



**APPLICATION OF AUTOREGRESSIVE DISTRIBUTED LAG MODEL ON THE INTERRELATIONSHIP BETWEEN INFLATION AND UNEMPLOYMENT RATES IN NIGERIA**

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**ABSTRACT**

Inflation, unemployment and growth are the big macroeconomic issues of our time. On one hand, inflation is bad, especially when unexpected, because it distorts the working of the price system. On the other hand, unemployment is bad because it disrupt lives and is associated with an irrecoverable loss of real output. This paper focus on the interrelationship between inflation and unemployment rates using Autoregressive Distributed Lag (ARDL) approach. To achieve this, annual data on inflation and unemployment was sourced from secondary sources spanning from 1972 to 2014. The unit root test revealed that inflation and unemployment are stationary at first difference. The result further revealed that inflation and unemployment rates in Nigeria follows an ARDL(1,1) for the period under study. Also, the result shows that there is no short run causality from unemployment rates to inflation rates but there exist a long run association between the variables. The study recommends that the present government should focus on how to reduce unemployment rate and inflation rate, in order to reduce hardship on the citizens.

**Keywords:** Inflation; Unemployment; Stationarity; Short run; Long run; Autoregressive Distributed Lag (ARDL); Model.

**INTRODUCTION**

Inflation, unemployment and growth are the big macroeconomic issues of our time (Lipsey and Chrystal, 1999). Inflation is bad, especially when unexpected, because it distorts the working of the price system, creates arbitrary redistribution from debtors to creditors, creates incentives for speculative as opposed to productive investment activity, and is usually costly to eliminate. Inflation can be defined as a positive rate of growth of the general price level. Eitrheim, et al. (2004) noted that if the inflation forecast is sufficiently close to the target, the policy instruments (a short-term interest rate) is left unaltered. But if the forecasted rate of inflation is higher or lower than the target, monetary instrument are changed until the revised forecast is closed to the inflation target.



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Several authors have studied the influence of inflation rates on other macroeconomic variable and how other macroeconomic variable affect inflation. Some of the authors include: Omotor (2010) who studied the relationship between inflation and stock market returns in Nigeria; Shittu and Yaya, (2011) studied the inflation rates in Nigeria, United States and United Kingdom using fractionally integrated logistic smooth transitions in time series; Abraham, (2011) studied the short and long runs effect of inflation rates on All Share Index (ASI) in Nigeria; Musa and Gulumbe, (2014) studied the interrelationship between inflation rate and government revenues in Nigeria using Autoregressive Distributed Lag (ARDL) model. Other economies have been also studied by several authors. Such authors include: Furuoka (2008) who studied the interrelation between unemployment and inflation in the Philipines using Vector Error Correction Model (VECM). Omar and Sarkar (2013) studied the relationship between commodity prices and exchange rate in the light of global financial crisis in Australia using Vector Error Correction Model (VECM). Mohaddes and Raissi (2014) examined the long-run relationship between consumer price index industrial workers (CPI-IW) inflation and GDP growth in India using cross-sectional Augmented distributed lag (CS-DL) as well as standard panel ARDL method. The findings of Mohaddes and Raissi suggested that, on the average, there is a negative long-run relationship between inflation and economic growth in India.

On the other hand, unemployment is bad because it disrupts lives and is associated with an irrecoverable loss of real output. In situation of excessive labour supply, it would be difficult for workers to find employment and unemployment would be at high levels (Furuoka, 2008). According to Adeyi (2012) unemployment remains considerable theoretical debate regarding the causes, consequences and its solution. Classical and Neoclassical economists argue that unemployment is a result of intervention imposed on the labour market from outside, and that market mechanisms are the reliable means of resolving the problem of unemployment. Keynesian economists emphasize the clinical nature of unemployment and recommends interventions as the solution especially during recessions.



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In Nigeria, unemployment is a big problem plaguing the economy, that is why many researches have been tailored toward resolving and solving unemployment in Nigeria. For example, Ejikeme (2014) studied unemployment and poverty in Nigeria as it relate to National insecurity; Aminu, et al. (2013) revealed that the rate of unemployment, poverty, corruption and inflation in Nigeria is alarming despite government efforts to reduced them; Bula (2014) studied the relationship between inflation, employment and economic growth in Nigeria from 1970 to 2012. Bula recommended the need to improve understanding of the relationships between unemployment and growth to ensure that growth generates positive and significant employment elasticity. Torruam and Abur, (2014) investigated the relationship between unemployment, inflation and crime using Vector Error Correction Model (VECM). Their result revealed that there is unidirectional causality running from unemployment and inflation to crime in Nigeria. The study concluded that unemployment in Nigeria Granger causes crime.

This study is therefore aimed at examining the interrelationship between inflation and unemployment rates in Nigeria using ARDL model.

### **Model Specification**

#### **Autoregressive Distributed Lag (ARDL) Model.**

Recently Pesaran, et al. (2001) proposed an Autoregressive Distributed Lag (ARDL) or Bounds testing approach to investigate the existence of cointegration relationship among variables. There are three specific advantages associated with this approach (Udoh et al. 2015):

1. It circumvents the problem of the order of integration associated with the Johansen likelihood approach.
2. Unlike most of the conventional multivariate cointegration procedures which are valid for large sample size, the bounds test approach is suitable for sample size study.
3. It provides unbiased estimates of the long run model and valid t-statistics even when some of the regressors are endogenous.

Autoregressive Distributed Lag (ARDL) Models have played a prominent role in numerous application in the Nigerian economy. Examples include the study of fiscal decentralization, economic growth and human resources development in Nigeria (Udoh, et al. 2015); Doguwa and Alade (2015) compared ARDL model among other models on the modeling of Nigeria's



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external reserves; Udom and Yaaba (2015) used ARDL model on the determination of the monetary policy instrument for Nigeria, and, Musa and Gulumbe (2014) studied the interrelationship between inflation rate and government revenues in Nigeria using ARDL model.

The ARDL model specification of the functional relationship between the inflation and unemployment rates is given below:

$$\Delta LNINF = \alpha_0 + \beta_1 LNINF_{t-1} + \beta_2 LNUNEMP + \sum_{i=1}^k \delta_{1i} \Delta LNINF_{t-1} + \sum_{i=1}^k \delta_{2i} \Delta LNUNEMP_{t-1} + \varepsilon_t \quad (1)$$

Where: LNINF= Natural Log of inflation rate; LNUNEMP= Natural Log of unemployment rate

K= Lag length for the Unrestricted Error- Correction Model (UECM);  $\Delta$  = First differencing operator;  $\varepsilon$  = white noise disturbance error term,  $\alpha_0$  = constant in the model,  $\beta_1$  and  $\beta_2$  are the long run coefficients,  $\delta_1$  and  $\delta_2$  are the short run coefficients.

The bound test approach for the long-run relationship between inflation and unemployment rates is based on the Wald test (F statistic), by imposing restrictions on the long-run estimated coefficients of one period lagged level of the inflation and unemployment rates to be equal to zero, that is,  $H_0 : \beta_1 = \beta_2 = 0$ . Then the calculated F statistic is compared to the tabulated critical value in Pesaran et al. (2001). The explanatory variables are assumed to be integrated of order zero, or I(0) for values of the lower bound, while the upper bound values assumed that they are integrated of order one, or I(1). Therefore, the decision rule is that if computed F-statistic falls below the lower bound value, I(0), the null hypothesis (no co-integration) cannot be rejected. While if the computed F-statistic exceeds the upper bound value, I(1) then it can be concluded that inflation and unemployment rates are co-integrated.

The long-run and short run parameters of equation (1) can then be estimated once a cointegration relationship had been established. The co-integration long run relationship was estimated using the following specification:

$$LNINF = \alpha_0 + \beta_1 LNINF_{t-1} + \beta_2 LNUNEMP + \varepsilon_t \quad (2)$$



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However, to restore equilibrium immediately may not be possible because of the speed of adjustment. This could be caused by the lags and adjustment process used to capture changes in any of the factors affecting inflation rate overtime. Hence, the error correction model was used to capture the speed of adjustment of inflation rate model. The model is expressed below thus:

$$\Delta LNINF = \alpha_0 + \sum_{i=1}^k \delta_{1i} \Delta LNINF_{t-1} + \sum_{i=1}^k \delta_{2i} \Delta LNUNEMP_{t-1} + \delta_3 ect_{t-1} + \varepsilon_t \quad (3)$$

Where:  $ect_{t-1}$  = the error correction term lagged for one period;  $\delta_3$  = the coefficient for measuring speed of adjustment in equation (3).

### MATERIALS AND METHODS

The data used in this paper was sourced from Bula (2014); Eme (2014) and CBN (2014) Statistical Bulletin. The data on annual inflation and unemployment rates in Nigeria spanned from 1972 to 2014.

### EMPIRICAL RESULTS AND DISCUSSION

Before proceeding with econometric estimations, it is required to obtain the optimal lag of the model and to investigate the integration properties of the used variables. The Optimal lag selection Using the AIC criterion, choose ARDL (1,1) as optimal. The unit root test using the Augmented Dickey- Fuller (ADF) test presented in Table 1 below revealed that the variables are stationary at their first difference.

**Table 1:** Augmented Dickey- Fuller (ADF) test for unit root

Variable	Intercept only	Intercept and Trend
D(LNINF)	-7.123405*	-7.085345*
D(LNUNEMP)	-7.147567*	-7.098895*

\*Significant at 1%, 5% and 10% level of significance



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**Table 2:** Regression Results of the ARDL (1,1) Bound Testing Approach

Dependent Variable: D(LNINF)

Method: Least Squares

Date: 03/16/16 Time: 17:07

Sample (adjusted): 1974 2014

Included observations: 41 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	2.904094	0.647254	4.486789	0.0001
D(LNINF(-1))	0.391365	0.147867	2.646741	0.0120
D(LNUNEMP(-1))	0.202212	0.288900	0.699938	0.4885
LNINF(-1)	-0.854224	0.174206	-4.903522	0.0000
LNUNEMP(-1)	-0.316047	0.146524	-2.156967	0.0378
R-squared	0.444065	Mean dependent var		0.009586
Adjusted R-squared	0.382294	S.D. dependent var		0.769641
S.E. of regression	0.604894	Akaike info criterion		1.946322
Sum squared resid	13.17228	Schwarz criterion		2.155294
Log likelihood	-34.89960	Hannan-Quinn criter.		2.022418
F-statistic	7.188942	Durbin-Watson stat		1.985919
Prob(F-statistic)	0.000231			

Table 2 above presents the results of the ARDL (1,1) model leading to the Bound testing for co-integration.

**Table 3:** Bound testing for co- integration.

Wald Test:

Equation: Untitled

Test Statistic	Value	Df	Probability
F-statistic	12.03651	(2, 36)	0.0001
Chi-square	24.07302	2	0.0000

Null Hypothesis: C(4)=C(5)=0

Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
C(4)	-0.854224	0.174206
C(5)	-0.316047	0.146524

Restrictions are linear in coefficients.

In table 3 above, the F-statistics=12.03651; while the Pesaran critical values are Lower



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bound=3.38 and upper bound=4.02. The F statistic is more than 4.02, we reject the null hypothesis. This means that the two variables (inflation and unemployment rates) have a long run association. This suggests the existence of co-integration between the two variables.

**Table 4:** Long Run Relationship between Inflation and Unemployment rates for cointegrated equation

Dependent Variable: LNINF  
Method: Least Squares  
Date: 03/16/16 Time: 17:19  
Sample: 1972 2014  
Included observations: 43

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	3.230632	0.297607	10.85535	0.0000
LNUNEMP	-0.299276	0.144168	-2.075878	0.0442
R-squared	0.095108	Mean dependent var		2.658128
Adjusted R-squared	0.073037	S.D. dependent var		0.761803
S.E. of regression	0.733455	Akaike info criterion		2.263295
Sum squared resid	22.05623	Schwarz criterion		2.345211
Log likelihood	-46.66085	Hannan-Quinn criter.		2.293503
F-statistic	4.309271	Durbin-Watson stat		1.107598
Prob(F-statistic)	0.044216			

Equation (2) was estimated to explore the long run relationship running from inflation rate to unemployment rate (means there is present of cointegration) .The result is presented in table 4 above. The result revealed a significant negative relationship between inflation and unemployment rates in Nigeria as stipulated by the Phillips curve (Bula, 2014). This means that a 1% increase in unemployment rate leads to approximate 0.3% decline in the inflation rate.



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**Table 5:** Equilibrium Correction Form of the ARDL(1,1)- the ARDL model of Inflation

Dependent Variable: D(LNINF)

Method: Least Squares

Date: 03/16/16 Time: 17:38

Sample (adjusted): 1974 2014

Included observations: 41 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.031247	0.095788	0.326205	0.7461
D(LNINF(-1))	0.387677	0.146042	2.654558	0.0116
D(LNUNEMP(-1))	0.169546	0.276639	0.612879	0.5437
ECT(-1)	-0.849701	0.172034	-4.939136	0.0000
R-squared	0.440926	Mean dependent var		0.009586
Adjusted R-squared	0.395596	S.D. dependent var		0.769641
S.E. of regression	0.598346	Akaike info criterion		1.903172
Sum squared resid	13.24665	Schwarz criterion		2.070350
Log likelihood	-35.01503	Hannan-Quinn criter.		1.964049
F-statistic	9.726955	Durbin-Watson stat		1.969538
Prob(F-statistic)	0.000072			

The ECM coefficient in the model presented in table 5 above has the correct sign and is statistically significant. This means that the system is getting adjusted towards long run equilibrium at the speed of 84.97 percent, that is, it means that approximately 84.97% of the discrepancy in the previous year is adjusted for by the current year. In the short run, the current inflation rate depends on the previous inflation rate and is statistically significant at 5% level of significance. While in the short-run, unemployment rate is positively related to inflation rate though not significant at 5% level of significance.

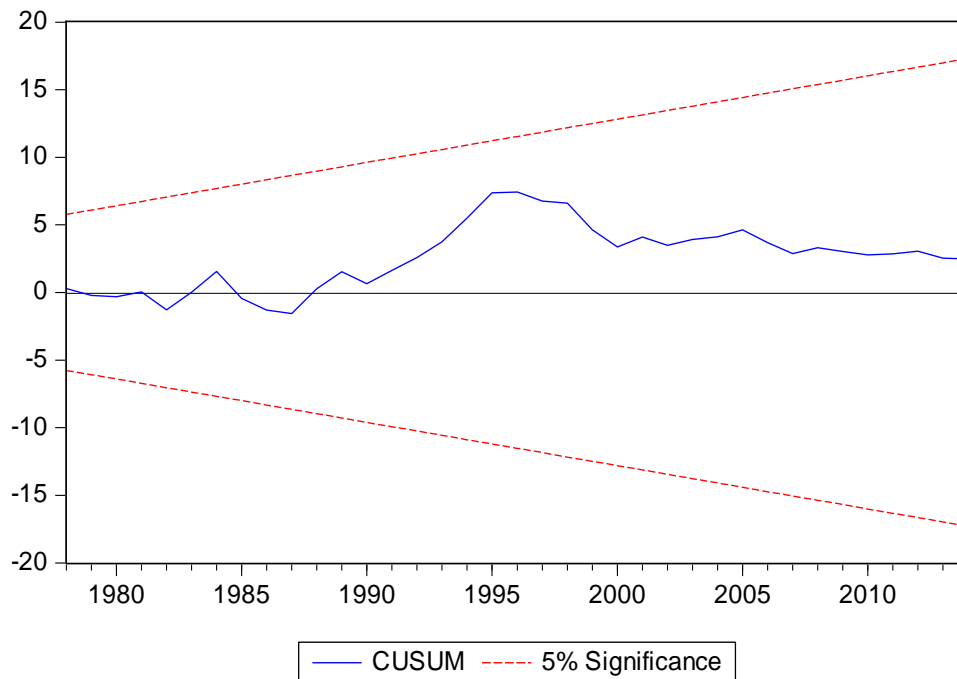
**Table 6:** Serial correlation

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	0.011788	Prob. F(1,36)	0.9141
Obs*R-squared	0.013420	Prob. Chi-Square(1)	0.9078

Table 6 above present the diagnostic test for the residual of the regression model. The test shows that there is no higher order serial correlation in the model.





**Fig 1:** CUSUM Test for Stability

Figure 1 above shows the stability of the model. The figure revealed that the model is stable, hence can be used for forecast.

**Table 7:** Short run causality

Wald Test:

Equation: Untitled

Test Statistic	Value	Df	Probability
t-statistic	0.612879	37	0.5437
F-statistic	0.375620	(1, 37)	0.5437
Chi-square	0.375620	1	0.5400

Null Hypothesis:  $C(3)=0$

Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
C(3)	0.169546	0.276639

Restrictions are linear in coefficients.

Table 7 above revealed that there is no short run causality running from unemployment rate to inflation.



### CONCLUSION AND RECOMMENDATIONS

This paper focuses on the interrelationship between inflation and unemployment rates using ARDL approach. To achieve this, annual data on inflation and unemployment was sourced from secondary sources spanning from 1972 to 2014. The unit root test revealed that inflation and unemployment are stationary at first difference. The results showed that unemployment rate influences inflation rate in Nigeria. The result further revealed that inflation and unemployment rates in Nigeria follows an ARDL(1,1) for the period under study. Also, the result shows that there is no short run causality from unemployment rates to inflation rates but there exist a long run association between the variables. The study recommends that the present government should focus on how to reduce unemployment rate and inflation rate, in order to reduce hardship on the citizens.

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