Macroeconomic Modelling of Investment, Unemployment and Inflation Rate

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Abstract
The major goal of the paper was to analyse the macroeconomic modelling of unemployment, inflation and investment. The researcher used time series method of analysis from 1986-2019. Secondary data obtained from Central Bank of Nigeria Statistical Bulletin were used. Having observed the time series properties, the Autoregressive Distributed Lag (ARDL) model technique was used in its estimation. All the variables contain unit root at levels. The ARDL co-integrating result shows low speed of adjustment. Government investment in the economy to curb unemployment and inflation has low speed of transmission mechanism and this stood at 25.6%. The findings also showed that long-run relationship exists among the variables. As investment increases by 1%, inflation increases by 1.7% and unemployment rate increases by 2.2%. The Breusch-Godfrey LM test and Breusch-Pagan-Godfrey test shows absence of serial correlation and Heteroskedacity respectively in the data properties which strengthened the reliability of the test results. As inflation increases, unemployment increases in a greater proportion. Therefore, policy makers need to exercise caution in the use of expansionary monetary policy to instigate investment in order to reduce unemployment. The researcher recommended close monitoring and proper scrutiny of government investment to ensure proper judicious use.

Keywords: Modelling, Unemployment, Inflation, Investment, Co-integration

Introduction and Motivation for Study
Unemployment rate, inflation and investment are basic macroeconomic data that respond to macroeconomic policy. Economic literature did not come to compromise on the applicability of macroeconomic variables of unemployment, inflation and growth. Some researchers, such as Lucy, Ali & Samuel (2017); Mohammed, Okorafor & Awe (2019); Uche (2019) accepted the applicability of the trade-off between inflation and unemployment to instigate economic growth. Olawunmi & Adebayo (2017) proposed that government must take charge of the economic activities, rather than the self-regulating classical model. Other studies are inter-twined within these two schools of thought. The work of Bello & Auwal (2015) established that inflation has more significant effect on economic growth than unemployment. Authors such as Jelilov, Obasa & Isik (2016) have made it clear that the real challenge to economic growth and subsequently, to economic development is for all hands to be on deck to fix the challenge of unemployment. With over 36% youth unemployment, it is suggested that the economy cannot achieve the desired economic growth. Thayaparan (2014) observes the time series
data, which contain unit roots. The study applies Ordinary Least Square (OLS) which could produce spurious policy results.

Therefore, the degree of linkage, relationship and the speed of transmission mechanism among these variables must constantly be subjected, not only to theoretical and policy research, but also, to empirical and rigorous scrutiny of econometrical analysis. Macro-econometric modelling was also done by Pamela (2014). It found an inverse relationship between inflation and unemployment. In that work, a linkage was established among unemployment, inflation and economic growth. This linkage was established according to Pamela to fully understand unemployment problem. This analysis falls within the domain of this subject because test of heteroskedasticity and collinearity were done. Pamela’s work further gives empirical backing to Okun’s law and Philip’s curve since his (Pamela) work found that unemployment was negatively related to inflation and economic growth. However, this work lacks the rigour of macro-economic modelling. It ignores the co-integration aspect of investment as a variable in the model. We must constantly establish and update the data set. We must constantly find out if these data co-integrate to avoid specification error. Fumitaka’s (2014) study used error correction model. In the study, unit root test, Johansson co-integration test and error correction model were used. Fumitaka’s work agrees with Philip’s proposition. However, investment variable was completely absent in this model. Thus, this study was motivated by the need to analyse the macro-economic modelling of unemployment, inflation and investment.

Statement of the Problem

The classical model advocated for price and wage flexibility. Keynes refuted such claim, saying the speed of adjustment is low, considering fluctuations in wages and unemployment. Also, interest rate does not have the freedom of intermittent adjustment of bringing investment and saving toward equilibrium. The classical economists always believe in the existence of full employment in the economy. To them, full employment was a normal situation and any deviation from this was regarded as something abnormal. To Keynes, full employment means the absence of involuntary unemployment. In other words, it is a situation in which everybody who wants to work gets work. Full employment so defined is consistent with frictional and voluntary unemployment. The orthodox economic theory concluded that inflation is a monetary phenomenon. The above assertion will not hold if increase in volume of money is accompanied by equal increase in output. Is there any empirical evidence in the Nigerian economy to justify any of the above schools of thought? This is the problem of the study.
Objectives of the Study
The objectives of the study were to:
1. Find out the relationship among investment, inflation and unemployment in Nigeria.
2. Determine the adjustment transmission mechanism among these macroeconomic variables.
3. Analyse the parameters of economic relationship in the specified model.

Theoretical Framework
The study is anchored on Jelilor, Obasa & Isik (2016) model and Sumera & Amajd (2016) model. The researcher, therefore, factors in investment as a major macroeconomic variable to determine how the structural parameters will be affected with the introduction of this variable. Sumera & Amajd (2016) introduced interest rate to their model since investment and interest rate are functionally related. The study theoretically postulates that as inflation increases by one percent, interest rate increases by 0.09 percent. Modelling is a theoretical construction represented by a set of variables for precision. To develop precise economic reality, a model can be developed to explain the researchers’ main objective. According to Hendry & Richard, cited in Damodar (2005), a model chosen for empirical analysis should satisfy the following conditions: be data admissible, be consistent with theory, have healthy exogenous regressors, exhibit data coherent and be encompassing. Examples of economic model include Solow-swan model of economic growth, Aggregate-Demand Aggregate-supply (AD-AS) macro-economic model which explain price level and output through the relationship of AD-AS. Cobb-Douglas production model which explains price level and output. Others include Lucas Islands model of money supply, Heckscher-ohlin model of international trade, IS-LM model of interest rate and asset market and various economic development and growth model.

Conceptual Review
Modelling macro-economic variables aim at explaining the empirical behaviour of an actual economic system. It is a mathematical representation of quantitative relationships among macroeconomic variables. The macro-economic variables of concern in this paper are unemployment, inflation and investment. Unemployment is a situation where people who fall within the age bracket of the working population, who are willing and able to work and equally searching for employment but are unable to find work. Types and theories of unemployment include: the classical and Keynesian, structural, frictional, voluntary and involuntary unemployment.

In classical sense, inflation refers to general increase in prices of goods and services. Keynes, however, insisted that a general increase in price that is accompanied by increase in production may not necessarily lead to inflation. Jhingan (2010) identifies two major theories of inflation: demand pull and cost push inflation. Similarly, three major economic theories surface under the demand pull. These include: the monetarist or monetary theory of inflation, Keynes theory of demand-pull inflation and Bent Hassan’s
excess demand model. Investment in economics is not linked to buying shares, stocks, bond and security. It include and more importantly, real investment which adds to the capital stock. However, worthy of note is that it entails looking toward future profit and it must always have some degree of risk. The two main determinants of investment are marginal efficiency of capital and marginal efficiency of investment, while the two major types of investment in economic theory are induced and autonomous investment.

**Empirical Literature**

Sumera & Amajd (2016) built a model comprising inflation, unemployment and interest rate. Amajd (2005), cited in Sumera & Amajd (2016) found a gap in required education and labour skill as the main cause of unemployment as against the country investment gap. Jelilov, Obasa & Isik (2016) established theoretical linkages between inflation and unemployment. The work found monetary and fiscal policy to be effective in the control of inflation and unemployment. The model by these authors does not include investment. If investment is factored into the model as a major macroeconomic variable, will monetary and fiscal policy still be effective in the control of inflation, unemployment and the Nigeria investment gap? Jones & Neary (1984), cited in Gordon (2007) built a Rapprochment Model (RM) where one equation model in a standard (two by two by two (2*2*2) competitive trade model (with two countries, two factors and two goods) is changed to create a within-country productivity gap. A point to note here is that explaining productivity gap in isolation without recourse to the major determinants of this gap calls for major concern. Similarly, Okeowo & Ozekhome (2020) insist that macroeconomic variable performance cannot be modelled in isolation. Thayaparan’s (2014) study established a uni-directional causality between unemployment and inflation. However, there is a point of caution in using Thayaparan (2014) outcome for policy prediction. The variables are tested for unit root and they contain unit root at levels. In that stance, using Ordinary Least Square (OLS) for the estimation of the parameter of economic relationship may produce spurious regression result. The point to note in that article is that econometric techniques that combine I(0) and I(1) should have been deployed.

Mohammed, Okowako & Awe (2015) established the classical trade-off between unemployment and inflation. Lucy et al (2017) established cost push inflation in Nigerian economy, while accepting the trade-off of macroeconomic variables of unemployment and inflation. Monetary authority according to contingency rule, should set a short term interest rate to target zero inflation to instigate consumption. Olawunmi & Adebayo (2017) deployed Johansen co-integration test in the analysis of macro-economic variables. Variation was established on the impact of unemployment, inflation, exchange rate and government expenditure on economic growth. The authors proposed inflation targeting as a panacea to economic growth downturn. However, Olawunmi & Adebayo opined that the government must take charge of the economy, rather than the self-regulating classical model. Having tested the variables for unit root using augmented Dickey fuller test, Bello & Auwal (2015) used OLS for estimation of the model since the unit root shows that the data set are stationary. Their findings revealed that inflation has more significant effect on economic growth than unemployment. The granger causality test conducted by these authors suggests that unemployment does not cause
economic growth and inflation. It was further established that economic growth and inflation granger cause unemployment. On the final note, one way causality is established is from inflation to Gross Domestic Product.

Nazifi & Aliyu (2017) examined the short-run dynamic and the long-run relationship among the three macro-economic variables of inflation, unemployment and economic growth. Var model was used to establish the causal relationship, while ARDL was used for the short-run and long-run relation of the estimated model. The scholars found a non-conformation of inverse linkage between unemployment rate and economic growth. Using the Time Fully Modified Least Square Regression Model (TFMLSRM), Uche’s (2019) study established that there exists an inverse relationship between inflation and unemployment as established in the Philip hypothesis. However, the findings revealed that Nigeria must be ready to accept 49% increase in inflation rate in order to reduce unemployment rate by 1%. The question is: is this not a huge price to pay in tackling unemployment scourge in the economy? A less striking effect policy can be used instead of trading 49% inflation rate for 1% increase in employment.

Methodology
The researcher used time series analysis from 1986-2019. Secondary data obtained from Central Bank of Nigeria Statistical Bulletin were used. Empirical study for macro-economic predictions requires rigorous data scrutiny with relevant and known a priori, first order statistical test and second order econometric test. The researcher used Augmented Dickey Fuller (ADF) unit root test to confirm the stationarity of the data. The Autoregressive Distributed Lag (ARDL) model technique using E-views 9 was used to analyse the estimate of the parameter of economic relationship.

Breusch-Godfrey and Breusch-Pagan Godfrey tests were used to determine the serial correlation and Heteroskedasticity of the time series data respectively. The functional form of the ARDL model is given as: \( \text{INVM}_t = \alpha + \sum \text{INVM}_{t-1} + \sum \text{UNMPR}_{t-1} + \sum \text{INFR}_{t-1} \) where INVM \(_t\) is Nigeria Investment as percentage of Gross Domestic Product, INVM \(_{t-1}\) is one year lag period of Nigeria Investment as percentage of Gross Domestic Product, INFR \(_{t-1}\) is one year lag period of Nigeria inflation rate and UNMPR \(_{t-1}\) is one year lag period of Nigeria unemployment rate.

Results and Discussion

<table>
<thead>
<tr>
<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>INFR Level</td>
<td>-1.227176 (-2.971853)</td>
<td>1(1) 1st Diff.</td>
<td>-3.690354 (-2.971853)</td>
</tr>
<tr>
<td>UNMPR Level</td>
<td>-2.371647 (-2.954021)</td>
<td>1(1) 1st Diff.</td>
<td>-5.224838 (-2.957110)</td>
</tr>
<tr>
<td>INVM Level</td>
<td>-1.221503 (-2.954021)</td>
<td>1(1) 1st Diff.</td>
<td>-2.475635 (-2.981038)</td>
</tr>
</tbody>
</table>
Result extracted from E-views 9 output
The ADF tests the unit root for inflation rate, investment and unemployment. The result shows that inflation rate contain unit root at level table 1. However, the first difference of inflation rate is stationary. Unemployment rate contains unit root at level. Just like inflation rate, unemployment rate is also stationary at first difference. Investment follows different behavioural patterns. It contains unit root at levels and at first difference.

Table 2: ARDL Bounds Test

<table>
<thead>
<tr>
<th>F – Statistics</th>
<th>Upper bounds</th>
<th>Lower bounds</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.76</td>
<td>4.14</td>
<td>3.17</td>
</tr>
</tbody>
</table>

Result extracted from E-views 9 output

Table 3 ARDL Co-integrating and Long-run Form

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-Statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>D(INFR)</td>
<td>0.017647</td>
<td>0.047410</td>
<td>0.372232</td>
<td>0.7125</td>
</tr>
<tr>
<td>D(UNMPR)</td>
<td>0.022824</td>
<td>0.150591</td>
<td>0.151560</td>
<td>0.8806</td>
</tr>
<tr>
<td>CointEq(-1)</td>
<td>-0.255565</td>
<td>0.082660</td>
<td>-3.091755</td>
<td>0.0045</td>
</tr>
</tbody>
</table>

Result extracted from E-views 9 output
The choice of econometric technique to be adopted depends on the time series properties of the data. The properties of the time series data in this study show that inflation rate, unemployment and investment are I(1); hence, the application of ARDL. The result shows that the variables are co-integrated. The F– Statistics value is higher than the Upper and Lower bounds table 2. However, table 3 shows that the long-run transmission mechanism among the variables is weak (25.6%). Pamela (2014) also did a similar work using time series data. The work established an inverse relationship between inflation and unemployment. However, it must be noted that this work used ARDL model, while Pamela used Ordinary Least Square. This model is superior to Pamela’s model, since it can accommodate I(0) and I(1) or both. Fumitaka & Qaiser (2014) studied macro-economic modelling, using annual data from 1975-2004 with evidence from error correction model. The scholars established an equilibrium relationship between inflation and unemployment without recourse to the current investment gap.

Table 4: Short-Run Dynamic Model

<table>
<thead>
<tr>
<th>Variables</th>
<th>Coefficients</th>
<th>Std. Error</th>
<th>T-ratio</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>INVM(-1)</td>
<td>0.744435</td>
<td>0.082660</td>
<td>9.005991</td>
<td>0.0000</td>
</tr>
<tr>
<td>INF R</td>
<td>0.017647</td>
<td>0.047410</td>
<td>0.372232</td>
<td>0.7125</td>
</tr>
<tr>
<td>UNMPR</td>
<td>0.022824</td>
<td>0.150591</td>
<td>0.151560</td>
<td>0.8806</td>
</tr>
<tr>
<td>UNMPR(-1)</td>
<td>0.463451</td>
<td>0.158379</td>
<td>2.926218</td>
<td>0.0067</td>
</tr>
</tbody>
</table>
ARDL enables policy makers to estimate the short-run dynamic result without losing the long-run property in a model. The results established a positive relationship among the variables. For every 1% increase in investment, inflation rate increases by 1.7%. The result equally shows that as inflation increases by 1.7%, unemployment increases by 2.2%. One lag period of unemployment rate stood at 46%, while one lag period of investment variable stood at 74.4%. This is in consonance with Chinwuba & Ibrahim (2016). They examined the forecasting performance of linear dynamic model and suggested that government policies directed at improving the performance of the economy should largely consider the short run and long run behavioural pattern of the variables.

**Table 5: Breusch-Godfrey Serial Correlation LM Test**

<table>
<thead>
<tr>
<th>F-statistic</th>
<th>Prob. F(2,26)</th>
<th>Prob. Chi-Square(2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.694630</td>
<td>0.5083</td>
<td>0.4330</td>
</tr>
</tbody>
</table>

**Table 6: Heteroskedasticity Test: Breusch-Pagan-Godfrey**

<table>
<thead>
<tr>
<th>F-statistic</th>
<th>Prob. F(4,28)</th>
<th>Prob. Chi-Square(2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.140897</td>
<td>0.9655</td>
<td>0.9572</td>
</tr>
</tbody>
</table>

The basic assumption here is that $E(U_i, U_j)$ is equal to zero, where ‘i’ is not equal to ‘j.’ That is, there is absence of serial correlation; in other words, the disturbance term relating to any observation is not influenced by the disturbance term of any other observation. Similarly, except the $U_i$ has equal variance (homoscedasticity), the time series data can produce a spurious result. In this study, the Breusch-Godfrey LM test was used to test the serial correlation of the disturbances term and Breusch-Pagan-Godfrey test was used to test the Heteroskedasticity. Table 5 shows absence of serial correlation while table 6 shows absence of Heteroskedasticity. This is in line with Sumera & Amajd (2016).

**Conclusion and Recommendations**

Based on the findings, it can be said that there is long-run relationship among investment, inflation rate and unemployment rate. Thus, the researcher concludes that a deviation from the long-run is corrected by around 25.6% which shows low adjustment transmission mechanism. As investment increases by one percent, inflation increases by 1.7%, while unemployment rate increases by 2.2%. Economic theories postulate a multiplier effect. As investment increases, unemployment reduces in a greater proportion with a moderate rate of inflation. Therefore, these findings are in agreement with economic theories. However, the adjustment transmission mechanism from investment to unemployment reduction is low. The study calls for policy mix as an effective macroeconomic policy target. The use of fiscal policy in controlling macroeconomic indices to achieve government’s desired objective is a step in the right direction. However, monetary policy measure must also be employed for effective macroeconomic...
variable control in order to reduce unemployment through increase in investment with moderate inflation rate.

More so, the findings revealed that as inflation increases (1.7%), unemployment increases in a greater proportion (2.2%); therefore, policy makers need to exercise caution in the use of expansionary monetary policy to instigate investment in order to solve or reduce unemployment. Again, the findings revealed that increase in investment leads to increase in unemployment, though at a lower proportion. The researcher also recommends close monitoring and proper scrutiny of government investment to ensure proper judicious use.

References


