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Assessing Linear Interdependence between Inflation and Unemployment Rate in Nigeria

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Abstract
This study examines the effect of inflation rate and unemployment rate in Nigeria for the period 1965-2017. Secondary was collected from the National Bureau of Statistics for the above period. The results from the Augmented Dickey Fuller (ADF) test showed all series are non-stationary at certain level but became stationary after first difference. The analysis using Multiple Regressions show that unemployment had a significant effect on inflation and vice-versa. The principal component analysis showed that only one factor explains 64.98% of the total variation; variables loaded shows that both factor and inflation increase while unemployment decreases and vice-versa. Result from Vector Autoregression also shows inflation and unemployment are affected by past values with the serial autocorrelation test showing the residuals are not correlated. While Granger Casualty shows there is no directional casualty between inflation and unemployment. However, a forecast of ten years was made using VAR (2) Model, based on the forecast Nigeria will not experience any significant increment or decrement in inflation and unemployment within the years of forecast. We therefore recommend a step up on Employment in order to reduce the rate of Inflation.

Keywords: Vector Autoregression, Granger Casualty, inflation rate, unemployment rate, unemployment rate.

1.0 Introduction

The relationship between inflation and unemployment has traditionally been an inverse correlation. However, this relationship is more complicated than it appears at first glance, and it has broken down on a number of occasions over the past 50 years. Since inflation and employment (unemployment) are some of the most closely monitored economic indicators, we will delve into their relationship and how they affect the overall economy (IMF 2020). When the unemployment is on the higher side, inflation is on the lower side and the inverse is true as well. The relationship between unemployment and inflation was first studied by Phillips (1958) and found a stable and inverse relationship between unemployment and inflation in UK. In the short term the Phillips curve happens to be a declining curve. However, when the per capita income is low, unemployment rates are expected to be high but very low inflation. Mankin (2019) suggested the various macroeconomic policies by government have been unable to achieve sustained price stability, reduction in unemployment and sustained economic growth. The essence of macroeconomic

management underlines the rationale of the government as a vital economic agent. However, it appears that government intervention has not been able to cure the ills in the economy.

Inflation is a situation of a rising general price level of broad spectrum of goods and services over a long period of time. It is measured as the rate of increase in the general price level over a specific period of time (Tejvan, 2018). To the neo-classical and their followers at the University of Chicago, inflation is fundamentally a monetary phenomenon. In the words of Friedman inflation is always and everywhere a monetary phenomenon and can be produced only by a more rapid increase in the quantity of money than output. According to Brooman inflation is continuing increase in the general price level (Sveriges, 2018a).

Unemployment can be conceived as the number of people who are unemployed in an economy often given as a percentage of the labour force Rafindadi, (2012) cited by Umaru, Donga and Hayatudeen, (2014). Unemployment is also defined as numbers of people who are willing and able to work as well as make themselves available for work at the prevailing wage but no work for them.

Sveriges (2018b) suggested that three major causes of inflation and unemployment include fiscal, monetary, and balance of payments policies. The fiscal aspect is closely linked to monetary explanations of inflation since government deficits are often financed by money creation. In the balance of payments, emphasis is placed on the high exchange rate. This simply means the exchange rate hikes bring about inflation either through higher import prices and increase in inflationary expectations which are often accommodated or through an accelerated wage indexation mechanism.

The relationship between economic growth, unemployment and inflation were reviewed. Stock and Watson (1999) used the conventional Phillips curve (unemployment rate) to investigate forecasts of U.S. inflation at the 12-month horizon. These authors focused on three questions. First, has the U.S. Phillips curve been stable? If not, what are the implications of the instability for forecasting future inflation? Second, would an alternative Phillips curve provide better forecasts of inflation than unemployment rate Phillips curve? Third, how do inflation forecasts from Phillips curve stack up against time series forecasts made using interest rate, money, and other series? Williams and Adedeji (2004) found that inflation forecasts produced by Phillips curve generally had been more accurate than forecasts based on other macroeconomic variables, including interest rates, money and commodity prices but relying on it to the exclusion of other forecasts was a mistake. Forecasting relations based on other measures of aggregate activity could perform as well or better than those based on unemployment, and combining these forecasts would produce optimal forecasts. The parsimonious and empirically stable error-correction model found that the major determinants of inflation were changes in monetary aggregates, real output, foreign inflation, and the exchange rate. However, there was an incomplete pass-through of depreciation from the exchange rate to inflation. Popovic (2009), also established a long-run relationship in the money and traded-goods markets, observing that inflation was influenced only by disequilibrium in the money market. Comparative analysis of Phillips regularity through correlation analysis of

unemployment and inflation in EU for the 1998-2007 periods'shows that the simple linear correlation coefficient between them is negativehence concluded that the relation between unemployment and inflation is moderate and inverse (negative). The relationship between inflation and economic growth in Azerbaijan using Threshold model and found that there is a nonlinear relationship between inflation and economic growth with the threshold level of 13%,Fakhri (2011).A study on the relationship among Chinese unemployment rate, economic growth and inflation using Granger causality test, unit root, co integration, VAR and VEC model revealed that unemployment impacted negatively on growth while inflation impacted positively on growth in China. The study also revealed no causation between unemployment and inflation, but there is causation between unemployment and growth, while two-way causation existed between inflation and growth Chang-Shuai Li and ZI-Juan Liu (2012). Inflation-unemployment trade-off in less developed countries (LDCs); a case study of Nigeria, using OLS model, found no trade-off between inflation and unemployment; the results revealed stagflation in Nigeria. He also found that there is causation between inflation and unemployment in Nigeria.The relationship between money, inflation and output by employing co-integration and Granger-causality test analysis revealed no existence of a co-integrating vector in the series used. Money supply was seen as causes to both output and inflation. The results suggest that monetary policy can contribute towards price stability in Nigerian economy since the variation in price level is mainly caused by money supply. This shows that inflation in Nigeria is too much a monetary phenomenon. They find empirical support in context of the money-price-output hypothesis for Nigerian economy. A study on the relationship between unemployment and inflation using OLS, ADF for unit root, Granger causality, Johansen co-integration, ARCH and GARCH techniques revealed negative relationship between unemployment and inflation and no causation between unemployment and inflation; though they found that there is long-run relationship between the two phenomena in Nigeria (Aminu & Anono, 2012).The effect of inflation on economic growth and development in Nigeria using OLS, ADF and Granger causality found that there was a positive correlation between inflation and economic growth in Nigeria, though the results revealed that the coefficient of inflation are not statistically significant, but are consistence with the theoretical expectation, causation runs from GDP to inflation implying that inflation does not Granger cause GDP but GDP does Bakere (2012). Stabilization policy, unemployment crises and economic growth in Nigeria using OLS found that the nexus between inflation, unemployment and economic growth were negative Rafindadi (2012). The relationship between output and unemployment dynamics in Nigeria using OLS and Threshold model shows a negative nonlinear relationship between output and unemployment as indicated by Aminu and Anono (2012) in their study.

However, the studies of Falowo (2015) revealed that inflation is always on the increase than unemployment, and the relationship existing between inflation and unemployment rate is moderate in a project study.

The increase in unemployment in Nigeria, on the other hand, has resulted to decrease in consumption, due to low income earned by the citizens, thereby resulting to low

production and the inability of firms to sell their goods, forces them to reduce their output. This has led to decrease in the economic growth of the nation.

Unemployment also has social consequences as it increases the rate of crime. Also, being without a job in Nigeria, is as good as losing your self-respect and self-esteem among the people of your age bracket. The proportion of workforce who are unemployed shows how well a nation's human resources are used and serves as an index of economic movement (positive or negative). From the forgoing, there seems to exist some sort of interactions between inflation and unemployment of every nation, community and in Nigeria, the focal point in this study.

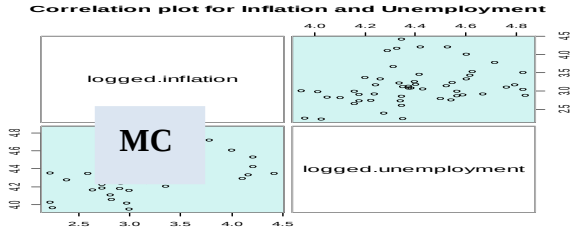
Why has unemployment and inflation continued to rise despite the substantial increase in the nation's GDP? Is it that successive government neglected the issue of unemployment and inflation or has the twine problems defied all economic theories? These are questions that is affecting our country and which is being discussed by both experts and lay- men alike. Therefore, this study will be of paramount importance to economic decision – makers, as it will equip them with the knowledge and skills needed to tackle the pressing issue of unemployment and inflation in our country. Also, to those who would like to carry out further research on this topic, it will be of valuable help in the course of this research.

2. Material and Methods

In analysing the serial data we intend to employ the correlation, multiple Regressions as the means of model function. The two variables that is, Inflation and Unemployment will be regressed and the VAR model will also be used to investigate the function. The data used in this study was collected from the bulletins of the National Bureau of Statistics 2018 edition, hence secondary in nature.

Data Analysis

Figure 1:Correlation plot between Inflation and Unemployment



Legend Value: MC: Moderately correlated

From the plots in figure 1 above, we can see that a moderate level of correlation exists between inflation and unemployment. The implication is that the variables have an effect on each other.

Table 1: Correlation Analysis

		Inflation Rate	Unemployment Rate
Inflation Rate	Pearson Correlation	1	.567
	Sig. (2-tailed)		.003
	N	53	53
Unemployment Rate	Pearson Correlation	.567	1
	Sig. (2-tailed)	.003	
	N	53	53

The correlation analysis shows a moderately relationship between inflation rate and unemployment with Pearson value (0.567), the p-value 0.003 is less than 0.05 level of significance. Hence the relationship between the duos is statistically significant

Model specification for Inflation:
Inflation = f(Unemployment)
Inflation = $\alpha + \beta_i Um + \varepsilon_i$
Where:
α= Y intercept
β_i= Effect of the independent variables on the Inflation
Um= Unemployment
ε_i=Random residual error
A regression analysis to determine the effect of unemployment on inflation is shown below;

Table 2:Result of the regression of Unemployment on Inflation

Coefficients	Estimate	Standard Error	t-value	p-value	Sig.	R^2
Intercept	0.2572	1.2950	0.199	0.8433	NS	**0.0887**
Unemployment	0.6552	0.2941	2.228	0.0303	*	

F-Statistics: 4.964, p-value: 0.3032, Residual error: 0.48
*NS: Not Significant; *; p<0.05*

From the column labelled R square shows that 32.15% of the dependent variable is explained by the predictors. It signifies R square shows the model is 32.15% fitted which is a moderately sufficient. Furthermore, the F-statistic and p-value (4.964 and 0.003). The p-value (0.003) which is less than 0.05, implies that the model is fit for use and is statistically significant for predicting inflation if there is a value of Unemployment.
From the above table labelled coefficients, the regression model is

$$y = \beta_0 + \beta_1 x_1,$$

Inflation = 0.2572 + 0.6552 (Unemployment)
From the Simple regression model, inflation is the dependent variable while unemployment is the independent variable. The values attached to each of the independent variables are the Betas. The

β_0 : is the intercept

β_1 : is the Slope

Model specification for Unemployment:
Unemployment = f(Inflation)
Unemployment = = $\alpha + \beta_i If + \varepsilon_i$
Where:
α= Y intercept
β_i= Effect of the independent variables on the Unemployment
If= Inflation
ε_i=Random residual error
A regression analysis to determine the effect of unemployment on inflation is shown below;

Table 3: Result of the Regression of Inflation on Unemployment

Coefficients	Estimate	Std Error	t-value	p-value	Sig.	R^2
Intercept	3.97317	0.19309	20.577	<2e-16	***	**0.0887**
Inflation	0.13539	0.06077	2.228	0.0303	*	

F-Statistics: 4.964, p-value: 0.3032, Residual error: 0.22
*NS: Not Significant; ***: p<0.001: *; p<0.05*

From the fitted model in the table above, we can see that the magnitude of the diversity in unemployment that can be explained by inflation is 8.87%. Inflation also shows a

significant effect on unemployment but the amount of variation explained by inflation is not sufficient enough to conclude on its effect even though it reports a statistically significant effect at 5% level of significance. However, the intercept (the mean estimate when inflation equals zero) is highly significant but it adds no value to the course of our study. From the fitted model in the table above, we can see that the magnitude of the diversity in unemployment that can be explained by inflation is 8.87%. Inflation also shows a significant effect on unemployment but the amount of variation explained by inflation is not sufficient enough to conclude on its effect even though it reports a statistically significant effect at 5% level of significance. However, the intercept (the mean estimate when inflation equals zero) is highly significant but it adds no value to the course of our study. From the fitted model in the table above, we can see that the magnitude of the diversity in unemployment that can be explained by inflation is 8.87%. Inflation also shows a significant effect on unemployment but the amount of variation explained by inflation is not sufficient enough to conclude on its effect even though it reports a statistically significant effect at 5% level of significance. However, the intercept (the mean estimate when inflation equals zero) is highly significant but it adds no value to the course of our study. From the fitted model in the table above, we can see that the magnitude of the diversity in unemployment that can be explained by inflation is 8.87%. Inflation also shows a significant effect on unemployment but the amount of variation explained by inflation is not sufficient enough to conclude on its effect even though it reports a statistically significant effect at 5% level of significance. However, the intercept (the mean estimate when inflation equals zero) is highly significant but it adds no value to the course of our study. From the fitted model in the table above, we can see that the magnitude of the diversity in unemployment that can be explained by inflation is 8.87%. Inflation also shows a significant effect on unemployment but the amount of variation explained by inflation is not sufficient enough to conclude on its effect even though it reports a statistically significant effect at 5% level of significance. However, the intercept (the mean estimate when inflation equals zero) is highly significant but it adds no value to the course of our study. From the fitted model in the table above, we can see that the magnitude of the diversity in unemployment that can be explained by inflation is 8.87%. Inflation also shows a significant effect on unemployment but the amount of variation explained by inflation is not sufficient enough to conclude on its effect even though it reports a statistically significant effect at 5% level of significance. However, the intercept (the mean estimate when inflation equals zero) is highly significant but it adds no value to the course of our study. From the fitted model in the table above, we can see that the magnitude of the diversity in unemployment that can be explained by inflation is 8.87%. Inflation also shows a significant effect on

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From the above table labelled coefficients, the regression model is

$$y = \beta_0 + \beta_1 x_1,$$

Unemployment = 3.97317 + 0.13539 (Inflation)

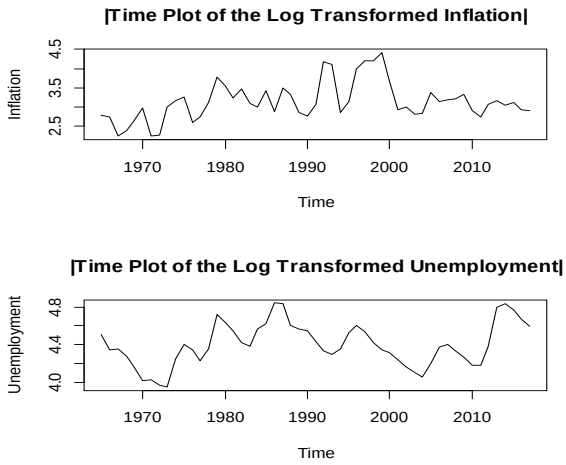
From the Simple regression model, unemployment is the dependent variable while inflation is the independent variable. The values attached to each of the independent variables are the Betas. The B_0: is the intercept

β_1: is the Slope

Vector autoregressive model analysis of the variables (Inflation and Unemployment)

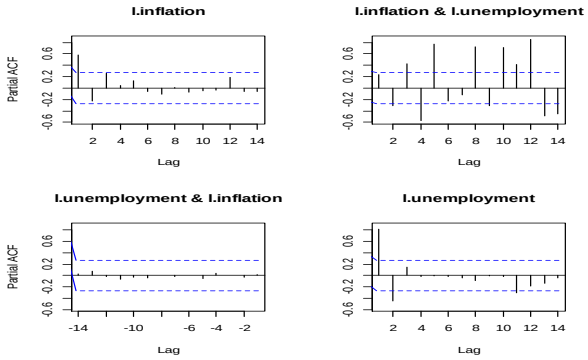
We employ the VAR model so that each variable tested for is a linear function of past lags of itself and past lags of the other variables. As stated earlier, a log transformation of the data set is necessary; this is because time series are heteroscedastic and the local variance of the series would become larger when the level of the series is higher, we present a plot of the log transformation of the time series object below.

Figure 2: Time plot of the log transformed variables (Inflation and Unemployment)



The plot shows dwindling movements as the series moves with time, showing that non-stationarity still persist even with the log transformation. These affirm the non-stationarity of the ACF and PACF plots of the series. Both plots ACF and PACF are presented in figure 4

Figure 3:**ACF plot of the series**



From the ACF and PACF plot of the time series data, it is established that the series is not stationary. The ACF plots of inflation and unemployment decays in a particular fashion, showing that there is a level of correlation between the various lags of the series. Briefly stated, a variable is said to be

integrated of order d written "I(d)", if it requires differencing "d" to achieve stationarity. To further test for the stationarity of the series, the commonly used augmented dickey fuller (ADF) test is conducted on the differenced and un-differenced log transformed series.

Test on the Stationarity of the log transformed series

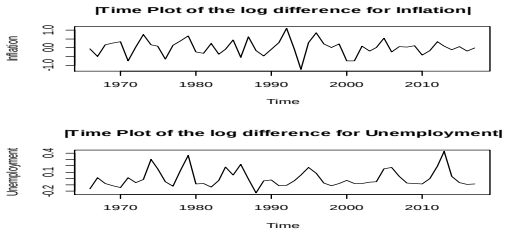
Table 4: The Augmented Dickey-Fuller Test

Variables	Test-Statistics	p-value	Differencing Order
Inflation	-2.306	0.4513	NIL
Unemployment	-2.2484	0.4745	NIL
Inflation Differenced	-5.7684	0.01	1st
Unemployment Differenced	-4.4041	0.01	1st

The Table 4 above shows p-value greater than α=0.05 for the un-differenced series (Inflation and Unemployment) in favour of the null hypothesis. Thus, we accept the null hypothesis at 5% level of significance that the time series is unit root non stationary. The smaller p-value of 0.01 for the differenced series (Inflation and Unemployment) is in favour of the alternate hypothesis. Thus we accept the alternate hypothesis at 5% level of significance that the time series for the differenced variable is unit root stationary.

Presented below are the time series plot, ACF plot and the PACF plot of the first ordinary difference of variables (Inflation and Unemployment)

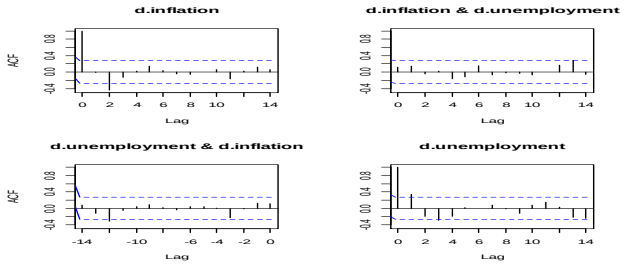
Figure 4: Plot of the differenced logged time series



We present the plot of the log transformed series in figure above. The plot shows dwindling movements as the series moves with time, showing stationarity can be achieved after differenced transformation.

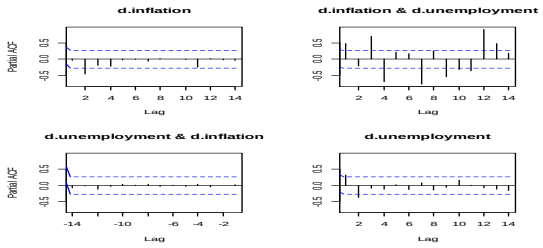
We can also affirm the stationarity of the series from the ACF and PACF plots of the series. Both plots (ACF and PACF) are presented in figures below.

Figure 5: ACF plots of the differenced log transformed time series



From the time series plot of figure above, it could be seen that the series shows an upward and downward movement about zero indicating, no trend pattern. The PACF plots also show a sinusoidal quick decay pattern which suggests stationarity. Since the differenced variable achieves stationarity, the differenced variable will be used to determine the number of lags for vector auto-regression.

Figure 6: PACF plots of the differenced log transformed time series



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VAR model parameter estimate

Table 5: Estimated results for Inflation

Coefficients Lagged Levels	**Estimate**	**Standard Error**	**t value**	**Pr(>|t|)**		**P-value**	**R^2**
Inflation (Lag 1)	-0.0383	0.1305	-0.294	0.7703	NS		
Unemployment (Lag 1)	0.6743	0.4567	1.477	0.1468	NS	**0.0146**	**0.2366**
Inflation (Lag 2)	-0.4603	0.1303	-3.532	0.00097	***		
Unemployment (Lag 2)	-0.1928	0.4534	-0.425	0.672614	NS		
Constant	0.0127	0.0572	0.223	0.824233	NS		

F-statistics: ***3.487,*** *Adjusted R^2:* ***0.1687****, Residual Standard Error:* ***0.4039***
*NS: Not Significant; ***: p<0.001*

From the result above, we can see that only a two-period inflation lag had a significant ($p<0.001$) effect on inflation. All other coefficients did not significantly influence Inflation at their various lags. The result gotten above indicates that after some period, inflationary pressure will tend to moderate itself. The diagnostic test for the results is however not impressive denoted by the R^2 value which is very low 0.2366 indicating that only about 23.7% of the variation in inflation can be explained by the coefficients above. Though the model passed the overall significant test at 5% level of significance, it does not prove to be too good an estimate.

Table 6: Estimated results for Unemployment

Coefficients Lagged Levels	**Estimate**	**Standard Error**	**t value**	**Pr(>|t|)**		**P-Value**	**R^2**
Inflation (Lag 1)	-0.0383	0.1305	-0.294	0.7703	NS		
Unemployment (Lag 1)	0.6743	0.4567	1.477	0.1468	NS	**0.0146**	**0.2366**
Inflation (Lag 2)	-0.4603	0.1303	-3.532	0.00097	***		
Unemployment	-0.1928	0.4534	-0.425	0.672614	NS		

(Lag 2)					
Constant	0.0127	0.0572	0.223	0.824233	NS

F-statistics: ***3.487,*** *Adjusted* R^2*:* ***0.1687****, Residual Standard Error:* ***0.4039***
*NS: Not Significant; ** p<0.01*

From the result above, we can see that unemployment at both lags (lag 1 and lag 2) had a significant (p<0.001) effect on unemployment. Other coefficients did not differ significantly from zero. The result gotten above shows a positive coefficient 0.4683 for a single period unemployment lag, while a negative coefficient for a two period unemployment lags. This result implies that overtime; there would be a reduction in the unemployment rate. This result also fails to prove to be too good an estimate with a low R_2 value, denoting that the diversity of all variation in unemployment that can be explained by the coefficients is 25.63%. Though the overall result is highly significant (p<0.01), much of the variation in unemployment is not explained.

Following the estimation of the VAR-model above, it is imperative that we test the residuals to see if they obey the model's assumptions i.e. we check for the absence of serial correlation and heteroscedasticity to see if the error process is normally distributed. For this, we use the Portmanteau test.

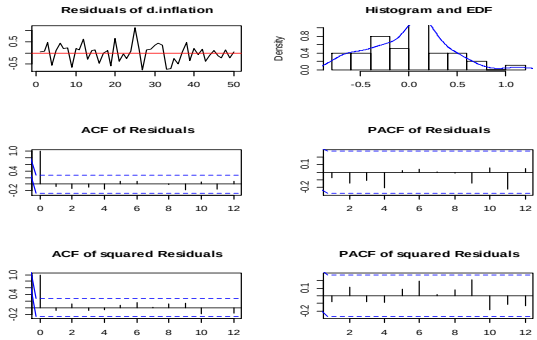
Test Hypothesis for Serial Correlation

Table 7: Portmanteau Test for Serial Correlation

Chi-Squared	Df	p-value
32.7333	32	0.4308

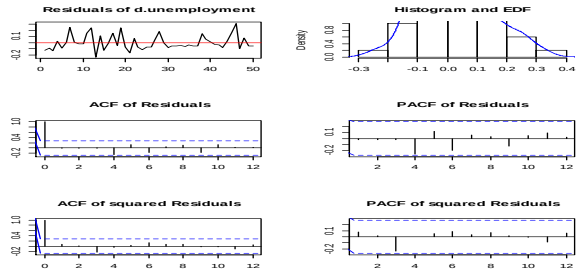
From the result above, a p-value of 0.4308 is in favour of the null hypothesis; we therefore reject the alternate hypothesis and conclude at 5% level of significance; that the residuals are not serially correlated. The plots of the residuals of the fitted model are displayed below;

Figure 7: Residual Plot for Inflation



From the above figure the residual plot shows a random pattern, indicating that there is no present of white noise in inflation observation and the data are randomly dispersed around the horizontal axis, hence the errors are independently identically distribution, further more Since there are no spikes outside the insignificant zone for both ACF and PACF plots we can conclude that residuals are random with no information or juice in them. Hence our ARIMA model is working fine.

Figure 8:Residual Plot for Unemployment



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insignificant zone for both ACF and PACF plots we can conclude that residuals are random with no information or juice in them. Hence our VAR model is working fine.

Granger causality of Inflation and Unemployment

Table 8: Causality Test on the Variables

Granger Causality	**Test-Statistics (F-Test)**	**p-value**
Inflation	0.5127	0.6006
Unemployment	1.0911	0.3403
Instantaneous causality between: Inflation and Unemployment		
Chi-squared Statistics	Df	p-value
0.1273	1	0.7212

From the result of the Granger Causality test in table 14 above, we can see that inflation does not granger-cause unemployment; also, unemployment does not granger-cause inflation. This is based on the large p-values for inflation and unemployment at (0.5127 and 1.0911) respectively. Also, the instantaneous causality between inflation and unemployment is in favour of the null hypothesis at 5% level of significance. Thus, we can conclude that there is no causal effect between inflation and unemployment.

3. Conclusion

It can be concluded that the VAR model is a good fit to the data and suitable for meaningful hypothesis at unit root of zero level and first difference to check for the stationary and non-stationary and however testing for the significance of inflation rate and unemployment rate. Besides it was observed that there is a moderately positive relationship and weak increment in accumulated response from unemployment to inflation since there is moderate bi-direction relationship between the pair. Based on findings, inflation has an increasing weight than unemployment.

4. Recommendation

From the result of this study, it is imperative that the Central Bank of Nigeria (CBN) focus on measures to reduce the level of inflation in the economy or revise existing policies on inflation targeting. Also, proper planning and policy implementation by the federal government should be accorded in the following areas;

1. Encourage self-employment/ entrepreneurship to overcome unemployment.
2. Government miscellaneous spending should be helpful in creating new jobs.

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