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Inflation and Unemployment Trade-off: A Re-examination of the Phillips Curve and its Stability in Nigeria

Nurudeen Abu[1]

ABSTRACT Although the maintenance of price stability and the attainment of full employment are important macroeconomics goals in any economy, Nigeria still contends with problems of high inflation and unemployment. This study examines the Phillips curve hypothesis (inflation and unemployment trade-off) and its stability in Nigeria from 1980 to 2016 using the Autoregressive Distributed Lag (ARDL) bounds testing approach. Other estimation techniques including the Fully Modified Ordinary Least Squares (FMOLS), Dynamic Ordinary Least Squares (DOLS), Static Ordinary Least Squares (OLS), and Canonical Cointegrating Regression (CCR) were employed to ascertain the consistency and robustness of the results that were generated using the ARDL bounds testing method. The results of the cointegration test reveal the existence of a long-run relationship between inflation and unemployment. The results of the ARDL bounds testing, FMOLS, DOLS, static OLS and CCR estimations indicate that there is a trade-off relationship between the variables, and higher unemployment leads to lower inflation in the long-run. The plots of the cumulative sum of squares of recursive residuals (CUSUMQ) confirm the stability of the long-run parameters. The results of the causality test using the standard Granger causality test and the Toda and Yamamoto approach demonstrate that there is unidirectional causality from inflation to unemployment. Based on these findings, this study recommends policies to reduce both inflation and unemployment.

KEY WORDS: Inflation, Unemployment, Phillips Curve, Nigeria

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[1] Umaru Musa Yar'Adua University, Department of Economics, Nigeria

1. Introduction

The maintenance of low inflation and unemployment rates are among the main goals of macroeconomics both in developing and developed countries. Although the Phillips (1958) curve hypothesis suggests that there is a trade-off relationship between the two undesirables (inflation and unemployment), a number of studies have argued that, at most, the trade-off exists only in the short-run, but not in the long-run (Friedman, 1968; Lucas & Rapping, 1969). However, others contended that the trade-off Phillips curve exists and is still alive in the short-run or the long-run (Fuhrer, 1995; Malinov & Sommers, 1997; Tang & Lean, 2007b). Moreover, Phelps (1967) submitted that the long-run Phillips curve is verti-

Correspondence concerning this article should be addressed to: **Nurudeen Abu**, Umaru Musa Yar'Adua University, Department of Economics, Katsina 2218, Nigeria. T: +2349052757265. E-mail: abu.nurudeen@yahoo.com

cal, and as a result there is no trade-off between inflation and unemployment.

Furthermore, certain scholars have suggested that the inflation-unemployment trade-off is nonlinear (Balaban & Vintu, 2010; Corrado & Holly, 2003; Hasanov, Araç, & Telatar, 2010; Huh & Jang, 2007; Tambakis, 2002; Stiglitz, 1997; Xu, Niu, Jiang, & Huang 2015). However, researchers such as Gordon (1997), Bhattarai (2016) and Blanchard (2016) subscribed to the linearity of the trade-off.

Additionally, the Phillips curve hypothesis has been studied from different perspectives. For example, Samuelson and Solow (1960) viewed the relationship in terms of price-level inflation, while Phelps (1967), Friedman (1968), Lucas (1973) and Fischer (1977) examined the connection between the variables within the rational expectations framework. Moreover, the Phillips curve hypothesis has been extended and analyzed using the forward-looking new Keynesian approach (Blanchard & Kiyotaki, 1987; Clarida, Galí, & Gertler, 1999; Rankin, 1992; Rumler, 2007; Zhang & Murasawa, 2011).

In Nigeria, high inflation and unemployment rates have coexisted overtime. Recently, it was announced that Nigeria has fallen into a recession since the country recorded a negative growth rate in 2016. Coupled with the double-digit inflation rate, one can safely say that Nigeria is experiencing stagflation, which is a condition that was reported few years ago (Nwaobi, 2009). High inflation and unemployment rates have the tendency to negatively impact the economy, including reducing the welfare and happiness of the people (Bhattarai, 2016; Di Tella, MacCulloch, & Oswald, 2001; Blanchflower, Bell, Montagnoli, & Moro 2014), and promoting crime (Tang, 2011; Tang & Lean, 2007a).

In the same manner, Ogujiuba and Abraham (2013) and Sa'idu and Muhammad (2015) reported that inflation and unemployment have adversely affected the Nigerian economy. In the same vein, Nwaobi (2009) argued that many social vices such as drug trafficking, prostitution and crime accompany high rates of unemployment.

Given the negative consequences of inflation and unemployment on the economy, it is important to ascertain the existence of the two indicators in Nigeria to guide policymakers regarding the steps to be taken in solving or reducing the problems. Additionally, it has been suggested that the presence of a trade-off Phillips curve is crucial for developing countries since the Phillips curve is a menu that policymakers can use to monitor inflation and unemployment rates (Samuelson & Solow, 1960; Tang & Lean, 2007b).

Estimating the inflation-unemployment relationship provides useful information to the government and policymakers. Based on any numerical value that is obtained from the estimation of an inflation-unemployment model, policymakers can know the amount of inflation to be accommodated if unemployment is lowered by 1%, and vice versa.

The trade-off Phillips curve has been studied extensively in Nigeria (Ogujiuba & Abraham, 2013; Ojapinwa & Esan, 2013; Okafor, Chijindu, & Ugochukwu, 2016; Orji, Anthony-Orji, & Okafor, 2015; Umaru & Zubairu, 2012; Umoru & Anyiwe, 2013). Whereas the efforts made by the researchers should be commended, certain weaknesses have been observed in their studies. For example, some studies employed annual data that was less than the conventional thirty (30) years in their analysis. They include Umoru and Anyiwe (2013) - twenty-seven (27) years (i.e.1986-2012), Umaru, Donga and Musa (2013) - twenty- seven (27) years (1984-2010), and Okafor et al. (2016) - twenty-six (26) years (1989-2014).

In addition, studies by Umaru and Zubairu (2012) and Umoru and Anyiwe (2013) employed the conventional cointegration techniques. However, the advantages of the ARDL bounds testing method that was used in this study over the conventional cointegration methods, including the ones employed by Okafor et al. (2016), Umaru and Zubairu (2012) and Umoru and Anyiwe (2013), are well documented (Abu, 2017). Even though Orji et al. (2015) and Ojapinwa and Esan (2013) went a step further by using an ARDL bounds testing approach, they failed to conduct important diagnostic tests to ascertain the presence of heteroscedasticity and serial-correlation problems in their estimates. Furthermore, none of the studies mentioned above attempted to check the consistency and robustness of their results.

Thus, this study attempts to fill the gap by employing the ARDL bounds testing method, conducting important diagnostic tests that previous studies on Nigeria failed to do, and extending the study period to 2016. In addition, this study employs other estimation

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techniques including the FMOLS, DOLS, static OLS, and CCR to check the consistency and robustness of the results that were obtained using the ARDL bounds testing method.

The empirical evidence illustrates that (i) there is a long-run trade-off relationship between inflation and unemployment, (ii) the relationship is stable over the long-run, and (iii) there is unidirectional causality from inflation to unemployment.

The main objective of this study is to re-examine the Phillips curve hypothesis and its stability in Nigeria. The remainder of this paper is organized as follow. The second section consists of the empirical literature review on inflation and unemployment, while the third section includes the model, econometric techniques and results. The fourth section concludes this paper.

2. Literature Review on Inflation and Unemployment (Phillips Curve)

Researchers have investigated the relationship between inflation and unemployment (Phillips curve) overtime. For example, Bhattarai (2016) employed fixed and random effects estimators including cointegration and Granger causality tests to examine the long-run relationships between inflation and unemployment in 40 advanced countries, the Organization for Economic Cooperation and Development (OECD) inclusive, during the 1990:1-2014:4 period. The results of the cointegration and Granger causality tests indicate the existence of long-run and bidirectional relationships between inflation and unemployment in the OECD countries. In addition, the results of the regression analyses validate the Phillips curve phenomenon in 28 of the 35 OECD countries that were considered in the study. Blanchard (2016) estimated the Phillips curve for the United States since the 1960s. The author found that a 1 percentage decrease in unemployment for one quarter increases the inflation rate by 0.2 percentage points. He concluded that the Phillips curve is alive and well.

Xu et al. (2015) used combined classical quantile regression and a nonlinear method of analysis to examine the trade-off between the output gap and inflation for the United States over the 1952:1-2011:4 period. The empirical evidence suggests the existence of different nonlinear Phillips curve relationships across quantiles of the inflation distribution. In addition, the results indicate that the shape of the Phillips curve is nonlinear and asymmetric, and the relationship between the variables varies significantly across quantiles. The authors also found that increases in the output gap raise inflation and inflation uncertainty.

Hasanov et al. (2010) employed the bivariate time varying smooth transition regression model and generalized impulse response functions to examine the nonlinearities in the Phillips curve for Turkey from 1980 to 2008. The results of the linearity test confirm a nonlinear relationship between the inflation rate and output gap. Balaban and Vintu (2010) examined whether the Phillips curve is nonlinear in Romania during 2000-2009 and the Euro zone from 1970 to 2008 using quarterly data. The estimation results reveal the presence of linearity for the Phillips curve in the Euro Area, while there is an evidence for nonlinearity of the Phillips curve in Romania. Corrado and Holly (2003) studied the nonlinearity of the Phillips curve for the United States and the United Kingdom using quarterly data over the 1966-1997 period. The authors found nonlinear relationships between inflation and the output gap.

Tang and Lean (2007b) employed the bounds testing approach to cointegration to examine the Phillips curve hypothesis and its stability in Malaysia from 1970 to 2005. The results demonstrate that inflation and unemployment (along with other determinants of inflation) are cointegrated. The results also reveal the existence of a trade-off Phillips curve, because a negative relationship was established between inflation and unemployment in the short-run and the long-run in Malaysia. Lastly, evidence was found for stability of the parameters during the period. Ribba (2007) used a structural cointegrated VAR model to evaluate the effects of the disinflationary policies and other aggregate demand shocks on the unemployment rate in Italy from 1979 to 1995. Contrary to the natural rate theories, the results illustrate that supply shocks and aggregate demand disturbances explain the movements in unemployment both in the short-run and the long-run. Ribba (2006) employed a structural VECM to study the dynamic interactions at different frequencies among inflation, unemployment and the federal funds rate in the United States during the 1980:1-2001:12 and 1961:1-1979:12 periods. The results suggest that both aggregate demand

and monetary policy shocks are responsible for the short-run trade-off between inflation and unemployment. On the other hand, permanent supply shocks contribute to the long-run movement in inflation and unemployment.

Ogbokor (2005) used a linear and logarithmic regression model to test the existence of a short-run Phillips curve relation in Namibia from 1991 to 2005. The results show that inflation and unemployment are positively related (stagflation) in Namibia. Welfe (2000) employed several techniques including cointegration and vector error correction to estimate an inflation model for Poland, using quarterly data from 1991 to 1996. The results suggest that unemployment is negatively related to inflation in the short-run, thus confirming the Phillips curve hypothesis. However, the effect of unemployment on inflation is negligible in the long-run in Poland. Dolado, López-Salido and Vega (2000) used a VAR approach to examine the joint dynamic behavior of inflation and unemployment in Spain from 1964 to 1997, including subperiods, with the primary objective to establish the existence of trade-offs between the variables during high and low frequency periods. The authors confirm the existence of trade-offs between unemployment and inflation in Spain.

Debelle and Laxton (1997) estimated both the linear and nonlinear models of the Phillips curve for Canada, the United Kingdom and the United States using quarterly data for the 1971-1995 period. The authors discovered that the nonlinear model fits the data better than the linear model. Carrin and Barten (1976) estimated an inflation and unemployment trade-off relationship by taking into account the price expectations for the Belgian economy from 1955 to 1971. The results indicate the existence of a long-run trade-off between price inflation and unemployment in Belgium. Lucas and Rapping (1969) examined the Phillips curve by considering the price expectations for the United States during the 1904-1965 period, which was further categorized into subperiods. The results suggest that the expectations-based Phillips curve is not stable in certain subperiods, while there is the presence of a short-run Phillips curve in most of the subperiods. Lastly, whereas there is an absence of a long-run Phillips curve for the 1904-1929 and 1946-1965 periods, it does hold for the 1930-1945 period.

In Nigeria, scholars have also studied the inflation and unemployment nexus. For example, Okafor et al. (2016) employed the error correction model and Johansen cointegration method to study the response of unemployment to variations in the price level in Nigeria from 1989 to 2014. The results indicate that unemployment and inflation (including money supply and exchange rate) have a long-run relationship, and inflation has a negative effect on unemployment. Orji et al. (2015) investigated the existence of the Phillips curve in Nigeria from 1970 to 2011 using the ARDL bounds testing approach. The empirical evidence demonstrates that unemployment has a positive and significant effect on inflation, and thus invalidates the Phillips curve proposition for Nigeria.

Ogujiuba and Abraham (2013) examined the existence of the Philips curve hypothesis in Nigeria over the 1970-2010 period by employing the generalized error correction model. The results illustrate that there is a negative but insignificant relationship between unemployment and inflation in the short-run. On the other hand, the results suggest that in the long-run, inflation and unemployment are positively related. Umaru and Zubairu (2012) assessed the inflation-unemployment relationship in Nigeria from 1977 to 2009 using the cointegration method and Granger causality test, and the ARCH and GARCH approaches to check the series' volatility. The results suggest that the variables are cointegrated, and inflation has a negative impact on unemployment. In addition, the results of the causality test show the absence of any causal relationship between inflation and unemployment.

Umoru and Ayinwe (2013) used the vector error correction technique to investigate the dynamics of inflation and unemployment in Nigeria from 1986 to 2012. The results indicate the presence of high inflation and unemployment rates (stagflation) in Nigeria, thus refuting the proposition of the short-run Phillips curve. Umaru et al. (2013) evaluated the effects of inflation and unemployment on Nigeria's economic growth using the ordinary least squares and cointegration methods, including Granger causality tests, over the 1984-2010 period. The results of the causality tests indicate that there is an absence of a causal relationship between inflation and unemployment.

Ojapinwa and Esan (2013) investigated both the existence and stability of the Phillips curve in Nigeria

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from 1970 and 2010 using methods that include ARDL bounds testing, DOLS general to specific cointegration, and the error correction approach. The results show that the inflation rate and unemployment rate are negatively related in the short-run. However, in the long-run, the inflation rate and unemployment rate are positively related, thereby indicating stagflation in the Nigerian economy. Finally, the results reveal a stable Phillips relationship.

This study contributes to the literature on the Phillips curve by assessing the connection between inflation and unemployment in Nigeria using the ARDL bounds testing approach and conducting diagnostic tests (heteroscedasticity and serial-correlation), which past studies on Nigeria failed to do. In addition, this study employs other estimation methods including the FMOLS, DOLS, static OLS and CCR to ascertain the consistency and robustness of the results that are generated using the ARDL bounds testing technique.

3. Model, Econometric Techniques and Results

In formulating a model relating inflation to unemployment, this study borrows the ideas of Phillips (1958), where the author argued that the rate of change of unemployment and the level of unemployment can explain the change of money wage rates (or inflation). By plotting data on the wage rates and the unemployment rates on a scatter diagram, Phillips suggested that the inflation rate tends to be high when unemployment rate is low. On the other hand, the inflation rate tends to be less or become negative when the rate of unemployment is high. Supporting this view, Blanchard (2016) reported that declining unemployment raises inflation, and rising unemployment leads to lower inflation.

Although several studies have employed linear models to analyze the Phillips curve hypothesis (Gordon, 1997; Ribba, 2006; 2007; Tang & Lean, 2007b), certain authors contended that the relationship between inflation and unemployment can better be captured using nonlinear models (Balaban & Vintu, 2010; Corrado & Holly, 2003; Hasanov et al., 2010; Huh & Jang, 2007; Tambakis, 2002; Xu et al., 2015). Recently, Bhattarai (2016) and Blanchard (2016) in his Policy Brief suggested that inflation and unemployment are linearly related. Thus, in line with Tang and Lean (2007b), Bhattarai (2016) and Blanchard (2016), an econometric model in which inflation (INF) is linearly dependent on unemployment (UNEM) is specified as follows:

$$INF_t = \alpha_0 + \alpha_1 UNEM_t + \mu_t \quad (1)$$

Using the natural logarithm of the variables to minimize skewness, the model is rewritten as follows:

$$LINF_t = \alpha_0 + \alpha_1 LUNEM_t + \mu_t \quad (2)$$

Annual data from 1980 to 2016 were employed in this study. The data on the inflation rate were collected from the World Development Indicators (various years), while the data on the unemployment rate were obtained from the National Bureau of Statistics (various years) and Atan (2013).

3.1 Unit Root Tests

Prior to estimating the relationship between macroeconomic variables, it is important to ascertain their stationarity properties. Therefore, two statistics, namely the Augmented Dickey Fuller (ADF) and Philips-Perron (PP), were used to check the stationarity properties of the variables that are employed in this study. The stationarity (unit root) test results that are reported in Table 1 illustrate that inflation is stationary at level (or has no unit root). On the other hand, unemployment has a unit root at level but becomes stationary after its first difference.

Given that the series are a mixture or combination of I(0) and I(1), the ARDL bounds testing method to cointegration (Pesaran & Shin, 1999; Pesaran, Shin, & Smith, 2001), was employed to estimate the relationship between the variables. Thus, the ARDL model to be estimated is specified as follows:

$$\Delta LINF_t = \alpha_0 + \sum_{i=1}^{n} \alpha_{1i} \Delta LINF_{t-i} + \sum_{i=0}^{n} \alpha_{2i} \Delta LUNEM_{t-i} +$$

$$+ \sigma_1 LINF_{t-1} + \sigma_2 LUNEM_{t-1} + \theta_1 ECM_{t-1} + \varepsilon_{1t}$$

3.2 ARDL Bounds Testing for Cointegration

One advantage of using the ARDL method is that it does not require pretesting unit root. However, it is important to verify the stationarity property of the

Table 1. Results of Unit Root Tests

	ADF		PP	
Variable	**Level**	**First Diff.**	**Level**	**First Diff.**
LINF	-3.3548**	-	-3.2397**	-
LUNEM	-1.9905	-5.6766***	-2.0625	-5.6947***

Note: ** and *** indicate a rejection of the null hypothesis of no unit root at the 5% and 1% levels, respectively.

variables since the inclusion of a series with a second order integration [I(2)] in an ARDL model produces spurious results.

The ARDL bounds testing technique is used to examine the cointegration relationships regardless of the order of integration of the series, either I(0) or I(1), or a combination of both. The advantages of the ARDL over other cointegration methods such as the residual-based technique (Engle & Granger, 1987) and Maximum likelihood test (Johansen, 1988; 1991; Johansen & Juselius, 1990) have been discussed extensively (Abu, 2017; Nyasha & Odhiambo, 2014; Ozturk & Acaravci, 2010; 2011; Tang & Shahbaz, 2011).

If it is confirmed that the calculated F-statistic is larger than the upper critical bounds value [I(1)], then we conclude that the series are cointegrated. On the other hand, if the F-statistic is less than the lower critical bounds [I(0)], we conclude that there is no cointegrating relationship between the variables. Moreover, if the F-statistic lies between the upper and lower critical bounds values, our inference would be inconclusive.

The results that are presented in Table **2** demonstrate that the calculated F-statistic (6.9249) is greater than the upper bounds value at the 1% level. This demonstrates that there is a cointegrating or long-run relationship between the variables.

3.3 Results of Selected Long-run and Short-run Models

Given the confirmation of a long-run relationship between the variables, the ARDL model was estimated by taking into account the optimal lag-length (2,2), as suggested by the Akaike Information Criterion (AIC). The AIC was used because it has been discovered to perform better than other lag selection criteria when determining the optimal lag length for a small sample size (Liew, 2004). In addition, Lutkepohl (1991) as cited in Tang and Lean (2007a) submitted that the AIC is superior to other information criterion including the Schwarz Bayesian criterion (SBC) in finite samples. The long-run and short-run results for the selected models are reported in Table **3**.

The long-run results (Panel A) indicate that unemployment has a negative and significant effect on inflation at the 1% level. A 1 percent increase in unemployment leads to a 0.47 percent reduction in inflation. Similarly, the short-run results (Panel B) demonstrate that unemployment has a negative and significant effect on inflation at the 10% level only. A 1 percent increase in unemployment leads to a 0.56 percent decrease in inflation. These findings lend support to the ones reported by prior studies on developing economies (Ojapinwa & Esan, 2013; Tang & Lean, 2007b). For example, Tang and Lean (2007b) confirmed a negative Phillips relationship both in the long-run and short-run for Malaysia. Similarly, Ojapinwa and Esan (2013) found a short-run Phillips curve for Nigeria.

The outcomes of this study are also consistent with those discovered for developed countries (Blanchard, 2016; Carrin & Barten, 1976; Welfe, 2000). For instance, Welfe (2000) discovered a short-run Phillips curve for Poland, and Blanchard (2016) discovered one for the United States. In the same manner, the results of the work of Carrin and Barten (1976) suggest the existence of a long-run Phillips curve trade-off for Belgium.

In contrast, the findings of this study are inconsistent with previous studies on Nigeria (Ogujiuba & Abraham, 2013; Umoru & Ayinwe, 2013). For example, Umoru and Ayinwe (2013) and Ogujiuba and

Table 2. Results of Bounds Tests to Cointegration

Dependent Variable		Function				F-Statistic	
LINF		F(LINF/LUNEM)				6.9249***	
Critical Values Bounds							
10%		5%		2.5%		1%	
I(0)	I(1)	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)
3.02	3.51	3.62	4.16	4.18	4.79	4.94	5.58

Note: *** denotes statistical significance at the 1% level.

Table 3. Results of the ARDL Model

Panel A: Long-run Coefficients - Dependent variable is LINF				
Regressor	**Coefficient**	**Standard Error**	**T-Ratio**	**Prob.**
C	3.5970	0.3323	10.8213	0.0000
LUNEM	-0.4686	0.1643	-2.8513	0.0079
Panel B: Short-run Coefficients - Dependent variable is ΔLINF				
Regressor	**Coefficient**	**Standard Error**	**T-Ratio**	**Prob.**
$\Delta LINF_{-1}$	0.4700	0.1741	2.6997	0.0115
ΔLUNEM	-0.5575	0.2849	-1.9567	0.0601
$\Delta LUNEM_{-1}$	-0.0369	0.2499	-0.1479	0.8834
ECM_{-1}	-0.9531	0.2022	-4.7124	0.0001
R^2	0.4186			
D.W	1.7568			

Note: Δ is the first difference operator.

Abraham (2013) found that inflation and unemployment are positively related (stagflation) in Nigeria. This may be due to the use of the conventional cointegration, which is not appropriate for small sample sizes (Mah, 2000; Tang & Lean, 2007b).

The coefficient of the error correction term lagged by one period (ECM_{-1}) is negative and statistically significant, and it suggests that approximately 95.3 percent of the deviations from the equilibrium would be corrected within one year.

3.4 Results of Diagnostic Tests

The results of the diagnostic tests are reported in Table 4. It can be seen that the ARDL model is free from the problems of serial-correlation and heteroscedasticity at the 5% level. Similarly, the estimated model passes

Table 4. ARDL Diagnostic Tests

LM Test Statistic	Results
Serial Correlation: $\chi^2(2)$	4.0023[0.1352]
Normality (Jarque-Bera)	1.1757[0.5554]
Heteroscedasticity: $\chi^2(5)$	6.4014[0.2691]
Functional form: Rest F-stat.(2)	2.4052[0.1093]

the normality test and it has no problem of misspecification at the 5% level.

Additionally, the cumulative sum of recursive residuals (CUSUM) and the cumulative sum of squares of recursive residuals (CUSUMQ) tests were conducted to determine the stability of the parameters over the studied period. The instability of the parameters is said to occur if the plots of the CUSUMQ break in the lower or upper bounds (Greene, 2003; Tang & Lean, 2007b). These plots in Figure 1 and Figure 2 were found to fall within the boundaries. These confirm the stability of the long-run parameters. This outcome is consistent with the work of Tang and Lean (2007b).

3.5 Results of Alternative Cointegration Methods of Estimation

In an attempt to ascertain the consistency and robustness of the estimates that were generated using the ARDL bounds testing approach, alternative cointegration methods of estimation were employed to examine the long-run relationship between inflation and unemployment. The techniques include FMOLS (Hansen & Phillips, 1990), DOLS (Saikkonen, 1992; Stock & Watson, 1993), and CCR (Park, 1992). The FMOLS, DOLS and CCR deal with endogeneity bias and serial-correlation problems and provide more efficient results with small sample sizes (Alhassan & Fiador, 2014; Montalvo, 1995; Narayan & Narayan, 2004; Singh, 2015).

The DOLS procedure entails regressing one of the I(1) variables on other I(1) variables, the I(0) variables, and the lags and leads of the first difference of the I(1) variables. This ensures that the DOLS is asymptotically efficient, since it solves endogeneity and serial-correlation problems. The FMOLS as a single cointegrating vector, is used for the long-run estimates of I(1) variables. The FMOLS modifies the least squares by taking into consideration the serial-correlation and endogeneity effects in the regressors that emanate from the presence of the cointegrating relationship. The procedure begins with the conventional OLS estimation, and it makes a nonparametric correction that accounts for the endogeneity and serial-correlation that might arise in the OLS residuals (Singh, 2015). The CCR method implements the OLS estimation by transforming variables using the long-run covariance matrix of the error terms so that the OLS estimator is asymptotically efficient (Beard, Jackson, Kaserman, & Kim, 2010).

Two estimations were conducted using the DOLS estimator. The first involves using fixed lead and lag lengths of 1 with the Bartlett Kernel and Newey-West automatic bandwidth. The second involves lead and lag lengths that are determined using the automatic AIC with the Bartlett Kernel and Newey-West automatic bandwidth. We also estimated a static OLS (excluding a lead or lag) with the Bartlett Kernel and Newey-West automatic bandwidth. The CCR was implemented using the automatic AIC to determine the lag length with the Bartlett Kernel and Newey-West automatic bandwidth. The FMOLS was estimated using the automatic AIC to determine the lag length with Bartlett Kernel and Newey-West automatic bandwidth.

The results of estimations using the FMOLS, DOLS, static OLS and CCR (Table 5) indicate that unemployment has a long-run negative and significant effect on inflation at the 1% level. For example, the result of the FMOLS estimation (Panel C) reveals that a 1 percent increase in unemployment leads to a 0.53 percent de-

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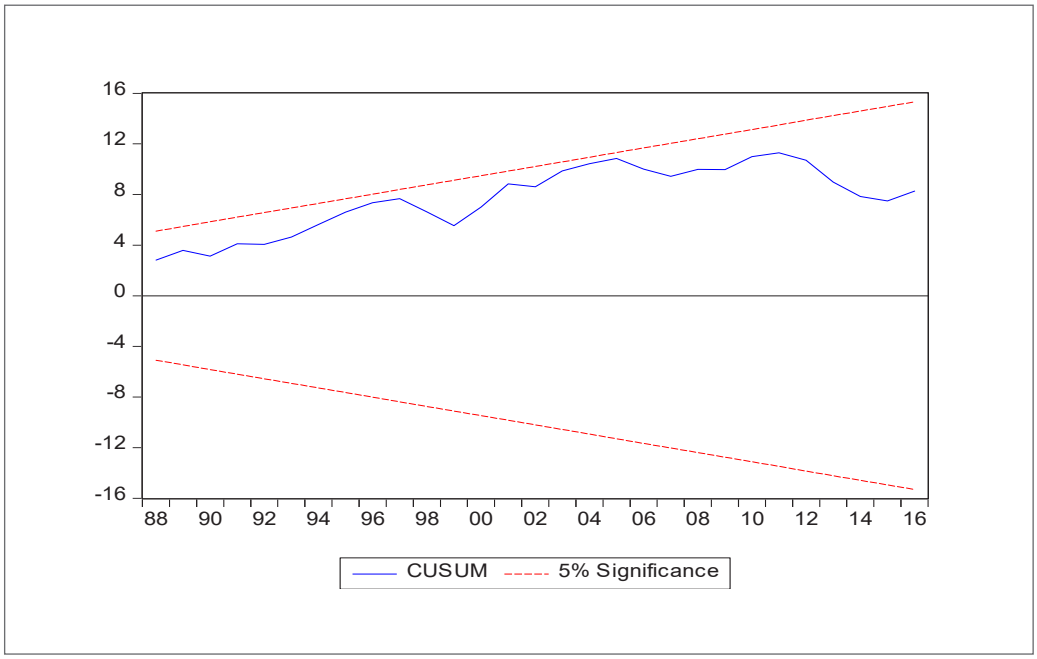

Figure 1. Cumulative Sum of the Recursive Residuals Plots

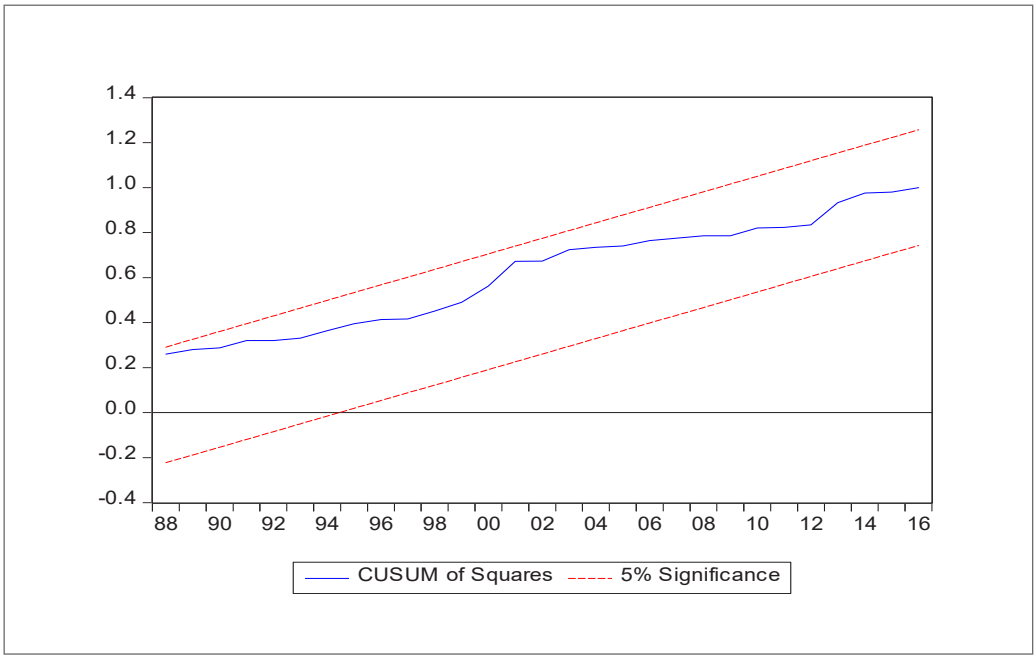

Figure 2. Cumulative Sum of Squares of the Recursive Residuals Plots

Table 5. Results of the FMOLS, DOLS, OLS and CCR Models

Panel C: FMOLS - Dependent variable is LINF				
Regressor	**Coefficient**	**Standard Error**	**T-Ratio**	**Prob.**
C	3.7725	0.2837	13.2953	0.0000
LUNEM	-0.5314	0.1380	-3.8491	0.0005
R^2	0.1914			
Panel D: Static OLS - Dependent variable is LINF				
Regressor	**Coefficient**	**Standard Error**	**T-Ratio**	**Prob.**
C	3.4312	0.2914	11.7719	0.0000
LUNEM	-0.3977	0.1435	-2.7698	0.0089
R^2	0.1614			
Panel E: DOLS (fixed lead=1, lag=1) - Dependent variable is LINF				
Regressor	**Coefficient**	**Standard Error**	**T-Ratio**	**Prob.**
C	3.7421	0.2010	12.8561	0.0000
LUNEM	-0.5418	0.1436	-3.7727	0.0007
R^2	0.2851			
Panel F: DOLS (lead=5, lag=7 based on AIC) - Dependent variable is LINF				
Regressor	**Coefficient**	**Standard Error**	**T-Ratio**	**Prob.**
C	4.1066	0.2853	14.3935	0.0000
LUNEM	-0.6365	0.1573	-4.0462	0.0029
R^2	0.6497			
Panel G: CCR - Dependent variable is LINF				
Regressor	**Coefficient**	**Standard Error**	**T-Ratio**	**Prob.**
C	3.7492	0.2766	13.5507	0.0000
LUNEM	-0.5223	0.1374	-3.8014	0.0006
R^2	0.1938			

crease in inflation. In addition, the result of the static OLS estimation (Panel D) indicates that a 1 percent increase in unemployment leads to a 0.40 percent decrease in inflation. Furthermore, the result of the DOLS estimation (fixed lead=1 and lag=1) (Panel E) illustrates that a 1 percent increase in unemployment leads to a 0.54 percent reduction in inflation. In the same vein, the result of the DOLS estimation (fixed lead=5 and lag=7) (Panel F) demonstrates that a 1 percent increase in unemployment leads to a 0.64 percent decrease in inflation. Additionally, the result of the CCR estimation (maxlag=3, based on the AIC) (Panel

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Table 6. Results of Causality Tests

Granger Causality Test				
Null Hypothesis	**No. of Lags**	**F-Stat.**	**Prob.**	**Conclusion**
LUNEM does not cause LINF	2	1.3389	0.2773	Accept Null Hypothesis
LINF does not cause LUNEM	2	3.2130	0.0544	Reject Null Hypothesis
Toda-Yamamoto Causality Test				
Null Hypothesis	**No. of Lags**	**Chi-Sq.**	**Prob.**	**Conclusion**
LUNEM does not cause LINF	2	0.8214	0.6632	Accept Null Hypothesis
LINF does not cause LUNEM	2	6.5615	0.0376	Reject Null Hypothesis

G) shows that a 1 percent increase in unemployment leads to a 0.52 percent reduction in inflation.

Overall, the results of the various estimation techniques including the ARDL bounds testing, FMOLS, static OLS, DOLS and CCR yield identical signs (i.e., negative), indicating that unemployment has a long-run negative and significant effect on inflation. In addition, the DOLS estimates appear to have the highest explanatory power, since the values of the unemployment coefficient (=-0.64) and R^2 (=65%) are the highest compared to other estimates. Nevertheless, the similarity in the coefficient signs further raises the confidence that the estimates are consistent and robust.

3.6 Results of Causality Tests

Having estimated the relationship between inflation and unemployment, a causality test was conducted to ascertain the direction of the causality between inflation and unemployment. To this end, the standard Granger causality test was employed. The results reported in Table 6 indicate that inflation Granger causes unemployment at the 10% level.

As a complement to the standard Granger causality test the Toda and Yamamoto (1995) approach was employed to perform the causality test. The method is very useful since it does not require pretesting for cointegration among variables (Chen, 2009). The results of the causality test (Table 6) demonstrate that inflation causes unemployment at the 5% level. These findings suggest that there is unidirectional causality from inflation to unemployment in Nigeria.

4. Conclusion

This study employs the ARDL bounds testing approach to investigate the Phillips curve hypothesis for Nigeria during the 1980-2016 period. Other estimation techniques including the FMOLS, DOLS, static OLS, and CCR were employed to check the consistency and robustness of the results that were obtained using the ARDL bounds testing method. The result of the cointegration analysis indicates that inflation and unemployment have a long-run relationship. The results of analyses using the ARDL bounds testing, FMOLS, DOLS, static OLS and CCR techniques illustrate that there is a trade-off between inflation and unemployment, and higher unemployment leads to lower inflation in the long-run. Moreover, the result of the CUSUMQ test indicates that the parameters are stable over the long-run. In addition, the results of the standard Granger causality and Toda and Yamamoto causality tests demonstrate that inflation causes unemployment.

The findings of this study indicate that the trade-off Phillips curve exists in Nigeria, and the relationship is stable over the long-run. Based on these findings, this study recommends policies to reduce inflation and unemployment in Nigeria.

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