0.77and -0.44 respectively and the short run income elasticity is 0.37 based on ARDL error correction model while the short run price elasticity is found - 0.27 the adjustment parameter is found to be 0.48 which implies that around 95% of the demand adjustment occurring after five period.

Malayaranjan (2018) examined the effect of unemployment on economic growth in india, both long run and short run relationship are analyzed through ARDL bound testing approach. The long run result revealed that unemployment rate increase economic growth by-1.07%. the study satisfied Okuns law. The policy implication is that private entrepreneurship should be encouraged and a micro small and median enterprise also plays an important rule for employment generation in India.

Ismaila (2016) examined the exchange rate depreciation and Nigeria economic growth during the SAP and post SAP period. he employed Johansen co-integration test and error correction model analysis, the result show that exchange rate has direct insignificant effect on Nigeria economic growth in both the long run and the short run, it implies that exchange rate depreciation during the SAP period has no effect on Nigeria economic performance. The study suggested that policy makers should not totally rely on exchange rate depreciation policy instrument to induce economic growth but should use it to complement other macro- economic policies such as monetary and fiscal policies.

Siyasanga and Hlalefang (2017) investigated the dynamic impact of broad money supply (M3) on economic growth (GDP) per capital in South Africa from 1980-2016 the study employed ARDL for co-integration and ECM to investigate the impact of M3 on GDP the findings revealed that there is negative and insignificant relationship between interest rate and economic growth both in short and long run.

Sumera&Amjad (2016) studied the interrelationship of unemployment, interest and inflation rate in Pakistan ARDL model was use to find integration among variable and VECM model utilized for analyzing short run dynamic of the model the result do not provide significant trade – off between unemployment rate and inflation- rate trade off exist in interest rate analysis over short run with inflation rate and unemployment rate. The empirical result show population growth and exchange rate have negative whereas external debt plays a positive role in determining unemployment rate in Pakistan. Money supply is revealed as major cause of inflation while exchange rate and import have contributed negatively in inflation the rate of interest has positive impact on domestic with to private sector where it is negatively related to exchange rate.

Ewubare and Ushie(2018) examined the link between unemployment rate and economic growth in Nigeria during 1990-2016 the data were sourced from world bank, world development indicator they employed descriptive statistic, ADF and ARDL in their analysis. ARDL revealed that the variables are co-integrated it was also revealed that in the short run male unemployment at lag 3 has significant negative impact on GDP growth rate. The long run estimate indicated that female unemployment is negatively related to GDP growth while youth unemployment impacted positively to GDP growth rate. The policy implication for rapid and sustained growth in Nigeria should prioritize employment generation by creating new employment opportunities.

Lee(2012) investigated the nature of the inflation hedging effectiveness of residential properties (four categories), common stock and time deposits for Hong Kong over the period of (1980-2011) he employed ARDL co-integration approach and classical regression approaches. The ARDL result suggest that all size of residential estate and common stock provide a better long term inflation hedge than time deposit but only the small and medium size properties provide a short term inflation hedge based on the regression results. The regression and co-integration results demonstrate that small and medium size real estate assets are the most effective investment vehicle for short and long term inflation hedge. It therefore implies that investors wishing to safeguard the value of purchasing power should reallocate their time deposit asset to the small and medium size residential property during the period of high inflation, during low inflation and deflation period, the results suggest the investor should shifts their investment away from all categories of residential properties to time deposits, the study concludes that the small and medium sizes properties provide a better short term and long term hedge against inflation than large, luxury apartments and financial assets in Hong Kong.

Iheanacho (2017) examined the trade liberalization in Nigeria as a developing economy from (1981-2014), he employed the ARDL / bound test approach. The result shows that the long and short run impacts of trade liberalization to economic growth suggests that the Nigeria economy is yet to harness the benefits of international trade, this is an indication that Nigeria has a lot to do in the exploit and harness a lot its potential. The findings offer some important policy implications, trade liberalization could be another avenue for economic diversification through foreign direct investment and by so doing there will be improved in gross capital formation and indeed economic growth.

Lacheheb & Siraq (2015) found that there was a significant relation between oil price increase and inflation. Where as a significant relation between oil price reduction and the inflation was absent, using ARDL approach. The study examines the relationship between oil price changes and inflation rate in Nigeria from 1970 – 2014.

Ebiringa and Anyaougu (2014) examined the relationship between exchange, inflation and interest rate in Nigeria from (1971-2010) using (ARDL) co-integration analysis, the paper established a significant short run and long run positive relationship between inflation and exchange rate. On the other hand, interest rate exhibited a negative relation though in significant. Concerted effort of all monetary authorities is therefore needed to ensure that periodic variation in inflation is kept at the barest minimum for stability in exchange rate require to be achieved.

Pallis (2006) focused his study on the relationship between inflation and unemployment in new European union member states. He obtained the data used in the analysis the annual data that covered the period from 1994 to 2005, which was taken from European commission 2004 referred to the new ten (10) European union (EU) member's states. The three variables used are the price deflation of GDP at market price, the nominal compensation per employee and then the total employment rate (%). In estimating are variables used in the study, nonlinear least square method of estimation and E – view techniques were used. The findings proved and concluded that the application of common policies across economy may be questionable because of the different effect, of these prices on unemployment and inflation.

Tung (2015) investigated the relationship between the remittance and economic growth in Vietnam during the period of 1996-2012, he applied an autoregressive distributed lag model ARDL bound testing approach to co-integration, error correction, model derived from the ARDL model was used to examine short run dynamic among variables. The finding revealed that remittance has significant positive effect on economic growth in both the short and long run.

Omeke and Ugwuanyi (2010) investigated the relationship between money inflation and output by employing granger causality test and co-integration analysis. The finding shows that co-integrating vector does not exist in the series used; money supply causes both output and inflation. The results indicate that since the price level varies and it causes by money supply, the monetary policy can contribute towards price stability in economics of Nigeria.

Aminu and Anono (2012) studied the impact of inflation on economic growth and development in Nigeria, OLS, ADF and granger causality test was employed and the result shows that there

is a positive correlation between inflation and economic growth in Nigeria and the coefficient of inflation is not statistically significant, but is consistence causation runs from GDP to inflation it money that inflation not granger cause GDP.

Innocent et al (2012) investigated the impact of economic growth and foreign direct investment in Nigeria they employed OLS and granger causality test and found that foreign direction investment (FDI) impacted positively and insignificance on economic growth proxy by GDP between FDI and GDP impacted causality result indicated bidirectional causality.

Maiga(2017) examined the impacted of interest rate of economic growth in Nigeria from 1999 to 2013. The results found that the interest rate has a slight impact on growth the finding shows that growth can be improved by lower the interest rate which will measure the investment. As a result of the study was foundout that Nigerian authorities should set interest rate policies that will boost the economic growth.

Ezirim et al (2012) examined the interdependencies between exchange rates and inflation rates behavior in Nigeria. Using autoregressive distributed lag techniques (ARDL) they found that exchange rates movements and inflation spiral are co-integration and short and long run also exist. This inflation targeting, policy aimed at exchange rates manipulation becomes a proper monetary action or vice versa.

Alex (2013) investigated the effect of factors affecting gross domestic product (GDP) in developing countries, the case of Tanzania from 1970 to 2009, he found that the most common GDP trend is a continuous acceleration and deceleration, he says GDP in same countries is confused and unbalanced with regular and deep unconditional GDP falls and booms. He says Tanzania GDP is influence by (government final expenditure and to selected final expenditure and exports.

Mitraand Pattnaik (2001) indicated that interest rates, inflation rates, and exchange rates are all highly correlated, by manipulating interest rates, central banks exert influence over both inflation and exchange rate and changing interest rates impact inflation and currency values.

Hatane and Stephanie (2015) in their studies, they found that there is a significant negative relationship of interest rates on GDP and a significant positive relationship of the exchange rates on the GDP, while inflation is not a significant influence on GDP. The study employed inflation, interest and exchange rate as independent variable and GDP as dependent variables.

Ifionu, and Ibe, (2015) investigated the impact of inflation, interest and real gross domestic product on stock prices of quoted companies on the Nigerian stock exchange (NSE) post SAP. Data covered a period from 1985-2012. Johansen multivariable co-integration test indicates the existence of the long run relationship among variables in the model; a granger causality test result indicates no causal relationship between the variables etc. the finding suggest that inflation was the most important variable influencing prices in Nigeria.

3. Research Method

Data was analyzed using various econometric techniques such as The ARDL co-integration technique which is used in determining the existence of long run relationship between series with different order of integration (Pesaran et al. 2001). The reparameterized result will gives

the short-run dynamics and long run relationship of the considered variables. Although ARDL co-integration technique does not require pre-testing for unit roots, to avoid ARDL model crash in the presence of integrated stochastic trend of $I(2)$, and VECM is employed for long run relationship between the variables, we are of the view the unit root test should be carried out to know the number of unit roots in the series under consideration. Augmented Dickey-Fuller (ADF) tests will be employed to test the presence of unit root in the series. The statistical package that is used in this work is EViews.

3.1. Test for Unit Root

In running the ARDL for the relationship among the variables in econometric analysis we must test for the existence of stationarity among the variables. We apply the Augmented Dickey - Fuller (ADF) Unit root test to check for the stationary state of the variables. Note that each of the variable must be tested for stationarity in the model before testing for the co-integration.

$$y_{1t} = \rho y_{1t-1} + u_t \quad (3.1)$$

Where ρ is constant, y_{1t-1} , u_t is lag of dependent variable and u_t is a white noise, Subtract

$$y_{1t-1} \quad \text{From both side we have. } y_{1t} - y_{1t-1} = \rho y_{1t-1} - y_{1t-1} + u_t$$

Note that $y_{1t} - y_{1t-1} = \Delta y_{1t}$

$$\Delta y_{1t} = (\rho - 1)y_{1t-1} + u_t \quad (3.2)$$

Equation 3.2 does not consider possible serial correlation of the error process we now replace AR (1) process with ARMA (p,q) which ensures serial correlation in the error term as

$$\Delta y_{1t} = \alpha + \beta t + (\rho - 1)y_{1t-1} + \sum_{j=0}^r \beta_j \Delta y_{1t-j} + u_t \quad (3.3)$$

Where β_t is deterministic trend, α is a constant, Δy_{1t-j} capture serial correlation, $\sum_{j=0}^r \beta_j$ is long run cumulative effect and β_j is lag weight, u_t is the error term.

Hypothesis of unit root is of the form $H_0: \alpha = 0, \beta = 0, \rho = 1$ against alternative $H_1: \alpha \neq 0, \beta \neq 0, \rho < 1$

If the null hypothesis is accepted, we assume that there is unit root and differencing the data before running the regression.

3.2 Tests for Co-integration

When the stochastic process is non-stationary, then the use of OLS can produce invalid estimates (Song and Wong, 2003). This may result the R-square to be much higher than the Durbin-Watson, t-ratio is also too high and leads to over rejection of the null hypothesis in the slope coefficient estimates and finally yields a result with no economic meaning at all. Granger and Newbold (1974) coined such estimates as “spurious regression”. To overcome such shortcoming requires the specified equation to transform into valid regression by taking the first difference of the variables. This method solves only the statistical problems but not the theoretical economic interpretability of the specification. By doing so, taking the first difference might lose significant information in the long run. Co-integration is a certain stationary linear combination of multiple $I(1)$ variables. The notion for co-integration arose out of concern about

spurious or nonsense regression in time series. The concept of Co-integration was developed by Engle and granger (1987)were the first to formalized the idea of Co-integration which is used to establish relationship among non-stationary series such that the relationship is reasonable, sensible and of statistical important, it also establishes a link between two non-stationary series by obtaining a linear combination which gives integration of order zero $I(0)$, it also specifies the Error Correction Model(ECM) which bring short and long run information

The econometric approach developed by Pesaran et al(2001) called Autoregressive Distributed lag (ARDL) model /bound test for co-integration is used, this technique have various advantage, for Example the ARDL can be apply to different orders of integration for the variables which the dependent variable should be $I(1)$, and other variables can be either $I(0)$ or $I(1)$ or both and robust when there is a single long run relationship between the variable in a small sample. The long-run relationship between the variable can be detected through the F-statistic (Wald test) when the F- statistics exceed the critical value band, this technique will crash in the presence of integrated stochastic trend of $I(2)$. Hence according to Sultan (2010) and Tung (2015) state that when the sample size from 30 to 80 is given the appropriate critical values for bound testing is Narayan (2005).

3.3. Determination of the Existence of the long Run Relationship of the Variables

As was said earlier the existence of the long run relationship that occurred between variables under investigation is tested by computing the bound F-statistics. The ARDL model specification between GDP, exchange, unemployment, and interest rate in equation

$$\Delta lny_t = a_o + \sum_{i=1}^k a_1 \Delta lny_{t-i} + \sum_{i=0}^p a_2 \Delta lnx_{1t-i} + \sum_{i=0}^q a_3 \Delta lnx_{2t-i} + \sum_{i=0}^r a_4 \Delta lnx_{3t-i} + \delta_1 lny_{t-1} + \delta_2 lnx_{1t-1} + \delta_3 lnx_{2t-1} + \delta_4 lnx_{3t-1} + ut \quad (3.4)$$

Where

a_o = intercept

a_s = short run relation

δ_s = long run relation

u_t = white noise

Δ = first difference operator.

k, p, q and r = Are the optimal lag lengths of $y, X1, X2$, and $X3$ respectively.

lny = Natural log of GDP

$lnx1$ = Natural log of Exchange Rate

$lnx2$ = Natural log of Unemployment Rate

$lnx3$ = Natural log of Interest Rate

The Akaike Information Criterion (AIC) was used for the lag length selection. ARDL bound testing for co-integration, F-statistics (Wald test) was used to examine the null hypothesis of no co-integration among the variables, and the estimated F-statistics value is compared with the two sets of critical values of the upper- and lower-bounds. If the estimated F-statistics value is higher than the upper- and lower-bound critical values, then the null hypothesis of no co-integration is rejected. If it lies between the two critical values, the conclusion is indecisive. If the F-statistics value is lower than the critical values, the null hypothesis of no co-integration

is accepted. After the bounds test confirms the co-integration between the variables, the long-run Equations (3.5) and short-run Equations (3.6) coefficients can be investigated.

$$\ln y_t = a_0 + \sum_{i=0}^k a_i \Delta \ln y_{t-i} + \sum_{i=0}^p a_1 \Delta \ln x_{1t-i} + \sum_{i=0}^q a_2 \Delta \ln x_{2t-i} + \sum_{i=0}^r a_3 \Delta \ln x_{3t-i} + u_{1t} \quad (3.5)$$

The next step is to obtain the short-run dynamic parameters by estimating an error correction model associated with the long-run estimates.

3.4. Estimation of short-run dynamics coefficients and Error correction Term

This involves the estimation of short-run dynamics by using the following model

$$\Delta \ln y_t = r + \sum_{i=0}^k a_0 \Delta \ln y_{t-i} + \sum_{i=0}^p a_1 \Delta \ln x_{1t-i} + \sum_{i=0}^q a_2 \Delta \ln x_{2t-i} + \sum_{i=0}^r a_3 \Delta \ln x_{3t-i} + g_0 ECT_{t-1} + u_{1t} \quad (3.6)$$

Where

g_0 is the coefficient of error correction term, which measures the speed of adjustment

ECT is the error correction term that measure short run dynamic.

Where ECT_{t-1} in equation (3.7) is given as

$$ECT_{t-1} = \ln y_{1t} - \hat{a}_0 - \sum_{i=1}^k \hat{a}_i \Delta \ln y_{1t-i} - \sum_{i=0}^p \hat{a}_1 \Delta \ln x_{1t-i} - \sum_{i=0}^q \hat{a}_2 \Delta \ln x_{2t-i} - \sum_{i=0}^r \hat{a}_3 \Delta \ln x_{3t-i} \quad (3.7)$$

The co-integration regressions consider only the long run properties of the model and do not consider short run dynamics but ECM measured the short run dynamic of the model of which the short run dynamics measure any dynamic adjustments between the first differences of the variables. However, to restore equilibrium between the variables, Error correction term is used to capture the speed of adjustment of variables.

The ECM shows how much of the disequilibrium is being corrected i.e any disequilibrium in the previous period is being adjusted. A positive and negative coefficient indicates divergence and convergence respectively, if the estimated $ECT=1$ it means 100% of adjustments takes place within the period and if $ECT=0.5$ it means 50% of adjustment take place in each period, if $ECT=0$ it shows that there is no adjustment and the long run relationship does not exist or make sense any more. Note the ECM as the speed of adjustment parameter is derived as the error term from the co-integration model (3.4) whose coefficients are obtained by normalizing the equation (3.4) respectively. In general the ECT_{t-1} should be negative and between 0 and 1 usually the ECT_{t-1} reports the speed of the adjustment to converge back to its long run equilibrium. (g_0) is the coefficient for measuring speed of adjustment in equation (3.6).

3.5. Johansen's test for co-integration

Johansen approach involves the following steps

1. All the variables have to be tested for order of integration.
2. Choose the appropriate lag length of the model.

3. In the multivariate system choosing the appropriate model regarding the deterministic Components.
4. Estimating the number of co-integrating vectors.

From (4) above and for the sake of this research there are two methods for determining the number of co-integrating vector where both of them involve estimation of matrix π .

In order to understand the procedures, if we have n characteristics roots given by $\pi_1 > \pi_2 > \pi_3 \dots > \pi_n$ if the variables under investigation does not have long run relationship then the rank of π is zero and all the characteristic roots above will be equal to zero and $(1 - \pi_i)$ will be equation 1 and $\ln(1) = 0$.

The T-statistics below test how many of the number of the characteristic roots are significantly different from zero.

The procedures to obtain the number of co-integration vectors are maximum engine value test and the trace test (Johansen & Juselius, 1990) where the maximum engine value statistic test the null hypothesis of r co-integrating relations and the alternative hypothesis of $r+1$ for $r=0,1,2,\dots, n-1$. With the T- statistics

$$\pi_{max}(r, r+1) = p \ln(1 - \hat{\pi}_{r+1}) \quad (3.8)$$

The trace statistic formula is computed as

$$\pi_{trace}(r) = -p \sum_{i=r+1}^n \ln(1 - \hat{\pi}_i) \quad (3.9)$$

Which examines the null hypothesis of r co-integrating relations against the alternative of n where n is the number of variable in the system for $r=0,1,2 \dots n-1$.

Where π is the maximum Eigen value, P = sample size, K = is the number of endogenous variables.

If there is divergence of results between these two test, it is advisable to rely on the evidence based on the π_{max} test because it is more reliable in small samples (Odhiambo, 2005; Mukhtar and Rasheed 2010).

3.6. Vector Error Correction Model (VECM)

VECM is VAR which has been designed for use with non-stationary data having co-integration relationship Mustofa et al (2017). In the other hand if co-integration has been detected between series we know that there exists long run equilibrium relationship between them so we apply VECM in order to evaluate the short run properties of the co-integrated series. In case of no co-integration VECM is no longer required and we directly proceed to granger causality test to establish causal links between variables. Again if a set of variables are found to have one or more co-integrating vectors then a suitable estimation technique is a VECM which adjusts to both short run changes in variables and deviation from equilibrium. According to Granger (1969) in his study on "Investigating causal relations by econometric models and cross-spectral methods" noted that; when time series variables are integrated at order (1), the best model for investigating a causal relationship among the variables is the Vector Error Correction Model (VECM).

This approach extent the single equation error correction model to a multivariate model, let assume that we have three variables x_1, x_2, x_3 which can be endogenous, that is

$$Y_t = [X_1, X_2, X_3] \quad (3.10)$$

$$Y_t = c + A_1 Y_{t-1} + A_2 Y_{t-2} + \dots + A_p Y_{t-p} + \mu_t \quad (3.11)$$

A VAR(p) can be reformulated in a vector error correction model as

$$\Delta Y_t = c + \sigma_1 Y_{t-1} + \sum_{i=1}^{p-1} A_i \Delta Y_{t-i} + \mu_t \quad (3.12)$$

Where:

Δ : Is the first difference operator, $\Delta Y_t = Y_t - Y_{t-1}$.

Y_{t-1} = Vector variables endogenous with first lag

μ_t = Vector residual

c = Vector intercept

δ_1 = Contains the long run information, hence δ_1 can be decompose as LB^t where L includes the speed of adjustment to equilibrium coefficient while B^t will be the long run matrix of coefficient.

A_1 = Matrix with order $k \times k$ of coefficient Endogenous of the i^{th} variables

4. Result and Discussion

4.1 Result

The data are also presented graphically as

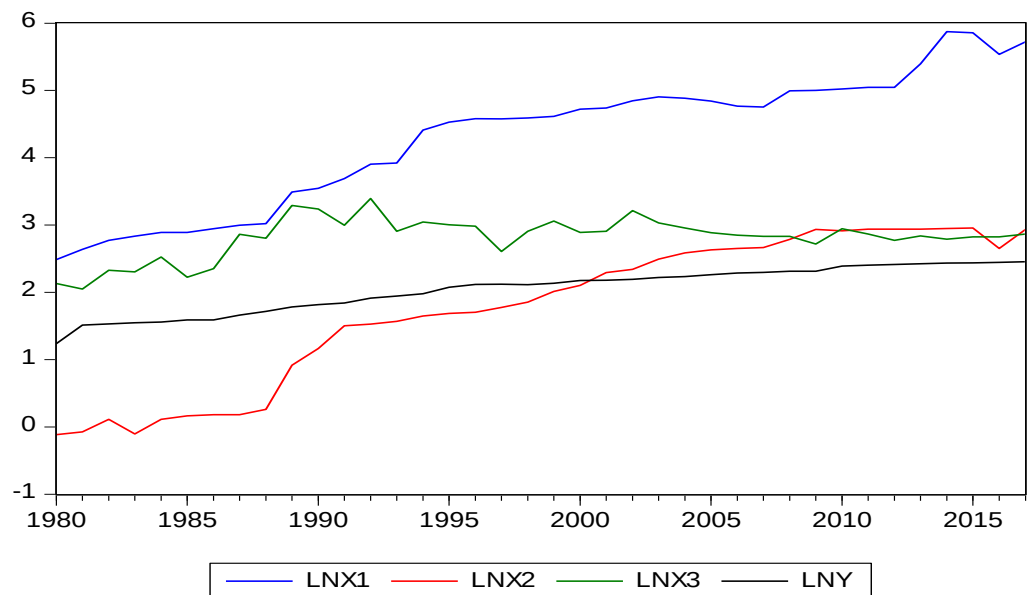


Fig 4.1: A Graph of Macro Economic Variables

The above graph is the graph of natural log transformation of the macro economic variables used in this study. The graph of Exchange and unemployment rate rise rapidly (positive growth), GDP increase slowly and stable while interest rate rise and fall (fluctuate)

Tabel 1. Descriptive Statistics

	LNx1	LNx2	LNx3	LNy
Mean	4.296647	1.757923	2.811595	2.043709
Median	4.603096	1.935601	2.863627	2.127686
Maximum	5.874256	2.954910	3.394508	2.453777
Minimum	2.484907	-0.116534	2.047693	1.238374
Std. Dev.	0.991118	1.092444	0.307299	0.335426
Skewness	-0.387528	-0.539351	-0.776786	-0.589503
Kurtosis	1.956598	1.847738	3.387195	2.210027
Jarque-Bera	2.674883	3.944568	4.058884	3.189013
Probability	0.262516	0.139139	0.131409	0.203009
Sum	163.2726	66.80107	106.8406	77.66095
Sum Sq. Dev.	36.34562	44.15705	3.494017	4.162885
Observations	38	38	38	38

Hypothesis of interest

Ho: Variables are normally distributed

H1: Variables are not normally distributed

Reject Ho if p-value<0.05

The above table 1 shows that the variables under study are normally distributed since their p-values>0.05.

Table 2: Test for Unit root using ADF.

Variables	ADF test statistics	p-value	Order of integration
Lnx1	-1.834518	0.6675	I(0)
D(lnx1)	-5.479964	0.0004	I(1)
Lnx2	-0.831883	0.9532	I(0)
D(lnx2)	-5.747158	0.0002	I(1)
Lnx3	-2.493229	0.3294	I(0)
D(lnx3)	-9.230705	0.0000	I(1)
Lny1	-3.539443	0.0497	I(0)
D(LNY1)	-11.67184	0.0000	I(1)

Table 4.2 above indicate natural log of x_1 , x_2 , and x_3 became stationary at first difference i.e. $I(1)$ except natural log of y_1 that is stationary at level and at first difference i.e. $I(0)$ and $I(1)$ at 5 percent level of significance which show the capability or flexibility of ARDL model which can handle different order of integration $I(0)$ or $I(1)$ or mixed. That is, the models follows an integrating $I(1)$ and $I(0)$ process.

4.2 Co-integration Test

After the ADF test for unit root, if all the variables are $I(1)$ the co-integration test is usually undertaken. The existence of the co-integration relationship implies that the variables share mutual stochastic trend and linked in common long run equilibrium. The test utilizes ARDL Model approach to co-integration Testing/Bound Testing Approach.

Table 3: Standard ARDL (1, 1, 2, 1) Model.

Dependent Variable: D(LNY)				
Method: Least Squares				
Date: 04/06/19 Time: 11:04				
Sample (adjusted): 1984 2017				
Included observations: 34 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.356608	0.267379	1.333719	0.1973
LNY(-1)	-0.326771	0.192450	-1.697952	0.1050
LN X_1 (-1)	0.013639	0.041086	0.331957	0.7434
LN X_2 (-1)	0.071050	0.036424	1.950639	0.0653
LN X_3 (-1)	0.056034	0.037958	1.476198	0.1555
D(LNY(-1))	0.152278	0.247433	0.615432	0.5452
D(LN X_1)	0.010735	0.036534	0.293830	0.7719
D(LN X_1 (-1))	0.004051	0.042861	0.094517	0.9256
D(LN X_2)	-0.001870	0.043537	-0.042951	0.9662
D(LN X_2 (-1))	-0.055553	0.038031	-1.460750	0.1596
D(LN X_2 (-2))	-0.064448	0.034333	-1.877174	0.0752
D(LN X_3)	0.069388	0.022267	3.116156	0.0054
D(LN X_3 (-1))	0.025634	0.025667	0.998722	0.3299
R-squared	0.596605	Mean dependent var		0.027541
Adjusted R-squared	0.354569	S.D. dependent var		0.025145
S.E. of regression	0.020201	Akaike info criterion		-4.679066
Sum squared resid	0.008162	Schwarz criterion		-4.089532
Log likelihood	90.20458	Hannan-Quinn criter.		-4.480706
F-statistic	2.464937	Durbin-Watson stat		2.204838
Prob(F-statistic)	0.035962			

Table 4: Bound Testing

Wald Test:

Equation: Untitled

Test Statistic	Value	Df	Probability
F-statistic	3.518164	(4, 20)	0.0249
Chi-square	14.07266	4	0.0071

Null Hypothesis: $C(2)=C(3)=C(4)=C(5)=0$

Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
C(2)	-0.326771	0.192450
C(3)	0.013639	0.041086
C(4)	0.071050	0.036424
C(5)	0.056034	0.037958

Restrictions are linear in coefficients.

To test whether the co-integration relations exist among the variables in equation (8), the bound testing for co-integration is carry out in table 4.4 above, the test is base on the hypothesis that H_0 : there is no co-integration if F-statistic(Wald test) is less than Perasan 2001 or Narayan 2005 critical values lower bound and H_1 : there is co-integration if F-statistic is grater than upper bound at 5% level of significance respectively, The result shows that F-calculated fall in between the critical values bound in both Perasan 2001 and Narayan 2005. Since F-calculated (3.518164) is in between the critical values bound, its means that the result isindecisive since we cannot conclude whether either of the hypothesis is rejected or accepted. Marashdeh and Shrestha (2010) posited that another means of establishing co-integration is by applying the ECM version of the ARDL model.

Table 5 below show the critical values for Perasan 2001 and Narayan 2005. Hence table 4.5 is a Standard ARDL (1, 1, 2, 1) model where AIC is used to obtain the optimal lag length.

Table 5:Perasan 2001 and Narayan 2005 critical values for bound testing

Critical values	Perasan (2001)		Narayan(2005)	
	Lower bound	Upper bound	Lower bound	Upper bound
1%	3.74	5.06	4.59	6.37
5%	2.86	4.01	3.28	4.63
10%	2.45	3.52	2.70	3.90

Table.6: Long Run Coefficients of ARDL(1,1,2,1)

Dependent variable (lny1)					
Variables	Coefficients	Std error	t-statistic	p-value	Remarks
Constant	1.0913	0.2905	3.7561	0.0012	Significant
Ln _{x1}	0.0417	0.1065	0.3921	0.6991	Not Significant
Ln _{x2}	0.2174	0.0653	3.3310	0.0033	Significant
Ln _{x3}	0.1715	0.1943	0.8823	0.3881	Not Significant

Table 6 above is the result of long run relationship between GDP, exchange, unemployment, and interest rates, the natural log of the variables indicate that there is long run positive non-significance impact between exchanges, interest rate with GDP, while Unemployment show positive significance impact with GDP

Table 7: Short Run Model of ARDL(1,1,2,1)

Dependent Variable: D(LNY1)

Method: Least Squares

Date: 04/06/19 Time: 11:46

Sample (adjusted): 1984 2017

Included observations: 34 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.019276	0.006916	2.787241	0.0105
D(LNY(-1))	0.414568	0.178337	2.324636	0.0293
D(LNX1)	0.051216	0.029262	1.750259	0.0934
D(LNX1(-1))	-0.047477	0.034003	-1.396266	0.1760
D(LNX2)	0.021202	0.032996	0.642578	0.5269
D(LNX2(-1))	-0.009429	0.030533	-0.308817	0.7602
D(LNX2(-2))	-0.038018	0.032397	-1.173499	0.2526
D(LNX3)	0.062577	0.019584	3.195243	0.0040
D(LNX3(-1))	0.055134	0.019958	2.762462	0.0111
ECM(-1)	-0.460739	0.150624	-3.058874	0.0056
R-squared	0.511494	Mean dependent var	0.027541	
Adjusted R-squared	0.320340	S.D. dependent var	0.025145	
S.E. of regression	0.020730	Akaike info criterion	-4.669448	
Sum squared resid	0.009884	Schwarz criterion	-4.215961	
Log likelihood	87.04590	Hannan-Quinn criter.	-4.516864	
F-statistic	2.675819	Durbin-Watson stat	2.165473	
Prob(F-statistic)	0.027415			

Table 7 above show -0.460739 as the Error Correction Coefficient (ECM), with the correct sign, it means that about 46% speed of adjustment after a shock take place and 46% of

disequilibria is been corrected from previous years in the current year, in the other hand after a shock 46% of disequilibria of previous years converge back to the long run equilibrium in the current year with p-value 0.0056 which is significant. Both previous GDP and interest rate have positive and highly significant impact on current GDP in the short run. However, the coefficients of exchange and unemployment are not significant at 5 percent level though with a negative sign.

Johansen Maximum Likelihood Co-integration Test Results

Table 8 Co-integration Test

Date: 08/17/19 Time: 14:40
Sample (adjusted): 1982 2017
Included observations: 36 after adjustments
Trend assumption: Linear deterministic trend
Series: LNX1 LNX2 LNX3 LNY
Lags interval (in first differences): 1 to 1

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.632630	66.01193	47.85613	0.0004
At most 1 *	0.404027	29.96208	29.79707	0.0479
At most 2	0.162715	11.32992	15.49471	0.1920
At most 3 *	0.128143	4.936673	3.841466	0.0263

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 *	0.632630	36.04985	27.58434	0.0032
At most 1	0.404027	18.63216	21.13162	0.1080
At most 2	0.162715	6.393249	14.26460	0.5633
At most 3 *	0.128143	4.936673	3.841466	0.0263

Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

Table 8 is the co-integration test between the variables which Trace Test indicate 2 co-integrating equation at 5% under at most 1 and 2 since p-value = 0.0479 and 0.0263 < 0.05 it shows that there exist a co-integration between the variables and therefore the Max-Eigen value

test indicates 1 co-integrating eqn(s) at 0.05 level under at most 3 which indicate long run relationship among the dependent and independent variables.

Since co-integration has been detected between series, we know that there exists a long run relationship between them, then, that will enable us to apply VECM in order to evaluate the long run and short run properties of co-integrated series.

Table 9 VAR Lag Order Selection Criteria

VAR Lag Order Selection Criteria

Endogenous variables: LNX1 LNX2 LNX3 LNY

Exogenous variables: C

Date: 08/17/19 Time: 14:50

Sample: 1980 2017

Included observations: 35

Lag	LogL	LR	FPE	AIC	SC	HQ
0	16.29982	NA	5.82e-06	-0.702847	-0.525093	-0.641486
1	151.5137	231.7952	6.45e-09	-7.515068	-6.626298*	-7.208265*
2	170.4088	28.07267*	5.69e-09*	-7.680501*	-6.080714	-7.128254
3	183.4465	16.39031	7.46e-09	-7.511229	-5.200426	-6.713540

* 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

Table 9 is the VAR Lag Order Selection Criteria, in table 4.9 the minimum values from each of the information criteria are given with star (*) show the Lag Optimal at Lag 2. But the lag of 1 (2-1) was utilized from the Akaike Information Criteria (AIC). This means the VECM (p) model used should be VECM (1).

Since their exist a long run relationship among the variables, then we now estimate the long run effect between independent variables on dependent variable.

Table 10 Long Run Estimate (VECM)

Dependent variable $\ln(y1)$

Variable	Coefficient	Std	t-calculate	Remark
Lnx1	0.21555	0.04318	4.99256	sig.
Lnx2	0.15940	0.03473	4.58958	sig.
Lnx3	-0.29945	0.05350	-5.59734	sig.
C	1.693462			

In the table 10 above the coefficient of Lnx1(exchange rate), Lnx2 (unemployment rate), are positive and significant related to Lny (GDP), except Lnx3(interest rate) which is negatively and significant related to Lny1 in the long run. This implies that a unit increase in Lnx1 and Lnx2 will result to an increase on Lny1. While unit increase in Lnx3 will lead to decrease on Lny1.

Table 11 Short Run Estimate (VECM)

Dependent Variable: D(LNY1)

Method: Least Squares

Date: 08/17/19 Time: 15:02

Sample (adjusted): 1982 2017

Included observations: 35 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.025763	0.006453	3.992570	0.0004
D(LNX1(-1))	-0.000410	0.035173	-0.011646	0.9908
D(LNX2(-1))	0.021224	0.034719	0.611312	0.5458
D(LNX3(-1))	0.021318	0.020632	1.033284	0.3100
ECM(-1)	-0.118249	0.126351	-0.935875	0.3571
R-squared	0.113519	Mean dependent var		0.027170
Adjusted R-squared	-0.008754	S.D. dependent var		0.024855
S.E. of regression	0.024964	Akaike info criterion		-4.407736
Sum squared resid	0.018072	Schwarz criterion		-4.183272
Log likelihood	79.93152	Hannan-Quinn criter.		-4.331188
F-statistic	0.928404	Durbin-Watson stat		1.651645
Prob(F-statistic)	0.461106			

Table 11 above indicates ECM coefficients. The ECM (-1) is the coefficient of the error correction mechanism which has a correct sign and the p-value is not significance (0.3571). Furthermore, the coefficient of the error correction mechanism revealed that about 11.8% or approximately 12% speed of adjustment take place in the system to come back to the equilibrium point which is very slow. It is also revealed that none of the variable is significantly related to GDP in a short run.

4.2 Discussion of Findings

Descriptive statistics in Table 4.1 shows the average, minimum and maximum values of log exchange rate, log of unemployment rate, log of interest rate and log of GDP). Jarque-Bera statistic of the variables and their p-values indicate that variables are normally distributed at 5% since null hypothesis of normality is accepted. This agrees with the work of Adenomon et al (2018) and Akutson et al (2018). The implication of this is that the ARDL and VECM models are appropriate because these models assume normal distribution.

Unit Root Test in Table 4.2 was done by Augmented Dickey Fuller (ADF) which can also use to capture serial correlation in the error term, and it revealed that all the variables are stationary at first difference i.e integrated at order 1, I(1) this is in lines with the work of Adenomon et al (2019) and Rao et al (2010).

ARDL/Bound test for co-integration in Table 4.4 the test indicates that Narayan (2005) and Paseran et al (2001) critical values shows that F-statistics 3.518164 lies in between the (lower= 3.28, upper 4.63) at 5% level. Hence we cannot conclude if there is long run relationship between the variables.

ARDL long run estimate in Table 4.6 revealed the effect of Unemployment rate, Exchange rate and Interest rate on GDP, the estimation result revealed that unit increase in unemployment, GDP will increase by 0.2% and is statistically significant the result is in line with the finding of Akutson et al (2018), Ezi (2014) but contrary with Malaranjar (2018) who found that an increase in unemployment lead to decrease in GDP. The implication of this result is that increase in unemployment in Nigeria can lead to increase in GDP. The ARDL long run estimate also revealed that unit increase in exchange rate will insignificant increase GDP by 0.042%. The estimation concurred with the finding by Ismaila (2016) but Utile (2018) disagree with this finding. Exchange rate has a tendency to improve the Nigeria economy performance. It was also revealed that unit increase in interest rate would insignificant increase GDP by 0.172%, this is also contrary to Udoka (2012) and Utile (2018).

Short run and ECM coefficient of ARDL (1, 1, 2, 1) model to understand the short run dynamic among the variables in Table 4.7 the ECM model was employed. The fitted ECM model revealed a short run impact from exchange rate, unemployment rate, and interest rate in Nigeria. While the ECM (-1) coefficient is -0.460739 which has the correct sign and significant, this means that the system to converge to equilibrium, it will take a speed of 46% annually. ECM (-1) also indicate that long run relationship exist since we cannot conclude from Standard ARDL(1,1,2,1) that long run relationship exist among the macroeconomic variables. The coefficient of exchange rate, unemployment rate are negative and statistically insignificant hence the unit increase in exchange rate will lead to 0.047% decrease in GDP, and unit increase in unemployment will lead to 0.009% decrease in GDP this result is consistent to the findings by Pierdzioch et al (2009), and Sibusiso (2018) and is contrary to Akusto (2018). The implication is that both exchange rate and unemployment rate does not influence Nigeria GDP.

It was also revealed that interest rate is positively and statistically significantly related to GDP and unit increase in interest rate lead to 0.06% increase in GDP, this result is contrary to Siyasanga and Hlalefang (2017).

Diagnostic Test the test revealed that there was no presence of multicollinearity, serial correlation and Heteroskedasticity the residual is normally distributed and the model is good for forecasting.

The Johansson co-integration test in Table 4.8 confirms the existence of long run relationship among the variables under study. According to economics theory which state that most macroeconomic variable exhibits long run relationship Adenomon et al (2018).

VECM long run estimate in Table 4.10 indicated that exchange, unemployment and interest rate are statistically significance at 5%. The result on the effect of interest rate on GDP revealed that there is significant negative effect of interest rate on GDP and it also shows that unit increase in interest rate lead to 0.30% decrease on GDP. This is in line with work of Hatane and Stephanie (2015). The implication of this is that an uncontrolled or higher interest rate decline

GDP in Nigeria. If the interest rates decrease then the investment increase Banerjee and Adhikary (2009) therefore economic growth through increased production will be reflected in GDP. VECM also revealed that there is positive and statistically significant relationship between exchange rate and GDP it also indicates that unit increase in exchange rate will lead to an increase in GDP by 0.216%. This is in line with the work of Hatane and Stephanie (2015), Brigitta (2015), and Olawunmi (2017). The implication is this is that economic growth usually caused by high levels of investment and higher export. VECM also revealed that there is positive and statistically significant relationship between unemployment rate and GDP it also revealed that unit increase in unemployment rate will lead to 0.159% increase in GDP. This is in line with the work of Olawunmi (2017) & Asoluka and Okezie (2011).

Short Run Estimate (VECM) in Table 4.11 the result revealed that exchange rate is insignificant and negative related to GDP with p-values 0.9908, this indicate that unit increase in exchange rate will lead to 0.0040% decrease in GDP this disagree with the work of Ismaila (2016). The test also revealed that unemployment is positive and insignificant related to GDP with p-value (0.5458) the result also revealed that unit increase in unemployment rate lead to 0.021% increase in GDP. This result is contrary with the work of Malayaranjan (2018). It was also revealed that unit increase in interest rate will lead to 0.021 increases on GDP. This result is contrary with the work of Siyasanga and Hlalefang (2017) and is positive and insignificant (0.3100) related to interest rate. Hence ECM (-1) has a correct sign and statistically not significant (p-value=0.3571) with 11.8% speed of adjustment take place in the system to come back to the equilibrium point which is very slow. According to Gujarati (2004) stated that when ECM coefficient has a correct sign and the p-value is insignificant then this implies that the results does not support the existence of a long run between the variables.

VEC Diagnostic Test revealed Variance inflation factor (VIF) < 10 which indicate that multicollinearity does not exist, VEC residual Jarque-Bera test for normality indicate P-value (0.0082) which is less than 0.05 this means that the error term is not normally distributed. VEC residual serial correlation LM test indicate that no serial correlation in the error term since P-value is > 0.05. VEC residual Heteroskedasticity test indicate that Heteroskedasticity with P-value 0.0988 > 0.05 indicates no presence of Heteroskedasticity in the error term. CUSUM at 5% significance indicate that model is stable for forecasting.

5. Conclusion

This study revealed that unemployment Rate was positively and statistically significantly related to Gross Domestic Product (GDP) while Exchange Rate and interest rate were positively and statistically insignificantly related to Gross Domestic Product (GDP) when ARDL model was used. While unemployment Rate and Exchange Rate were positive and significant related to gross domestic product (GDP) and interest rate was negative and significant related to gross domestic product (GDP) when VECM model was used.

This study contributed to the body of the knowledge as the researcher employed two models to test for co-integration between the variables as well as to investigate the long run and short run effect among the variables under study, it was revealed that only unemployment is positive and

significant related to GDP on the two models and only interest rate was negative significance in short run using ARDL.

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