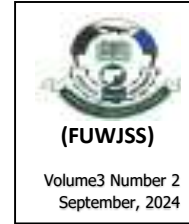


ANALYZING INFLATION AND UNEMPLOYMENT RATES ON ECONOMIC GROWTH IN NIGERIA USING A NON-LINEAR ARDL APPROACH



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Abstract

Economic growth depends on the magnitude and signs of macroeconomic variables like interest rate, inflation and unemployment rates. While many studies have investigated the linear relationship between economic growth and its determinants, only few have assessed non-linear relationship between economic growth and its determinants. It is in view that this study investigated the non-linear responses of Nigerian economic growth to positive and negative changes in inflation and unemployment rates. The study adopted non-linear unit root test and non-linear ARDL as the estimation methods. The non-linear bound test shows that inflation and unemployment are cointegrated with economic growth in the long-run. The study also found that increase in inflation rates leads to increase in economic growth at statistical significance of 5%, and that decrease in inflation rate also leads to increase in economic growth. The study concludes that both the positive and negative changes in unemployment rates are positively associated with Nigerian economic growth at 5% statistical significance. The study recommends that policymakers are to tighten and consolidate the inflation-targeting programmes of the Central Bank of Nigeria and employment generation programmes of the government to achieve inflationary and unemployment rates that are harmless to the economy.

Keywords: Inflation rate, unemployment rate, nonlinear unit root, nonlinear ARDL.

Introduction

Theoretically, several macroeconomic factors have been documented as the major determinants of economic growth. Countries that are categorized as economically developed have low and moderate inflation, stable exchange rate, low rate of unemployment and low poverty level, while underdeveloped economies are characterized by high inflation rates, high and volatile exchange rates, high rates of unemployment and high poverty level (Jhingan, 2014). The overall effects of relationships among the variables on the economy and people's standard of living necessitate much research to know the direction, influence and consequences of such relationships. Specifically, the effect and consequences of inflation and unemployment rate on economic growth have been widely investigated. The increasing research on the subject is borne out of the instability of inflation and unemployment, and their adverse effect on economic growth. Several authors like Phiri (2014); Khoza, Thebe and Phiri (2016); Mazorodze and Siddiq (2018); Hongo, Li, Ssali, Nyaranga, Musamba and Lusaka (2019); Yemba, Kitenge and Woodburne (2020) have shown the relationship between inflation rates, unemployment rates and economic growth.

In recent times, the possibility of a nonlinear relationship among macroeconomic variables and its consequence on the adjustment process towards the long-run equilibrium has gained a center stage in the Macroeconomics research. The reason is that if variables are nonlinearly related, but are assumed to be linearly related, policy formulation and implementation on such will be misleading and counterintuitive. Several researchers like Marinkov and Geldenhuys (2007); Anoruo (2011); Bildirici and Turkmen (2015) and Phiri (2014) have pioneered empirical studies on the asymmetry relationship among macroeconomic variables. Shin, Yu and Greenwood-Nimmo (2013) showed that unemployment is asymmetrically related to economic growth in USA, Canada and Japan. Hongo et al (2019) demonstrated the presence of an asymmetry linkage between inflation, unemployment, output and social wellbeing. In Nigeria, studies of such nature are rare; most of the existing studies are of linearity relationships. Studies like Omitogun and Longe (2017); Idris (2021) and Ademola and Badiru (2016) have investigated and showed that inflation, unemployment and economic growth are linearly related in Nigeria. The current study however uniquely investigated the asymmetry effects of changes in inflation rates and unemployment rates on Nigerian Economic growth. It is meant to be a pioneering work on the responses

of economic growth to nonlinear changes in inflation rates and unemployment rates.

Inflation and Unemployment Rates across Countries of the World

In the extant literature, the presence of nonlinear relationships among macroeconomic variables has gained higher momentum among researchers. It has therefore emphasized the need to investigate the nature and presence of asymmetry relationships among macroeconomic variables. The justification is that forecasts and predictions made based on the linear relationship may be misleading if a nonlinear relationship exists among the investigated variables. The most relevant studies like Sere and Tchereni (2020); Neifar (2020); Mazorodze and Siddiq (2018); Phiri (2014); Shin, Yu and Greenwood-Nimmo (2013) and Marinkov and Geldenhuys (2007) are reviewed in this study.

Using quarterly data spanning from 1994Q1 to 2019Q4, Sere and Tchereni (2020) explored the nonlinear link between economic growth and unemployment in South Africa. The study found that both positive and negative unemployment are strongly and negatively related to economic growth in the short run. The study suggested that South Africa's leaders and policymakers use expansionary measures to encourage faster economic growth and lower unemployment. In a related study, Neifar (2020) applied static and dynamic linear models to test the linkage between cyclical unemployment and cyclical growth rate in MENA Zone (Tunisia, Egypt, Morocco, Lebanon, Jordan, and Oman) using a quarterly dataset covering the period 2000:1- 2014:4. The empirical findings showed that the relationship between the unemployment rate and economic growth was inverse (except for Oman). The study did not find long-run trade-off between output and unemployment when static and dynamic linear models were adopted. However, a long-run asymmetric link between unemployment and economic growth was discovered when the NARDL gap definition was applied. The study discovered that increased output can lead to more employment.

Using quarterly data covering the period of 1994Q1 to 2017Q4, Mazorodze and Siddiq (2018) examined the asymmetric effects of cyclical output on South Africa's unemployment rate. Applying Non-Linear Autoregressive Distributed Lag (NARDL) model, the study found evidence of both a long-term and short-term asymmetry in the association. Also, the study found a long-term asymmetric reaction of the labor market for every 10% change in the size of the economy. Workers

were lost during contractions at a higher rate (10.3%) than they were hired during recoveries (8%). The findings, which imply that businesses were more risk-averse to transient recoveries, are particularly clear during the post-2009 Global Crisis. The study concluded that the sluggish reaction of the labor market during expansions may mean that economic recovery alone may not be sufficient to alleviate South Africa's unemployment issue.

Phiri (2014) investigated the existence of asymmetric co-integration adjustment in South Africa between the years 2000 and 2013 using a Momentum Threshold Autoregressive (MTAR) econometric framework. According to the study, there is an inverse relationship between economic growth and unemployment, and that long-term unemployment generally leads to economic growth. Given the results, the authors hypothesized that rising economic growth might not result in falling unemployment, but that falling unemployment might result in rising production growth. Instead of relying on greater economic growth as a strategy to lower unemployment rates, the authors advocated placing more emphasis on improving labor market reforms to promote economic growth in South Africa. In a related study, Shin, Yu, and Greenwood-Nimmo (2013) used Nonlinear Autoregressive Distributed Lag (NARDL) to model the effect of positive and negative partial of unemployment on aggregate output in US, Canada and Japan. Strong evidence of long-run asymmetry was identified in the analysis, supporting the growing body of data suggesting unemployment is more susceptible to busts than booms. It was discovered that dynamic asymmetries, particularly in Canada, show that businesses hire quickly and slowly.

Adopting different Detrending techniques, Marinkov and Geldenhuys (2007) investigated the relationship between changes in output and unemployment in South Africa from 1970 to 2005. The study examined whether, in the presence of structural discontinuities in the variables, the relationship between output and unemployment adheres to the inverse relationship described by Okun's law. Regardless of the detrending methods used, the study showed evidence of both symmetry and asymmetry between output and unemployment. The authors concluded that a more expansionary macroeconomic policy may only have a limited effect on South Africa's overall unemployment rate because cyclical unemployment only makes up a small portion of total unemployment rates in the country.

A number of studies have also investigated the asymmetry relationship between inflation and economic growth, the most related

ones like Ngoc (2020), Karahan and Çolak (2020), Hossain, Acet, Ahmed and Majumder (2021) and Hongo, Li, Ssali, Nyaranga, Musamba and Lusaka (2019), were reviewed in this study. Using the Nonlinear Autoregressive Distributed Lag method, Ngoc (2020) examined the asymmetric impact of inflation and money supply on economic development in Vietnam from 1990 to 2017. The study discovered that the influence of money supply has a favorable impact on the economy's growth both in the short run and the long run, and that the impacts of inflation on economic growth are negative and asymmetric in the long run. The author advised policymakers to design monetary policies and manage inflation in a way that will make it easier to achieve sustainable economic development.

Using NARDL estimation technique, Karahan and Olak (2020) investigated the nonlinear link between inflation and economic development in Turkey over the years 2003 to 2017. The study found that long-term inflation and economic growth have a nonlinearly negative relationship. The study concluded that price stability is a fundamental condition for ensuring Turkey's long-term economic progress. The authors also recommended strengthening Turkey's anti-inflationary measures rather than sacrificing by tolerating high inflation as indicated by the Keynesian strategy to boost economic growth. In a related study, Hossain et al. (2021) examined the relationship between Bangladesh's inflation and economic development during the period from 1986 to 2017. Using NARDL method, the study discovered an unbalanced association between inflation rates and GDP growth. Both in the long run and the short run, it discovered a strong and positive nexus with statistically significant findings. The study also discovered that an increase in inflation had a greater impact on GDP growth than a decrease. Additionally, the short-term growth rate is significantly and favourably impacted by the improvement in inflation rates. However, a negative shift in inflation's impact is statistically insignificant. The study suggested that decision-makers and development partners use the findings to establish policies and to attain a controlled inflation rate as a key goal.

In Kenya, Hongo et al. (2019) investigated the asymmetric responses of unemployment to business cycle output, and the nonlinear effects of unemployment, inflation, and output on social wellbeing. The authors used NARDL as their estimation method and the output gap as their trade-off regulator. The study found that output per capita gap is crucial in controlling the inflation-unemployment trade-off and negative consequences on social wellbeing, with unemployment having more

expensive repercussions than inflation. Secondly, it was discovered that long-term shocks to cyclical output trade off with unemployment. Also, a long-term inverse relationship between unemployment and fiscal policy was also discovered. The study concluded that in order to improve social wellbeing, strategies to reduce unemployment must be undertaken. The study also emphasized that implementation of workable policies to reduce unemployment is necessary for improving social wellbeing. The study therefore recommended that workable labor supply and fiscal side policies be adopted to reduce labor market inequalities and incarcerate persistent unemployment.

Research Methodology

The study uses time-series data spanning from 1985 to 2022. The growth rate of Nominal GDP, sourced from the Central Bank of Nigeria Bulletin was used as a proxy of Nigerian economic growth. Unemployment rate, sourced from the National Bureau of Statistics and changes in inflation rate, sourced from World Bank Database were used as independent variables.

Model Specification

The study uses NARDL, propounded by Shin et al. (2014), to investigate responses of Nigerian economic growth to nonlinear changes in unemployment and inflation rates. The basic linear regression model of the relationship is presented below:

$$ECOGR_t = b_0 + b_1 UNEMP_t + b_2 INFL_t + \mu_t \quad (1)$$

Where ECOGR denotes economic growth (Represented by GDP per capita growth), UNEMP denotes unemployment rate and INFL denotes a change in inflation rates. The NARD specification of the relationship can be specified below:

$$ECOGR_t = b_0 + b_1 (UNEMP^{+} + UNEMP^{-}) + b_2 (INFL^{+} + INFL^{-}) + \mu_t \quad (2)$$

In equation (2), the independent variables (unemployment and inflation rates) are decomposed into negative and positive components. Equations 3, 4, 5 and 6 show the partial sum of positive and negative changes in unemployment and inflation rates:

$$UNEMP^{+} = \sum_{i=1}^t \Delta UNEMP_i^{+} = \sum_{i=1}^t \max (\Delta UNEMP_i, 0) \quad (3)$$

$$UNEMP^- = \sum_{i=1}^t \Delta UNEMP_i^- = \sum_{i=1}^t \min (\Delta UNEMP_i, 0) \quad (4)$$

$$INFL^+ = \sum_{i=1}^t \Delta INFL_i^+ = \sum_{i=1}^t \max (\Delta INFL_i, 0) \quad (5)$$

$$INFL^- = \sum_{i=1}^t \Delta INFL_i^- = \sum_{i=1}^t \min (\Delta INFL_i, 0) \quad (6)$$

Asymmetric model of the above equations is specified in equation 7 below:

$$\begin{aligned} \Delta ECOGR_t = & \theta + \sum_{k=1}^{P1} \theta_k \Delta ECOGR_{t-k} + \sum_{k=1}^{P2} \theta_k \Delta UNEMP_{t-k}^+ + \\ & \sum_{k=1}^{P3} \theta_k \Delta UNEMP_{t-k}^- + \\ & + \sum_{k=1}^{P4} \theta_k \Delta INFL_{t-k}^+ + \sum_{k=1}^{P5} \theta_k \Delta INFL_{t-k}^- + \omega_1 ECOGR_{t-1} + \\ & \omega_2 UNEMP_{t-1}^+ \\ & + \omega_3 UNEMP_{t-1}^- + \omega_4 INFL_{t-1}^+ + \omega_5 INFL_{t-1}^- + \mu_t \end{aligned} \quad (7)$$

Equation 7 represents a NARDL equation that was used to examine nonlinear link between unemployment and Nigerian economic growth in this study.

Results and Discussions

The descriptive statistics of the data are contained in table 1 below. The table contains the mean, minimum, maximum and Jarque-Bera values of the variables used in the model

Table 1: Descriptive Statistics of the Variables

	GDP Growth	Unemployment Rate	Inflation Rate
Mean	8.7302	12.3761	19.3053
Minimum Values	5.0937	1.8000	5.3880
Maximum Values	11.7577	27.4000	72.8355
Jarque-Bera Probability	3.0021	3.4232	22.1470
	0.2229	0.1806	0.0002

Source: Authors' Computation (2023)

As shown in Table 1, the average growth rate of GDP is 8.73%, a minimum value of 5.09%, and a maximum value of 11.78%. As for the unemployment rate, the table shows an average rate of 12.37, a minimum of 1.8 and a maximum of 27 per cent. As for changes in the inflation rate, there is an average change of 19.31 per cent, a minimum change of 5.39 and a maximum change of 72.84 per cent. The table equally shows that both GDP growth and Unemployment are normally distributed Jargue-Bera is greater than the five per cent significance level, while an annual change in inflation rate is not normally distributed because the probability of the Jargue-Bera is less than the five per cent significance level. To be able to decide on the best cointegration method to be adopted, the unit root test conducted is presented in table 2.

Table 2: Unit Root Tests of the Variables

BreakPoint Unit Root Test (Innovation Outlier)					
Variables	Level		First Difference		Order of Integration
	Intercept	Intercept and Trend	Intercept	Intercept and Trend	
GDPGR	0.3345	-3.1944	-4.7335**	-5.3807***	1
INFL	-6.6910***	-7.0373***	-7.5502***	-6.9193***	0
UNEMPL	-2.0851	-4.4068	-6.0062***	-5.8717***	1
Break Point Unit Root Test (Additive Outlier)					
GDPGR	-4.1864	-4.0009	-4.7335**	-4.8631**	1
INFL	-7.5542***	-7.8068***	12.8454***	-11.0629***	0
UNEMPL	-2.2227	-4.7543*	-5.1513***	-5.8812***	1

Note: *, ** & *** represent 1%, 5% & 10% levels of statistical significance respectively.

A unit root with structure break is applied in checking the level of stationarity of the model. This is necessary for the current model where the nonlinear cointegration method is adopted. It will reveal any hidden characteristics of the data that may be hidden in linear unit root tests like Augmented Dickey-Fuller and Philip Perron tests. Particularly, breakpoint unit root with innovation and additive outlier that are available in EViews were used. In both cases, table 2 shows that the model has a combination of I(1) and I(0) variables and that the model does not have an I(2) variable. With these results, Nonlinear ARDL Bound Test by Peasan and Peason (1997) was applied to check whether or not long-run Cointegration is present in the model. The result is presented in table 3.

Table 3: Nonlinear ARDL Bound Test Procedure

Dependent Variable	Function					F-statistics
GDP Growth	GDP Growth $f(UNEMP^+UNEMP^-INFL,+ INFL^-)$					= 15.0347
Critical Values	1%		5%		10%	
	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)
	3.29	4.37	2.56	3.49	2.2	3.09

Source: Authors' Computation (2023)

As shown in Table 3, the F-statistics of 15.03 is greater than 3.49. It implies that we cannot reject the null hypothesis, and therefore conclude that there is a long-run Cointegration in the model. It implies that economic growth, unemployment rate and changes in inflation rate move together in the long run.

Consequently, short and long-run estimations of NARDL were conducted. Table 4 also contains the short-run results, and diagnostics tests that are used to ascertain the stability and reliability of the model. The adjusted R^2 shows that about 99% of the variation in the economic growth is explained by unemployment and changes in inflation rates. The Jarque-Bera statistics and its probabilities show that the model is normally fitted, this is because its probability is greater than 5% statistical significance. Also, the test of serial correlation shows an absence of autocorrelation in the residual, while heteroscedasticity shows that model the model has constant variance over time. Ramsey Reset Test also shows that the model is well specified. This is because the probability value of the test is greater than the 5% statistical significance level. The table also shows that positive inflation and its first lag have a positive impact on economic growth, and the first lags of negative inflation have a positive impact on economic growth. The table also shows that positive unemployment does not have a significant impact on economic growth while negative unemployment has a positive impact on economic growth.

Table 4: Nonlinear ARDL Estimation Results

Variables	Coefficient	Standard Error	T-statistics
GDPGR (-1)	0.2562	0.1811	1.4147
GDPGR (-2)	0.6203**	0.1860	3.3358
INF^+	0.0042**	0.0014	3.008
INF^+ (-1)	0.0048**	0.0014	3.5224
INF^-	-0.0030	0.0009	-3.3522
INF^- (-1)	0.0026**	0.0010	2.6169

$INF^- (-2)$	0.0056**	0.0011	4.8679
$UNEMP^+$	-0.0218*	0.0109	-1.9878
$UNEMP^+ (-1)$	-0.0012	0.0128	-0.0964
$UNEMP^-$	0.0828**	0.0161	5.1325
$UNEMP^- (-1)$	0.0120	0.0150	-0.8030
Constant	0.9251**	0.2001	4.6233
Adjusted R^2		0.99	
F-statistics		5718.545(0.000)	
X^2 Norm		1.6871(0.4302)	
Ramsey Test		0.3201(0.7326)	
X^2 Het		0.4864(0.9997)	
X^2 Sec		0.8137(0.5551)	

Note: *, ** and *** represent 10%, 5% and 1% levels of statistical significance respectively. X^2 Norm represents Normality Test, X^2 Het represents Breusch- Pagan Heteroscedasticity, X^2 Sec represents Breusch-Godfrey Serial Correlation Test.

Table 5: Long-run Relationship

Variables	Coefficient	Standard Error	T-statistics
$UNEMP^+$	0.1583**	0.0359	4.4032
$UNEMP^-$	0.5291**	0.1988	2.6616
$INFL^+$	0.0725**	0.0238	3.0464
$INFL^-$	0.0060	0.0101	0.6142
C	7.4933	1.4178	5.2852

Note: *, ** and *** represent 10%, 5% and 1% levels of statistical significance respectively.

Table 5 shows that positive and negative changes in the unemployment rate are positively and significantly related to economic growth. This implies that an increase in the unemployment rate leads to an increase in economic growth, and a decrease in the unemployment rate will also lead to a decrease in economic growth. A 1% increase in the unemployment rate leads to a 16% increase in economic growth, while a 1% decrease in unemployment leads to a 53% decrease in economic growth. The finding is contrary to that of Sere and Tchereni (2020), Shin, Yu and Greenwood-Nimmo (2013), Mazorodze and Siddiq (2018) and Phiri (2014).

The table also shows that positive change in inflation rates has a positive and significant association with Nigerian economic growth at a 5% level of statistical significance, while negative changes in inflation rates do not have a statistically significant relationship with Nigerian economic growth. The result implies that increase in inflation rate leads

to increases in Nigerian economic growth, and that decrease in inflation rate does not have significant effect on Nigeria economic growth. The finding is in line with Hossain et al (2021) This implies that increases in changes in the inflation rate will lead to an increase in Nigerian economic growth by 7%. The positive findings between inflation and Nigerian economic growth conforms with the apriori expectation and the reality of the Nigerian experience, where continuous increase in inflationary rate is associated with some level of economic growth. However, the non-significance of the relationship between decrease in inflation and Nigerian economic growth could be because inflation rate in Nigeria has always maintained a persistent upward trend. The attempt to investigate the negative trend is therefore insignificant because it is practically non-existent.

To ascertain that the residuals of the model are structurally stable and free from estimation errors, some post-estimation tests like CUSUM and CUSUM square tests were conducted. The tests require that the blue lines of the graphs are in-between the lower and upper bands of the graphs (Browns, Durbin and Evans, 1975). As presented in figures 1 and 2, the model is well-behaved, the blue lines are in-between the red lines of the CUSUM and CUSUM square. It, therefore, implies that the parameters of the model are structurally stable over time and the estimates are useful for forecasting and decision-making.

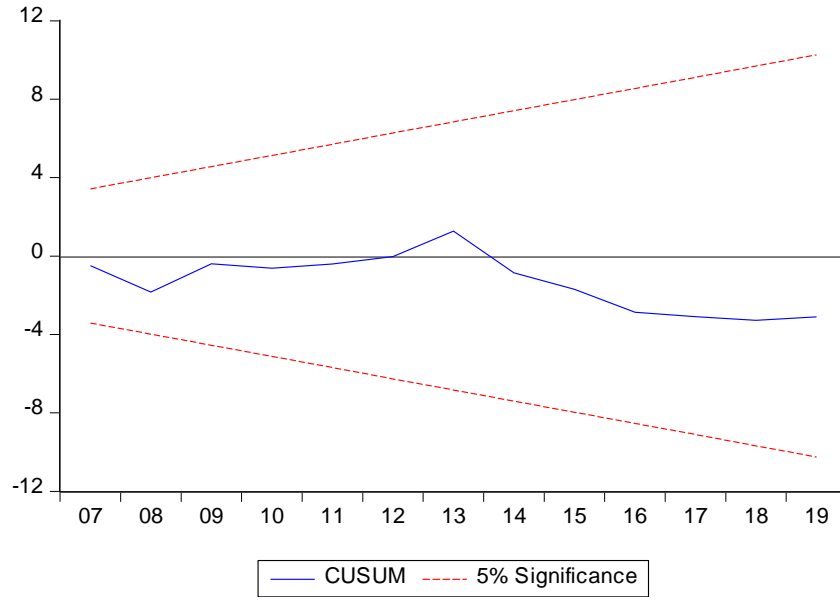


FIGURE 1: CUSUM GRAPH FOR MODEL 1

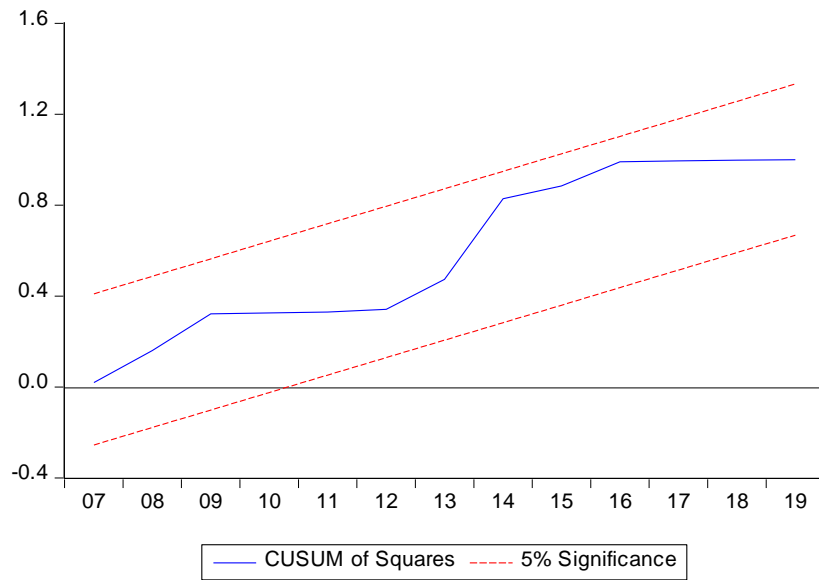


FIGURE 2: CUSUM SQUARE FOR MODEL 2

Conclusion and Recommendations

The study used the NARDL model to examine the nonlinear impacts of inflation and unemployment on Nigerian economic growth, using annual data from 1985 to 2022. The NARDL was used to investigate the positive and negative impacts of the independent variables on the dependent variable. The study found that unemployment and inflation rates are nonlinearly cointegrated with economic growth in the long run. The study also found that both positive and negative changes in the rates of unemployment are positively and significantly associated with economic growth. It implies that an increase in unemployment rates leads to an increase in economic growth while a decrease in the unemployment rate leads to a decrease in economic growth. This reflects the reality of the Nigerian economy because there is an increase in economic growth despite the increasing unemployment rate in the country. It is further confirmed by the descriptive statistics in table 1 where there is an average economic growth of 9% and an unemployment rate of 12%. In the presence of economic growth, unemployment also increases.

The study also found that changes in inflation rates have an asymmetry relationship with Nigerian economic growth. The study shows that the effect of changes in inflation rates on the Nigerian economy can be disaggregated into positive and negative changes in the variable. The NARDL model shows that only positive change in inflation rates have a positive and statistically significant relation with Nigerian economic growth at 5% statistical significance, the negative changes in inflation rate is not statistically significant. It implies that a positive change in inflation rates will lead to an increase in economic growth. This reflects the reality of happenings in the Nigerian economy. Within the time scope of the study, economic growth is always accompanied by positive changes in the inflation rate. Conforming with the findings of the study, economic growth is persistently accompanied by increase in inflationary rate in Nigeria. This is further confirmed by the descriptive statistics in table 1, the data used in the study indicates an average economic growth of 9% and an average change in the inflation rate of 19%.

Given the findings of the study, it can therefore be concluded that there is nonlinear cointegration between changes in inflation rates, unemployment and economic growth. It can also be concluded changes in inflation rates and unemployment rates are asymmetrically related to Nigerian economic growth. Positive and negative changes in unemployment are positively and statistically associated with economic

growth, while the positive change in inflation rate is positively and statistically associated with Nigerian economic growth. Policy makers are therefore advised to tighten and consolidate the inflation-targeting programme of the Central Bank of Nigeria to ensure minimal inflationary rate that is harmless to economic growth. Doing so will not only reduce the adverse effect and persistent positive changes in inflation rates, it will alleviate the suffering of the masses, reduce unemployment and enhance overall economic growth and development.

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