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Empirical assessment of the relationship between inflation, exchange rate and unemployment in Nigeria, 1999-2021

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Abstract
The correlation between unemployment and inflation is a significant topic in economics, as unemployment remains a global economic issue. Achieving price stability is agreed to have a positive impact on employment and economic growth, though finding the ideal balance is difficult. Central banks worldwide are striving to boost employment levels while maintaining price stability. In analyzing annual data from 1999 to 2021, the ARDL model and Bound test were used to study how changes in price levels affect unemployment in Nigeria. The findings show that a 1% inflation rate increase results in a 0.10% long-term unemployment rate increase. A 1% change in the exchange rate leads to a 1.2% increase in the unemployment rate. GDP has a negative but insignificant effect on the unemployment rate, correlating with a 1.3% decrease. While a long-term relationship exists between unemployment and inflation, there is divergence corrected at a 38% annual adjustment rate. Economic deepening, rather than solely relying on monetary targeting, can support maintaining an optimal inflation rate and minimal unemployment level.

Keywords: Unemployment; Inflation; Nigeria

1. Introduction

The Central Bank continues to prioritize maintaining price stability in their monetary policy. In order to achieve this goal, the Central Bank relies on inflation forecasts. These forecasts aid policymakers in determining whether an expansionary or contractionary monetary policy stance is appropriate (Omran & Bilan, 2021) [19]. Economic slack is a commonly used predictor of short-term inflation according to Doh (2011) [9]. Economic slack refers to the underutilization of resources such as labor and capital in the economy. The Phillips curve is a mathematical model utilized by economists to describe the short-term relationship between a sluggish economy and inflation (Crump, Eusepi, Giannoni & Şahin, 2022) [7]. It does this by using unemployment as a measure of economic slack. The Phillips curve depicts a predictable downward pressure on the cyclical component of inflation when the cyclical component of the unemployment rate increases (Doh, 2011) [9].

Unemployment has become a global issue, posing challenges for nations at all levels of development. Despite the growth in the number of individuals in the working-age population who are unemployed, fiscal and monetary policies have yet to effectively address this concern (Fung & Nga, 2022) [11]. Unemployment is characterized by a lack of job opportunities for individuals who are actively seeking employment, despite their willingness and ability to work. Traditionally, economists have believed that there is a trade-off between unemployment and inflation, which has implications for policymakers (ECB, 2021) [10]. However, this perspective is no longer universally held, as some economists argue that full employment is only achieved when every person who desires work can find it. While policymakers aim to keep unemployment rates as low as possible, it is a challenging objective to achieve (Carnevali & Deleidi, 2020) [5].

However, there exists another group of individuals who maintain that full employment can only be attained when the rate of unemployment is at its minimum and the rate of inflation remains stable at the same time, also known as the natural rate of inflation according to economists.

Policymakers could benefit greatly from determining the natural rate of unemployment. One characteristic of inflation is its tendency to react slowly to monetary policy changes implemented to manage it. For example, the impact of an expansionary monetary policy approach on inflation might not be immediately apparent. Likewise, when the inflation rate is high, it may not react promptly to contractionary monetary policy methods meant to reduce it, resulting in a slow response. Since these strategies may carry short-term economic costs and could be inadequate, most people prefer to maintain low inflation rates to prevent inflation from spiraling out of control. (Cashell, 2004; Boissay *et al*., 2021) [6, 4].

Phillips (1958) demonstrated a remarkable relationship between unemployment and inflation through a graphical representation. The Phillips curve suggests that an improvement in labor market conditions, such as a decrease in unemployment or an increase in employment levels, results in a positive correlation with the rate of price growth. Essentially, when the rate of inflation decreases, the unemployment rate tends to rise. While this link is generally accepted in the short run, it may not apply in the long run when inflationary policies are not likely to decrease unemployment. Samuelson and Solow (1960) used the Phillips hypothesis in their research on the correlation between unemployment and inflation in the United States. They found a clear inverse relationship between the two, with low unemployment rates being accompanied by high inflation rates, and vice versa. The argument was that pursuing monetary or fiscal expansion that may lead to inflation would effectively tradeoff for a lower unemployment rate. Therefore, achieving both full employment and price stability is a challenging trade-off for governments.

Although government deficit spending can boost the economy, leading to a rise in gross domestic product and a drop in unemployment rates, it will also cause inflation to increase (Jeke & Wanjuu, 2021) [14]. This is a necessary sacrifice to achieve low unemployment rates. However, if the policy is executed successfully, it may cause inflation to rise to a point where the nation's ability to maintain its current level of macroeconomic stability is threatened (Qin and Wang, 2013). Cashell (2004) [6] suggests that any tool that gives decision-makers the information they need to prevent higher inflation rates would be invaluable. The non-accelerating inflation rate of unemployment, which is an advancement on the natural rate of unemployment (NAIRU), is one such tool. In most cases, the NAIRU denotes the unemployment level below which inflation starts to surge. The idea is that if one wants to keep prices steady, they must allow prices to gradually rise while keeping unemployment at a certain level.

2. Empirical Review

The evidence of a positive correlation between inflation and unemployment in Nigeria disproves the applicability of the Phillips curve to the country's economy. Meanwhile, the study by Mirza and Mujahid (2015) on Pakistan's economy supports the idea of the Phillips Curve by demonstrating an indirect relationship between the two variables from 1973 to 2014. In Jordan, Hussein (2014) utilized the Johansen cointegration and Granger causality tests to examine the trade-off between unemployment and inflation from 1984 to 2011. The results revealed no causal relationship between the two variables. Gur's (2015) [13] investigation of the BRIC countries (Brazil, Russia, India, and China) between 2001 and 2012, using panel data analysis, found that inflation and population growth are the primary factors driving unemployment rates up in these nations, whereas GDP and industrial product growth contribute to a decrease in the unemployment rate.

Umaru, Donga, and Musa (2013) conducted a study on the impact of unemployment and inflation on Nigeria's economic growth from 1986 to 2010. Their research involved the use of the Johansen cointegration and Granger causality tests. The study found that unemployment and inflation were causally related to real GDP, whereas real GDP had no causal effect on unemployment and inflation. The Johansen cointegration tests revealed a long-term connection between economic growth, unemployment, and inflation. Furthermore, the study highlighted that reducing unemployment and inflation could stimulate economic growth. Aurangzeb and Asif (2013) [3] utilized the Johansen cointegration, Granger causality, and regression analysis methods to investigate macroeconomic determinants of unemployment rates. Their study covered India, China, and Pakistan from 1980 to 2009. The Granger causality test results indicated no evidence of a bidirectional chain of causation between unemployment rates, inflation, and economic growth in any of the three countries. Conversely, the cointegration tests showed a long-term relationship between the three variables in all models.

Vermeulen (2015) [27] explored the effect of inflation on employment in South Africa by utilizing the Engle-Granger Error-Correction approach. His research revealed a negative correlation between inflation and employment. The primary objective of the study was to determine whether high inflation could result in job creation. The results indicated a positive relationship between output and employment in the long run, supporting the claim that factors negatively impacting output, such as high inflation, would hinder job creation. However, there was no substantial link between inflation and job creation in the short term.

Thayaparan's (2014) [24] research revealed that inflation is the only significant factor impacting unemployment reduction rates in Sri Lanka. Although gross domestic product has a positive influence on unemployment, its impact is insignificant. In addition, the study discovered a unidirectional causal relationship between inflation and unemployment, as well as bidirectional causal relationships between unemployment and gross domestic product, and between inflation and gross domestic product in Sri Lanka, during the period 1990-2012.

Orji, Orji, and Okafor's (2015) investigation in Nigeria aimed to determine the applicability of the conventional Phillips curve model in its original form. The study found that unemployment is one of the main drivers of inflation, and the rate of inflation is positively correlated with Nigeria's unemployment rate. Umoru and Anyiwe (2013) [2] had previously invalidated the Phillips curve hypothesis in Nigeria, and findings in Orji *et al*. (2015) [20] are consistent with this.

Qin and Wang (2013) argue that the Phillips curve cannot effectively determine the causal link between unemployment and inflation in China because it was developed in the United States and does not take into account the complexity of the Chinese economic system. Their empirical study, which looked at the correlation coefficient and causal link between China's unemployment and inflation rates from 1978 to 2011, supports this argument. Similarly, Umoru and Anyiwe (2013) [2] used the Vector Error Correction Technique to study long-term trends of inflation and unemployment in Nigeria and

concluded that the Phillips curve's position on the relation between inflation and unemployment was incorrect due to the presence of stagflation in the Nigerian economy. However, Nitzan (1990) [18] contends that while certain factors may challenge the Phillips curve, the inverse relationship between inflation and unemployment is too significant to ignore, and auxiliary factors can be introduced for augmentation.

Resurreccion (2014) [23] study on the correlation between unemployment, inflation, and economic growth in the Philippines between 1980 and 2009 showed that while unemployment has an indirect relationship with economic growth and inflation, there is a connection. The study provided evidence to support both Okun's Law and the Phillips Curve in relation to the Philippines. Furuoka and Munir (2014) [12] argued that the Phillips curve hypothesis applies to Malaysia's economy. Using the Error Correction Model, their research revealed a stable relationship between high unemployment and high inflation in Malaysia over the long run. Additionally, they discovered an inverse relationship between unemployment and inflation, supporting the Phillips curve's accuracy in representing economic dynamics.

Kogid *et al*. (2013) investigated the relationship between inflation and unemployment in Malaysia between 1975 and 2007, using ARDL bounds testing, ECM-based ARDL, and Toda-Yamamoto techniques. Their study identified a long-term relationship between inflation and unemployment, with inflation having a causal effect on unemployment. This suggests that inflation plays a significant role in determining levels of unemployment in Malaysia, and the authors concluded that there is a trade-off relationship between the two variables. In a similar study, Umaru and Zubairu (2012) examined the correlation between inflation and unemployment in the Nigerian economy between 1977 and 2009. Their findings, published in 2012, revealed that inflation has a detrimental impact on unemployment levels in Nigeria. However, while the Johansen cointegration test indicated a long-term link between the two variables, the Granger causality test did not show any causal relationship between inflation and unemployment during the period of the study.

3. Data and Methodology

To ensure the validity of our econometric estimations, we obtained secondary data from the World Bank's World Development Indicators (WDI) for the period of 1999-2021. As our investigation covers an extended time period, it is important to test for stationarity before applying advanced econometric techniques to our data. To determine the stationarity of our variables, we will be using the Augmented Dickey-Fuller (ADF) unit root test. Since the order of integration is mixed, the Bound test for cointegration and the Autoregressive Distributed Lag (ARDL) model are the primary analytical techniques used to estimate the relationship between unemployment and inflation. The ARDL model is similar to the aforementioned model but modified to incorporate the selected indicators in a time series analysis. Therefore, the dynamic models are represented as follows:

$$\Delta UER_t = \sum_{j=1}^{p-1} \lambda_j \Delta UER_{t-j} + \sum_{j=0}^{q-1} \delta_j \Delta INF_{t-j} + \sum_{j=0}^{q-1} \delta_j \Delta GDPG_{t-j} + \sum_{j=0}^{q-1} \delta_j \Delta InEXR_{t-j} + \varphi_i'[UER_{t-i} - \{\beta_0 + \beta_1 INF_{t-1} + \beta_2 GDPG_{t-1} + \beta_3 InEXR_{t-1}\}] + \varepsilon_{it} \quad (1)$$

Equations (1) represent the functions for unemployment and inflation. In these equations, t denotes the time period, while UER represents the unemployment rate, INF represents the inflation rate, GDPG represents the growth rate of gross domestic product, InEXR represents the natural logarithm of exchange rate, and ε represents the error term. The short-run parameters of the lagged dependent and independent variables are denoted by λ and δj respectively, while Δ represents the differencing operator. The long-run coefficients are represented by β1 – β3, with β0 being the intercept. The coefficient of speed of adjustment towards the long-run equilibrium is represented by φ.

4. Results and Analysis

4.1 Descriptive statistics

Table 1: Descriptive statistics of variables

Statistic	UER	INF	GDPG	EXR
Mean	5.152739	12.09389	5.029811	174.6454
Max.	9.714000	18.87365	15.32916	358.8108
Min.	3.700000	5.388008	-1.794253	92.33810
S.D	2.189369	3.754029	3.784043	77.86984
Obs.	23	23	23	22

Table 4.1 presents a statistical summary of each variable from 1999 to 2021. The data indicates that the unemployment rate (UER) experienced an average increase of 5.15% and reached its highest point in 2020 at 9.71%. Inflation rate and GDP growth rate had average values of 12.09% and 5.03%, respectively, while the mean of the exchange rate was 174.65 over the covered period.

4.2 Unit root test

Table 2: Augmented Dickey-Fuller (ADF) Unit root Test

Variables	ADF Test Statistic	Critical Value at 5%	Order of Integration
UER	-4.445650	-3.644963	1(1)
INF	-4.074618	-3.644963	1(0)
GDPG	-4.409032	-3.632896	1(0)
InEXR	-3.225385	-3.012363	1(1)

The table presented in Table 4.2 indicates that all the variables under consideration do not possess a unit root and therefore exhibit stationarity at a 5% level of significance. The unemployment rate (UER) and natural logarithm of exchange rate (InEXR) achieved stationarity at first difference, while inflation rate (INF) and gross domestic product growth rate (GDPG) are stationary at the level. This result confirms that the data satisfies the necessary assumption of stationarity required for advanced econometric analysis. As a result, we can now proceed to estimate our model using the Autoregressive Distributed Lag (ARDL) approach.

Bound Test for cointegration

Table 3: Cointegration Test Results

F-Bounds Test		Null Hypothesis: No levels relationship		
Test Statistic	**Value**	**Signif.**	**I(0)**	**I(1)**
			Asymptotic: n=1000	
F-statistic	6.850032	10%	2.37	3.2
k	3	5%	2.79	3.67
		2.5%	3.15	4.08
		1%	3.65	4.66

Table 4.3 displays the results of the bound test. The outcome indicates that the critical F-statistic value of 6.85 is higher than the lower and upper bound values at the 5% level of significance. This finding suggests that the estimated series are co-integrated. In simpler terms, the unemployment rate and the rate of inflation exhibit a long-run relationship and move together in the long run. This result supports the existence of a long-term equilibrium relationship between these variables, suggesting that changes in one variable will have a lasting impact on the other variable. The cointegration of these variables provides evidence for a stable and predictable long-term relationship, which can be beneficial for policymakers to develop effective economic policies.

4.3 Regression Results

Table 4: ARDL Short Run Coefficients

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-5.957347	2.264457	-2.630807	0.0175
UER(-1)	-0.376624	0.107314	-3.509557	0.0027
INF	0.047697	0.028501	1.673511	0.125
GDPG(-1)	-0.125963	0.042196	-2.985178	0.0083
InEXR	3.655014	1.174851	3.111045	0.0064
D(GDPG)	-0.067280	0.035166	-1.913226	0.0727
CointEq(-1)	-0.376624	0.056693	-6.643273	0.0000

The short-run dynamics models presented in Table 4.4 reveal significant findings regarding the relationships between the variables. Firstly, the results show a negative and significant relationship between the current unemployment rate and the lagged unemployment rate. This indicates that an increase in the lagged unemployment rate is associated with a decrease in the current unemployment rate.

Secondly, the analysis highlights a direct association between inflation rate and an increase in unemployment rate. The results indicate that a unit change in inflation rate leads to an increase of approximately 4.8% in the short-run. Additionally, the exchange rate was found to be correlated with a 3.6% increase in unemployment rate, while gross domestic product (GDP) exerted a negative but insignificant influence on unemployment rate.

Furthermore, the error correction term (ECT) provides information about the speed of adjustment to long-run equilibrium. The results show that around 38% of deviations from long-run equilibrium are corrected each year, indicating a relatively slow process of adjustment. Overall, these findings suggest that inflation rate and exchange rate have significant impacts on unemployment rate in the short-run, while GDP has a negligible influence. The negative relationship between the current and lagged unemployment rate implies some degree of persistence in unemployment, while the ECT shows that the system gradually adjusts towards long-run equilibrium.

Table 5: ARDL Long Run Coefficients

Variable	Coefficient	Std. Error	t-Statistic	Prob.
INF	0.100657	0.078357	1.603650	0.1283
GDPG	-0.066805	0.149328	-1.920634	0.0728
InEXR	1.30224	2.621942	3.963568	0.0011
C	-5.63746	6.213444	-2.838597	0.0119

Table 4.5 provides the results of our long-run estimations, indicating a positive relationship between inflation rate and unemployment rate. Specifically, the data reveals that a 1% change in inflation rate results in a 0.13% increase in the unemployment rate in the long run. Additionally, exchange rate also demonstrates a positive and significant relationship with unemployment rate, with a parameter estimate indicating that a 1% change in exchange rate leads to a 10.40% increase in unemployment rate. Conversely, gross domestic product (GDP) shows a negative influence on unemployment rate, although this relationship is found to be insignificant. The data suggests that a correlation of approximately 0.29% exists between GDP and a decline in unemployment rate. These findings have important implications for policymakers as they highlight the impact of inflation and exchange rate on unemployment rates in the long run, as well as the relatively limited influence of GDP. Therefore, measures to stabilize inflation and exchange rates may be effective in reducing unemployment rates over the long term.

4.4 Diagnostics Test

Table 4.5 provides the results of the Serial Correlation and Heteroskedasticity diagnostic tests. The first panel presents the results of the Serial Correlation test, which confirms the Durbin Watson statistic presented in Table 4.4, indicating that the model variables do not exhibit any significant autocorrelation. In the second panel, the Heteroskedasticity test results suggest that the model is homoskedastic, as the probability values of the observed R-squared are higher than the 5% probability level. Furthermore, Figure 4.1 shows the stability of the regression coefficients using the Cumulative Sum (CUSUM) recursive estimate, where the middle line falls within the upper and lower bounds, indicating that the regression coefficients are stable over the period of the study. These diagnostic tests provide further evidence that the econometric model used in this study is valid and reliable for analyzing the relationship between unemployment, inflation, GDP growth rate, and exchange rate in the economy.

Table 6: The Serial Correlation and the Heteroskedasticity Tests

Breusch-Godfrey Serial Correlation LM Test:			
F-statistic	1.153475	Prob. F(2,14)	0.3438
Obs*R-squared	3.253817	Prob. Chi-Square(2)	0.1965
Heteroskedasticity Test: Breusch-Pagan-Godfrey			
F-statistic	0.785236	Prob. F(6,16)	0.5940
Obs*R-squared	5.232019	Prob. Chi-Square(6)	0.5144
Scaled explained SS	3.182339	Prob. Chi-Square(6)	0.7856

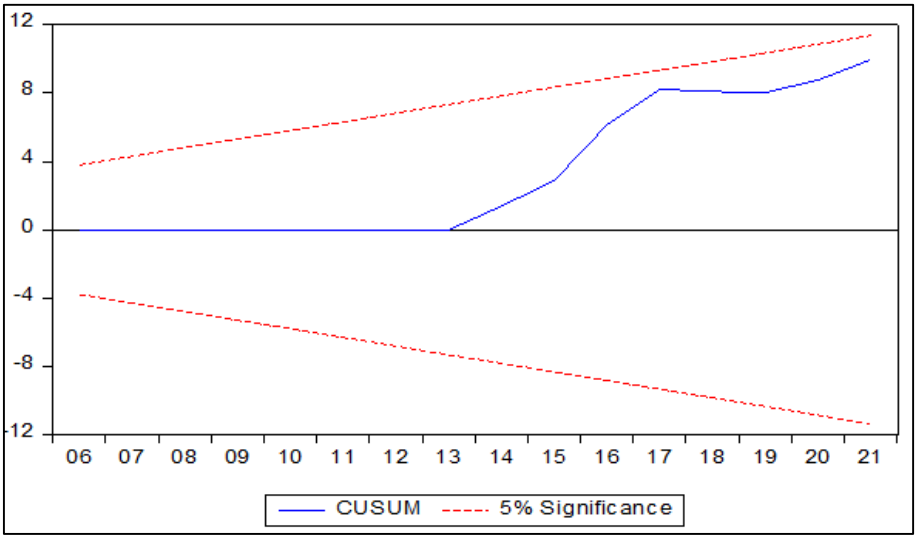

Fig 2: CUSUM Test

5. Conclusion and Recommendation

The relationship between unemployment and inflation is an important subject of inquiry for economists and researchers because unemployment remains a significant challenge faced by developing and emerging economies around the world. Achieving price stability is often believed to have a positive impact on economic growth and employment, particularly if the optimal threshold can be identified. However, striking the optimal balance between employment and price stability has proven to be difficult for central banks worldwide. Therefore, this study aims to investigate how changes in the general price level affect the unemployment rate in Nigeria using annualised data from 1999 to 2021. The research results indicate that there is a positive association between inflation and the unemployment rate in both the short-run and long-run. Additionally, economic growth and exchange rate were found to be positively related to unemployment rate during the period. The study also revealed that despite the long-term relationship between unemployment and inflation, there is a divergence along the equilibrium part that is corrected at a rate of 38 percent annually. Based on these findings, we suggest that output targeting, achieved through economic deepening, can play a crucial role in maintaining an optimal inflation rate and a minimal unemployment level. Rather than solely relying on monetary targeting, policymakers should consider focusing on expanding the economy and promoting economic growth to reduce unemployment and achieve price stability. In conclusion, the relationship between unemployment and inflation is a complex one that requires careful analysis and consideration of multiple variables. This study contributes to the ongoing debate on the optimal balance between price stability and employment and provides insights that can inform policy decisions in Nigeria and other similar economies.

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