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Article

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ON THE STABILITY OF THE PHILLIPS CURVE IN NIGERIA: DOES THE LUCAS CRITIQUE APPLY?¹

Moses K. Tule (PhD)² and Adegoke Ibrahim ADELEKE (PhD)³

Abstract

This study seeks to examine the stability of the Phillips Curve in Nigeria, as well as to ascertain the applicability of the popular Lucas Critique to the Phillips Curve in Nigeria. Using quarterly data from 1990Q1 to 2018Q3, the model is estimated with robust OLS that accounts for possible heteroscedastic and autocorrelation standard errors. The empirical results reveal that the standard empirical Phillips Curve appears not to apply strictly in the Nigerian case and this result is in conformity with the existing literature, particularly from developing countries. It also shows that an increase in economic output has the tendency of reducing inflationary pressure in the Nigerian economy. The study, therefore, recommends that fiscal and monetary policy must improve on measures and policies that could enhance domestic productivity in order to tame inflationary pressure in the Nigerian economy.

JEL Classification: E31; E01; C22

Key Word: Inflation, Output Gap, Phillips Curve, Robust Least Square Model, Nigeria

¹ The views expressed in this paper are those of the authors and do not in any way reflect the official position or thinking of the Central Bank of Nigeria. All Correspondence on this paper should be directed to aiadeleke@cbn.gov.ng or adelekeibrahim2004@yahoo.com. We are grateful to the anonymous reviewers and editors for their insightful comments on this paper.

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1.0 INTRODUCTION

The underlying rationale for the implementation of macroeconomic policies is to achieve the primary objectives of attaining full employment for the working population and maintaining economic stability by mitigating inflationary shocks. This realization prompted Phillips (1958) to study the relationship between inflation and unemployment following which it was observed that there exists an inverse relationship between the unemployment rate and inflation. The findings compelled Okun (1962) to analyse the relationship between output gap and inflation, where it was discovered that a positive correlation between the output gap and inflation exists. The Philips Curve clearly indicates the trade-off that must ensue in order to achieve key macroeconomic objectives (Onakoya, 2018).

The extant literature on the interaction between inflation and unemployment, in the attempt to acquire an instrument with which to adequately forecast macroeconomic variables and effectively implement monetary policies, led to the emergence of the Phillips Curve theory (Sergo *et al.*, 2012). The classic Phillips Curve principle proposes that inflation and unemployment are not positively correlated as highlighted in Phillips (1958) classic examination of wage behavior in the United Kingdom. Nonetheless, this postulate has received several criticisms which have led to its refinement, including the realization that there exist some issues with regard to the absence of rational expectations in the classic Phillips Curve and the typical assumption of linear equilibrium and parameter stability in the process of estimation (Chuku, *et al.*, 2017). In sharp and noteworthy criticism of the theory, however, Lucas (1976), objects to the adoption of backward-looking estimation models, which lack predictive abilities due to the assumption of equilibrium of parameters, adding that this would be insufficient to cater for the potential changes in the behaviour of economic agents in line with policy shifts.

The consensus remains that inflation and unemployment are contemporary issues in many countries, as policymakers strongly desire to attain low levels of both parameters. There is a contention that low level inflation; commonly in the single digits, combined with a rate of unemployment not exceeding five per cent is almost guaranteed to preserve the stability of a nation's macro economy, which is integral to achieving sustained economic growth. It is for this reason and for the overarching goal of economic stability that policymakers are interested in analyzing shifts in inflation and unemployment.

The extant literature in Nigeria attempts to analysis the relationship between inflation and unemployment to test the stability of the Phillips curve. A number of these studies invalidated the Phillips curve hypothesis being applied in Nigeria (Orji *et al.*, 2015). Some authors have criticized these findings, arguing that the extant analysis does not take into account possible structural breaks which may exist and affect the dynamics of the interaction of the variables (Chuku *et al.*, 2017). It is also suggested that studies on the Phillips curve in Nigeria, which account for these breaks in addition to testing the applicability of the Lucas critique, are significantly lacking. In this regard, this paper seeks to analyze the stability or otherwise of the Phillips curve in Nigeria and the applicability of the Lucas critique with the application of standard econometric analysis.

This paper seeks to re-evaluate the stability of the Phillips curve using Nigerian data, in addition to determining the applicability or otherwise of the Lucas critique in Nigeria. The rationale for this paper, premised on the existence of the Phillips curve, describes the trade-off that must be achieved and the sacrifice ratio for the inflation rate to allow a tolerable unemployment rate.

This paper is structured into six (6) sections; Section 1 provides the introduction for the study including the importance of the stability of the Phillips curve for monetary policy in Nigeria; Section 2 presents the stylized facts on key macroeconomic variables in Nigeria; Section 3 is a review of the extant literature

on the subject-matter including a discussion of the theoretical underpinnings and an empirical review; Section 4 presents the research methodology, while Section 5 presents and discusses the research findings; Section 6 summarizes and concludes the paper with policy recommendations.

2.0 STYLISTED FACTS OF THE KEY MACROECONOMIC VARIABLES IN NIGERIA

2.1 Trend Analysis of Key Economic Variables

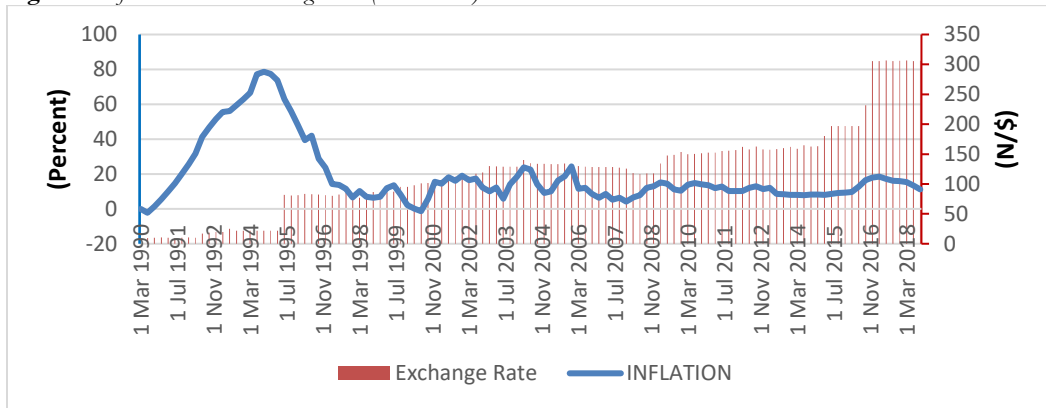
The maintenance of price stability is a major macroeconomic challenge that the Nigerian policymaker has been confronted with throughout the country's economic history. Not every rise in prices is termed as inflationary because for a rise in price to be termed inflationary, such a rise must be constant, persistent and sustained. A sustained rise in the general price level is particularly detrimental to low-income earners in an economy due to the absence of savings with which to cushion the effect of the upward trending prices.

In more recent times, the policy debate has centered on the pathway to achieving desirable and sustainable rates of inflation in the Nigerian economy. Thus, the focus may not be on attaining a single digit inflation, but rather on maintaining the rate within the limits of a favorable threshold. The data shows that Nigeria's inflation rate dropped by 14.2 percentage points from 21.4 per cent to 7 per cent between 1980 and 1981 but experienced a surge in the following years to over 40 per cent by 1983. This was remedied by the introduction of the Structural Adjustment Program (SAP) during 1986 to 1992, which reduced inflation to an average rate of 32 per cent.

From the figure below, it is evident that Nigeria's inflation rate recovered, to about 13 percent in the years leading up to 2007. This may be attributed to Nigeria's initiation of democratic governance along with shifts in the economic management architecture. The inflation rate reduced further to an all-time low of 5.57 per cent in 2007 before spiking to double digits and stood at 15.1 per cent at the end of 2008, owing largely to the Global Financial Crisis of 2007-2008. In the following years, inflation rates remained at double digits up until 2013 when it fell to 8.25 per cent and remained at single-digits up until 2015 to average 9.2 per cent at the end of the same year.

Nigeria's more recent data shows that inflation doubled from 9.5 per cent in December 2015 to 18.5 per cent in December 2016, largely driven by a surge in food and energy prices, in addition to the direct and latent effect of the Naira's depreciation following the low global oil prices and low accretion to external reserves coupled with the attendant external shocks. The inflation rate has since maintained a steady decline, decreasing significantly to 11.3 per cent in September 2018.

Figure 1: Inflation and the Exchange Rate (1990-2018)

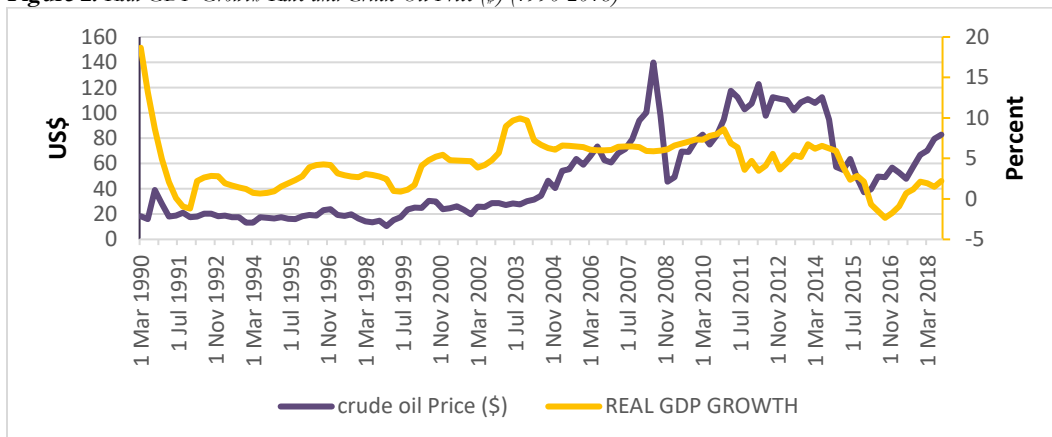


Source: CBN Online Database

The relationship between inflation and the exchange rate, and the mechanism through which the exchange rate appreciates and depreciates without government intervention, is determined by the following: the exchange rate regime, macroeconomic objectives of government, the nation’s economic openness and the level of capital mobility in the economy. The exchange rate regime that a country adopts plays a significant role in the stability of the real exchange rate, which consequently impacts the rate of inflation. Ultimately, ensuring price stability and maintaining favourable levels of inflation in the economy have been major objectives of the Central Bank of Nigeria since its inception.

Throughout the economic history of Nigeria, various exchange rate regimes have been practiced. From 1986 till recent times, Nigeria has operated the Second-Tier Foreign Exchange Market, managed-floating exchange rate system and various auction systems such as Auction System, Dutch Auction System, Wholesale Dutch Auction System, and Retail Dutch Auction System.

Figure 2: Real GDP Growth Rate and Crude Oil Price (\$) (1990-2018)

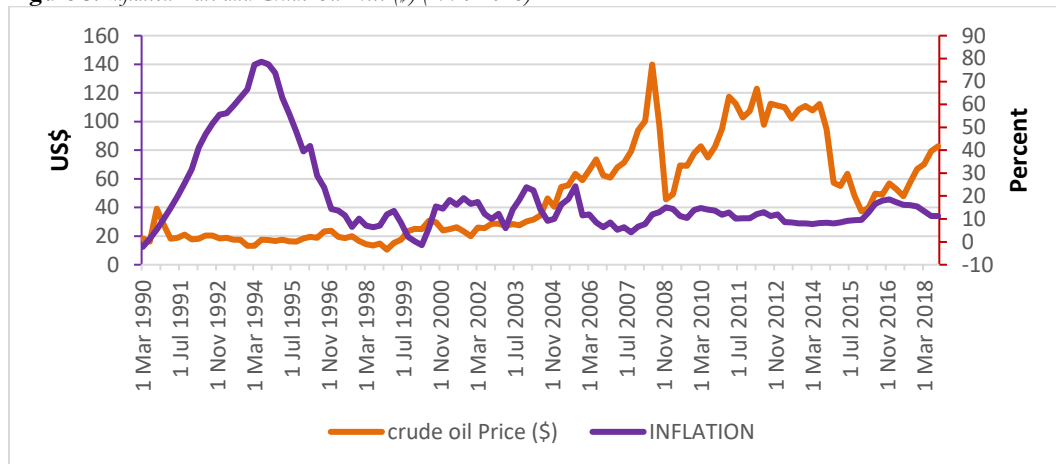


Source: CBN Online Database

The consequences of substantial misalignments of the exchange rate can lead to output contraction and extensive economic hardship. Moreover, there is reasonably a strong evidence that the alignment of exchange rates has a critical influence on the rate of growth of per capita output in low-income countries (Isard, 2007). For a developing and oil-dependent economy such as Nigeria, the price of oil bears significant influence on the country's gross domestic output (GDP).

The trend in crude oil price and real GDP growth rate shows that these variables are closely aligned. A rise in crude oil prices indicates a subsequent rise in growth of real GDP and vice-versa. Crude oil prices maintained a steady rise in the 1990s until 2008, when it crashed from 100.3 USD per barrel during the first quarter (Q1) of 2008 to 45.59 USD in the 4th quarter (Q4) of 2008, owing largely to the global financial crisis in the same year. In the following years, crude oil prices increased up to an annual average of 93.03 USD per barrel in 2014 before dipping to 37.3 in December 2015 and, then rising steadily to 82.72 USD in the third quarter (Q3) of 2018. Real GDP growth rate was also observed to be moving in the same direction, rising to an annual average of 6.23 percent in 2014 before dipping to -1.56 in 2016 and, eventually rising to 1.5 in the second quarter (Q2) of 2018.

Figure 3: Inflation Rate and Crude Oil Price (\$) (1990-2018)



Source: CBN Online Database

The rapid growth in money supply which arose following the monetization of oil earnings also exerted upward pressure on the general price level. From the figure above, inflation rate and oil prices tend to move in a correlated fashion. Oil prices experienced a rise from an average of 27 US dollars per barrel in 2000 to an all-time high of about 100 US dollars per barrel in 2008. There was also a corresponding rise in inflation from a yearly average of 8.6 per cent in 2000 to a double-digit figure of 12.0 percent by 2008, reaching a high of 15.1 percent in the 4th Quarter of 2008.

Interestingly, oil prices crashed in the 4th Quarter of 2008, dropping to a low of 45.6 US dollars per barrel, demonstrating a decline of over 50 per cent. This sharp decline can be ascribed to the Global Financial Crisis of 2007-2008. During the period, data shows that Nigeria's inflation rate began to experience a steady rise, as is expected in a period of financial crisis. From 2013 to 2018, inflation is observed to level out and eventually declined as crude oil prices gained stability and, subsequently began to rise in 2017.

2.2 Inflation and Unemployment Rates in Nigeria-The Phillips Curve Trade-Off

The unemployment rate is another notable variable in macroeconomic management, as it provides insight into the level of output loss or gain to an economy; and a higher rate of unemployment connotes costs to economic output. The rate indicates the proportion of the population fit for employment but unable to obtain it. Early statistical data on Nigeria's unemployment erroneously suggests that the economy was operating at full employment; however, during the democratic administration which commenced in 1999, the unemployment rate recorded at annual average of 6.05 per cent, falling slightly to 5.56 per cent by the end of that administration in 2007. Unfortunately, Nigeria's unemployment rate failed to adequately rebound, rising to an annual average of 17.11 per cent in 2017, with a projection that the rate of increase would be sustained beyond year 2020.

Figure 4: Inflation and Unemployment Rates (in Percent), 1990-2018



Source: CBN Online Database

Where there exists a steady rise in unemployment and inflation, the situation gives rise to a phenomenon known as stagflation which hinders optimal macroeconomic stability. The literature, however, argues that in order to achieve the seemingly impossible policy objectives of low unemployment and low inflation rates, a trade-off must be determined as to what the sacrifice ratio should be for the inflation rate to allow a tolerable unemployment rate (Ekpo, 2012).

Following Phillips (1958) observation of the opposing interaction of unemployment and inflation in the UK economy during the period of 1861-1957, Samuelson and Solow (1960) and Samuelson (2008) confirmed that similar arrangements existed in countries outside Europe. The commonality in these studies was that low rates of unemployment were linked to high inflation rates, while higher unemployment rates were associated with low inflation. A key suggestion of the Phillips curve is that a country's fiscal authority is equipped to simultaneously manage inflation and unemployment in order to achieve low unemployment within a reasonable limit of inflation, for example, since there would be a trade-off between the variables. Studies also suggest that economic stimulus and increase in a nation's GDP by means of policy measures such as deficit budgets will generate lower unemployment with the absence of a significant spiral in the inflation rate.

Table 1: Key Macroeconomic Variables in Nigeria (1990-2018)

5-Year Average	CRUDE OIL PRICE (\$)	REAL GDP GROWTH	INFLATION	UNEMPLOYMENT RATE	EXCHANGE RATE
1990-1994	19.304	3.268	42.678	0.735	16.680
1995-1999	18.112	2.636	20.673	0.730	84.801
2000-2004	28.904	6.078	13.700	3.530	120.885
2005-2009	72.852	6.386	11.310	3.575	131.476
2010-2014	101.120	5.835	10.575	7.461	159.081
2014-2018	64.696	2.036	12.384	13.339	244.215

Source: CBN and Bloomberg Online Database

The absence of a spiral in the rate of inflation indicates that policymakers have a choice to prioritize either stable inflation or unemployment, for which Phillips curve investigations suggest that a trade-off, with the support of instruments of demand management, is essential to impact inflation and the rate of economic growth. In this regard, where there exists a high rate of unemployment and low inflation, the monetary authorities may seek to encourage aggregate demand in order to tackle unemployment, but at the opportunity cost of spiking inflation. The Phillips Curve concept has, however, received some criticism from 'monetary economists' with the argument that a trade-off between unemployment and inflation was not required in the long term, and this followed the collapse of the Phillips Curve and ensuing stagflation of the 1970s.

The analysis of the interaction between inflation and unemployment in the extant literature reveals varying viewpoints which are primarily due to several manifestations of the instability of the interaction.

3.0 LITERATURE REVIEW

3.1 Theoretical Review

Phillips (1958) produced his famous paper titled "The Relationship between Unemployment and the Rate of Change of Money Wage Rates in the United Kingdom 1861-1957" in which he argued that a significant trade-off existed between unemployment and inflation in the economy under review – the United Kingdom. This negative relationship established by Phillips is referred to as the Phillips Curve. Following the claims made by Phillips, various studies have been conducted with the aim to refute or confirm it. The Phillips curve depicts a negative correlation between inflation and unemployment. A rise in inflation owing to increased economic growth would result in the creation of more jobs and an eventual decline in the unemployment rate.

In the study, Phillips analyzed the correlation between unemployment and inflation by investigating the trade-off in their relationship (Phillips, 1958). Although a negative relationship exists in the short-run, similar behavior has not been observed in the long-run. On the role of monetary policy in the management of inflation and unemployment, Friedman (1968) argued that the Phillips curve does not hold validity in the long-run as monetary policy would not impact unemployment in the long-run to decrease it and, therefore, the Phillips curve argument could only be applied in the short-run. He then predicted the behaviour and trend of inflation and unemployment, stating that the variables would

experience an increase in the years which followed. Friedman's argument maintained that the trade-off of the Phillips Curve would not exist in the long-run because the relationship is ephemeral and accidental.

The Lucas critique is a key aspect of economic theory (Lucas, 1976). Lucas critique of economic policy evaluation states that if there is a statistical relationship between two variables, for example, inflation and unemployment in the Philips curve, any attempt to explain this relationship may result in its breakdown. In other words, purely empirical relationships cannot be used to perform meaningful counterfactual policy analysis.

It is, therefore, crucial to model simple phenomenon such as the supply and demand curves also in addition to more complex economic parameters such as consumer preferences. The Lucas critique argues that there were errors with how certain groups of economists performed research in the mid-1970s because these econometric models assumed parameter constancy and, therefore could not account for potential changes that economic agents make when policies change. These shortcomings, Lucas argued, would generate unsatisfactory policy recommendations.

The Lucas (1976) critique of the Phillips curve agrees with the Phelps-Friedman theory which suggests that permanent changes in inflation will not alter the average rate of employment. He argues that one can imagine situations where an empirical Phillips curve exhibits long lags and a phenomenon where it exhibits an absence of lagged effects. Either way, the relationship between inflation and output in the long run as estimated conventionally, lacks bearing on the actual consequences of policymakers implementing an inflation-targeting approach.

The Lucas critique consequently postulates that the framework of an econometric model comprises key decision rules of economic agents and that these principles fluctuate methodically with changes in the structure of arrangements suitable to the management of the central bank. It posits that any adjustment in approach would efficiently modify the structure of the econometric models.

Ultimately, empirical studies have presented varied results. Various researchers observed the significant trade-off correlation between unemployment and inflation while some argued the absence of this relationship. Shaari et al., (2017) in their study on the presence of the Phillips curve found that there exists a bidirectional relationship between inflation and unemployment in both the short-and long-run for high-income countries. Among the extensive literature produced in the 1990s, Alogoskoufis and Smith (1991) examined and provided empirical evidence with which to reinforce the "Lucas critique" which refutes that a trade-off relationship exists between unemployment and inflation.

On the other hand, studies including King and Watson (1994) examined, using post-war economic data, the presence of the Phillips curve. They found evidence to the presence of a negative trade-off inherent in the unemployment-inflation relationship in the United States. The study concluded that the Phillips curve could exist if noise in the short- and long-run are removed from the economic data. Hogan (1998) examined the Phillips curve, employing the macroeconomic data for the period 1960 to 1993 for the United States. Their findings indicate that a significant trade-off exists with unemployment and inflation even though the Phillips curve appears to over-estimate the rate of inflation. Hansen and Pansc (2001) investigated the presence of the Phillips curve in Latvia and discovered the existence of a critical relationship between the unemployment rate and inflation.

3.2 Empirical Review

In the developed countries, several studies have been carried out on the relationship between inflation and unemployment. For instance, Alogoskoufis & Smith (1991) state that evidence on the significance of the Lucas critique was required and, thus, aimed in their study, at providing such evidence from various exchange-rate regimes. They presented empirical evidence from the United States and the United Kingdom, to show that the sustained rise in the level of prices is essentially larger under a fixed exchange rate regime. These distinctions are observed in the expectations-augmented Phillips curves. The study used a two-nation macro model, to show that looser monetary policies and greater tolerance of inflation differentials in the exchange rate would result in a continuous rise in inflation. The evidence did not repudiate this conclusion, but rather bolsters the theory of forward-looking price-setters and features the exact centrality of the Lucas critique.

The inflation-forecasting ability of the Phillips curve was explored by Chlestos et al., (2016) which investigated the period of the Great Recession. They utilized quarterly data for the United States and Canada and estimated the slope of the Phillips curve over a rolling 10-year (40-quarter) window. The results of the paper revealed evidence which supported the empirical instability of both countries. The results of the study indicate that the United States experiences a smaller slope coefficient from 1980 upwards while the opposite occurs for Canada as the slope coefficient increased from 2000. The study subsequently concludes that it is appropriate to model the variation in time of the slope parameter as it aids in achieving prediction accuracies for the United States, although not for Canada.

In the study by Turner & Seghezza (1999), the panel data estimation technique was utilized. The paper investigated 21 OECD countries, by examining the trend with the aim of determining the behavior of the Phillips curve in these economies from the 1970s up until 1997. To examine the pooled data, the study employed the Seemingly Unrelated Estimation (SURE) technique instead of the Ordinary Least Squares (OLS) method. The study inferred that the general outcome provided “strong support” for the presence of the standard Phillips curve among the selected member states of the OECD.

Relatively few studies have been carried out in this area in Africa. It has been suggested that the Phillips curve (positive output-inflation correlation) experiences an inverse phenomenon in lower-income countries. Studies including Bleaney & Fransisco (2017), argue that ephemeral supply-side shocks in low-income economies, such as with agricultural output, cause a trade-off between prices and output as opposed to the notion that a trade-off would exist between inflation and output. The study provides evidence to reveal that there exists a significant presence of the standard Phillips output-inflation relationship, which is typically translated as representing aggregate demand shocks, for the developed economies, while in contrast, in developing and poor economies this relationship is weak and statistically insignificant.

Despite the availability of substantial research on the Phillips Curve, studies that investigate the hypothesis in the case of developing economies have been lacking. Furuoka (2007) in the study to support the existence of the Phillips Curve, chose Malaysia as a case study for the contextual analysis to examine the connection between inflation and unemployment. The study demonstrated the presence of a long run and negative correlation – and furthermore, revealed a causal correlation between unemployment and inflation in Malaysia.

Esu & Atan (2017) sought to evaluate the legitimacy of the Phillips Curve in Sub-Saharan Africa. The study utilized the panel data analysis method; the empirical analysis revealed that there was no notable correlation between the inflation rate and the rate of unemployment in the selected countries. The result of the study, therefore, invalidates the existence of the Phillips Curve in the Sub-Saharan region.

In Nigeria, an array of research has been undertaken to determine if the relationship of the Phillips curve exists in the Nigerian economy and the significance of this relationship. These empirical studies of the Phillips curve hypothesis vary in their conclusions.

Orji et al., (2015) in their study examined the inflation and unemployment relationship in Nigeria by investigating whether the original Phillips Curve argument holds for Nigeria or not. This work adopted a distributed lag model with data spanning the period 1970-2011. The result revealed that unemployment is a significant determinant of inflation and that a positive relationship exists between inflation and unemployment rate in Nigeria. They, therefore, claimed that the results of their findings invalidate the original proposition on the Phillips Curve hypothesis in Nigeria.

Likewise, in the paper by Iyeli and Ekpung (2017) to investigate the existence of an asymmetry between price expectation and unemployment, the findings revealed a direct or positive relationship between inflation and unemployment in the Nigerian economy. This result deviates from the inverse relationship argued by the Phillips curve.

On the other hand, studies by Balewa and Jelilov (2018) claimed that unemployment is negatively influenced by inflation and a strong relationship was seen to exist between unemployment and inflation in Nigeria. Their study employed the Autoregressive Distributive Lag (ARDL) model and the results of the empirical analysis revealed also that a long run relationship exists between unemployment rate and inflation. Adebowale (2015) also had similar results as his study revealed a negative relationship between unemployment and inflation in Nigeria. His paper adopted the Vector Error Correction Model and Granger Causality techniques in order to test the Phillips curve hypothesis in Nigeria.

Various other studies including Asosu (1998) support the proposition that no inverse relationship exists between inflation and unemployment in Nigeria. On the other hand, Oluleye (2005) using the descriptive approach of plotting two-dimensional graph of inflation and unemployment data for the period 1980-2003, found that there exists an inverse relationship between inflation and unemployment in Nigeria. Likewise, Onwioduokit (2006) also found a negative relationship in his study.

It is clear from the empirical literature that there are conflicting results and this evidently points to further investigation, hence this present study, taking advantage of an extended data set as well as make effort to account for potential structural breaks in the relationship.

4.0 METHODOLOGY OF THE STUDY

This paper analyses the stability of the Phillips curve in Nigeria and at the same time examines if the Lucas critique applies to the Nigerian case. The study uses quarterly data for the period 1990Q1 to 2018Q3. Hence, the study utilizes time series econometrics technique to model the interrelationship amongst the key variables of interest. The contemporaneous relationship is examined using the regression approach in the context of correlation coefficient, and estimated the model using ordinary least square (OLS) with heteroskedasticity autocorrelation robust (HAC) standard errors to account for the possible serial correlation in the model. The summary statistics was utilized to scrutinize the basic statistical properties of the different variables entering the model. This is a very critical pre-estimation test. The Pearson correlation matrix (multi-collinearity test) was equally carried out to observe the association between the variables used in the study.

Other econometric tests employed to analyze the time series behaviour of the series include the Augmented Dickey-fuller (ADF) and Phillips-Perron (PP) tests for unit root to confirm stationarity or otherwise. This is often used in order to determine the order of integration of the variables of interest, that is, if they are integrated of order one $I(0)$ or integrated of higher order(s). The idea of differencing may sometimes imply very valuable information in the long-run which may be peculiar to the characteristics of the variable. The final specification of the model incorporated the dynamic process that is consistent with data. We followed the popular Gordon's (1982) model specification of the Phillips curve which states that current inflation depends on the previous inflation values, economic activities, supply shocks and stochastic error term, often specified as:

$$\pi_t = \mu + \alpha(L)\pi_{t-1} + \beta(L)x_t + \gamma(L)z_t + \varepsilon_t \quad (1)$$

where μ is a constant term, $\alpha(L)$ and $\beta(L)$ are lag polynomials written with a lag operator L , x_t is economic activities variables that often influence inflation in the Nigerian economy, z_t is a vector of supply shock variables, and ε_t is a stochastic disturbance term.

Equation (1) states that current inflation is dependent on some level of real economic activity, previous level of inflation which accounts for inflation persistence (Fuhrer and Moore, 1995). In this model, we followed the existing literature (such as Mazumder, 2010) by utilising world crude oil price to proxy supply shock variables, which is an important variable to describe some aspects of inflation behaviour that economic activity and lags of inflation may not be ably represented. The lags of $\alpha(L)$ and $\beta(L)$ are selected separately based on standard lag length selection criteria (such as Final Prediction error, Akaike, Hannan-Quinn and Schwarz information criterion).

In terms of measurement of variables used in the model, we utilised consumer price index (CPI) data obtained from the Central Bank of Nigeria (CBN) online database as well as the Statistical Bulletin to measure inflation. Two measures of supply shock variables were used in this study. We constructed the naira equivalent of the world crude oil price (US Dollar) by multiplying the series with the average Naira/U.S. Dollar exchange rate. Also, we transformed this variable by detrending the log of the naira equivalent oil price. This is the first measure of supply shock. In addition, we followed the literature (see Mazumder, 2010 and Paul, 2009) by using oil price shock dummy to serve as a robustness check for the actual oil price variable, where the dummy variable takes the value of 1 for the period where the international oil price is above the national (budget) crude oil price benchmark and the two quarters that follows, and 0 otherwise. For economic activities in the Phillips curve, we utilised the output gap (by computing the HP filter (Hodrick and Prescott, 1997)) of detrended log of GDP as against the actual output level. We also attempted to carry out robustness check for the GDP by using the unemployment rate in the economy as an alternative to the real GDP series/output gap.

5.0 PRESENTATION AND DISCUSSION OF RESULTS

This section presents the results of the different models estimated to understand the stability of the Philips Curve as well as the empirical validity of the Lucas critique in Nigeria.

5.1 Summary of the Descriptive Statistics of the Variables under Consideration

Table 2 below provides the descriptive statistics for the variables used in the analysis containing the means, medians, maximum, standard deviation, skewness, kurtosis as well as Jacque-Bera statistics and corresponding probabilities (p-values). The results of the summarized statistics indicate that all the

variables exhibit a positive mean return and varying degrees of volatility as can be seen from the standard deviations, with oil price being the most volatile and real GDP the least volatile. The p-value of Jarque-Bera statistic indicated evidence of non-normality in the distribution of the individual series.

Table 2: *Descriptive Statistics*

	INF	GDP	UNEMP	OIL
Mean	19.150	4.331	4.727	49.458
Median	12.850	4.363	3.127	38.190
Maximum	78.635	18.672	22.580	139.830
Minimum	-2.227	-2.340	0.171	10.530
Std. Dev.	18.076	3.111	4.960	33.759
Skewness	1.926	0.823	1.716	0.752
Kurtosis	5.782	6.032	5.676	2.331
Jarque-Bera	107.208	56.554	89.964	12.879
Probability	0.000	0.000	0.000	0.002
Observations	114	114	114	114

Source: Authors' Computation

5.2 Pearson Correlation Matrix

Table 3 presents the correlation analysis based on the variables used in the models. One of the key assumptions the ordinary least squares method relies on is the independence of the explanatory variables and pairwise correlation method is one of the commonly-used approach of analysis. It is often argued that the correlation coefficient among the independent variables should not be greater than 0.8 or 0.9 in absolute terms in order to avoid collinearity problem. Collinear variables do not allow independence of each variable in the model and, thus, tends to obscure the required separate information coming from each of the variables in the model, despite the fact that the variables may be based on sound economic judgement.

Table 3: *Correlation Matrix*

	INF	GDP	UNEMP	OIL
INF	1.0000			
GDP	-0.4106	1.0000		
UNEMP	-0.3018	-0.1860	1.0000	
OIL	-0.4110	0.2666	0.5108	1.0000

Source: Authors' Computation

Exploring the correlation between the variables in Table 3 indicates that all the variables are negatively related to inflation in line with a-priori expectations. The correlation is quite low among the variables; therefore, no strong correlation and multi-collinearity exists. The implication is that they are not substitutable between the variables.

5.3 Unit Root Test Results

This section presents the results of the unit root (stationarity) tests. The time series characteristics of the variables are presented in Table 4, using the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests at both level and first difference of the series. The time series property of each series was tested using the ADF test. In order to be sure that the stationarity properties of the series are confirmed, we have also carried out the Phillips-Perron (PP) test as shown below:

Table 4: Unit Root Test Results

	Augmented Dickey-Fuller (ADF) Test		Philips-Perron (PP) test		REMARK
	At Level	1st Diff	At Level	1st Diff	
INF	5.6884*	-11.3282*	-5.6983*	-64.2805*	I(0)
GDP	0.0007	-10.7753*	0.0930	-10.7883*	I(1)
UNEMP	-0.9265	-16.0627*	-1.1854	-16.4157*	I(1)
OIL	-1.0082	-7.2498*	-0.7594	-7.1683*	I(1)

Source: Authors' Computation *Indicates significance at 1 per cent level

The results presented in Table 4 indicate that the variables are integrated of mixed orders, that is, either stationary in levels I(0) or stationary after first differencing I(1). For instance, INF is integrated of order zero i.e. I(0) while GDP, OIL and UNEMP are integrated of order one i.e. I(1).

5.1 Empirical Analysis of the Stability of the Phillips Curve in Nigeria

In order to estimate the model in equation (1), we need to select the appropriate lag length for the empirical model. This was established based on the traditional lag length selection criteria i.e. the log likelihood test, sequential modified LR, the Schwarz Information Criterion (SIC), the Akaike Information Criterion (AIC), the Final Prediction Error (FPE) and the Hannan-Quinn (HQ) information criterion. The AIC and FPE supported lag length of three (3), while the SIC and HQ suggested 1 lag.

Table 5: Lag Order Selection Criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-1287.858	NA	6043860.	24.12818	24.20312	24.15856
1	-828.3161	884.7251	1330.509	15.70684	16.00660*	15.82836*
2	-819.3243	16.80712	1331.321	15.70700	16.23157	15.91965
3	-808.5050	19.61626	1288.200*	15.67299*	16.42238	15.97678
4	-804.2452	7.484558	1410.332	15.76159	16.73580	16.15652
5	-802.2468	3.399207	1612.611	15.89246	17.09149	16.37853
6	-791.3931	17.85276*	1564.934	15.85782	17.28166	16.43502
7	-787.8254	5.668379	1743.343	15.95935	17.60801	16.62770
8	-781.7272	9.346731	1856.299	16.01359	17.88707	16.77308

* 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

Based on this premise, the results of the estimated Phillips curve equation for Nigeria can be seen in Table 6. A critical examination of the result shows that the coefficients (both contemporaneous and lagged coefficients) of economic activity variable (ECOACT) clearly support the existing literature on Nigeria that the Phillips curve appears to be weak and insignificant for Nigeria. Specifically, the ECOACT and ECOACT(-2) coefficients are negative, though only significant at the 10% level for lags 2 and 3, signifying that the connection between output and inflation in Nigeria is not binding. Hence, the Phillips Curve appears not to hold strictly for the Nigerian case. In terms of the magnitude of the coefficients, it shows that a one per cent change (say an increase) in economic activity (output level) would generate about 0.70 per cent decline in inflation in Nigeria after two quarters. This portrays important economic information for policymakers since an increase in economic output has the tendency of reducing inflationary pressure in the Nigerian economy. That is, inflation and lags of economic activity are highly negatively related in Nigeria. Hence, one important policy implication emanating from this result is that government and policymakers that are desirous of reducing the inflationary pressure in the economy must ensure that they implement policies and programmes that will improve economic growth. Also, the result shows that the oil price variable plays an important role in influencing Nigeria's inflation rate from 1990Q1 to 2018Q3. It must be noted that even though the estimated sign of oil price is mixed, it shows the nonlinear or quadratic relationship between inflation

and oil price in Nigeria, as suggested in many other related literature⁴. In sum, the entire model fits the data well as it has a fairly high R^2 of about 62 per cent, laying credence to the fact that the Phillips curve does not necessarily fit empirical evidence for Nigeria.

Table 6: The Nigerian Phillips Curve, 1990:1-2018:3 (Dependent Variable INF)

Variable	Coefficient	Std. Error	Prob.
C	-4.9718	6.4926	0.4438
INF(-1)	1.0283	0.0859	0.0000
INF(-2)	0.0786	0.1202	0.5131
INF(-3)	-0.2032	0.0855	0.0174
ECOACT	-0.2133	0.1485	0.1509
ECOACT(-1)	0.6662	0.4320	0.1230
ECOACT(-2)	-0.6981	0.4228	0.0987
ECOACT(-3)	0.2456	0.1393	0.0778
OILGEN	2.0760	0.9995	0.0378
OILGEN(-1)	-5.7806	2.9519	0.0502
OILGEN(-2)	5.3915	2.9394	0.0666
OILGEN(-3)	-1.6867	0.9868	0.0874
R-squared	0.6226		

Source: Authors' Computation

5.2 Empirical Analysis of the Lucas Critique of Phillips Curve

The empirical analysis of the Lucas critique of the Phillips Curve as it relates to Nigeria would imply that the estimated model would not be stable over the long term. In other words, the estimated results would not be stable as the behaviour of the regimes or monetary policy authority changes (Fuhrer, 1995; Mazumder, 2010). In the empirical literature, there are two ways of testing the Lucas critique in the Phillips curve: it can be done by searching for the structural break evidence in the Phillips curve data or alternatively, we can estimate the Phillips Curve model for different monetary policy regimes and thereafter, extract the forecast of inflation for these estimated regimes. Although there are different approaches of identifying monetary policy regime in the literature, following existing literature (see Blanchard 1984) we assume that the emergence of a new central bank governor to be a credible proxy for categorising different monetary policy regime in Nigeria, as each governor comes with his own monetary policy thrust. Hence, in this paper, we describe monetary policy regime in Nigeria as the

⁴ We decided not to report the oil price dummy variable result as it appears trivial and this is in line with the existing literature (see Mazumder 2010).

period that various Central Bank of Nigeria Governors spent in office (see Table 7). We assigned the period of analysis/ regime to be the Governor that spent the longest time in office in case of overlap. Also, we merged the period for the Governor that spent less than four quarters as part of the next period, for convenience of analysis.

Table 7: *Nigeria's Monetary Policy Regimes*

Governor/Regime	Term Start	Term End	Analysis of Period in Office
Abdulkadir Ahmed	28 June 1982	30 September 1993	1990:1-1993:3
Paul Agbai Ogwuma	1 October 1993	29 May 1999	1993:4-1999:2
Joseph Oladele Sanusi	29 May 1999	29 May 2004	1999:3-2004:2
Charles Chukwuma Soludo	29 May 2004	29 May 2009	2004:3-2009:2
Sanusi Lamido Aminu Sanusi	3 June 2009	20 February 2014	2009:3-2014:1
Sarah Alade	20 February 2014	3 June 2014	2014:2-2018:3
Godwin Emefiele	3 June 2014	to date	

Note: *We assigned the period of analysis/ regime to the Governor that spent the most months in office in case of overlap. Also, we merged the period for the Governor that spent less than four quarters as part of the next period, for convenience of analysis.*

Nigeria's Phillips Curve monetary policy regimes results are presented in Table 8. From the Table it is clear that the data appears not to fit the model well as most of the variables in the early part of the monetary policy regimes are not significant except in the most recent regime (2014:2-2018:3) where most of the variables are quite significant. Hence, the R-squared in all the models range from 0.57 to 0.98 with the most recent regime of (2014:2-2018:3) having the highest of 0.98 and the period (2004:3-2009:2) having the lowest R-squared.

Table 8: Nigeria's Phillip's Curve (Monetary Policy Regimes) Results

Variable	A. Ahmed		P. Ogwuma		J. Sanusi		C. Soludo		Lamido Sanusi		G. Emefele	
	Coeff	Pro b.	Coeff	Pro b.	Coeff	Pro b.	Coeff	Pro b.	Coeff	Pro b.	Coeff	Pro b.
C	616.41	0.40	1215.54	0.14	-3818.11	0.22	-3220.55	0.23	-2407.69	0.00	719.53	0.10
INF(-1)	-0.30	0.56	-0.05	0.84	0.34	0.33	0.06	0.81	-0.34	0.16	0.64*	0.01
INF(-2)	0.32	0.66	-0.15	0.52	0.06	0.88	0.10	0.68	-0.15	0.36	-1.03*	0.01
ECOACT 1	-3.18	0.17	-1.65	0.13	-2.15**	0.02	0.38	0.85	0.63**	0.00	0.77*	0.02
ECOACT 1(-1)	5.45	0.18	3.77*	0.09	4.58**	0.03	0.15	0.97	-0.69**	0.02	-1.31*	0.02
ECOACT 1(-2)	-2.36	0.20	-2.09*	0.07	-2.59**	0.05	-0.16	0.91	-0.02	0.83	0.53*	0.02
OILGEN1	28.71	0.17	9.65**	0.02	19.03	0.32	2.99	0.73	3.66**	0.00	-1.62*	0.09
OILGEN1 (-1)	-39.99	0.22	-19.08*	0.01	-37.97	0.27	-5.95	0.69	-3.34**	0.00	1.56	0.10
OILGEN1 (-2)	10.97	0.36	9.25**	0.01	19.52	0.23	3.04	0.68	-	-	-	-
R-squared	0.69		0.90		0.86		0.57		0.92		0.98	

Source: Authors' Computation

Note: * denotes 10% level of significance
 ** denotes 5% level of significance
 *** denotes 1% level of significance

To determine if there is empirical evidence for a change in monetary policy regimes as well as policy setting behaviour in the Central Bank of Nigeria among the different regimes, we carried out a structural break test for each regime, utilising the CUSUM of Squares Residual. Figure 5 shows the results of the structural breaks/stability test results for different monetary policy regime in Nigeria. It is clear from the Figure that the estimated model results are stable for most part of the period except in two regimes of 2004Q3 to 2009Q2 and 2014Q2 to 2018Q3 (see Figure 5d and 5f) where the results are not stable. Generally, the behaviour of the regimes or monetary policy authority changes are stable in a large part of the regimes, hence, we can infer that the popular Lucas critique hypothesis does not really apply experimentally to the Nigerian Phillips Curve, that is estimated for the period 1990Q1 to 2004Q2 as well as from 2009Q3 to 2014Q1, since the data for a larger part of the period is stable.

Figure 5: Structural Breaks/Stability Test for Different Monetary Policy Regime in Nigeria

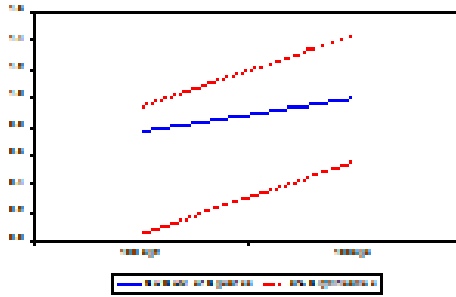


Figure 5a: Governor A. Ahmed Regime

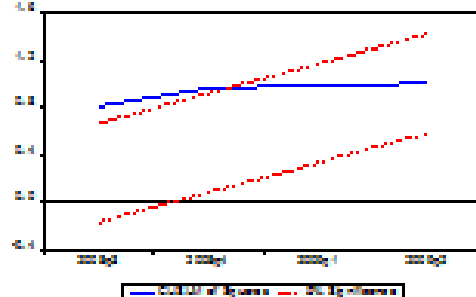


Figure 5d: Governor C. Soludo Regime

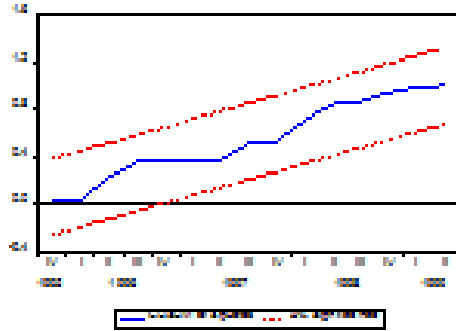


Figure 5b: Governor P. Obasanjo Regime

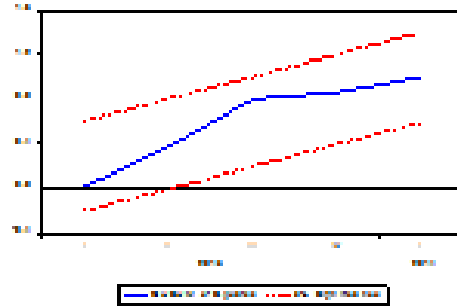


Figure 5e: Governor L. Sarajedini Regime

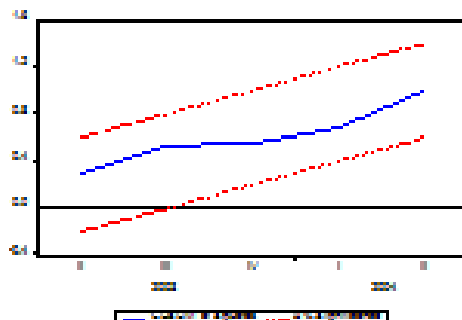


Figure 5c: Governor J. Sanusi Regime

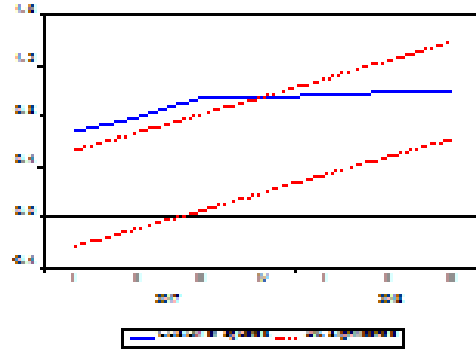


Figure 5f: Governor G. Emefiele Regime

6.0 SUMMARY, CONCLUSION AND RECOMMENDATION

This study seeks to examine the stability of the Phillips Curve for Nigeria as well as check the applicability of the popular Lucas Critique to the Nigerian Phillips Curve. It utilises robust OLS with heteroscedastic-autocorrelation standard errors to account for possible serial correlation in the model. Empirical results showed that the Phillips Curve appears not to apply strictly to the Nigerian case and, also the popular Lucas critique hypothesis does not really apply empirically to the Nigerian Phillips curve, as the estimated stability test result for the larger part of the period is stable. This study is particularly important because it is expected to bridge a yawning gap in the existing literature on the stability of the Phillips curve and the applicability of the Lucas critique to Nigeria.

The results also contain important economic information for policymakers, as an increase in output has the tendency of reducing inflationary pressure in the economy. That is, inflation and lags of economic activity are highly negatively correlated in Nigeria. Hence, one important policy recommendation emanating from this result is that government and policymakers that are desirous of reducing inflationary pressure in the economy must ensure that they implement policies and programmes that will improve economic growth.

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APPENDIX

Appendix: Table Analysis of the Literature Review

Author (Year)	Scope/Focus of the Study	Methodology	Theory / Theoretical Framework	List of Variables/Data	Result
Adebowale, K. B. (2015)	The Nigerian economy from 1977-2013	Vector Error Correction Model and Granger Causality Test	Augmented and Original Phillips Curve	-Inflation - Unemployment Rate -Interest Rate	This study shows that a negative and significant relationship exists between inflation and unemployment and that they are destructive to the development and growth of the Nigerian economy.
Alogoskoufis, G. S., & Smith, R. (1991)	The United States and the United Kingdom from 1857-1987	Two-Country Macro Model with forward looking price setters	Expectations Augmented Phillips Curve	-Hourly Wages -Retail Price Index (UK) -Consumer Price Index (US) -Unemployment Rate -GDP deflator (UK) -GNP deflator (US) -Exchange Rate	The result of this study reveals that higher monetary accommodation of inflation and exchange rate accommodation of inflation differentials increase inflation persistence.
Bleaney, M., & Francisco, M. (2017)	Large number of countries stratified by income groups from 1990-2012	Pooled OLS Estimation	New Keynesian Specification of the Phillips Curve	-Inflation -Real GDP Growth -Real Effective Exchange Rate -World Oil Price Inflation -World Rice Price Inflation -World Maize Price Inflation -Fiscal Balance/GDP Ratio	This study shows that the traditional Phillips inflation-output correlation exists significantly in high-income countries while a weak and insignificant relationship exists in middle-income and low-income countries. This weak relationship is due to temporary supply-side shocks such as climatic shocks on agricultural output experienced by developing countries.
Chlestos, M., Drosou, V., & Roupakia	The US and Canadian economy from 1960-2013	Ordinary Least Square Estimation technique and Hodrick-	The Standard Phillips Curve	-Inflation -Unemployment	The results of the study further suggest that the slope coefficient becomes smaller for the USA from 1980 and onwards, while it

s, S. (2016)		Prescott filter.			increases for Canada since 2000. The paper therefore concludes that modeling time variation of the slope parameter helps improve the accuracy of predictions for the USA, but not for Canada.
Esu, G., & Atan, J. (2017)	Sub-Saharan African Region from 1991 to 2015	Fixed Effect Panel Data Regression	Expectation Augmented Phillips curve	-Inflation -Unemployment Rate	The results show that there was an insignificant relationship between unemployment and inflation, thereby invalidating the existence of the Phillips curve in the Sub-Saharan African Region.
Friedman, M. (1968)	The United states economy from the 1920s-1960s	Descriptive Analysis	Monetary Policy Framework	-Inflation -Unemployment -GDP Growth	The study argued that the Phillips Curve was only applicable in the short-run and monetary policies would not decrease unemployment in the long-run. Therefore, the trade-off of the Phillips Curve would not exist in the long-run because the relationship is ephemeral and accidental.
Furuoka, F. (2007)	The Malaysian economy from 1973-2004	Vector Error Correction Model (VECM) analysis and Granger-Causality Test	Traditional Phillips curve	-Inflation -Unemployment Rate	This study showed that a trade-off existed between inflation and unemployment and that a long-run and a causal relationship also existed between inflation and unemployment in Malaysia.
Hansen, M., & Pancs, R. (2001)	The Latvian economy from 1996 to 2001	Descriptive Analysis	Phillips curve and Beveridge curve	-Inflation -Unemployment rate -GDP	This study shows that a negative relationship exists between output and unemployment in the Latvian economy when investigated through the Beveridge curve but no apparent relationship exists

					between inflation and unemployment through the Phillips curve.
Hogan, V. (1998)	The United States economy from 1960- 1993	Cochrane-Orcutt Estimation Technique	Traditional Phillips Curve	-Unemployment Gap -Price of Imports -Price of Oil -Minimum Wage	Results of the study showed that a significant and negative relationship existed between unemployment and inflation although the Phillips curve appeared to over-predict the rate of inflation
Iyeli, I. I., & Ekpong, E. G. (2017)	The Nigerian economy from 1970 - 2011	Co-Integration Estimation Technique	Traditional Phillips Curve	-Inflation -Unemployment	The findings obtained revealed a direct or positive relationship between inflation and unemployment in the Nigerian economy. This result deviates from the inverse relationship argued by the Phillips curve.
King, R. G., & Watson, M. W. (1994)	The United States economy from 1950 -1982	Bivariate Vector Auto Regression	-The traditional Keynesian macroeconomic model -Monetarist model of inflation and unemployment	-Inflation -Unemployment	The study shows that tradeoffs in the business cycle are due to demand shocks and are less significant in the long-run.
Lucas, R. E. (1976)	The Theory of Economic Policy	Descriptive Analysis	-The Lucas Critique	-Inflation -Unemployment	This study argued that there were errors with the Phillips curve model because the econometric model assumed parameter constancy and therefore could not account for potential changes that economic agents make when policies change. He therefore suggests that permanent changes in inflation rate will not alter the average rate of employment.
Orji, A., Anthony-Orji, O. I., &	The Nigerian economy from 1970-2011	Distributed Lag Model	The Modified Phillips Curve (inverse relation of	-Consumer Price Index -Unemployment Rate	The findings of the study reveal that unemployment is a significant determinant

Okafor, J. C. (2015)			unemployment and changes in inflation)	-Rate Of Money Supply -Budget Deficit -Real GDP -Interest Rate	of inflation and that there is a positive relationship between inflation and unemployment rate in Nigeria.
Phillips, A. W. (1958)	The UK economy from 1861-1957	Quantitative Analysis	The Phillips Curve	-Money Wages -Unemployment	The results show that the rate of change of money wage rates in the UK can be explained by the level of unemployment and the rate of change of unemployment, except in or immediately after those years which experience sufficiently rapid rise in import prices.
Shaari, M. S., Abdullah, D. N., Razali, R., & Md Saleh, M. L.-H. (2017)	Selected high-income countries from 1990-2014	Panel Data Analysis	The Phillips Curve	-Inflation -Unemployment	The findings of the study show that a bidirectional relationship exists between unemployment and inflation in both the long and short run.
Turner, D., & Seghezzi, E. (1999)	OECD Countries from 1964 - 1972	Single Equation OLS Estimation and System Estimation Technique	The Phillips Curve	-Inflation Rate -Output Gap -Ratio of imports of goods and services to GDP	The study shows that there is well determined long-run effect from the output gap on inflation for most of the countries however the speed of adjustment is typically faster for European Union countries, particularly the larger ones.