DS Reviews of Commerce and Economics
Volume 1 Issue 1, 1-8, Oct - Dec 2024
ISSN: XXXX-XXXX

Original Article

Econometric Analysis of Macroeconomic Objective: Application of ARCH and GARCH Model

OKEOWO Idowu Adeniyi

Department of Economics, Samuel Adegboyega University, Edo State.

Okeowo4hope@gmail.com

Received: 12 August 2024; Revised: 10 September 2024; Accepted: 05 October 2024; Published: 21 October 2024;

Abstract - For macroeconomic objectives to be achieved and sustained, these objectives must be modeled together rather than isolation modeling. The main objective of this paper is to model the inflation rate, unemployment rate, exchange rate and growth rate simultaneously. The study used a time series analysis method from 1987-2022 to model macroeconomic objectives. Having observed the Autoregressive Conditional Heteroscedasticity (ARCH) effect in the data properties, the Generalised Linear Model (GLM) model was used in its estimation. All the variables contain unit roots at levels except the inflation rate. 16% increase in the inflation rate and a 7% increase in the unemployment rate bring about a 1% change in GDP. Reduction in unemployment and income inequality, encouraging small enterprises and development of rural areas are proffered as policy options. As inflation rate increases by 16%, the economy grows by 1%. In order to check the increasing rate of inflation, reduction in unnecessary government expenditure, rational wage policy, increase in production and effective price control mechanisms were equally recommended as alternative policy options. The model shows that the exchange rate depreciates as economic growth increases. To solve the problem of exchange rate misalignment, expenditure-reducing policy, import substitution, export promotion and expenditure-switching policy were recommended as viable macroeconomic policy targets.

Keywords - Macroeconomic, Unemployment, Inflation, Exchange rate, Heteroscedasticity.

1. Introduction

Econometrics is the combination of economic theory, mathematical economics and statistics. Its main function is to aggregate economic theory quantitatively for effective decision-making. Jason (2020) sees econometrics as combining quantitative statistics and mathematics to forecast trends. Macroeconomic policy is achieved through certain policy objectives; these objectives are referred to as macroeconomic objectives. Peter (2011), Soyung (2015), Gilles (1984), and Christie & Omar (2019) analyse the objective of price stability with economic growth without considering the impact of the unemployment rate and exchange rate, which are important macroeconomic objectives in growth determinants. Muhammed (2014) and Olawunmi & Adedayo (2017) articles analyse how to solve the unemployment challenge in Nigeria's economy. The general price level and the exchange rate were not considered in these analyses; hence, a gap which this article intends to fill. These researchers analyse macroeconomic objectives in isolation. Predictions and policy recommendations were made based on individual macroeconomic policy objectives.

Rizwanul (2018) analysed the applicability of Keynesian theory to developing countries for economic growth to be achieved and sustained. One of the propositions of Keynesian theory is that unemployment is a result of a lack of effective demand. It means that by solving the problem of effective demand, you have indirectly solved the

unemployment problem. The challenge in developing countries, especially in Nigeria, is that unemployment is not a result of a lack of effective demand; it is a result of defective economic structure. In such a defective structure, unemployment is chronic and not transitory. Applying economic tools in solving economic challenges is not unexpected. However, the point is that Keynesian economic tools assume that the supply of labour and machines are available but are temporarily suspended. The argument here is that these basic requirements are absent in developing countries.

Therefore, if they are absent, increasing effective demand cannot be the right key that opens the employment door in developing countries. Undoubtedly, this could work in developed countries, according to Rizwanul, not in developing countries like Nigeria. He, therefore, advocated for adaptive macroeconomic policy frameworks that suit different countries' development processes. The research work's main purpose is to analyse four macroeconomic objectives - price stability, full employment, economic growth and exchange rate stability - simultaneously using econometric techniques, which provide a framework for qualitative data aggregation.

The objectives of the paper were to:

1. Analyse the impact of price and employment rate volatilities on economic growth rate.
2. Analyse the impact of exchange rate volatility on economic growth.

2. Theoretical Literature

Economic theory and empiricism are the core benchmarks for economic policy formulation. Researchers want to authenticate the viability of a theory before its applicability to solve present-day challenges. The research is anchored on Trevor Swan's theory of macroeconomic objective coordination. The macroeconomic objective of price stability implies that inflation has to be checked by the monetary authorities. A continuous rise in the general price level not accompanied by an increase in goods and services can be inimical to an economy.

Similarly, for investment to be instigated, expansionary monetary policy can be a good monetary policy instrument. Invoking these instruments to increase investment, which indirectly increases economic growth, is consistent with the objective of price stability. Policy analysts have to strike a balance. Keynes proposed a moderate inflation rate of 2% for investment to be instigated. Sonmez and John (2006) found out that inflation targeting policy may not be a desirable rule of thumb, even if a price stability goal is a desirable policy goal. In inflation targeting, all monetary policy instruments are tailored to mitigate the effect of inflation on macroeconomic variables. The paper argues that inflation targeting is not natural both in the short and long run, with its attendance consequence of the reduction in equilibrium growth rate. However, in the aspect of real wage increment, the paper favors inflation targeting.

In other words, different countries have different needs at a particular point. If the major goal is to increase the real wage rate, inflation targeting can be a viable macroeconomic objective. Theoretically, there is a positive relationship between employment and gross domestic product. The above assertion is credited to Arthur Okun (1961), cited in Jhingan (2010). The unidirectional relationship has come to be known as Okun's law. The law state that as gross national product increase by 3%, unemployment reduces by 1%. That means that compensatory fiscal policy and expansionary monetary policy, all things being equal, can be used to increase employment generation in the economy, leading to an increase in GDP and GNP.

3. Empirical Literature

Fabiyi et al. (2018) mirrored macroeconomic objectives with unemployment, export and import, among other variables. These authors' empirical work regarding unemployment and economic growth is consistent with economic theory. Similarly, to maintain a balance of payments equilibrium, a rise in prices lead to an increase in import. It means that if the government tried to solve the unemployment problem by allowing a certain level of

inflation, it could lead to disequilibrium in the balance of payments. This is in recognition of the conflicting policy theory of inflation–unemployment syndrome as propounded by Philip.

Fabiyi et al. use econometric analyses to confirm this underpinning theoretical principle in economic literature. The article found out that as unemployment increases, import increases while export falls. However, a word of caution is needed here. The authors disaggregated the nature of the importation and exportation in terms of consumption or capital goods, which calls for more empirical work for clarity of purpose. All the same, a model framework has been set in consonance with existing economic literature. Ilugbusi (2017) examined macroeconomic variables that determine economic growth while (Barro, 1995, and Ball et al. 2022) examined the relationship between inflation and growth. Monetary, fiscal and real gross domestic products were important macroeconomic variables determining growth.

The study found that foreign direct investment, government expenditure and capital formation are the main determinants of development. Kargbo et al. (2015) identify budget deficit, high inflation and exchange rate instability as impeding economic growth. Sunday et al. (2016) examined the link among macroeconomic variables. Using a vector auto-regression framework, they established an empirical linkage between unemployment and monetary policy. The finding revealed that all the variables used in the model granger cause unemployment. Their finding equally showed a dynamic relationship between monetary policy and unemployment in Nigeria. Ugochukwu and Chijioke (2011) examined five important macroeconomic shocks in analysing macroeconomic policy for full, productive and decent employment in Nigeria.

These include monetary policy rate shock, credit growth shock, money supply shock and exchange rate shocks. The impulse response function developed by these authors shows that a tight monetary policy negatively impacts the growth rate. Degol and John (2011) opined that macroeconomic policy objectives should be tamed toward reducing poverty in developing countries. These objectives should be achieved in the framework of revenue mobilisation, scaling-up of public investment and preventing overheating in macroeconomic objectives.

Jonathan (2001) and Blanchard (2010) opined that macroeconomic policy objectives should be modified to accommodate the current trajectory. Jonathan argued that the current macroeconomic policy trend is becoming obsolete. He maintained that the basic tenets of macroeconomic policy objectives need to be redefined in the context of the current global challenges and that the objectives of macroeconomics policy should include economic stabilisation, distributional equity, broad social goals such as income security, education, universal health care and the management of economic growth.

4. Macroeconomic Policy Instruments and Objectives

Monetary and fiscal policies are tailored by authorities to achieve full employment. Monetary and fiscal policy will automatically deliver full employment in the economy if well managed by the stakeholders. This line of reasoning is not unconnected with classical ideas. Classical economists believed that full employment was a normal situation, and any deviation from this was regarded as something abnormal. Piguo, a classical economist, has been quoted in several economic literature that the working of economic agents will provide full employment. Unemployment resulted from the rigidity in the working of the market system in the form of trade unions. The classical never believed in involuntary unemployment. What that means is that you are unemployed because you are not prepared to work, given the current wage rate. This explains why a young graduate will prefer to manage a fifteen thousand naira job instead of sitting at home idle.

The recent recession hit Nigeria's economy grievously because of policy inconsistency. Classical ideology should have been applied instead of engaging in policy somersault. At that time, workers will prefer wage cuts rather than being laid off. Apart from theorising economic phenomenon, economic theories are economic philosophy that is scientific, and it often appeals to common sense. All things being equal, a worker collecting a

monthly wage of three hundred thousand naira will prefer a wage cut to two hundred thousand nairas or even one hundred thousand naira rather than being sacked, especially when such workers do not have other alternatives.

On the one hand, how consistent was the 'Monetary Policy' of laying off workers almost every day and still insisting that such policy would strengthen the economy?

Keynes believed that the absence of involuntary unemployment signifies full employment. Monetary and fiscal policies should be geared toward the above concept in Nigeria's economy. Jeffrey (2009) sees moral hazard as an obsolete government policy objective that has outlived its usefulness both as a theoretical concept and as a tool for policy recommendation. A moral hazard is a concept in which individuals, firms or governments have incentives to alter their behaviours when their risks or bad-decision making is borne by others. A good example is when the government promises to bail out loss-making banks. This can encourage banks to take greater risks.

The major objective of macroeconomic policies, which monetary policy and fiscal policies must strive to achieve, is economic growth. Economic growth means increasing the quantity of goods and services produced in a country, raising its national income. It is the rate of expansion of the national income. Monetary policy and fiscal policies should be strengthened not only to stimulate growth but also to ensure that it leads to economic development. Like human beings, the economy may be growing without maturing. Economic development does not only talk about the increase in goods and services that are produced in a country but also the maturity of the quality and quantity of goods and services produced in a country, the transformation of the economy from primary to secondary sectors, changes in the citizen creative energies and acquisition of special creative skills. Monetary and Fiscal policies contribute to growth by helping to maintain the stability of prices (Jhingan, 2010).

These policies ensure that fluctuation and recession are moderated if not avoided. It helps in achieving the growth objectives. Okun's law describes a relationship between unemployment and gross national product, in which lowered unemployment results in higher national output. As more people in a nation get employment and are productively engaged, it seems only right that the nation's output should increase. Lucas (2003) traced monetary policy to 1960.

He submitted that the key issue in monetary theory is whether changes in the stock of money or the growth rate of money can have lasting effects on real economic variables. In particular, the question concerning the so-called super neutrality of money - whether a permanent change in money growth has no long-term effects on the real interest rate, capital accumulation and output growth - has been the subject of extensive theoretical analysis since the early 1960s. Lucas concluded that inflation is fundamentally a monetary phenomenon. Monetary and fiscal Policies are used to stabilise prices.

Economic stability and price fluctuation do not portray an economy well internally and externally. Price fluctuation makes planning difficult to achieve. The objectives of avoiding inflation and deflation are desirable since rising and falling prices are both bad, bringing unnecessary losses to some and undue advantages to others. The Central Bank of Nigeria controls economic activities by ensuring the general price level is stable. Hence, monetary and fiscal policies play a stabilisation role in the economy through different means.

However, achieving one objective may be limited by the simultaneous pursuit of other objectives of monetary policy, the nature of the monetary policy transmission mechanism and other factors, including the uncertainty facing policymakers. Some inflation and deflation are purely monetary phenomena through money supply. Monetary policy uses its instruments to check the money supply to maintain price stability in the short to long term. Economic supports moderate inflation in the economy. It means that high inflation is damaging to long–run economic performance and welfare. However, Keynes advocates a certain level of inflation (say 2%) to instigate investment and growth.

Nwoko et al. (2016) examined the effectiveness of the monetary policy. The effect of money supply, average price, interest rate, labour force and Gross Domestic Product (GDP) was modeled using the classical least square. The empirical finding showed that average price, labour force and interest rate have a significant effect on GDP, while money supply was not significant. They opined that Central Bank monetary policy could effectively instigate investment, reduce unemployment and stabilise the economy. An analysis of Nigeria's susceptibility to external shocks reveals that price stability and a freely floating exchange rate look like a panacea for Nigeria's imbalanced fiscal-monetary policy mix (Nocolelta, 2004). He also suggested a stable price with a free float regime, vastly superior to a fixed exchange rate. Nocolelta concluded that stable prices with a free float regime may still be the best available option for Nigeria in the long run.

5. Methodology

The study uses the Generalised Linear Model (GLM) with time series analysis from 1987-2022. Secondary data obtained from the Central Bank of Nigeria Statistical Bulletin is used. The choice of the techniques is necessitated, having observed that the time series properties contain the ARCH effect. When modeling economic data that display high volatility clustering, including 'varying variance', Autoreggressive Conditional Heteroscedasticity (ARCH) and Generalised Autoreggressive Conditional Heteroscedasticity (GARCH) models can be used. It is often employed to model the conditional variance, which is often applied in econometrics, especially in exchange rate volatility, inflation and financial time series analysis. The ARCH and GARCH (1,1) model is specified as:

$$Yt = Xt\lambda + Ui \quad (1)$$

$$\sigma_i^2 = a + \alpha a^2_{t-I} + \beta\sigma^2_{t-I} \quad (2)$$

The mean equation one is written as a function of exogenous variables with an error term. Where σ_i^2 is the one-period forecast variance. The variance is the conditional variance. The conditional variance specified in equation two is a function of three terms. A constant term 'a', the ARCH term 'a^2_{t-I} 'and the GARCH term 'σ^2_{t-I} '. The functional form of the GLS is given as:

$$GDP_i = \varphi + \varphi_1 UNMPR + \varphi_2 INFR + \varphi_3 EXR + U_I \quad (3)$$

If the heteroscedastic variances σ^2_i are known, then equation three can be divided by the known heteroscedastic variance, such that:

$$GDP_i/\sigma_i = \varphi/\sigma_i + \varphi_1 UNMPR/\sigma_i + \varphi_2 INFR/\sigma_i + \varphi_3 EXR/\sigma_i + Ui/\sigma_i \quad (4)$$

The transformed variables become

$$GDP^* = \varphi + \varphi_1 UNMPR^* + \varphi_2 INFR^* + \varphi_3 EXR^* + Ui \quad (5)$$

The original OLS formulated in equation three, which is the functional form of GLM, has been transformed. The GLM is OLS whose variables have been transformed to satisfy the standard OLS assumption. The GLM estimators are BLUE.

6. Results and Discussion

Econometric research analysts must rigorously inspect the data set before the application of econometric tools. One of such pre-tests is the stationarity test. If a time series is stationary, it implies that its mean, variance and autocovariance are time-invariant. The ADF unit root is used to conduct the test as shown below:

Table 1. Unit root test

Variables		ADF Test Stat.	Conclusion		ADF Test Stat.	Conclusion
GDPGR	Level	-1.395431 (-2.960411)	1(1)	1st Diff.	-3.050934 (-2.951125)	1(0)
INFR	Level	-3.119534 (-2.951125)	1(0)	1st Diff.	-5.577598 {2.951125}	1(0)
UNMPR	Level	-1.039835 (-2.951125)	1(1)	1st Diff.	-13.46101 (-2.951125)	1(0)
EXR	Level	1.650827 (-2.948404)	1(1)	1st Diff.	-5.875252 (-2.951125)	1(0)

Result extracted from E-views 9 output.

INF is stationary at the level and first difference. The unemployment rate, gross domestic product and exchange rate are not stationary at levels; however, they are stationary at first difference in line with econometrics theory.

Table 2. ARCH/GARCH model output

Variable	Coefficient	Std. Error	z-Statistic	Prob.
RESID(1)^2	0.991797	0.692683	1.431819	0.1522
GARCH(-1)	-0.047304	0.098549	-0.480004	0.6312

Dependent Variable: GDPGR
Method: ML ARCH - Normal Distribution
GARCH = C(4) + C(5)*RESID(-1)^2 + C(6)*GARCH(-1)
Result extracted from E-views 9 output.

The sum of the ARCH and GARCH coefficient ($\alpha + \beta$) is very close to one, as shown in Table 2, indicating persistent volatility shocks and the presence of the ARCH effect. The presence of this effect requires that GLM will have to be used to estimate the model's parameters.

Table 3. Generalized linear model

Variable	Coefficient	Std. Error	z-Statistic	Prob.
UNMPR	0.067461	0.000238	283.3826	0.0000
INFR	0.156608	3.79E-05	4127.282	0.0000
EXR	0.017632	1.76E-05	1002.913	0.0000

Dependent Variable: GDPGR
Method: Generalized Linear Model
Result extracted from E-views 9 output.

Table 3 shows that when the macroeconomic objectives variables are simultaneously modeled together, inflation, exchange, and unemployment rates are positively related to economic growth.

As inflation rate increase by 16%, GDP increase by 1%. Similarly, as the unemployment rate and exchange rate increase by 7% and 2% respectively, GDP increase by 1%.

7. Conclusion

Macroeconomic policy objectives and their attainment are the main pillars of any economy. If these pillars are weak, it implies that the economy is on the verge of collapse. Okun's law has shown that full employment and economic growth objectives are compatible. It means that as economic growth increases, unemployment falls. Contrary to the above assertion, for the period examined, the result shows that unemployment increases as the economy grows, indicating a clear case of Dutch disease syndrome and glaring income inequality due to scarring unemployment figures. Empirically, the result confirms the fact that the goals of economic growth and income distribution are incompatible.

Economic growth emphasises maximising the growth rate, leaving the income distribution untouched. This leaves the gain of economic growth to skew to certain individuals at the expense of others. Therefore, an increase in employment and a reduction of income inequality cannot be overemphasised to sustain economic growth. In terms of policy measures, small enterprises should be encouraged by all levels of government. The young graduates should be given startup capital to practice what they learn in their various higher institutions. Bottlenecks such as inadequate power supply and decaying infrastructural facilities should be removed for industries to produce at their full capacities. There should be deliberate government policy to develop rural areas to avoid city congestion. Industries can be sited in these rural areas to utilise the local raw materials. This will go a long way in discouraging rural-urban migration.

The objectives of price stability and economic growth are incompatible; to instigate investment, there should be a certain minimal level of inflation. To keep inflation at bay, there should be a reduction in unnecessary government expenditure, a rational wage policy, an increase in production and an effective price control mechanism. The model shows exchange rate depreciation as the economic growth rate increases. The paper recommended expenditure-reducing policy, stimulation of exports, import-substituting industrial strategy and expenditure-switching policy as a viable macroeconomic policy target.

References

[1] H. Adam, Economics, Corporate Finance and Accounting, Financial Analysis, 2022. [Online]. Available: www.investopedia.com

[2] Olivier Blanchard, Giovanni Dell'Ariccia, and Paolo Mauro, Rethinking Macroeconomic Policy, International Monetary Fund, 2010. [Online]. Available: https://www.imf.org/external/pubs/ft/spn/2010/spn1003.PDF

[3] Laurence M. Ball, Daniel Leigh, and Prachi Mishra, "Understanding U.S. Inflation during the COVID-19 Era," *National Bureau of Economic Research Working Paper Series 30613*, 2022. [CrossRef] [Google Scholar] [Publisher Link]

[4] Robert J. Barro, "Inflation and Economic Growth," *National Bureau of Economic Research*, 1995. [CrossRef] [Google Scholar] [Publisher Link]

[5] Smith Christie, and Aziz Omar, "Monetary Policy Objectives-Price Stability and Macro Stabilisation," *Reserve Bank of New Zealand Bulletin*, vol. 82, pp. 1-14, 2019. [Google Scholar] [Publisher Link]

[6] Degol Hailu, and John Week, "Macroeconomics Policy for Growth and Poverty Reduction: An Application to Post Conflict and Resource-Rich Countries," *Economic and Social Affairs*, pp. 1-15, 2011. [Google Scholar] [Publisher Link]

[7] Fabiyi Oluwafunbi Dorcas, Adeyi Adedoyin, and Isiaka Muideen, "Relationship between Unemployment and Macroeconomics of Nigeria," *Nigeria Journal of Management Review*, vol. 12, no. 2, pp. 45-56, 2018. [Google Scholar] [Publisher Link]

[8] Gilles Oudiz et al., "Macroeconomic Policy Coordination among the Industrial Economies," *Brookings Papers on Economic Activity*, vol. 1984, no. 1, pp. 1-75, 1984. [CrossRef] [Google Scholar] [Publisher Link]

[9] Segun Bamidele Ilugbusi, "Macroeconomics Policy and Economic Growth in Nigeria," *Adekunle Ajasin University Journal of Financial and Social Issues*, vol. 3, no. 1, pp. 177-190, 2017. [Google Scholar] [Publisher Link]

[10] Gordon Jason, Econometrics Definition, 2020. [Online]. Available: https://thebusinessprofessor.com/

[11] Jeffrey M. Lacker, "Government Lending and Monetary Policy," *Business Economics*, vol. 44, no. 3, pp. 136-142, 2009. [CrossRef] [Google Scholar] [Publisher Link]

[12] M. L. Jhingan, *Macro Economic Theory*, 12th ed., Vrinda Publication, 2014. [Publisher Link]

[13] Harris M. Jonathan, "Macroeconomics Policy and Sustainability," *Global Development and Environment Institute*, pp. 1-17, 2001. [CrossRef] [Google Scholar] [Publisher Link]

[14] Kargbo Mohamed et al., "An Empirical Study of Macroeconomic Policy and Economic Growth in Sierra Leone," *International Journal of Research*, vol. 2, no. 5, pp. 397-412, 2015. [Google Scholar] [Publisher Link]

[15] Lucas Papademos, "The Contribution of Monetary Policy to Economic Growth," *European Central Bank, 31st Economics Conference*, 2003. [Google Scholar] [Publisher Link]

[16] Mohammad Chowdhury, and Md. Tanjil Hossain, "Determinants of Unemployment in Bangladeshi: A Case Study," *Developing Countries Studies*, vol. 4, no. 3, pp. 16-20, 2014. [Google Scholar] [Publisher Link]

[17] Nicoletta Batini, "Achieving and Maintaining Price Stability in Nigeria," *International Monetary Fund (IMF)*, pp. 1-40, 2004. [Google Scholar] [Publisher Link]

[18] Nnenna M. Nwoko, J. C. Ihemeje, and E. Anumadu, "The Impact of Monetary Policy on the Economic Growth of Nigeria," *Africa Research Review*, vol. 10, no. 3, pp. 192-206, 2016. [CrossRef] [Google Scholar] [Publisher Link]

[19] Olawunmi Omitogun, and Adedayo Emmanuel Longe, "Unemployment and Economic Growth in Nigeria in the 21st Century: VAR Approach," *Acta Universitatis Danubius. Œconomica*, vol. 13, no. 5, pp. 155-168, 2017. [Google Scholar] [Publisher Link]

[20] Peter Quartey, *The Effect of Price Stability on Real Sector Performance in Ghana*, African Economic Research Consortium (AERC) Research Paper, no. 228, 2011. [Google Scholar] [Publisher Link]

[21] Rizwanul Islam, "Macroeconomic Policy and Employment: A Development Perspective," *The Indian Journal of Labour Economics*, vol. 61, pp. 427-451, 2018. [CrossRef] [Google Scholar] [Publisher Link]

[22] H. Atesoglu Sonmez, and John Smith, "Inflation Targeting in a Simple Macroeconomic Model," *Journal of Post Keynesian Economics*, vol. 28, no. 4, pp. 673-688, 2006. [Google Scholar] [Publisher Link]

[23] Soyoung Kim, and Aaron N. Mehrotra, "Managing Price and Financial Stability Objectives – What Can We Learn from the Asia-Pacific Region?," *Bank for International Settlement (BIS) Working Paper Number 533*, 2015. [Google Scholar] [Publisher Link]

[24] Sunday N. Essien et al., "Monetary Policy and Unemployment in Nigeria, Is There a Dynamic Relationship?" *CBN Journal of Applied Statistics*, vol. 7, no. 1b, pp. 209-231, 2016. [Google Scholar] [Publisher Link]

[25] Agu Ugochukwu, and Evoh J. Chijioke, "Macroeconomics Policy for Full and Productive and Decent Employment for all: The Case of Nigeria," *International Labour Organisation, Employment Working Paper 107*, 2011. [Google Scholar] [Publisher Link]