

Monetary Policy, Energy Consumption and Economic Growth in Nigeria

Obiwumi Gboyega AKINWALE
LCU/PG/003121

**Being a M.Sc. Thesis Presented to the Department of Economics and Development Studies,
Faculty of Management and Sciences, Lead City University, Ibadan, Oyo State, Nigeria**

**In Partial Fulfillment of the Requirements for the Award of Master of Science Degree
(M.Sc.) in Economics**

2024

Certification

This is to certify that this thesis titled “Monetary Policy, Energy Consumption and Economic Growth in Nigeria” was carried out by Obiwumi Gboyega AKINWALE with Matriculation number of LCU/PG/003121 in the Department of Economics, Faculty of Management and Social Sciences, Lead City University, Ibadan, under my supervision and that this work has not been previously submitted.

.....

Dr. Esther R. Aderinto
(Supervisor)

.....

Date

.....

Dr. Olusola O. Ogunjinmi
Head of Department

.....

Date

Dedication

This master's degree project is dedicated to Almighty God who spare my life from the beginning of this project till today and my mother, Mrs. S. Kofoworola Akinwale and my Brother, Engineer Obaniyi Akinwale whose unwavering love, support, and encouragement have been the driving force behind my academic journey. Their belief in my abilities has inspired me to overcome challenges and pursue excellence in every aspect of my education.

Lead City University Ibadan DO NOT COPY

Acknowledgements

I wish to appreciate the Management of Lead City University for the opportunity afforded me to pursue my Postgraduate Studies with the laudable university. My profound gratitude goes to the school library and the school of Post-graduate Studies for the necessary corrections and guidance.

There was never lack of wants throughout as GOD Almighty strengthened me during difficult times, my sincere appreciation goes to my Supervisor, Dr E. R. Aderinto whose contributions and constructive criticism pushed me this far. My profound gratitude goes to Head of Department, Dr. O. O. Ogunjinmi, the Dean, Faculty of Management and Social Sciences, Professor O. Campbell. My warm appreciation goes to my lecturers; Dr. Oyaromade R., Dr. Adesina O. O., Dr. Ogunro T.O., Dr. O. Y. Alimi, Dr. Emiola T., Mrs. Oduyoye-Ejumedia A., and Miss. F. V. Oniyide, of the Department of Economics for the support and individual contribution to ensure the work comes out unique. Also, I appreciate the Administrative staff and fellow postgraduate students in the Department of Economics and Developmental studies.

Furthermore, I am thankful to Lead City University Ibadan for providing the platform, necessary resources and facilities essential for the successful completion of this project.

Lastly, I am deeply grateful to my wife (Mrs. Folasade H Akinwale, my son (Nicholas Toluwani Akinwale), my daughters (Helen & Esther Akinwale) and my brother (Oluwatosin Akinwale) for their unwavering support, understanding, and patience during this endeavor.

As the inputs and assistance for the above-mentioned institutions and individuals towards the completion of this work are acknowledged, I bear the responsibility for any error or omission, if any found in the work.

Abstract

This study investigates the links among monetary policy, energy consumption, and economic growth in Nigeria from 1990 to 2022, employing both Autoregressive Distributed Lag (ARDL) and Toda-Yamamoto-Dolado-Lutkepohl (TYDL) approaches. Using time-series data, the study examines the short- and long-run relationships between monetary policy variables (monetary policy rate, money supply, and liquidity ratio), renewable and non-renewable energy consumption, and GDP growth. The ARDL results reveal that monetary policy rate and money supply significantly impact short-run renewable energy consumption, while non-renewable energy consumption is positively influenced by monetary policy rate but negatively affected by liquidity ratio and money supply. In the long run, only liquidity ratio positively impacts renewable energy consumption. Regarding economic growth, the ARDL findings indicate a direct impact of monetary policy rate lags on short-run economic growth, with liquidity ratio positively influencing long-run economic growth. More so, renewable energy consumption at lag one positively influence economic growth in the short run. In the long run, both renewable and non-renewable energy consumption indirectly impact economic growth in Nigeria. The TYDL approach confirms Granger causality from economic growth to energy consumption, monetary policy rate and money supply in the short run. However, liquidity ratio granger causes GDP growth. Also, liquidity ratio granger causes renewable energy, non-renewable energy, and money supply. In the long run, renewable energy consumption, non-renewable energy consumption and liquidity ratio granger cause economic growth in Nigeria. Meanwhile, output growth granger causes monetary policy rate. A uni-directional relationship exists from non-renewable consumption to monetary policy rate. There is need for government to consider implementing measures to incentivize investment in renewable energy projects to spur economic outputs. Also, to support short-run economic growth, policymakers should focus on enhancing the effectiveness of monetary policy transmission mechanisms.

Keywords: Monetary policy rate, money supply, liquidity ratio, renewable energy, non-renewable energy, GDP growth.

Word Count: 285.

Table of Contents

Contents	Page
Title	i
Certification	ii
Dedication	iii
Acknowledgement	iv
Abstract	v
Table of Contents	vi
List of Tables	x
List of Figures	xi
Chapter One: Introduction	
1.1 Background to the Study	1
1.2 Statement of the Problem	5
1.3 Research Questions	7
1.4 Objectives of the Study	7
1.5 Hypotheses	8
1.6 Significance of the Study	8
1.7 Scope of the Study	10
1.8 Limitations to the Study	13
1.9 Operational Definition of Terms	10

Endnotes	12
----------	----

Chapter Two: Literature Review

2.1	Conceptual Review	14
2.1.1	Monetary Policy	14
2.1.2	Energy Consumption	18
2.1.3	Economic Growth	21
2.2	Theoretical Review	24
2.2.1	Theoretical Links between Monetary Policy and Economic Variables	24
2.2.2	Theoretical Links between Energy Consumption and Economic Growth	28
2.2.3	Growth Theories	31
2.3	Empirical Review	35
2.3.1	Monetary Policy and Economic Growth	35
2.3.2	Energy Consumption and Economic Growth	47
2.3.3	Monetary Policy and Energy Consumption	57
2.4	Conceptual Framework	62

2.5	Summary of Gaps in Literature	65
	Endnotes	67
Chapter Three: Methodology		
3.1	Model Specification	74
3.1.1	Model for Examining the Effect of Monetary Policy on Energy Consumption	74
3.1.2	Model for Investigating the Effect of Monetary Policy on Economic Growth	75
3.1.3	Model for Determining the Effect of Energy Consumption on Economic Growth	75
3.1.4	Model for Examining the Causal Links among Monetary Policy, Energy Consumption and Economic Growth.	76
3.2	A'Priori Expectation	77
3.3	Method of Estimation	79
3.3.1	Pre-Estimation Test	79
3.3.2	Unit Root Test	79
3.3.1.1	Conventional Unit-root tests	79
3.3.1.2	Efficient Unit Root Tests	82
3.3.2	Bound Test for Cointegration	83
3.3.3	Estimation Technique	84
3.4	Sources and Measurement of Data	86
	Endnotes	88

Chapter Four: Results and Discussion of Findings

4.1	Data Presentation	90
4.2	Presentation of Results	90
4.2.1	Summary Statistics	90
4.2.2	Correlation Analysis	97
4.5	Trend Analysis	99
4.3	Pre-Estimation Test (Unit Root Test)	108
4.4	Presentation of Results	110
4.4.1	Empirical Results of the Impact of Monetary Policy on Energy Consumption Cointegration Test Result	110
4.2.3	Empirical Results of the Effect of Monetary Policy on Economic Growth Cointegration Results	125
4.4.3	Empirical Results of the Effect of Energy Consumption on Economic Growth Cointegration Test Result	133
4.3.4	Results of the Causal Relationship between Monetary Policy, Energy Consumption and Economic Growth	140
4.5	Discussion of Findings	143
	Endnotes	149

Chapter Five: Conclusion

5.1	Summary of Findings	151
5.2	Conclusion	153

5.3	Recommendations	154
5.4	Contributions to Knowledge	156
5.5	Suggestion for Further Study	157
	Bibliography	158
	Appendices	166
	Bio-data	230
	The University Compliance Certification	239

List of Tables

Table	Title	Pages
3.1:	Source of data and variable measurements	87
4.1:	Descriptive statistics	91
4.2	Correlation Matrix	98
4.3:	Unit Root Test Results [Trend and Intercept]	110
4.4:	Existence of cointegration between monetary policy and energy consumption	113
4.5:	Results of estimated ARDL model of renewable energy consumption	116
4.6:	Results of estimated ARDL model of non-renewable energy consumption	120
4.7	Existence of cointegration between monetary policy and economic growth	126

4.8	Results of estimated ARDL model of Monetary Policy and Economic growth	128
4.9	Existence of Long run cointegration between energy consumption and economic growth	127
4.10	Results of estimated ARDL model of economic growth	136
4.11	Short-run Granger Causality Results based on TYDL Procedure and VECM	141
4.12	Long-run Granger Causality Results based on TYDL Procedure and VAR	142

List of Figures

Figures	Title	Pages
2.1	Conceptual Framework of Monetary Policy, Energy Consumption and Growth	63
4.1	Monetary policy and economic growth in Nigeria	100
4.2	Energy consumption and economic growth in Nigeria	104
4.3	Investment, Labor and economic growth in Nigeria	106
4.4a-b	Cumulative sum and Cumulative sum of Squares	118
4.5a-b	Cumulative sum and Cumulative sum of Squares	124

4.6a-b Cumulative sum and Cumulative sum of Squares 132

4.7a-b Cumulative sum and Cumulative sum of Squares 139

Lead City University Ibadan DO NOT COPY

Chapter One

Introduction

1.1 Background to the Study

Monetary policy, energy consumption, and economic growth are three interconnected concepts that have a significant impact on the functioning and development of modern economies. Monetary policy refers to the actions taken by a central bank or monetary authority to manage the money supply, interest rates, and credit in an economy. The primary goal of monetary policy is to achieve price stability and promote sustainable economic growth. In general, central banks adjust monetary policy in response to changes in economic conditions, such as inflation, unemployment, and economic growth¹. Energy consumption is the consumption of energy resources, such as fossil fuels, electricity, and renewable energy sources, by individuals, businesses, and governments. Energy consumption is a critical factor in economic growth, as it is necessary for the production and distribution of goods and services. However, energy consumption also has environmental and social impacts, such as greenhouse gas emissions and resource depletion². Meanwhile, economic growth refers to the increase in the production of goods and services in an economy over time. Economic growth is typically measured by changes in the gross domestic product (GDP) of a country. Economic growth is affected by various factors, including investment, technology, labor productivity, and international trade³.

The relationship between monetary policy, energy consumption, and economic growth is complex and multifaceted. Changes in monetary policy can influence energy consumption and economic growth through various channels. For example, lowering interest rates can encourage investment and consumption, leading to increased economic activity and energy consumption.

However, it can also increase inflationary pressures and worsen environmental impacts. Similarly, energy consumption can affect economic growth and monetary policy. Increases in energy consumption can boost economic output, but also lead to higher energy costs and environmental degradation. These impacts can influence the effectiveness of monetary policy and the stability of financial markets. In summary, the relationship between monetary policy, energy consumption, and economic growth is a critical area of study for economists and policymakers. Effective management of these factors is essential for promoting sustainable economic growth while mitigating environmental impacts⁴.

Nigeria's economy, which is heavily dependent on imports, is subject to economic turbulence, unstable business cycles, and stagnant growth. Unemployment, inflation, low productivity, and balance of payments imbalance are typical outcomes of this. To ensure that resources are allocated and used effectively in order to maximize the welfare of the populace, government has in one way or another regulated and controlled the economy⁵. The Nigerian government, like the governments of other developing nations, uses three different categories of public policy to achieve its goals of resource allocation and income distribution. These tools of public policy include those related to income, fiscal, and monetary policy. In Nigeria, the government has historically relied on monetary policy to accomplish a number of macroeconomic goals, including employment, economic growth and development, balance of payment stability, and a generally stable general price level. Monetary policy is considered because it has key implication on fiscal and income policy measures⁵.

On whether monetary policy intervention by the government will result in economic stabilization, economists are divided. This disagreement created separate schools of economic thought. These

are the monetarist, Keynesian, and classical schools, respectively. Each of them has an opinion on the potential impact of monetary aggregate variation on economic stabilization¹. According to the classicists, the change in money supply will only alter price and have no impact on real demand, investment, or output because of the equation of exchange, stability in the velocity of money, and the assumption that the economy runs at full employment. The Keynesians, on the other hand, hold that changes in the money supply may cause interest rates to rise or fall. A lower interest rate will influence overall investment and boost overall income and output. This is predicated on the idea that the main factor influencing investment in a market economy is the interest rate. Employing labor and capital as part of the investment process results in a rise in overall employment⁵. The money supply is the primary variable influencing the health of the economy, according to monetarists. They contend that a rise in the money supply will result in a rise in nominal demand, and if there is an excess of capacity, output will rise. According to the monetarist viewpoint, an increase in the money supply will cause inflation in the long run without having any impact on investment, employment, or aggregate demand^{5,6}.

Energy demand and supply issues continue to be of concern on a worldwide scale, particularly in this period of increased population growth trends and technological advancements in contrast to a lack of infrastructure development. Energy difficulties pose significant hurdles to government growth and development objectives and create societal problems for human societies⁷. Energy can be produced from both renewable and non-renewable sources, generally speaking. Although non-renewable energy sources, like fossil fuels, have a higher carbon content, higher maintenance costs, higher capital intensity, a higher rate of depletion, are insufficient, and have inconsistent supply, renewable energy sources like solar, wind, geothermal, hydropower, and

biomass offer clean, environmentally friendly, inexpensive, and sustainable energy⁸. Inadequate non-fossil energy supply is to blame for the excessive reliance of the world's population on alternative (non-renewable) sources of energy⁹. Because to this approach, the ecosystem is more susceptible to serious environmental problems such ozone layer depletion, pollution, and deforestation. According to a study, non-fossil fuels lower the amount of carbon dioxide in the atmosphere while fossil fuels dramatically increase carbon emissions¹⁰.

Mixed results arise from empirical studies on the relationship between economic growth and energy consumption. Some studies show a strong positive influence of energy consumption on economic activities^{8,11,12,13}. However, other studies reveal a negative impact of energy consumption^{14,15,16}. The absence of academic agreement serves as inspiration for additional research on the topic. Also, the lack of empirical data on how actual activities respond to changes in capital consumption and financial development, as seen in the literature under evaluation, guided their inclusion in this study.

Notwithstanding these controversies, the Nigerian government continues to implement monetary policy in conjunction with the country's monetary authority in order to control the economy's usage of energy and other economic activity. As a result, the Central Bank of Nigeria implements both contractionary and expansionary measures as part of its monetary policy to control the economic swings that have been experienced thus far. The introduction and use of monetary policy has been successful in growing economies, which is why this action is being taken. As a result, it is vital to investigate how changes in monetary policy (interest rate, money supply and domestic credit to private sector by banks) might be used to affect energy consumption in order to increase output.

Lead City University Ibadan DO NOT COPY

1.2 Statement of the Problem

The Nigerian economy heavily relies on the export of crude oil, which makes it vulnerable to fluctuations in the global oil market. Additionally, the country's energy consumption is heavily dependent on fossil fuels, making it susceptible to fluctuations in fuel prices. This dependence on oil exports and fossil fuels has hindered Nigeria's economic growth, as well as its efforts to transition to more sustainable and environmentally friendly sources of energy. Furthermore, monetary policy in Nigeria has also been a challenge, with issues of inflation and foreign exchange management. The Central Bank of Nigeria has struggled to balance the need to stimulate economic growth through low-interest rates with the need to combat inflation and maintain the value of the Nigerian currency. All these factors have contributed to an economic situation in Nigeria characterized by high inflation, low GDP growth, and a lack of sustainable energy alternatives. Addressing these issues will require a comprehensive and coordinated approach that includes diversifying the economy, investing in renewable energy, and implementing effective monetary policies that support economic growth while controlling inflation.

Stabilizing economic growth is one of Nigeria's primary monetary policy goals. With the Central Bank of Nigeria, the Nigerian government has implemented a number of monetary policies over the years to promote economic growth. Even if Nigeria places more attention on manipulating monetary policy, the issue with that country's economic expansion still exists. High unemployment, limited investment, high inflation, and unpredictable currency exchange rates are a few examples of such issues. It is asserted that these alleged issues are what led to Nigeria's economic development rapidly declining⁸. Low output has been rising astronomically despite the

monetary policy committee's regular meetings and various monetary policy rates throughout the years. According to statistics, real GDP growth in the last quarter of 2010 was 9.76% while the monetary policy rate (MPR) was 6.25%¹⁷. However, MPR increased to 12% in 2011 and 2012, but real GDP growth decreased to 4.89% and 4.28%, respectively. Once more, MPR rose from 13% in 2014 to 14% in 2016, but real GDP growth decreased from 5.39 to -1.62%, respectively. In 2020, the COVID-19 pandemic era, MPR fell to 11.5% while real GDP fell to -1.79%¹⁷.

Despite Nigeria's abundance in energy resources, the bulk of the population lacks a sufficient and reliable supply. The majority of rural residents are underserved. The vast amounts of solar radiation, plentiful wind energy, significant fossil fuel reserves, and hydropower resources in the nation that may be used to generate electricity are mostly untapped. These resources could be used to provide a steady, balanced, and sufficient supply of essential resources with the right policy combination. Despite the existence of five (5) refineries with glaringly underutilized capabilities, the nation now exports a significant amount of crude oil while also importing a significant amount of processed petroleum products. Such an irony! The refineries use imported technology that the country's current technical infrastructure cannot handle, acting as conduits for the flow of foreign currency. These systemic inefficiencies result in an insufficient power supply and a high cost for the energy that is available.

The ability of the local refineries to function at maximum capacity utilization is hampered by the low degree of local content in the sector. In the oil industry, chances to optimize domestic technology have repeatedly been lost. For instance, using local technology to refine petroleum products was one of the benefits of the Nigerian civil war (1967–1970). Local refining operations continue to take place even in the Niger Delta's creeks; however, the profits do not

contribute to the country's GDP. These skills can be used more profitably to increase the domestic supply of petroleum products, ensuring a greater supply of energy at a lower cost, with the proper attitude and policies. Cheap energy, which is a necessary component of industrial production, can encourage output development by enhancing the capacity utilization of domestic production facilities. Therefore, it is essential to draw attention to Nigeria's monetary policy and assess the degree to which it has genuinely influenced energy consumption and economic output development.

The relationship between monetary policy and energy consumption in Nigeria presents a significant challenge that warrants thorough investigation. As the government implements monetary policies such as adjusting interest rates and controlling money supply these decisions directly impact the economy's overall health and, consequently, energy consumption patterns. For instance, when interest rates are lowered, borrowing becomes cheaper, encouraging investments in energy infrastructure and consumption. Conversely, high-interest rates can stifle economic growth, leading to reduced energy demand.

However, the existing literature on this topic is often inconclusive, leaving a gap in understanding how these policies specifically affect energy consumption in Nigeria. This research aims to address this gap by exploring how monetary policy influences energy consumption and, in turn, how both factors contribute to economic growth.

Moreover, Nigeria faces unique challenges, such as inadequate energy supply and infrastructural deficits, which complicate the relationship between monetary policy and energy consumption. The study seeks to uncover whether the current monetary policies effectively support energy consumption growth or if they inadvertently hinder it. By examining these dynamics, the

research aims to provide insights that can guide policymakers in crafting strategies that not only stimulate economic growth but also ensure a sustainable energy future for Nigeria.

1.3 Research Questions

This research study provides answers to the following research questions:

1. To what extent does monetary policy affect energy consumption in Nigeria?
2. How has monetary policy impacted economic growth in Nigeria?
3. What is the effect of energy consumption on economic growth in Nigeria?
4. What is the causal relationship among monetary policy, energy consumption and economic growth in Nigeria?

1.4 Objectives of the Study

The main objectives of this study is to investigate the relationship among monetary policy, energy consumption and economic growth in Nigeria. The specific objectives of the study are to:

1. determine the effect of monetary policy on energy consumption in Nigeria;
2. examine the impact of monetary policy on economic growth in Nigeria;
3. investigate the effect of energy consumption on economic growth in Nigeria; and
4. evaluate the causal relationship among monetary policy, energy consumption and economic growth in Nigeria.

1.5 Hypotheses

The following null hypotheses tested in this study are stated as follows:

- H₀₁:** Monetary policy has no significant impact on energy consumption in Nigeria.
- H₀₂:** Monetary policy has no significant effect on economic growth in Nigeria;
- H₀₃:** Energy consumption has no significant effect on economic growth in Nigeria.
- H₀₄:** There is no significant causal relationship among monetary policy, energy consumption and economic growth in Nigeria.

1.6 Significance of the Study

The Nigerian government uses a variety of monetary tools, including the interest rate, control of money supply and financial credit supports from banks, to have a bigger impact on the country's economic activity. But what impact does this have on indicators of overall economic activities, such as human welfare in terms of energy consumption, which act as conduits for the influence of these tools on economic growth. For instance, anticipated interest rate has climbed significantly in Nigeria over time, despite the fact that this hasn't resulted in an improvement in the growth of economic activities. This study's timeframe might therefore investigate these consequences and offer policy alternatives to ensure better economic activities (i.e. output growth and green energy consumption).

Because economic growth is one of the top priorities on the development agenda, the government's responsibility in ensuring improvements in output growth cannot be overstated. Ensuring proper progress in economic activities is essential for a society's overall economic development as well as for the development of its human capital and national economy. Monetary policy is quite favorably correlated with both energy consumption and economic growth, which is crucial for nations to achieve sufficient economic potential for continued

development. This vicious cycle of low per capita income, unstable interest rate, high fossil fuel consumption, and generally dismal economic consequences poses a severe development challenge. An economy must improve to increase production, promote economic growth and development, and lessen poverty. Therefore, an improvement in monetary policy formulation, output growth, and green energy consumption are seen as prerequisites for a nation's long-term socioeconomic advancement and her key development indices.

Therefore, it is essential to comprehend how apex bank policy and money control affect economic activities and energy consumption to develop public policies and social programmes to mitigate their effects on any economy, particularly in less developed nations since they are more vulnerable to decrease interest rate. In fact, insufficient financial credit supports have caused enormous hardship in many nations, particularly in Sub-Saharan Africa, Latin America, and Asia, with negative macroeconomic effects such as low economic growth and high fossil fuel consumption. At the national, regional, and international levels, immediate and coordinated action is required, focusing on both comprehensive medium- to long-term solutions and urgent short-term actions. The supply of social infrastructure is essential for achieving rising output and energy consumption, which are essential for accomplishing the sustainable development goals and economic development, making this study pertinent to policy makers and the government. The study will be significant for academics and researchers as it will update existing knowledge about the phenomena and provide a crucial body of literature for studies to come on monetary policy, energy consumption, and economic growth in Nigeria.

1.7 Scope of the Study

The scope of this study is focused on the relationship between monetary policy, energy consumption, and economic growth in Nigeria, covering a time frame from 1990 to 2022. This period was chosen deliberately to capture significant economic phases in Nigeria's history, including the aftermath of the Structural Adjustment Program and the implementation of various economic reforms.

By examining data from this extensive timeframe, the study aims to provide a comprehensive understanding of how monetary policy has evolved and its effects on energy consumption and economic growth over the years. The years selected encompass critical events that have shaped Nigeria's economic landscape, such as shifts in government policy, changes in global energy markets, and the country's ongoing struggle with energy supply issues. This historical context is essential for identifying trends and patterns that can inform current and future policy decisions.

1.8 Operational Definition of Terms

Energy consumption: It is the consumption of energy resources, such as fossil fuels, electricity, and renewable energy sources, by individuals, businesses, and governments. Energy consumption is a critical factor in economic growth, as it is necessary for the production and distribution of goods and services.

Monetary policy: This refers to the actions taken by a central bank or monetary authority to manage the money supply, interest rates, and credit in an economy. The primary goal of monetary policy is to achieve price stability and promote sustainable economic growth.

Interest rate: This is the amount of interest due each period expressed as a percentage of the amount lent, deposited, or borrowed is known as an interest rate. The total interest on a loaned or

borrowed sum is determined by the principal amount, the interest rate, the frequency of compounding, and the period of time the loan, deposit, or borrowing took place.

Economic growth: This refers to the increase in the production of goods and services in an economy over time. Economic growth is typically measured by changes in the gross domestic product (GDP) of a country. It is affected by various factors, including investment, technology, labor productivity, and international trade.

Lead City University Ibadan DO NOT COPY

Endnotes

1. I., Chugunov, M. Pasichnyi, V. Koroviy, T. Kaneva, & A. Nikitishin. *Fiscal and monetary policy of economic development*. **European Journal of Sustainable Development**, 10(1), 2021, 42-42.
2. D. Schoenmaker. *Greening monetary policy*. **Climate Policy**, 21(4), 2021, 581-592.
3. S. P. Nathaniel, M. Murshed, & M. Bassim. *The nexus between economic growth, energy consumption, international trade and ecological footprints: the role of environmental regulations in NII countries*. **Energy, Ecology and Environment**, 6(6), 2021, 496-512.
4. M. Talha, M. Sohail, R. Tariq, & M. T. Ahmad. *Impact of oil prices, energy consumption and economic growth on the inflation rate in Malaysia*. **Cuadernos de Economía**, 44(124), 2021, 26-32.
5. N. M. Nwoko. *The Impact of Monetary Policy on the Economic Growth of Nigeria*. **African Research Review**, 10(3), 2016, 192-206.
6. L. Zhe, S. Yüksel, H. Dinçer, S. Mukhtarov, & M. Azizov. *The positive influences of renewable energy consumption on financial development and economic growth*. **Sage Open**, 11(3), 2021, Doi: 21582440211040133.
7. J. Chen, Y. Wu, C. Xu, M. Song, & X. Liu. *Global non-fossil fuel consumption: Driving factors, disparities, and trends*. **Management Decision**, 57(4), 2019, 791-810.
8. L. U. Okoye, A. E. Omankhanlen, J. I. Okoh, N. B. Adeleye, F. N. Ezeji, G. K. Ezu, & B. I. Ehikioya. *Analyzing the energy consumption and economic growth nexus in Nigeria*. **International Journal of Energy Economics and Policy**, 11(1), 2021, 378-387.
9. C. Egbichi, O. Abuh, V. Okafor, A. Godwin, & O. Adedoyin. *Dynamic impact of energy consumption on the growth of the Nigerian economy (1986-2016): Evidence from symmetrical ARDL model*. **International Journal of Energy Economics and Policy**, 8(2), 2018, 188-195.
10. P. O. Alege, S. A. Oluwasogo, & A. A. Ogundipe. **Pollutant emissions, energy consumption and economic growth**. **International Journal of Energy Economics and Policy**, 6(2), 2016, 202-207.
11. T. Akinlo, & O. T. Apanisile. *The impact of volatility of oil price on the economic growth in Sub-Saharan Africa*. **British Journal of Economics, Management and Trade**, 5(3), 2015, 338-349.
12. E. Ebele. *Oil price volatility and economic growth in Nigeria: An empirical investigation*. **European Journal of Humanities and Social Sciences**, 34, 2015, 1900-1918.
13. C. O. Manasseh, J. E. Ogbuabor, F. C. Abada, E. U. O. Okoro, A. E. Egele, J. U. Onwumere. *Analysis of oil price oscillations, exchange rate dynamics and economic*

- performance. International Journal of Energy Economics and Policy*, 9(1), 2019, 95-106.
14. S. U. R. Aliyu. *Impact of oil price shock and exchange volatility on economic growth in Nigeria: An empirical investigation. Research Journal of International Studies*, 11, 2009, 4-15.
 15. K. E. Dogah. *The impact of oil price shocks on the macroeconomy of Ghana. Journal of Poverty Investment and Development*, 9, 2015, 37-54.
 16. Z. Qianqian. *The impact of international oil price fluctuation on China's economy. Energy Procedia*, 5, 2011, 1360-1364.
 17. Central Bank of Nigeria (CBN). *Statistical bulletin*, 2021.

Lead City University Ibadan DO NOT COPY

Chapter Two

Literature Review

This chapter presents the literature review of the links among monetary policy, energy consumption and economic growth. This review of literature is presented under the following sections, conceptual review, theoretical review, empirical review, summary of gaps in literature, conceptual framework, and theoretical framework.

2.1 Conceptual Review

2.1.1 Monetary Policy

Monetary policy refers to the strategic measures implemented by a nation's monetary authority with the aim of influencing monetary and financial circumstances to achieve overarching goals such as promoting high employment rates and maintaining price stability, typically characterized by a low and consistent inflation rate¹. The additional objectives of a monetary policy may encompass the promotion of economic stability and the preservation of stable exchange values vis-à-vis other currencies. Currently, the majority of central banks in industrialized nations implement their monetary policy within the framework of inflation targeting, while the monetary policies of central banks in most developing countries follow a fixed exchange rate system¹. During the 1980s, there was a prevalent adoption of a third monetary policy technique known as targeting the money supply. However, its popularity has since declined. Nevertheless, it continues to be the official strategy in certain emerging economies².

Monetary policy pertains to the precise measures implemented by the central bank to control the value, supply, and cost of money within the economy, with the aim of attaining the

macroeconomic goals set by the Government. The objectives of monetary policy are specifically outlined in the statutes that establish the central bank in many nations, although in others, they are not explicitly mentioned. Monetary policy objectives may differ across countries, but there are two primary perspectives. The initial perspective advocates for the implementation of monetary policy to attain price stability, but the subsequent perspective aims to achieve price stability alongside other macroeconomic goals. Like other central banks in developing nations, the Central Bank of Nigeria attains its monetary policy objective by manipulating the quantity of money supplied. Monetary policy encompasses the measures implemented by a central bank to regulate the money supply and interest rates within an economy, with the objective of attaining macroeconomic objectives such as maintaining stable inflation, reducing unemployment, and fostering economic expansion. Potential actions that can be undertaken include the manipulation of interest rates, the purchase or sale of government securities, and the modification of reserve requirements for commercial banks³.

The instruments of monetary policy differ among central banks, contingent upon the country's developmental stage, institutional framework, historical background, and political system. Interest rate targeting is commonly employed as the principal mechanism, which can be achieved by either direct manipulation of the central bank's interest rates or indirect manipulation through open market operations. Interest rates have a significant impact on overall economic activity, employment, and inflation through many channels, together referred to as the monetary transmission mechanism. Additionally, they play a crucial role in determining the exchange rate. Additional policy instruments encompass communication tactics such as forward guidance and, in certain nations, the establishment of reserve requirements. Monetary policy is commonly

categorized as either expansionary, which aims to stimulate economic activity and subsequently impact employment and inflation, or contractionary, which seeks to reduce economic activity, hence reducing employment and inflation³.

Financial channels such as interest rates, exchange rates, and prices of financial assets are influenced by monetary policy, hence exerting an impact on the economy. In contrast, fiscal policy is predicated upon alterations in taxation and government expenditure as mechanisms employed by a government to effectively address business cycle occurrences, such as recessions. Monetary policy in industrialized countries is typically formulated independently from fiscal policy, with modern central banks in developed economies operating without direct government oversight or directions².

Direct Monetary Policy

Direct monetary policy encompasses the implementation of quantitative monetary measures, including credit limitations, credit rationing, and statutory liquidity ratios, with the aim of regulating the liquidity of the money supply. Additionally, it pertains to the explicit correlation between the specific monetary policy tool and the intended policy goal. Monetary policy instruments are employed to establish or restrict prices and/or quantity variables, such as interest rates and the distribution of credit across sectors. Policy makers have been attracted to direct techniques due to their perceived reliability in controlling credit costs and distribution. Additionally, these methods offer a relatively straightforward approach to conducting monetary policy. Significantly, governments find direct monetary controls to be highly appealing as they aim to direct credit towards specific sectors in order to achieve predetermined economic goals.

This approach to implementing monetary policy is typically employed in economies characterized by a basic financial sector and a weak transmission mechanism, primarily in developing nations. Undoubtedly, direct monetary restrictions serve as a provisional yet indispensable measure for economies of this nature until suitable institutions for the utilization of indirect tools are developed. However, a significant obstacle to the implementation of direct monetary policy lies in the potential for inefficiency in the allocation of resources, which can result in substantial costs. Furthermore, it has been suggested that direct instruments may experience a decline in their ability to generate substantial effects due to the tendency of economic agents to develop strategies to bypass such instruments. The Central Bank of Nigeria (CBN) adopted and executed a direct monetary policy from its establishment until 1992.

Indirect Monetary Policy

The implementation of monetary policy by indirect means entails the utilization of market-based instruments, such as open market operations. Put simply, it entails the central bank exerting influence on the conditions of the money market. In the late 1970s, industrialized countries started to use market mechanisms for implementing monetary policy, leading to a wider acceptance of indirect instruments of monetary management. Undoubtedly, the implementation of indirect monetary policy tools signifies the shift towards elevating price signals as a significant indicator in the economy. Moreover, the rising utilization of indirect tools in the majority of economies acts as a supplementary measure to the expanding trend of current account convertibility among nations. The efficacy of direct instruments has diminished due to the growing inclination towards transparency and adherence to market principles.

The Central Bank of Nigeria (CBN) Act of 1958, along with its later revisions, delineates the monetary policy objectives of the Bank. As per the Act, the primary objectives of the Bank are as follows:

- To guarantee stability in money and prices;
- To uphold external reserves to protect the international value of the legal tender currency;
- To introduce legal tender currency in Nigeria; • To foster a strong financial system in Nigeria; and
- To serve as a banker and offer economic and financial guidance to the Federal Government.

The monetary policy objectives are consistently prioritized in the Bank's monetary, credit, international trade, and exchange rate policies, as well as in the decisions made by the Monetary Policy Committee (MPC). Consequently, the Monetary Policy Committee (MPC) is legally entrusted with the duty of overseeing the implementation of monetary policy in Nigeria. The Committee devises and oversees the execution of monetary policy to accomplish the objectives of monetary policy.

2.1.2 Energy Consumption

Energy consumption refers to the comprehensive quantity of energy necessary for a specific process, typically quantified in kilowatt hours (kWh). The sources encompass electricity, gas, diesel, oil, and biomass⁴. The term “energy consumption” can also encompass the quantity of electrical energy and demand, as well as the consumption of natural gas, oil, propane, or other fuels within a facility during a specific billing period. Additionally, this principle is applicable to

utility services, such as water and sewer, wherein the provision of these services necessitates the consumption of energy. Energy consumption refers to the amount of energy required to manufacture one metric tonne of sanitary paper. This includes the manufacturing of wood chips, significant process chemicals, the overall energy consumption at pulp and paper mills (the difference between energy purchased and generated and sales), and the energy consumed for off-site treatment facilities. It does not include the energy consumed in mining and forestry activities, transportation energy, and the energy obtained from burning biomass (such as bark or sawdust).

Energy consumption plays a pivotal role in contemporary society and exhibits a strong correlation with economic activity, technical advancement, and overall societal welfare. There are multiple sectors involved in this domain, which include residential, commercial, industrial, and transportation. Furthermore, this concept encompasses the quantification of energy consumption by individuals, organizations, or entire societies within a specified timeframe. The measurement of energy is commonly expressed in measures such as kilowatt-hours (kWh) or British thermal units (BTUs), which are contingent upon the specific energy source being utilized, such as electricity, natural gas, oil, and so forth. In 2017, Nigeria's energy consumption amounted to 1,540,259,766,000 BTU (1.54 quadrillion BTU). This accounts for 0.26% of the total energy usage worldwide. A total of 5,952,847,305,000 BTU (5.95 quadrillion BTU) of energy was generated by Nigeria, which accounted for 386% of its yearly energy consumption requirements⁵.

In Nigeria, energy consumption plays a pivotal role in driving economic activities, powering industries, facilitating transportation, and meeting the daily needs of households. The energy

sector in Nigeria is characterized by a mix of traditional and modern energy sources, including fossil fuels, hydroelectric power, and renewable energy.

Electricity Generation: Electricity is the primary form of energy consumed in Nigeria. Most of the electricity generation in the country comes from thermal power plants fueled by natural gas and, to a lesser extent, from hydroelectric dams such as the Kainji and Shiroro dams. However, Nigeria still faces significant challenges in electricity generation, distribution, and access, resulting in frequent power outages and limited coverage, especially in rural areas.

Petroleum Products: Nigeria is a major oil-producing country, and petroleum products such as gasoline, diesel, and kerosene are widely consumed for transportation, cooking, and heating purposes. The country's reliance on imported refined petroleum products has led to issues of fuel scarcity, price fluctuations, and smuggling.

Renewable Energy: While still relatively underdeveloped, renewable energy sources such as solar, wind, and biomass are gaining traction in Nigeria. Solar energy, in particular, holds significant potential due to the country's abundant sunlight. Efforts are underway to promote renewable energy deployment through incentives, policies, and investments.

Biomass: Traditional biomass fuels, including firewood, charcoal, and agricultural residues, are widely used for cooking and heating, especially in rural areas where access to modern energy sources is limited. However, reliance on biomass fuels contributes to deforestation, indoor air pollution, and adverse health effects.

Energy Infrastructure: Nigeria faces challenges in energy infrastructure development, including inadequate power generation capacity, aging transmission and distribution networks,

and insufficient investment in renewable energy projects. These limitations hinder the country's ability to meet growing energy demand, attract investment, and achieve sustainable development goals.

Energy Access: Despite being an energy-rich nation, millions of Nigerians still lack access to reliable and affordable energy services. Addressing energy access challenges requires expanding electricity coverage, improving grid reliability, promoting off-grid solutions, and supporting decentralized renewable energy initiatives.

2.1.3 Economic Growth

Economic growth refers to an increase in the size of a country's economy over a period⁶. The size of an economy is typically measured by the total production of goods and services in the economy, which is called gross domestic product (GDP). Economic growth can be measured in 'nominal' or 'real' terms. Nominal economic growth refers to the increase in the dollar value of production over time. This includes changes in both the volume of production and the prices of goods and services produced. Economists normally talk about real economic growth i.e., increases in the volume produced only, which takes away the effect of prices changing. This is because it better reflects how much a country is producing at a given time, compared with other points in time.

Economic growth is the process of increasing the sizes of national economies, the macro-economic indications, especially the GDP per capita, in an ascendant but not necessarily linear direction, with positive effects on the economic-social sector, while development shows us how growth impacts on the society by increasing the standard of life⁷. Typologically, in one sense and in the other, economic growth can be: positive, zero, negative. Positive economic growth is

recorded when the annual average rhythms of the macro-indicators are higher than the average rhythms of growth of the population. When the annual average rhythms of growth of the macro-economic indicators, particularly GDP, are equal to those of the population growth, it is said to be zero economic growth. Negative economic growth appears when the rhythms of population growth are higher than those of the macro-economic indicators⁷.

Economic growth is a complex, long-run phenomenon, subjected to constraints like excessive rise of population, limited resources, inadequate infrastructure, inefficient utilization of resources, excessive governmental intervention, institutional and cultural models that make the increase difficult, etc. It is obtained by an efficient use of the available resources and by increasing the capacity of production of a country. It facilitates the redistribution of incomes between population and society. The cumulative effects, the small differences of the increase rates, become big for periods of one decade or more. It is easier to redistribute the income in a dynamic, growing society, than in a static one. The history of Nigeria's economic growth is characterized by significant fluctuations, driven primarily by changes in global oil prices, government policies, political instability, and structural challenges. An overview of Nigeria's economic growth history is presented as follows:

Pre-Independence Era (Pre-1960)

Nigeria's economy was primarily agrarian, centered around the cultivation and export of cash crops like cocoa, palm oil, and groundnuts. The agricultural sector was the mainstay of the economy, employing a significant portion of the population and contributing substantially to GDP.

Post-Independence and Oil Boom (1960s-1970s)

Nigeria gained independence in 1960 and soon witnessed a transformative period with the discovery of oil in commercial quantities in the late 1950s. The oil boom of the 1970s propelled Nigeria into a period of rapid economic growth, buoyed by soaring oil revenues. This period saw substantial investment in infrastructure, urbanization, and social programs, as Nigeria emerged as a major player in the global oil market.

1970s to 1980s (Oil Boom to Economic Downturn)

However, the oil boom was followed by a subsequent economic downturn in the late 1970s and early 1980s. Plunging oil prices, coupled with mismanagement of oil revenues and excessive borrowing, led to economic instability and fiscal challenges. Nigeria's economy experienced a period of stagnation, marked by high inflation, currency devaluation, and dwindling foreign reserves.

Structural Adjustment Program (SAP) Era (1980s-1990s)

In response to the economic crisis, Nigeria implemented Structural Adjustment Programs (SAPs) in the mid-1980s, under the guidance of international financial institutions. SAPs aimed to liberalize the economy, deregulate markets, and reduce government intervention, with a focus on fiscal discipline and structural reforms. However, SAPs also brought about social hardships, including austerity measures, subsidy removals, and privatization, leading to widespread protests and social unrest.

1990s (Transition and Challenges)

Throughout the 1990s, Nigeria grappled with political instability, military coups, and civil unrest, which further hindered economic progress. Despite efforts to implement economic reforms, Nigeria continued to face macroeconomic imbalances, corruption, and governance challenges.

Early 2000s (Reform Initiatives and Recovery)

The early 2000s witnessed a resurgence in economic growth, driven by rising oil prices, increased oil production, and efforts to diversify the economy. The government launched various reform initiatives aimed at improving the business environment, attracting foreign investment, and revitalizing non-oil sectors such as telecommunications, banking, and services.

2008 Global Financial Crisis and Beyond

The global financial crisis of 2008 had a significant impact on Nigeria's economy, leading to a downturn in oil prices and reduced foreign investment. Despite the challenges, Nigeria demonstrated resilience and implemented fiscal stimulus measures to mitigate the impact of the crisis.

Recent Years (Challenges and Opportunities)

In recent years, Nigeria's economy has faced challenges such as fluctuating oil prices, security threats, infrastructure deficits, and governance issues. Efforts to diversify the economy away from oil dependency and address structural constraints continue, with a focus on sectors like agriculture, manufacturing, and technology.

Nigeria's economic growth history reflects a mix of periods of rapid expansion, economic downturns, and modest recovery, shaped by internal and external factors. Achieving sustained and inclusive economic growth remains a key challenge for the country, requiring structural

reforms, investment in infrastructure and human capital, and diversification away from oil dependency.

2.2 Theoretical Review

2.2.1 Theoretical Links between Monetary Policy and Economic Variables

The classical monetary theory is widely recognized as the initial prominent theory of monetary policy. It is outlined in the Irving Fisher quantity theory of money, which establishes the fundamental connection between monetary policy (money) and economic variables. According to this theoretical framework, it is expected that both the velocity of money and output remain constant. Consequently, any augmentation in the quantity of money will solely result in a corresponding increase in prices, aligning with the principles of the quantity theory. Real forces exclusively influenced the long-term growth, while the money supply exhibits both short-term and long-term neutrality. Keynes, in both theoretical and applied policy contexts, expressed his rejection of the quantity theory, contending that the velocity of money is not constant and exhibits instability⁸. The fundamental assumption of the quantity theory of money is the absence of a trade-off between inflation and output. Keynesianism posited that prices are inflexible, and that the money supply responds swiftly. According to the liquidity preference hypothesis, the need for money is not exogenous but rather endogenous, and it is contingent upon factors such as income and interest rates. According to the theory, there exists a positive correlation between production and interest rate, which is derived from the liquidity preference money supply relationship, commonly referred to as the LM curve. The fundamental iteration of the IS_LM model operates under the assumption of a constant price level, rendering it unsuitable for analyzing inflation but rather focusing on short-term output⁹.

The liquidity preference theory integrates the demand for money with the amount of money provided by the central bank to establish the level of money equilibrium. The state of equilibrium refers to the monetary phenomenon of interest rates. The assumption is made that the money supply is exogenous, meaning that any increase in the money supply will result in a decrease in the interest rate until the quantity of money required is equal to the supply. Reducing interest rates has a beneficial effect on the efficiency of capital and investment, resulting in an increase in output. Hicks's IS/LM perspective on Keynes's general theory, however, faced empirical opposition¹⁰.

John Maynard Keynes expressed scepticism over the efficacy of monetary policy in situations where the economy is trapped in a liquidity trap and uncertain conditions prevail in the financial markets. Keynes advocated for an increased emphasis on fiscal policy. Both classical and Keynesian models have faced challenges and rejections in following and modern theories, leading to the abandonment of the concept of exogenous money supply⁸. According to Keynes's theory, extended periods of low interest rates are thought to cause distortions in the form of unsustainable asset price bubbles¹¹.

The emergence of monetarist theory occurred around the 1950s, with its foundation rooted in the quantity theory of money. This theory posits that the velocity of money, as described by the quantity theory, remains relatively constant¹⁰. Consequently, it suggests that nominal income is primarily determined by the money supply. The monetarist espoused the notion of a trade-off between inflation and output, while also redefining the Philips curve to incorporate real wages rather than nominal wages¹¹. The attainment of equilibrium in the labour market is achieved by the natural rate, with the prevailing assumptions of sticky wages. Monetary policy has a short-

term impact on real income through nominal rigidities in wages and prices. In the short run, an increase in money stock leads to a temporary increase in real output (GDP) and employment. However, in the long run, there is no effect due to the countervailing effect of an increase in the general price. The theory assumes long-term monetary neutrality since the money supply is inflationary in the long run. There is ample evidence, including current literature, to substantiate this claim¹².

Monetarism, nevertheless, has encountered opposition due to advancements in technology and the volatility of the money demand function. Monetarism has been subject to theoretical and empirical debates due to its assumption of an exogenous money supply. There has been equal challenge to the assumption of constant velocity of money. The empirical research has also presented challenges to the concept of long-run neutrality. Evans (1996) argues that money is not neutral in the long run, even if it is not neutral in the short run, particularly when growth is endogenous. Long-run neutrality is observed when growth is exogenous¹³.

Real business cycle models, the New Classical Model, New Keynesian Models, and the New Consensus Model have exerted significant influence over post-monetarism. There is a minimal distinction between these theories, which pertains to their approach towards nominal rigidities of wages and prices, as well as their treatment of demand. In addition to assuming perfect competition and full flexible prices in all markets, the New Classical Monetary Model also incorporates this assumption. The model additionally forecasts a state of neutrality or approximation of neutrality in monetary policy in relation to actual variables. The New Classical model encompasses four fundamental assumptions, namely rational expectations, the natural rate hypothesis, continuous market clearing, and the presence of imperfect information among agents

(specifically, imperfect information serves as a driving force for cycles within these models). Monetary policy does not influence the equilibrium dynamics of employment, production, and the real interest rate. The only actual driving force is fluctuations in technology¹⁴.

The New Classical real business cycle (RBC) theory is based on two fundamental principles: The role of money in business cycles is quite insignificant. Additionally, business cycles are shaped by rational actors who respond optimally to genuine shocks, particularly technological advancements, within a market environment characterized by perfect competition and frictionless transactions. According to the reasonable expectations hypothesis and the continuous market clearing assumption, it is projected that monetary policy will not exert any influence on real GDP. The transient impact on real variables is solely attributed to unforeseen monetary policy surprises. The New Keynesian theorists questioned the assumptions of continuous market clearing, flexibility of wages and prices, and instantaneous adjustment of the economy to its long-run equilibrium. The theory's significance is also refuted by numerous empirical studies. The prominent characteristic of New Keynesian Economics was the incorporation of sticky prices and monopolistic competition within the frameworks of the Resource-Based View (RBV)¹⁵.

2.2.2 Theoretical Links between Energy Consumption and Economic Growth

Energy Efficiency Hypothesis

The energy efficiency hypothesis posits that improvements in energy efficiency can drive economic growth by reducing production costs, increasing competitiveness, and spurring innovation. According to this theory, investments in energy-saving technologies and practices can enhance productivity and stimulate economic activity while mitigating environmental

impacts associated with energy consumption. One key aspect of the Energy Efficiency Hypothesis is its focus on technological innovation and adoption. Investments in energy-saving technologies and practices, such as improved industrial processes, energy-efficient appliances, and renewable energy sources, can lead to significant gains in efficiency across various sectors of the economy. By reducing energy waste and optimizing resource utilization, businesses can lower their operating costs, improve their bottom line, and remain competitive in global markets¹⁶.

Furthermore, the Energy Efficiency Hypothesis emphasizes the role of government policies and regulations in promoting energy efficiency. Policies such as energy efficiency standards, subsidies for clean energy technologies, and incentives for energy conservation measures can create favorable conditions for businesses and consumers to adopt more efficient practices. Additionally, research and development initiatives focused on advancing energy-efficient technologies can drive innovation and contribute to economic growth. The benefits of energy efficiency extend beyond cost savings and economic competitiveness. By reducing energy consumption and greenhouse gas emissions, energy-efficient practices contribute to environmental sustainability and climate change mitigation efforts. This aligns with broader societal goals of promoting sustainable development and transitioning towards a low carbon economy¹⁷.

From a macroeconomic perspective, the Energy Efficiency Hypothesis suggests that improvements in energy efficiency can have multiplier effects on economic activity. As businesses invest in energy-saving technologies and upgrade their infrastructure, they create demand for goods and services in related industries, leading to job creation, income generation,

and overall economic expansion. This virtuous cycle of investment, innovation, and growth can contribute to long-term economic prosperity. Moreover, energy efficiency measures can enhance energy security by reducing dependence on imported fossil fuels and mitigating the risks associated with energy price volatility and supply disruptions. By diversifying the energy mix and promoting domestic sources of renewable energy, countries can enhance their energy resilience and reduce vulnerabilities to external shocks¹⁸.

Energy-Led Growth Hypothesis

The energy-led growth hypothesis posits that energy consumption plays a pivotal role in driving economic growth, suggesting a direct and positive relationship between the two variables. According to this hypothesis, increased energy consumption is essential for sustaining and accelerating economic expansion, particularly in sectors that heavily rely on energy inputs, such as manufacturing, transportation, and construction. This theory is rooted in the recognition of energy as a fundamental factor of production, without which economic activities would be severely constrained¹⁹.

The proponents of the energy-led growth hypothesis argue that higher levels of energy consumption enable economies to achieve greater levels of output and productivity, leading to increased economic activity and overall growth. In this view, energy serves as a catalyst for economic development, providing the essential power required for industrial processes, transportation networks, and household activities. As economies expand and modernize, the demand for energy typically rises, reflecting the increasing use of energy-intensive technologies and appliances¹⁸.

One of the key mechanisms through which energy consumption drives economic growth is through its role in facilitating technological innovation and industrialization. Energy is a critical input in the production process, enabling firms to operate machinery, power equipment, and fuel transportation networks. As economies invest in expanding their energy infrastructure and harnessing new energy sources, they can enhance their productive capacity and competitiveness, driving economic growth in the process¹⁹.

Moreover, the energy-led growth hypothesis emphasizes the importance of energy security and access in supporting economic development. Reliable and affordable energy supplies are essential for powering economic activities, attracting investment, and promoting business expansion. Countries with abundant and affordable energy resources may have a competitive advantage in attracting industries and fostering economic growth compared to those with limited or unreliable energy supplies.

However, critics of the energy-led growth hypothesis raise concerns about the sustainability and environmental consequences of relying heavily on energy consumption for economic growth. They argue that unchecked energy consumption can lead to environmental degradation, resource depletion, and climate change, posing long-term risks to economic stability and societal well-being. As such, there is a growing recognition of the need to balance energy-driven growth with environmental sustainability and energy efficiency measures²⁰.

2.2.3 Growth Theories

The goal of economic growth theories is to explain the various factors that determine the success of a project. They try to identify the most critical conditions that can trigger development. Neo-classical, classical, and even endogenous growth theories all attempt to find a model that can be

applied to various issues. However, many of the standard growth theories ignore the role of quality institutions.

Classical Theory

The classical growth theory states that markets regulate themselves. The theory states that the increase in wealth of people is linked to the improvement in the output of factor inputs, which in turn increases the size of the functioning capital. Adam Smith argues that population growth is a function of the substance available to the individual. The concept of investment is also considered as an asset that can be produced because of savings. The rise in land productivity was attributed to technological advancements and geographical discoveries. The main factor that drives productivity growth is the division of labour. The theory of competition states that technological advancements can lead to rapid growth. However, it warns that a sudden increase in real output per person could cause a population explosion that would reduce real gross domestic product. This concept is based on Thomas Malthus's theory of agriculture. Thomas Malthus' examples show that the number of seeds harvested from a plot of land is related to the number of workers employed on it²¹.

Neoclassical Growth Model

The concept of the neoclassical growth model was developed by Trevor Swan and Robert Solow in the 1960s. It states that the rate of growth of the gross domestic product is increased by the higher share of investment and the decrease by the rate of depreciation of the physical capital stock. The model assumes that the labour force growth is constant, and all saving is equal, and that the output is dependent on the interaction between labour and capital. It also states that the production function $Y = F(K, L)$ shows constant returns, and that other factors such as the

variable factor, also hold constant²². According to the neoclassical growth theory, the continuous increase of the labour force is required to boost productivity. This is done through the build-up of various resources, such as human capital and physical capital. It also states that the accumulation of these factors is stimulated by the private sector. The idea that government can only affect economic growth by investing in education and research was suggested by the neoclassical growth model. The literature also stated that an increase in the total factor productivity of the country would compel an increase in the output per worker²³. The school of thought explained that the effect of a decrease or increase in the national product on the growth rate of the worker would depend on the share of capital that is owned by the owners of the country's economy. The marginal product of capital is computed by considering the share of capital that is equal to the total output.

The neoclassical growth model states that technological progress is determined by the level of competition in a country. The inclusion of this assumption in the model was necessary to ensure that all the resources are properly allocated. The criticism levelled against the model has led to the development of the endogenous growth theory²⁴. The ideal competition theory states that the optimal allocation of resources is achieved through the proper allocation of capital. This ensures that markets are open and that investors can make informed decisions. Unfortunately, when markets fail to clear, investors' expectations are disrupted, and the information becomes inaccurate. The effects of changes in investment plans on economic growth are typically the main factors that affect the country's long-term growth rate. The failure of the neo-classical model to consider the various factors that affect the country's long-term growth rate is a major weakness.

Endogenous Growth Theory

Before the emergence of the endogenous growth models, various attempts to endogenize technology were made. The classical model of external factors failed to explain how economic growth can be sustained²⁵. According to the theory of the endogenous growth, the factors that contribute to economic growth are the investments in capital, knowledge, and innovation. The long-run growth rate of an economy is a function of its total factor productivity. In the case of the neoclassical view, the long-run rate of technological progress is mainly influenced by external factors. The goal of the endogenous growth theory is to explain how technological progress can be influenced by factors outside the control of the government. According to a noted author, technological progress is made through the invention of new products and processes, which are often the result of economic activities²⁶. Learning by doing is not restricted to the firms that produced the goods and services, but also to the firms that acquired them. Thus, in a competitive equilibrium, technological progress would not be compensated for by the additional capital that would be received by the labour and capital.

The growth of technological progress is dependent on the increase in saving propensity. This is why the Arrow model was only used in the case of fixed capital requirements and fixed labour requirements. It shows that the long-run growth of output was limited by the growth in labour. The accumulation of capital is a crucial factor that limits the growth of an economy. In a neoclassical model, the other factors that affect the output, such as the employment of workers and technological progress, are also considered. In a different type of model, the other determinants are considered, and the growth of one of these factors is assumed to automatically increase the output in proportion to capital. This method allows the output to grow in line with

the increase in capital. The AK model was the first major innovation in the field of economics. It predicted that a country's long-run growth rate would be dependent on various factors such as the efficiency of the country's resource allocation. The first analytic models of AK were traced to prominent authors²⁴. Some of them developed models with fixed coefficients and others with substitutable factors and market clearing features. The latter model was designed to reconcile the positive long-term growth result of Harrod-Domar with the neoclassical model's constraints²⁷. The Solow model is a constant savings rate, while the Frankel model proposes a learning-by-doing approach that can increase productivity. According to the author, capital is the determining factor of capital, but not employment. He noted that the similarities between capital and knowledge can lead to the elimination of the Harrod-Domar model's fixed coefficients. A new approach to the AK model was presented by two researchers²⁵. They argued that knowledge could be profitable to the explorer, but it could also lead to technological spill-over and make it more accessible to others. Their model was based on a combination of social learning and the trade-off between consumption and capital.

The development of new economic theories has been linked to the effects of policies that support research and education. This is because these policies could have a significant impact on the long-term growth of the economy. New institutional economics has also been developed, which suggests that the role of institutions in the market economy is becoming more apparent. For instance, according to the author, factors such as technological and institutional conditions can affect the sustainability of an economy²⁷. In another perspective, this suggests that the quality of institutions is also linked to the capital and resources that they produce. The sustainability of an economy can be achieved through the various institutional settings that are designed to improve

the efficiency of the financial system. According to literature, good institutions can help boost the efficiency of the financial system by investing in areas that are expected to stimulate growth, while weak institutions can allow their activities to divert credit to unproductive and inefficient activities^{29,30}. The relationship between monetary policy and energy consumption can also be affected by the substitution of various inputs with technological change. For instance, technological change can affect the composition and quality of the institutional output. In his paper, Solow criticized the limits of the theory on technological progress as a way of mitigating the effects of the scarcity of resources.

2.3 Empirical Review

2.3.1 Monetary Policy and Economic Growth

Some scholars investigated the impact of monetary policy on economic growth in Nigeria. The analysis was based on secondary data obtained from the Central Bank of Nigeria statistical bulletin, spanning the years 1980 to 2017. The estimates of the model were derived using a multiple econometric model of ordinary least squares. This model was employed to examine the impact of many factors, including money supply, credit in the economy, interest rate on credit, infrastructure, inflationary rate, external debts, and price index, on the growth of Nigeria. The findings indicated that the variables of money supply, interest rate on credit, infrastructure, and external debt exhibited statistical significance in elucidating their effects on economic growth. The report suggests, among other recommendations, that to ensure the efficient implementation of monetary policy measures in the Nigerian economy, it is advisable to provide the Central Bank of Nigeria complete autonomy in carrying out its monetary policy functions. The

replacement of partial autonomy with full autonomy is necessary for central banks in developing countries, as they are consistently susceptible to government meddling and political influences³¹.

Similarly other scholars investigated the efficacy of the Monetary Policies implemented by the Central Bank of Nigeria in fostering economic growth throughout the time frame spanning from 1990 to 2011. The study employed multiple regression models as the primary statistical technique for analyzing the impact of money supply, average price, interest rate, and labour force on Gross Domestic Product. Research indicates that the procedures implemented by the Central Bank of Nigeria (CBN) for Monetary Policy are successful in controlling both the monetary and real sector aggregates, including employment, prices, output level, and economic growth rate. The study's empirical findings suggest that the average price and labour force exert a substantial impact on Gross Domestic Product (GDP), however the money supply does not demonstrate a significant influence. The adverse interest rate exhibited a statistically significant negative trend. Hence, it is advisable that the Central Bank's Monetary Policy serves as a potent instrument to stimulate investment, diminish unemployment, lower lending rates, and stabilize Nigeria's economy³².

Some other academicians also investigated the comparative efficacy of monetary and fiscal policies on the economic growth of Bangladesh during the time span from 1974 to 2015. The study uses cointegration and Vector Error Correction Model (VECM) as analytical tools. As a measure of economic growth, they employed nominal GDP as a substitute, while wide money supply (M2) and reserve money (RM) serve as substitutes for monetary policy. The proxies employed for fiscal policy are total government income (TR) and total government expenditure (TE). The results of the Johansen cointegration tests indicate that in Bangladesh, monetary policy

(namely M2 and RM) exerts a more substantial and beneficial influence on long-term economic growth compared to fiscal policy. The findings of the Vector Error Correction Model (VECM) indicated the presence of a modest long-term causal relationship between monetary and fiscal policy and economic development. Furthermore, it can be argued that economic growth serves as a prominent indication in relation to fiscal policy in the immediate term. In conclusion, it can be inferred that monetary policy is a more efficacious mechanism compared to fiscal policy for fostering economic growth in both the short and long term within the context of Bangladesh³³.

Most scholars in Ghana have not extensively examined the effect of monetary policy instruments. Hence, some scholars assessed the influence of monetary policy instruments on economic growth by analyzing time series data spanning from 1990 to 2019. The stationarity of the variables was assessed using augmented Dickey-Fuller and Phillips-Perron unit root tests. The long- and short-run dynamics of the variables were estimated using Johansen cointegration and error correction technique. The findings derived from the estimation demonstrated a statistically significant and positive relationship between money supply and exchange rate with economic growth, both in the short and long term. Furthermore, the growth rate was considerably impacted in a negative manner by the monetary policy rate, interest rate, and inflation. The findings also demonstrated a reciprocal causal relationship between the money supply and the pace of economic expansion. In the long run, a unidirectional association was observed between interest rates and economic growth, inflation and economic growth, and monetary policy rates and economic growth. The study suggests that it would be beneficial for monetary policy authorities and the Bank of Ghana (BoG) to implement structural changes and policies aimed at fostering a conducive environment for both domestic and foreign investment. It is imperative for the Bank

of Ghana (BoG) to effectively manage interest rates, policy rates, and inflation to mitigate the potential contraction of economic activities, as these factors exert a direct impact on overall growth³⁴.

Similarly, a study examined the efficacy of monetary policy instruments in ensuring the stability of economic growth in Nigeria. The study utilized three components of monetary policy, namely money supply, interest rate, and exchange rate, to assess the efficacy of monetary policy in maintaining economic growth stability in Nigeria throughout the period spanning from 1998 to 2018. The results indicate that the money supply has a significant beneficial impact on the GDP, which serves as an indicator of the stability of economic growth. Nevertheless, the GDP is not significantly influenced by interest rates and exchange rates. The study asserts that the money supply is the most effective instrument of monetary policy in Nigeria and suggests its appropriate utilization to attain optimal economic advantage. The central bank of the country, known as the Central Bank of Nigeria (CBN), is being pushed to enhance credit accessibility by implementing measures to mitigate interest rate and currency rate swings³⁵.

Some authors also investigated the correlation between monetary policy and economic growth in Nigeria. The study employed the Granger pair-wise causality model to examine the nature and direction of causation. Additionally, a multiple regression model was developed, drawing upon the theoretical framework of the research. The researchers employed the error correction mechanism (ECM) technique to accurately estimate the equation and assess the intrinsic relationship between monetary policy and economic growth. Additionally, they examined the influence of money supply, interest rate, and exchange rate on the rate of economic growth in Nigeria. The finding indicated the presence of a one-way causal connection between the money

supply and economic growth in Nigeria. Furthermore, economic growth is adversely impacted by interest rates and exchange rates, whereas money supply has a beneficial impact on economic growth. In order to mitigate inflation and foster economic growth in Nigeria, authorities should focus on regulating key macroeconomic factors, namely the money supply, exchange rate, and interest rate³⁶.

Some scholars also examined the correlation between monetary policy and economic growth in Nigeria. The study encompassed a period of 18 years, specifically from 2000 to 2017. The study used the GDP as a surrogate for economic growth and serves as the variable that is influenced by other factors. The explanatory factors included the interest rate, open market activities, exchange rate, monetary policy rate, and cash reserve ratio. The research included time series data for the variables under investigation and utilized the ordinary least squares method. Additionally, the ADF unit root test was undertaken to assess stationarity, and the error correction mechanism was employed for co-integration testing. The research revealed that factors such as interest rate, open market operations, and exchange rate exhibit a positive influence on the Gross Domestic Product (GDP). Conversely, the monetary policy rate and cash reserve ratio demonstrate an inverse association with the GDP. Therefore, the study suggested that the government should implement suitable policy measures to address the key variables in relation to the established aims and objectives³⁷.

To analyze the impact of monetary policy shocks on economic growth in Nigeria. Some researchers utilized an ex post facto research strategy and employed a regression model. The dependent variable in this model was economic growth, while the explanatory factors included money supply, inflation, and interest rate. The study utilized time series data from the Central

Bank of Nigeria (CBN) Statistical Bulletin and the World Bank Development Index (WDI) spanning from 1986 to 2018. The analysis in this paper utilized the Vector Autoregression (VAR) methodologies. The findings from the vector autoregression analysis indicated that there is a statistically significant positive relationship between money supply and economic growth in Nigeria. However, the impact of inflation and interest rate on economic growth in Nigeria is shown to be statistically negligible. The findings demonstrate that monetary policy shocks have a substantial impact on economic growth in Nigeria, although interest rate and inflation do not exhibit any influence. It has been suggested that the Central Bank of Nigeria (CBN) should implement a downward adjustment of the Monetary Policy Rate from 12% to 9% in order to improve financial accessibility³⁸.

Some scholars also investigated the correlation between monetary policy and economic growth in Nigeria by analyzing time series data spanning from 1980 to 2017. This study utilized the Cointegration test and the Ordinary Least Square (OLS) technique to estimate the coefficients of the model and demonstrate the policy relationship between the variables. The findings suggested the presence of a sustained correlation between quantitative measures of monetary policy and the rate of economic growth. Additional empirical evidence demonstrates that the money supply exerts a positive impact on the real GDP, whereas both the exchange rate and interest rate exhibit a negative influence. Therefore, it is imperative for the monetary authorities in Nigeria to effectively oversee and regulate the expansion of the money supply in order to achieve the intended level of growth. In light of the prevailing socio-economic and political circumstances in Nigeria, there is an increasing imperative to develop suitable monetary policies that can

incentivize borrowing by implementing a robust and effective interest rate structure, alongside maintaining a stable currency rate³⁹.

To examine the dynamics of monetary policy, inflation, and economic growth within the Ghanaian economy from 1982 to 2017, some authors employed the Autoregressive Distributed Lag (ARDL) cointegration model and the findings of this study indicated that there exists a significant long-term relationship between interest rates and economic growth. However, this relationship is negative in nature, suggesting that higher interest rates tend to impede economic growth and contribute to inflationary pressures. Regarding the exchange rate, the long-term outcome suggested a negligible adverse impact on economic growth. Overall, the findings indicate that the macroeconomic factors that impact economic growth are the interest rate and currency rate. These findings provide empirical support for the notion that macroeconomic instability exert a substantial impact on economic growth. Consequently, it is necessary to grant the Bank of Ghana fiscal restraint and independence authority, with reduced interference from the government, to facilitate the effective execution of monetary policy without any political interference⁴⁰.

Likewise, some authors examined the impact of monetary policy on economic development from 1981 to 2014, utilizing secondary data sourced from the Central Bank of Nigeria's publications, including annual reports, statements of economic and financial review, and Statistical Bulletins. The findings indicated that the monetary policies implemented during the examined period have had a significant influence on the economic growth of Nigeria⁴¹.

Some scholars also examined the effectiveness of monetary policy instruments in Nigeria by analyzing monthly data spanning from 2000 to 2016. The research employed the Johansen

Multivariate Cointegration methodology and considered the application of Vector Error Correction (VECM). The results of the Cointegration test indicate the presence of a sustained association between monetary policy instruments and economic development. The study additionally demonstrated that the variables exhibited a monthly rate of adjustment towards their long-term equilibrium trajectory, reaching approximately 27 percent. The primary finding of the study revealed that the Consumer Price Index (CPI), Real Exchange Rate (RER), Money Supply (M2), and Interest Rate (INT) played a crucial role as monetary policy tools in driving economic growth in Nigeria during the examined timeframe. As a result, the study concluded by suggesting that the monetary authority in Nigeria should adopt Nominal GDP targeting as the framework for their monetary policy making process⁴².

To investigate the impact of monetary policy on the economic growth of a specific group of SAARC countries, some authors carried out an extensive study to achieve this main objective, the analysis relies on panel data spanning 25 years, from 1996 to 2020, from five selected SAARC states. The study employed a research strategy that utilized descriptive and causal relationships, relying on secondary data sources. The Hausman test was conducted to determine the appropriate model between fixed and random effects. In this study, a correlation matrix was employed to provide a concise summary of the relationship between the variables. The study revealed that foreign reserve and broad money variables exhibited a statistically significant positive impact on GDP, whereas the exchange rate variable demonstrated a statistically significant negative impact. Furthermore, the study revealed that inflation had a statistically minor negative impact on economic growth, with a significance level of 5%. This paper asserts that the limited efficacy of monetary policies in achieving their policy objectives can be

attributed to deficiencies in the policy instruments employed, hence constraining their impact on economic growth, despite the notable contributions made by monetary policies over time⁴³.

To examine the influence of monetary policy on the economic growth prospects of Nepal, some scholar utilized data obtained from the national account sources of the World Bank, covering the period from 1965 to 2020. To mitigate the occurrence of spurious regression, an Augmented Dickey-Fuller unit root test was conducted. The Johansen co-integration test was employed subsequent to the integration of all variables in order I (1). Subsequently, the Vector Error Correction model was utilized to determine the rate at which the system adjusts towards long-run equilibrium. The VECM coefficient exhibited a negative and statistically significant link, indicating a long-term association between monetary policy and GDP growth. The findings of the study indicate a bidirectional causal relationship between the money supply and GDP growth. The findings provide evidence for the influence of monetary policy on the economic growth of the nation. Monetary authorities and policy makers should prioritize the implementation of a sound monetary policy to foster economic growth within the country, as it has the potential to mitigate unemployment, stimulate investments, and enhance economic stability⁴⁴.

Some authors also conducted an empirical analysis to investigate the impact of monetary policy on the economic growth of Lao PDR. The present research employed the Vector Autoregressive Model (VAR) and utilized quarterly data spanning from the initial quarter of 1995 to the final quarter of 2018. The findings of the study demonstrated a negative relationship between GDP and price level. This suggests that when the central bank implements an expansionary monetary policy or experiences a shock in monetary policy, it will have an impact on consumer price levels. Consequently, this would lead to a fall in real output within the Lao economy. Additionally, this

study has identified a detrimental impact of real interest on the Gross Domestic Product (GDP) in Lao PDRD⁴⁵.

To investigate the transmission of monetary policy instruments on the economic growth of Nigeria, some authors analyzed quarterly time series data spanning from Q12008 to Q42018. The research utilized the Augmented Dickey Fuller's unit root test, lag selection criteria, and impulse response function within the framework of the Toda-Yamamoto approach to investigate the transmission of monetary policy tools on economic growth. The findings indicated that the effectiveness of monetary policy tools, namely the manipulation of money supply, is not consistently consistent. Any changes in these factors, whether they increase or decrease, may have a negative impact on the availability of credit to the key private sectors, hence impeding growth, and development. This study suggested that the monetary authority should take proactive efforts to ensure the stability and strength of commercial banks, which can provide significant money to the core private sector to enhance economic productivity. It is possible to accomplish this objective by closely monitoring banks and assuring the comprehensive deployment of indirect monetary policy instruments⁴⁶.

To examine the influence of monetary policy instruments on the economic growth of Azerbaijan from 2005 to 2018, employing the Vector Error Correction Model (VECM), some researchers employed robustness test, various co-integration approaches, specifically Johansen, DOLS, FMOLS, and CCR. The results obtained from various co-integration approaches exhibit congruence and validate the presence of enduring associations among variables. Moreover, the findings from the Vector Error Correction Model (VECM) indicated that the monetary base and exchange rate exert a positive and statistically significant influence on long-term economic

growth. Conversely, the discount rate does not demonstrate a meaningful impact. The article asserts that policymakers should prioritize the promotion of the monetary base and exchange rate over other monetary policy tools when implementing monetary policy to stimulate economic growth⁴⁷.

To investigate the relationship between monetary policy and economic growth in Ethiopia through the analysis of time series data spanning from 1980 to 2019, some authors conducted the unit root tests by Zivot and Andrews (ZA) and Clemente (CMR) which demonstrated that the real interest rate exhibited stationarity at level. The ARDL limits test for co-integration yielded data indicating the existence of a long-term relationship among the series observed during the duration of the investigation. The findings of the long-term estimation revealed a statistically significant positive relationship between money supply, real interest rate, reserve requirement, and gross capital formation with economic growth in Ethiopia over the duration of the study. The results of the Error Correction Model (ECM) test indicate that around 29% of short-term disequilibrium is subject to annual adjustments. The causality test revealed a substantial causal relationship between real gross domestic product and inflation, exchange rate, and money supply at a 5% level of significance. Additionally, a significant causal relationship was seen between real gross domestic product and gross capital creation at a 10% level of significance. In summary, this analysis found a positive correlation between many monetary policy instrument variables and economic development, with the exception of inflation and exchange rate. It is recommended that the national banks of Ethiopia demonstrate a strong commitment to the objective of maintaining price stability⁴⁸.

Some scholars examined the influence of monetary policy on the economic growth of Nigeria. The study utilized annual time series data spanning from 1981 to 2020. The study employed the growth rate of gross domestic product (GRGDP) as the endogenous variable, while the exogenous variables and proxies for monetary policy included broad money supply (MS2), monetary policy rate (MPR), inflation (INFL), liquidity ratio (LDQR), and exchange rate (EXCH). The data utilized in this study were sourced from the Statistical Bulletin of the Central Bank of Nigeria for multiple years, as well as the World Bank National Account Data. Descriptive statistics were employed in the investigation, followed by a unit root test conducted using the Augmented Dickey-Fuller test, an Autoregressive Distributed Lag (ARDL) Bound test, and the application of Toda Yamamoto to examine causality. The Toda Yamamoto causation test demonstrated that all external factors exhibited bi-directional causation with economic growth, except for the exchange rate, which shown uni-directional causality with economic growth. Based on the research findings, it was recommended that the management and manipulation of Broad Money Supply (MS2) be effectively implemented to attain the desired growth, aligning with the monetary policy stance maintained by the monetary authority. Furthermore, it is imperative for the monetary authority and the government to actively pursue policies aimed at promoting financial inclusion in Nigeria, since this would significantly bolster the efficacy of the monetary policy⁴⁹.

Similarly, a study focused on the output of the manufacturing sector to analyze the impact of monetary policy on industrial growth in Nigeria from 1986 to 2019. The study's data were obtained from the CBN Statistical bulletin. The researchers created a multivariate regression model and used the Ordinary Least Square (OLS) regression approach to analyze the data. The

findings of the study indicated that there is a positive and significant relationship between Open Market Operation (OMO), as measured by the Treasury bill rate, and the Gross Domestic Product (GDP) of the Nigerian Manufacturing Domestic Sector. Additionally, the Cash Reserve Ratio (CRR) also has a positive and significant impact on the GDP of the Nigerian Manufacturing Sector. On the other hand, the Monetary Policy Rate (MPR) has a negative and significant effect on the GDP of the Nigerian Manufacturing Sector. The paper asserts that monetary policy is an effective instrument for bolstering the expansion of the industrial sector in Nigeria. It was advised that the monetary authority should guarantee a reduced Monetary Policy Rate (MPR) to stimulate investment and thus enhance industry growth⁵⁰.

2.3.2 Energy Consumption and Economic Growth

Several scholars have conducted an analysis on the correlation between energy consumption and economic growth in the context of Indonesia. The present study employed a quantitative research approach to evaluate the relationship between energy consumption and economic growth in Indonesia throughout the time frame spanning from 2000 to 2019. The study examined the relationship between energy consumption as the independent variable and economic growth in Indonesia as the dependent variable. The analysis includes the calculation of long-term and short-term coefficients, as well as the use of Augmented Dickey Fuller and Johansen co-integration. The results of the study indicate a significant correlation between economic growth and energy usage. The analysis of historical data reveals that energy consumption possesses the capacity to serve as a predictive factor for economic growth in Indonesia. The research can be enhanced by augmenting the sample size, expanding the number of variables, and incorporating additional nations for comparative analysis. This study also offers guidance to policymakers on

the development of energy consumption policies that promote economic growth inside the country⁵¹.

The objective of certain authors was to investigate the interconnection between energy and economic growth in post-communist countries from 1995 to 2014. The growth model is used as an empirical model, using an economic complexity indicator to assess the ability to export advanced items. The long-term relationship between the variables was evaluated using Pedroni's (1999) panel cointegration tests and Panel Dynamic OLS estimation. We have established cointegration between energy consumption and economic growth at a significance level of 1%. The findings of the Panel Dynamic Ordinary Least Squares (OLS) analysis indicate a positive relationship between economic growth and energy consumption in post-Communist republics. The panel Granger causality test conducted by Dumitrescu and Hurlin (2012) revealed a unidirectional causal relationship from economic growth to energy consumption. The conservation hypothesis is confirmed by the correlation between economic growth and energy usage in post-communistic countries⁵².

Several scholars conducted a study to investigate the causal relationship between energy consumption and real GDP in the fourteen MENA Countries from 1987 to 2019. They employed a bivariate Vector Auto-regression model and the Granger causality technique for their analysis. The study demonstrates the presence of either a one-way, two-way, or unrelated causal connection between energy consumption and economic growth in various nations within the MENA Region. To ensure sustainable economic growth in the MENA area, it is imperative for environmental and energy policy to acknowledge the correlation between energy consumption and economic growth⁵³.

The impact of oil, gas, and biomass fuel consumption, road infrastructure, life expectancy, and average length of education on economic growth in Indonesia from 1990 to 2019 was examined by some scholars. The present study employed a quantitative approach, utilizing linear regression as the chosen method for data analysis. The utilized data include time series data spanning from 1990 to 2019. The findings of this study indicated that there is a positive and statistically significant relationship between oil, petrol, and biomass fuel consumption, average length of education, and economic growth in Indonesia from 1990 to 2019. However, it was observed that road infrastructure and life expectancy do not have a significant impact on economic growth during this period. The study proposed enhancing energy reserves through the expansion of energy sources and the development of additional infrastructure to bolster and enhance energy supply⁵⁴.

To examine the correlation between the consumption of energy in several industries, specifically oil, coal, gas, and electricity, and economic growth. The study utilized annual time series data of Pakistan spanning from 1972 to 2016. The ARDL bound test was employed to examine cointegration, while the Granger causality test is utilized to assess short-term causation. The findings of the study indicate that there is a positive and statistically significant relationship between oil consumption in the industrial and transport sector, petrol consumption in the fertilizer and power industry and electricity consumption in the industrial sector, and long-term economic growth. Nevertheless, the consumption of oil in the agricultural and power sectors, coal in the power and brick kilns sector, gas in the cement sector and electricity in the agricultural sector all exert a detrimental and substantial influence on economic growth. There is no evidence of a causative relationship between oil consumption and economic growth. However,

in the short term, there is a unidirectional causal relationship from economic growth to coal consumption in the brick kilns sector, gas consumption in the industrial sector and electricity consumption in the agriculture sector. To ensure a sustainable energy supply, it is important to decrease the reliance on oil and coal and instead utilize locally accessible resources. However, for sustainable economic growth, it is advisable to promote the use of electricity in the industrial sector and encourage the fertilizer and power sector to utilize gas⁵⁵.

Some authors examined the long run correlation and causative link between energy consumption and economic growth in the BRICS countries from 1990 to 2018. They used the Pair-wise Granger-causality technique to examine the causal link between the variables. The findings of the study indicated the existence of a sustained correlation between economic development, energy consumption, employment, and trade openness among the BRICS countries. The study findings also revealed a one-way causal relationship from economic growth to energy consumption. This suggests that the implementation of conservation policies aimed at reducing energy loss could be feasible in the BRICS countries without causing negative impacts on economic growth⁵⁶.

Some researchers analyzed the causal relationship between energy consumption and economic growth in Kuwait. Additionally, they examined the influence of rising local energy prices on Kuwait's economic growth. They employed statistical analysis to examine the causal relationships between different factors, including GDP, annual oil production, oil-reserves depletion, annual energy consumption, and CO₂ emission. The findings indicated a strong correlation between Kuwait's oil exports (sales) and its total GDP. The disparity between the overall Gross Domestic Product (GDP) and the GDP derived from oil precisely corresponds to

the non-oil-related economic growth that contributes to the country's economy. The results of the study offer a dependable and appropriate foundation for policy formulation, not only in Kuwait but also in other nations that rely on a single source of oil production, such as the Gulf Cooperation Council (GCC) countries⁵⁷.

Similarly, some scholars also investigated the intricate interplay between energy consumption, foreign direct investment, and economic growth in the Sub-Saharan African region. They examined the impact of energy consumption, foreign direct investment, and economic growth using the Generalized Method of Moments, in addition to examining the tripartite causal relationship. The research employed data from a total of 42 Sub-Saharan African countries, covering the period from 1991 to 2018. The study's findings indicated that a rise in energy consumption by a certain percentage lead to a corresponding economic growth of 1.3 percent. In contrast, economic development leads to a 0.004 percent increase in energy consumption. Moreover, a notable unidirectional causal relationship exists between foreign direct investment (FDI) and economic growth. There was no statistically significant relationship observed between energy usage and foreign direct investment (FDI) in either direction. The report proposes that it is imperative for the government in Sub-Saharan Africa to prioritize the provision of increased energy access to bolster economic growth⁵⁸.

Some scholars also investigated the effects of energy consumption and energy costs on economic growth using three data sets consisting of panel groups from Next 11 nations. The analysis was conducted within a multivariate panel framework, covering the period from 1990 to 2013. The panel Autoregressive Distributed Lag estimation approach reveals that energy consumption had a positive effect on economic growth in both the long-run and short-run for the entire group of

Next 11 countries. Additionally, the results of panel causality tests confirm a unidirectional causal relationship between economic growth and energy consumption. The panel Dynamic Ordinary Least Squares approach revealed that economic growth in the 6 out of Next 11 net oil-importing countries is adversely affected by both energy consumption and energy prices. The panel Autoregressive Distributed Lag estimation approach for the panel group of 5 out of the next 11 net oil-exporting countries reveals that, in the long term, energy consumption has a detrimental impact on economic growth, while energy prices have a positive influence on economic growth. However, in the short term, both energy consumption and energy prices have a negative effect on economic growth⁵⁹.

Similarly, some academicians focused on the correlation between the consumption of renewable energy and the economic growth in Uganda, utilizing data from 1988 to 2018. The study employed a vector error correction model and utilized the augmented Dickey Fuller test to assess stationarity. Additionally, the Johansen test was employed to examine cointegration. The Granger test was employed to examine the presence of causation among the variables under investigation. The results suggested a detrimental correlation between renewable energy and economic expansion. The study recommended that government should prioritize the implementation of clean energy policies and enhance its power trade within the East African community to effectively manage surplus electricity supply during periods of high domestic usage⁶⁰.

A researcher examined the correlation between environmental deterioration, energy usage, and economic expansion in Cameroon by analyzing time series data from 1970 to 2018. The data analysis in this study utilized the Autoregressive Distributional Lag (ARDL) model, employing the Econometrics View Package (E-views 10). The findings of the study indicate a significant

and positive correlation, both in the short term and the long term, between energy consumption (energy consumption) and economic growth (RGDP). Furthermore, a robust and statistically significant correlation exists between power consumption and economic growth, whether observed in the short-term or long-term. Once again, the findings confirmed a detrimental correlation between environmental deterioration (CO₂) and economic expansion (RGDP) in both the immediate and extended periods. Additionally, the findings indicated a statistically significant and positive correlation between energy consumption and CO₂ emissions in the short term, but this association was shown to be statistically negligible in the long term. In conclusion, the coefficients associated with the ARDL error correcting mechanism (ECM(-1)) exhibit negative values and demonstrate statistical significance. This suggests that the rate at which the system adjusts from the short-term to the long-term equilibrium is substantial. The report suggested that oil refining and transport businesses should enhance the nationwide supply of fuel and petrol by establishing oil pipelines to connect important communities. Additionally, it was recommended that the government augment its budgetary commitment towards the energy industry⁶¹.

Some researchers also investigated the influence of energy consumption on the economic growth of post-transition countries, both inside and outside the European Union. This study employed panel data from 10 post-transition nations throughout the observed period of 2012-2020 to assess the influence of energy consumption on economic development. The findings indicated that there is a positive and statistically significant relationship between energy consumption and economic growth. A marginal increase of one percent in per capita final energy consumption is associated with an average gain of 0.557 percent in real GDP per capita. The findings of the study hold

significance in informing policy interventions and energy incentives aimed at promoting the adoption of new technologies and energy-efficient sectors, hence fostering sustainable economic growth⁶².

The relationship between economic growth and energy consumption is interconnected within an economy, and it is anticipated that these variables will exhibit a positive association. Some researchers examined this link inside the United Arab Emirates from 1996 to 2020. The analysis in the paper employed fundamental regression and Vector Auto Regression approaches. The research revealed a positive correlation between energy consumption and non-renewable energy consumption, which is contingent upon the economic growth of the country. Furthermore, this relationship reaches its optimal state when there is a lag of 7 years⁶³.

Some scholars used the auto-regressive distributed lag approach to estimate the impact of energy consumption on economic growth in Nigeria from 1981 to 2017. The findings suggested that the increase of economic activity in Nigeria is highly influenced by energy consumption and gross fixed capital creation, which serves as a proxy for infrastructure. Furthermore, the research provided empirical evidence that an endogenous variable exhibits a delayed response to both its own shocks and shocks to explanatory factors. Hence, it may be argued that energy consumption has a significant role in shaping economic growth in Nigeria, thereby supporting the energy-led hypothesis. The empirical evidence of a positive correlation between electricity usage and capital use lends support to the endogenous growth theory. There is a significant advocacy for more investment in energy and infrastructural development by both the government and business sector⁶⁴.

Some authors utilized the ARDL bounds test methodology and the VECM test technique to investigate the enduring association and causation direction between renewable energy consumption and economic growth in Argentina. The study utilized quarterly time series data spanning from 1990 to 2018. The study used trade openness, capital, and employment to establish a multivariate framework. The findings indicate the presence of a sustained association between the variables. The VECM test methodology has substantiated the presence of a unidirectional causal relationship, wherein economic growth influences the usage of renewable energy. Consequently, energy conservation regulations potentially do not have a detrimental impact on economic growth. The report thus proposed the implementation of a suitable and efficient energy policy in the long term⁶⁵.

In a bid to reassess the impact of renewable energy consumption on economic growth within a sample of 38 nations that consume renewable energy, spanning the period from 1990 to 2018. Some scholars employed the dynamic ordinary least squares (DOLS), completely modified ordinary least squares (FMOLS), and heterogeneous non-causality methodologies. The empirical research provides evidence supporting the existence of a sustained correlation between the consumption of renewable energy and the growth of the economy. Additionally, their analysis revealed that renewable energy, nonrenewable energy, capital, and labour exert a favourable influence on economic growth. Notably, the use of renewable energy demonstrates a favourable impact on economic growth in 58% of the nations included in our sample. The findings from the empirical analysis indicated that it is imperative for international cooperation agencies, energy organizers, governments, and affiliated entities to collaborate to enhance investment in renewable energy, hence promoting low carbon growth in the majority of these economies⁶⁶.

To investigate the causal relationship between the utilization of renewable energy and economic growth through the application of a threshold model. Some authors conducted an analysis using a sample of 103 countries spanning the years 1995 to 2015. The correlation between the utilization of renewable energy and economic growth is contingent upon the quantity of renewable energy employed. The findings of their study indicate that there exists a positive and statistically significant relationship between the consumption of renewable energy and economic growth. However, this relationship is contingent upon developing countries or non-OECD countries exceeding a specific threshold of renewable energy consumption. Nevertheless, when developing nations employ renewable energy sources at a level that falls below a specific threshold, the impact of renewable energy consumption on economic growth becomes adverse. Nevertheless, the analysis revealed that the utilization of renewable energy does not have a substantial impact on the economic growth of developed nations, whereas it does have a favourable and substantial impact on the economic growth of OECD countries. The results indicate that for developing nations to achieve favourable economic growth through their investments in renewable energy, they must exceed a specific threshold of renewable energy consumption⁶⁷.

To investigate the correlation between economic growth and energy consumption within the time frame of 1986 to 2015, focusing on a sample of 15 developed nations. Some researchers employed the dynamic panel analysis technique to consider cross-section dependence and homogeneity tests. Consequently, the decision was made to conduct unit root and cointegration tests. The findings of the cointegration test indicate the presence of a sustained association between economic growth and energy consumption over an extended period. The findings derived from the examination of the Dumitrescu-Hurlin causality test indicate the presence of a

reciprocal causal relationship. Based on the conducted analysis, it was determined that there exists a causal relationship between economic growth and energy consumption for the time frame spanning from 1986 to 2015 in a sample of 15 industrialized nations⁶⁸.

A study examines the relationship between the consumption of renewable energy and economic growth in developing nations, as well as the influence of environmental sustainability on this relationship. A researcher utilized the General Method of Moment (GMM) to address the potential issue of endogeneity that has been observed in prior studies, employing data obtained from the World Bank. Research has revealed that the utilization of renewable energy has a beneficial albeit modest effect on the economic growth of emerging nations. However, when considering environmental sustainability, the influence of renewable energy consumption becomes more significant. Likewise, the interaction between carbon dioxide (CO₂) and renewable energy results in a shift in the polarity of CO₂ from positive to negative. The study suggests that the economic effects of renewable energy consumption may be limited, but they are justified due to its potential for environmental sustainability⁶⁹.

A research reassesses the correlation between energy usage and economic expansion in Nigeria from 1995Q1 to 2016Q4 by employing various model assumptions. Some scholars employed a nonlinear (or asymmetric) autoregressive distributed lag (ARDL) model using an ARDL-ECM specification, which assumes a linear relationship rather than a nonlinear one. In general, the analysis indicates that the impact of energy consumption on economic growth has been minimal, implying that further efforts are required to fully realize the anticipated role of energy in the Nigerian economy. The results of the Granger causality tests indicate a unidirectional causal relationship from energy consumption to economic growth. This suggests that Nigeria has the

potential to achieve significant levels of sustainable growth through the enhancement and stability of its energy supply. Therefore, the study asserts that the findings serve as a significant reminder to governments and policymakers in Nigeria and other Sub-Saharan African economies that exhibit structural resemblances. It emphasizes the pressing necessity to develop and execute policies that effectively tackle the energy demands faced by these economies⁷⁰.

2.3.3 Monetary Policy and Energy Consumption

The study investigates if there is an uneven effect of US monetary policy uncertainty on energy consumption⁷¹. The study utilizes both symmetric and asymmetric autoregressive distributed lag (ARDL) estimation methods. It reveals that monetary policy uncertainty has adverse effects on renewable energy consumption in both the short and long term within the linear model. Additionally, a reduction in monetary policy uncertainty significantly decreases renewable energy consumption in the USA, as observed in the non-linear model. Nevertheless, the analysis reveals that the level of uncertainty in monetary policy has a negligible influence on non-renewable energy consumption in both the short and long term. However, heightened uncertainty in monetary policy in the United States has adverse consequences, whereas reduced uncertainty has beneficial effects on non-renewable energy consumption in both the short and long term, as indicated by the non-linear model.

The study examined the influence of monetary policies on carbon emissions in certain Asian economies from 1990 to 2014⁷². It also considered other factors such as income, remittances, urbanization, fossil fuels, and human capital as control variables. The data was analyzed using the Pedroni and Kao co-integration tests, panel completely modified, and panel dynamic least

squares approaches. The findings demonstrated a substantial and enduring correlation between expansionary monetary policy and carbon emissions. The contractionary monetary policy is an effective measure to reduce carbon emissions. Moreover, enhancements in human capital yield a favourable effect on mitigating carbon emissions. Carbon emissions are significantly influenced by remittances and fossil fuels.

The study investigates the relationship between monetary policy and renewable energy in the United States by examining the effects of monetary policy on renewable energy⁷³. The findings demonstrate that implementing expansionary monetary policy has a positive impact on the development and adoption of renewable energy sources, both in the long-term and short-term. Similarly, the opposite relationship holds true as well. Moreover, the influence of monetary policy is considerably potent in the immediate term. Consequently, financing rates have an impact on forthcoming alterations in renewable energy.

Some scholars analyze the macroeconomic impacts of energy price shocks in energy-importing nations using a heterogeneous-agent model⁷⁴. The New Keynesian model is a theoretical framework used in economics. When the marginal propensity to consume is very high and the elasticity of substitution between energy and domestic products is significantly low, an increase in energy costs leads to a decrease in real wages and triggers a recession, regardless of whether the central bank tightens monetary policy or not. Imported energy inflation can lead to wage inflation through a wage-price spiral, but this does not alleviate the decrease in real wages. Implementing monetary tightening measures in isolation has a modest impact on imported inflation. However, when done in cooperation with other energy importers, it can have a strong effect by reducing global energy demand. Fiscal policy, particularly the provision of energy price

subsidies, can shield individual energy importers from the impact of shocks. However, it also generates significant adverse effects on other economies.

Four researchers conducted a study on the relationship between the monetary and fiscal policies of G7 countries and the generation of renewable energy at a detailed level from 2000 to 2018⁷⁵. The researchers utilize the well accepted Stochastic Impact of Regression on Population, Affluence, and Technology (STIRPAT) model and employ cross-sectional augmented econometric methods to provide impartial and efficient findings. The findings indicate that increasing government spending has a notable and favourable impact on the production of renewable energy. Simultaneously, the expansionary monetary policy of the G7 countries demonstrates an unfavourable reaction against investment in renewable energy generation. Furthermore, it saw a comparable pattern of reaction across different levels of energy production. Nevertheless, the causal test indicates that there is a one-way causality from renewable energy to the fiscal and monetary policy indicators of G7 economies.

The paper analyses the impact of monetary policy instruments, namely interest rate, exchange rate, and money supply, on five sustainable development indicators as defined by the United Nations in Iraq⁷⁶. The sustainable development indicators comprise the Proportion of the population living below the international poverty line Proportion of population using safely managed drinking water Change in water-use efficiency Renewable energy share in the total final energy consumption, and Annual growth rate of real GDP per capita .Applying the two-stage least squares (2SLS) technique, the findings indicate that the exchange rate has a favourable impact on poverty indices, effective water resource management, and per capita economic growth. However, it has an adverse influence on access to safe drinking water. Out of

all the tools used in monetary policy, only the amount of money in circulation has a favourable impact on reducing poverty. In all other instances, it does not have a noteworthy effect.

The study investigates the impact of monetary policy on carbon emissions in specific nations throughout the time frame of 2000-2019, focusing on non-linear effects⁷⁷. The study utilized the Panel Smooth Transition Regression (PSTR) method and discovered a non-linear and positive correlation between the quantity of money supply and carbon emissions. Moreover, the impact of monetary policy on carbon emissions is less significant in nations that have greater levels of human development or modest proportions of manufacturing in their GDP. This suggests that these countries are more effective in executing monetary policy in an environmentally friendly manner. In addition, countries that have a significant proportion of their economy based on manufacturing and/or have a poor level of human development should exercise caution when implementing economic stimulus measures, as these measures might have a greater negative impact on the environment.

Three scholars conducted a study to examine how the breakdown of economic policy uncertainty, namely in monetary, fiscal, and trade policies, affects energy consumption in the United States⁷⁸. The study analyzed data from January 1990 to December 2020. The study specifically utilized sectoral energy consumption, which refers to the energy consumed by different sectors such as residential, industrial, transit, electric power, and commercial sectors, in addition to total energy consumption. The results obtained from the bootstrap ARDL approach demonstrate that fluctuations in monetary policy uncertainty have a negative impact on energy consumption, while fluctuations in trade and fiscal policy uncertainty have a positive impact on energy consumption in the long term. In contrast, there is a varied and diverse effect of uncertainty in

fiscal and monetary policies on different sectors in the immediate term, although trade policy has no influence on energy use.

The research used the panel system generalized moments approach to empirically examine the influence of monetary policy on the energy security of 16 Asian nations during the period from 2000 to 2019⁷⁹. The study finds that there is a positive correlation between the real interest rate, total reserve, and exchange rate with energy security. In other words, when these three indicators decrease, the risk of energy security also increases. It suggests that policymakers must closely monitor the energy security trend while pursuing loose monetary policy. Furthermore, it has been determined that the correlation between monetary policy and energy security experienced a substantial rise following the 2008 financial crisis. Moreover, the level of economic development directly influences the likelihood of encountering energy security difficulties resulting from shifts in monetary policy.

The study analyses the impact of two types of monetary policies, targeted refinancing, and broad refinancing, on the optimization of the energy supply structure⁸⁰. This is done using a dynamic stochastic general equilibrium model. The findings indicate that focused refinancing efforts result in a specific rise in bank loans to the green energy industry, accompanied by reduced interest rates. This, in turn, facilitates the transition towards sustainable energy sources. Conversely, when it comes to general refinancing, there is a substantial increase in loans for fossil energy, resulting in higher production. However, this has a detrimental influence on the outputs of the green sector.

An empirical study examines the influence of monetary policy on the production of renewable energy in Iran⁸¹. The analysis focuses on three categories of renewable energy production:

overall renewable energy production, solid biomass and biogas energy production, and the combined energy production from hydropower, solar, and wind sources. The study used the Kalman filter and vector autoregression (VAR) models to analyze annual data spanning from 1984 to 2016. The Kalman filter model demonstrated that the money supply parameter had a consistent trend, except for a sudden disruption during the Iran-Iraq War. A distinct inflection point may be identified for the real interest rate parameter; however, its value is also influenced by the timing of global crises and sanctions. The results of the VAR model suggest that only a perturbation in the money supply has the potential to impact all three types of renewable energy output.

A study examines the causal link between economic policy uncertainty and energy consumption as well as carbon (CO₂) emissions in G7 countries⁸². The analysis utilizes a bootstrap panel Granger causality test, which was created by Kónya in 2006⁸³. The test is used to a yearly dataset covering the period from 1998 to 2018⁸³. The findings offer substantial evidence for a one-way relationship where economic policy uncertainty influences energy consumption in Japan, CO₂ emissions in the USA and Germany, and both energy consumption and CO₂ emissions in Canada. In Italy, there is a causal relationship where CO₂ emissions influence economic policy uncertainty. Additionally, there is a bidirectional causal relationship between economic policy uncertainty and energy use. Additionally, it discovered a one-way relationship in which energy usage influences CO₂ levels in the USA.

2.4 Conceptual Framework

The conceptual link among monetary policy, energy consumption, and economic growth is presented in Figure 2.1. At its core, monetary policy, conducted by central banks, aims to

regulate the money supply and interest rates to achieve macroeconomic stability and promote sustainable economic growth. Expansionary monetary policy, characterized by lower interest rates and increased money supply, typically stimulates economic activity by encouraging borrowing, investment, and consumption. Conversely, contractionary monetary policy, marked by higher interest rates and reduced money supply, aims to control inflation, and prevent economic overheating^{31,34,37}. These policy tools have direct implications for economic growth, as they influence investment decisions, consumer spending, and overall aggregate demand, thereby shaping the pace and direction of economic expansion.

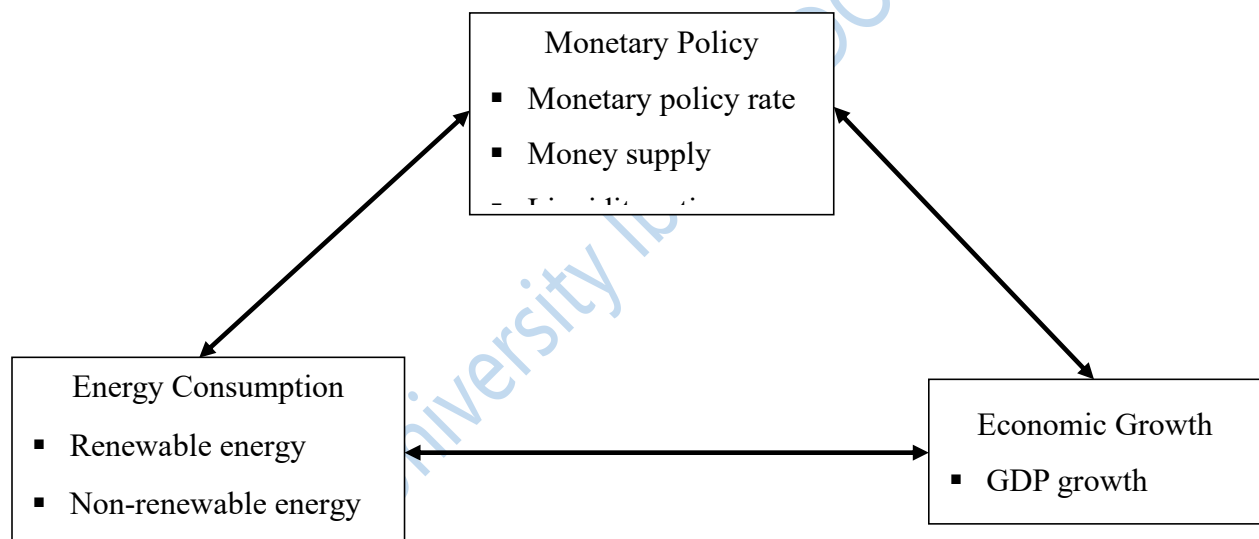


Figure 2.1: Conceptual link of monetary policy, energy consumption and economic growth

Source: Author's conceptualization

Energy consumption is a fundamental driver of economic growth, as it powers various sectors such as manufacturing, transportation, and services. Access to reliable and affordable energy sources is essential for productivity, innovation, and economic development^{52,54,55,56}. Higher levels of energy consumption are often associated with increased industrialization, urbanization, and technological advancement, which contribute to higher levels of output and economic

growth. However, the impact of energy consumption on economic growth is not unidirectional. While energy-intensive industries may experience rapid growth, excessive reliance on fossil fuels and inefficient energy usage can pose challenges such as environmental degradation, pollution, and resource depletion, which may undermine sustainable growth in the long term^{52,54,56}.

The causal linkages among monetary policy, energy consumption, and economic growth are intricate and multifaceted. Monetary policy decisions, such as changes in interest rates and money supply, can indirectly influence energy consumption and economic growth by affecting borrowing costs, investment decisions, and consumer behavior. Expansionary monetary policy, by lowering interest rates, can incentivize borrowing for investment in energy-intensive industries, leading to increased energy consumption and economic activity. Conversely, contractionary monetary policy may dampen investment in energy-related projects due to higher borrowing costs, which could slow down energy consumption and economic growth^{59,60}.

Conversely, energy consumption also influences monetary policy decisions and economic performance. Fluctuations in energy prices, particularly oil prices, can impact inflation rates, production costs, and overall economic stability. Changes in energy consumption patterns can also affect the trade balance, currency values, and inflationary pressures, prompting central banks to adjust monetary policy accordingly. Moreover, the relationship between energy consumption and economic growth is bidirectional, as economic growth drives energy demand, while energy availability and efficiency contribute to sustained economic expansion. Therefore, policies that promote energy efficiency, renewable energy sources, and sustainable development can complement monetary policy measures aimed at fostering long-term economic growth^{60,61,62}.

The conceptual links among monetary policy, energy consumption, and economic growth underscore the intricate interactions between monetary factors, energy dynamics, and macroeconomic outcomes. It shows the need to balance the objectives of price stability, full employment, and sustainable economic growth while considering the environmental implications of energy consumption. Moreover, coordinated efforts are needed to address structural constraints, promote energy transition, and enhance the resilience of economies to external shocks. By adopting a holistic approach that integrates monetary policy, energy policy, and economic development strategies, countries can unlock the full potential of their economies while ensuring long-term sustainability and resilience.

2.6 Summary of Gaps in Literature

The existing literature on the interplay between monetary policy, energy consumption, and economic growth reveals significant gaps that warrant further exploration. While several studies have examined the direct effects of monetary policy on economic growth, few have specifically addressed how these policies influence energy consumption within the Nigerian context. For instance, Akinwale (2020) highlights that the relationship between energy consumption and economic growth remains underexplored, suggesting that a deeper understanding of this nexus is crucial for sustainable development in Nigeria. Additionally, previous research has predominantly employed linear models, which may overlook the complexities of these relationships (Ogunleye & Akinwale, 2021).

Moreover, the existing studies often fail to incorporate the interactive effects of monetary policy instruments, such as interest rates and money supply, on energy consumption and economic growth (Ojo & Akinwale, 2022). This oversight limits the ability to fully comprehend the transmission mechanisms at play. Furthermore, while some scholars have utilized the Autoregressive Distributed Lag (ARDL) model, they have not adequately considered the mixed order of integration of the variables involved (Adeyemi & Akinwale, 2021).

Endnotes

- 1) Board of Governors of the Federal Reserve System. *Federal Reserve Board - Monetary policy: What are its goals? How does it work?* Board of Governors of the Federal Reserve System, July 29th, 2021. Available at https://en.wikipedia.org/wiki/Monetary_policy#cite_note-2
- 2) S. T. Adrian. *Central bank independence and the development of payments and CBDCs*. International Symposium on Central Bank Independence, 2023. Available at <https://www.imf.org/en/News/Articles/2023/01/10/sp-central-bank-independence-development-payments-and-cbdc>
- 3) Central Bank of Nigeria (CBN). *What is monetary policy?* Monetary Policy Department, CBN, 2006. Available at <https://www.cbn.gov.ng/out/eduseries/series1.pdf>
- 4) REPSOL. *Towards more sustainable household energy consumption*. REPSOL, 11th September, 2023. Available at <https://www.repsol.com/en/energy-and-the-future/future-of-the-world/energy-consumption/index.cshtml#:~:text=Energy%20consumption%20is%20the%20total,diesel%2C%20oil%2C%20and%20biomass>
- 5) Worldometer. *Nigeria energy statistics*. Worldometer, 2024. Available at <https://www.worldometers.info/energy/nigeria-energy/>
- 6) Reserve Bank of Australia. *Economic growth*. Available at <https://www.rba.gov.au/education/resources/explainers/pdf/economic-growth.pdf>
- 7) A. P. Haller. *Concepts of economic growth and development: Challenges of crisis and of knowledge*. **Economy Transdisciplinarity Cognition**, 15(1), 2012, 66-71.
- 8) E. N. Twinoburyo and N. M. Odhiambo. *Monetary policy and economic growth: A review of international literature*. **Journal of Central Banking Theory and Practice**, 2, 2018, pp. 123-137.
- 9) M. Amran, N. Makul, R. Fediuk, Y. H. Lee, N. I. Vatin, Y. Y. Lee, & K. Mohammed. *Global carbon recoverability experiences from the cement industry*. **Case Studies in Construction Materials**, 2022, 1;17:e01439.
- 10) J. Qingquan, S. I. Khattak, M. Ahmad, & L. Ping. *A new approach to environmental sustainability: assessing the impact of monetary policy on CO2 emissions in Asian economies*. **Sustainable Development**, 28(5), 2020, 1331-46.
- 11) M. S. Islam, M. E. Hossain, S. Chakroborty, & N. S. Ema. *Does the monetary policy have any short-run and long-run effect on economic growth? A developing and a*

- developed country perspective. Asian Journal of Economics and Banking*, 6(1), 2021, 26-49.
- 12) I. Harahap, & K. Tambunan. *The effect of SBI and SBIS as monetary instruments on the Indonesian economy. Share. Jurnal Ekonomi Dan Keuangan Islam*, 11(1), 2022, 1-9.
 - 13) A. B. Abille, & D. M. Mpuure. *Effect of monetary policy on economic growth in Ghana. Applied Economics Journal*, 27(2), 2020, 110-24.
 - 14) O. F. Ezeibekwe. *Monetary policy and domestic investment in Nigeria: The role of the inflation rate. Economics and Business*, 34(1), 2020, 139-55.
 - 15) I. Chugunov, M. Pasichnyi, T. Kaneva, A. Nepytyliuk, & V. Koroviy. *The influence of inflation targeting on economic growth in the OECD and developing countries. Montenegrin Journal of Economics*, 17(2), 2021, 173-86.
 - 16) R. Akram, F. Chen, F. Khalid, Z. Ye, & M. T. Majeed. *Heterogeneous effects of energy efficiency and renewable energy on carbon emissions: Evidence from developing countries. Journal of Cleaner Production*, 247, 2020, 119122.
 - 17) M. A. Alsaedi, F. Abnisa, P. A. Alaba, & H. U. Farouk. *Investigating the relevance of Environmental Kuznets curve hypothesis in Saudi Arabia: Towards energy efficiency and minimal carbon dioxide emission. Clean Technologies and Environmental Policy*, 24(4), 2022, 1285-300.
 - 18) P. Xie, Z. Zhu, G. Hu, & J. Huang. *Renewable energy and economic growth hypothesis: Evidence from N-11 countries. Economic Research-Ekonomskaistraživanja*, 36(1), 2023.
 - 19) L. Yang, X. Zhou, & X. Feng. *Renewable energy led Economic Growth Hypothesis: Evidence from novel panel methods for N-11 economies. Renewable Energy*, 197, 2022, 790-797.
 - 20) C. O. Ibukun, T. T. Osinubi, & O. N. Oladunjoye. *Growth-Led Energy Hypothesis In Nigeria: An Asymmetric Investigation. Ilorin Journal of Economic Policy*, 8(1), 2021, 31-45.
 - 21) A. Aydin, & Z. Iqbal. *Islamic finance approach to financial inclusion to enhance shared-prosperity. Financial Inclusion for Poverty Alleviation*, 174(196), 2018, 174-196.
 - 22) K. Buckles, D. Hungerman, & S. Lugauer. *Is fertility a leading economic indicator? The Economic Journal*, 131(634), 2021, 541-565.
 - 23) M. Salman, X. Long, L. Dauda, & C. N. Mensah. *The impact of institutional quality on economic growth and carbon emissions: Evidence from Indonesia, South Korea and Thailand. Journal of Cleaner Production*, 241, 2019, 118331.

- 24) F. Hindriks, & F. Guala. *The functions of institutions: Etiology and teleology*. **Synthese**, 198(3), 2021, 2027-2043.
- 25) K. Purewal, & H. Haini. *Re-examining the effect of financial markets and institutions on economic growth: evidence from the OECD countries*. **Economic Change and Restructuring**, 55(1), 2022, 311-333.
- 26) B. Balachandran, & B. Williams. *Effective governance, financial markets, financial institutions & crises*. **Pacific-Basin Finance Journal**, 50, 2018, 1-15.
- 27) D. W. Kim, J. S. Yu, & M. K. Hassan. *Financial inclusion and economic growth in OIC countries*. **Research in International Business and Finance**, 43, 2018, 1-14.
- 28) P. Dykas, T. Tokarski, R. & Wisła. *The Solow model of economic growth: Application to contemporary macroeconomic issues*. 1st Edition. Routledge, 2022.
- 29) M. Balcilar, R. Gupta, W. Ma, & P. Makena. *Income inequality and economic growth: A re-examination of theory and evidence*. **Review of Development Economics**, 25(2), 2021, 737-57.
- 30) L. Xiang, M. Tang, & Z. Yin. *The COVID-19 pandemic and economic growth: theory and simulation*. **Frontiers in Public Health**, 9, 2021, 741525.
- 31) P. Okoye, I. Molokwu, & I. Onwuteaka. *Effect of monetary policy on economic growth in Nigeria*. **International Journal of Trend in Scientific Research and Development**, 3(3), 2019, 590-597. <https://doi.org/10.31142/ijtsrd22984>.
- 32) N. Nwoko, J. Ihemeje, & E. Anumadu. *The impact of monetary policy on the economic growth of Nigeria*. **African Research Review**, 10(3), 2016, 192. <https://doi.org/10.4314/afrrrev.v10i3.13>.
- 33) M. Hasan, M. Islam, M. Hasnat, & A. Wadud. *The relative effectiveness of monetary and fiscal policies on economic growth in Bangladesh*. **Economics**, 5(1), 2016, 1-21. <https://doi.org/10.11648/j.eco.20160501.11>
- 34) M. Donkor, Y. Kong, M. Musa, M. Hafeez, & S. Antwi. *Nexus of monetary policy on economic growth: a study of Ghana*. **The Economics and Finance Letters**, 8(2), 2021, 251-265. <https://doi.org/10.18488/journal.29.2021.82.251.265>
- 35) C. Omodero and M. Okafor. *Monetary policy mechanisms and economic growth stability in Nigeria*. **Research in World Economy**, 11(6), 2020, 225-241. <https://doi.org/10.5430/rwe.v11n6p225>
- 36) A. O. Jacob, O. J. Umoh, & A. K. Akpan. *Effects of monetary policy on economic growth in Nigeria*. **Economic Growth and Environment Sustainability**, 1(1), 2022, 10-15. <https://doi.org/10.26480/egnes.01.2022.10.15>.

- 37) C. Daniel and V. Inim. *An evaluation of monetary policy and economic growth in Nigeria(2000 – 2017)*. **International Journal of Advances in Scientific Research and Engineering**, 6(1), 2020, 101-107. <https://doi.org/10.31695/ijasre.2020.33686>.
- 38) A. K. Toriola, O. O. Adeniwura, F. O. Lawale, A. V. Eyeke, F. C. Nwakpa, & I. Adeniran. *Monetary policy shocks and economic growth in Nigeria*. **Indonesian Journal of Contemporary Education**, 4(2), 2022, 71-79. <https://doi.org/10.33122/ijoce.v4i2.37>
- 39) M. Idris. *Monetary policy and economic growth in developing countries: evaluating the policy nexus in Nigeria*. **International Journal of Business and Economics Research**, 8(5), 2019, 290-300. <https://doi.org/10.11648/j.ijber.20190805.17>
- 40) G. Wauk and G. Adjorlolo. *The game of monetary policy, inflation and economic growth*. **Open Journal of Social Sciences**, 7(3), 2019, 255-271. <https://doi.org/10.4236/jss.2019.73022>
- 41) T. Akintola and A. Cole. *Monetary policy and Nigeria economic growth (1981-2014)*. **The International Journal of Business & Management**, 8(1), 2020, 336-340. <https://doi.org/10.24940/theijbm/2020/v8/i1/bm2001-024>
- 42) M. Tule, O. Ogundele, & M. Apinran. *Efficacy of monetary policy instruments on economic growth: evidence from Nigeria*. **Asian economic and Financial Review**, 8(10), 2018, 1239-1256. <https://doi.org/10.18488/journal.aefr.2018.810.1239.1256>
- 43) P. Shrestha. *The effect of monetary policy on economic growth of selected SAARC countries*. **The Lumbini Journal of Business and Economics**, 10(1-2), 2022, 122-132. <https://doi.org/10.3126/ljbe.v10i1-2.54210>.
- 44) U. Joshi. *Impact of monetary policy on economic growth in Nepal: an empirical analysis*. **International Research Journal of MMC**, 3(3), 2022, 54-65. <https://doi.org/10.3126/irjmmc.v3i3.48635>
- 45) K. Srithilat, T. Khamthoummabounmy, V. Lienpaserth, P. Chanthavixay, & V. Douangty. *The effect of monetary policy on economic growth in Lao PDR*. **International Journal of Economics and Financial Issues**, 12(1), 2022, 67-74. <https://doi.org/10.32479/ijefi.10557>
- 46) A. Sule. *Pass-through effect of monetary policy tools on economic growth in Nigeria*. **Journal of Public Affairs**, 22(3), 2021. <https://doi.org/10.1002/pa.2588>.
- 47) J. Aliyev, S. Mukhtarov, K. Haydarov, & M. Isgandarov. *Does monetary policy boost economic growth? the case of small open economy*. **Research in World Economy**, 11(3), 2020, 216. <https://doi.org/10.5430/rwe.v11n3p216>
- 48) G. Hunibachew. *The effect of monetary policy on economic growth in Ethiopia*. **International Journal of Finance and Banking Research**, 7(6), 2021, 133. <https://doi.org/10.11648/j.ijfbr.20210706.11>

- 49) O. David, O. Ita, U. Eyo, & E. Ikenna. *An assessment of the impact of monetary policy on economic growth in Nigeria: Toda-Yamamoto approach*. **International Journal of Research and Innovation in Social Science**, 6(11), 2022, 537-547. <https://doi.org/10.47772/ijriss.2022.61126>
- 50) E. Uju and P. Ugochukwu. *Effect of monetary policy on industrial growth in Nigeria*. **International Journal of Entrepreneurship and Business Innovation**, 4(1), 2021, 47-60. <https://doi.org/10.52589/ijebi-1z4iybye>.
- 51) N. Dat, N. Hoang, M. Huyen, D. Huy, & L. Lan. *Energy consumption and economic growth in Indonesia*. **International Journal of Energy Economics and Policy**, 10(5), 2020, 601-607. <https://doi.org/10.32479/ijeep.10243>
- 52) U. Umurzakov, B. Mirzaev, R. Salahodjaev, A. Isaeva, & S. Tosheva. *Energy consumption and economic growth: Evidence from post-communist countries*. **International Journal of Energy Economics and Policy**, 10(6), 2020, 59-65. <https://doi.org/10.32479/ijeep.10003>
- 53) N. Saqib. *Energy consumption and economic growth: empirical evidence from MENA region*. **International Journal of Energy Economics and Policy**, 11(6), 2021, 191-197. <https://doi.org/10.32479/ijeep.11931>
- 54) S. Purnomo, N. Wani, S. Suharno, A. Arintoko, H. Sambodo, & L. Badriah. *The effect of energy consumption and renewable energy on economic growth in Indonesia*. **International Journal of Energy Economics and Policy**, 13(1), 2023, 22-30. <https://doi.org/10.32479/ijeep.13684>
- 55) K. Munir and S. Nadeem. *Disaggregate energy consumption and economic growth in Pakistan: A sectoral analysis*. **International Journal of Energy Economics and Policy**, 12(1), 2022, 296-306. <https://doi.org/10.32479/ijeep.11615>
- 56) H. Khobai, S. Abel, & P. Roux. *A review of the nexus between energy consumption and economic growth in the BRICS countries*. **International Journal of Energy Economics and Policy**, 11(3), 2021, 424-431. <https://doi.org/10.32479/ijeep.6373>
- 57) M. Al-Zuhair and T. Al-Bazali. *Causality between energy consumption and economic growth: the case of Kuwait*. **International Journal of Energy Economics and Policy**, 12(6), 2022, 22-29. <https://doi.org/10.32479/ijeep.13477>
- 58) I. A. Olanrele and S. S. Awode. *Assessing the nexus among energy consumption, foreign direct investment and economic growth in sub-Saharan Africa*. **Central Bank of Nigeria Journal of Applied Statistics**, 13(1), 2022, 27-53. <https://doi.org/10.33429/cjas.13122.2/9>
- 59) J. Ferdaus, B. K. Appiah, S. C. Majumder, & A. A. Martial. *A panel dynamic analysis on energy consumption, energy prices and economic growth in next 11 countries*.

- International Journal of Energy Economics and Policy**, 10(6), 2020, 87-99.
<https://doi.org/10.32479/ijeep.9880>
- 60) G. Mutumba, G. Mubiinzi, M. Kaddu, & J. Otim. *Renewable energy consumption and economic growth in Uganda*. **Journal of Energy Research and Reviews**, 10(2), 2022, 36-50. <https://doi.org/10.9734/jenrr/2022/v10i230252>
- 61) N. Tah. *Environmental degradation, energy consumption and economic growth in Cameroon*. **International Journal of Social Science and Economic Research**, 5(5), 2020, 1271-1294. <https://doi.org/10.46609/ijsser.2020.v05i05.012>
- 62) D. Peković. *The effects of energy consumption on economic growth in post-transition countries*. **Ecologica**, 30(109), 2023, 76-80. <https://doi.org/10.18485/ecologica.2023.30.109.11>
- 63) M. Alshami. *A VAR based study on energy consumption and economic growth*. **International Journal of Energy Economics and Policy**, 13(1), 2023, 317-321. <https://doi.org/10.32479/ijeep.13767>
- 64) L. U. Okoye, A. Omankhanlen, J. I. Okoh, N. B. Adeleye, F. N. Ezeji, G. K. Ezu, & B. Ehikioya. *Analyzing the energy consumption and economic growth nexus in Nigeria*. **International Journal of Energy Economics and Policy**, 11(1), 2021, 378-387. <https://doi.org/10.32479/ijeep.10768>
- 65) H. Khobai. *Renewable energy consumption and economic growth in Argentina: A multivariate co-integration analysis*. **International Journal of energy Economics and Policy**, 11(3), 2021, 563-570. <https://doi.org/10.32479/ijeep.6375>
- 66) M. Shahbaz, C. Raghutla, K. R. Chittedi, Z. Jiao, & X. Vo. *The effect of renewable energy consumption on economic growth: Evidence from the renewable energy country attractive index*. **Energy**, 207, 2020, 118162. <https://doi.org/10.1016/j.energy.2020.118162>
- 67) C. Chen, M. Pinar, & T. Stengos. *Renewable energy consumption and economic growth nexus: Evidence from a threshold model*. **Energy Policy**, 139, 2020, 111295. <https://doi.org/10.1016/j.enpol.2020.111295>
- 68) O. Uçan, H. Budak, & E. Aktekin-Gök, *Analysis of relationship between economic growth and energy consumption in developed countries*. **Journal of Human Earth and Future**, 3(1), 2022, 82-89. <https://doi.org/10.28991/hef-2022-03-01-06>
- 69) T. Joseph and A. Charles. *Renewable energy consumption, environmental sustainability, and economic growth in developing countries*. **Asian Bulletin of energy Economics and Technology**, 6(1), 2021, 43-49. <https://doi.org/10.20448/journal.507.2021.61.43.49>

- 70) P. Ekeocha, D. Penzin, & J. Ogbuabor. *Energy consumption and economic growth in Nigeria: a test of alternative specifications*. **International Journal of Energy Economics and Policy**, 10(3), 2020, 369-379. <https://doi.org/10.32479/ijeep.8902>
- 71) M. T. Sohail, Y. Xiuyuan, A. Usman, M. T. Majeed, & S. Ullah. *Renewable energy and non-renewable energy consumption: Assessing the asymmetric role of monetary policy uncertainty in energy consumption*. **Environmental Science and Pollution Research**, 28, 2021, 31575-31584.
- 72) J. Qingquan, S. I. Khattak, M. Ahmad, & L. Ping. *A new approach to environmental sustainability: assessing the impact of monetary policy on CO₂ emissions in Asian economies*. **Sustainable Development**, 28(5), 2020, 1331-1346.
- 73) S. M. Hashmi, Q. R. Syed, & R. Inglesi-Lotz. *Monetary and energy policy interlinkages: The case of renewable energy in the US*. **Renewable Energy**, 201, 2022, 141-147.
- 74) A. Auclert, H. Monneray, M. Rognlie, & L. Straub. *Managing an energy shock: Fiscal and monetary policy* (No. w31543). National Bureau of Economic Research, 2023.
- 75) C. Sun, A. Khan, Y. Liu, & N. Lei. *An analysis of the impact of fiscal and monetary policy fluctuations on the disaggregated level renewable energy generation in the G7 countries*. **Renewable Energy**, 189, 2022, 1154-1165.
- 76) O. A. Jothr, A. I. Jummaa, & A. Ambariyani. *The impact of monetary policy instruments on sustainable development*. **Revenue Journal: Management and Entrepreneurship**, 1(1), 2023, 22-26.
- 77) J. Wu, C. Yang, & L. Chen. *Examining the non-linear effects of monetary policy on carbon emissions*. **Energy Economics**, 131, 2024, 107206.
- 78) R. Bhowmik, F. Durani, M. Sarfraz, Q. R. Syed, & G. Nasseif. *Does sectoral energy consumption depend on trade, monetary, and fiscal policy uncertainty? Policy recommendations using novel bootstrap ARDL approach*. **Environmental Science and Pollution Research**, 30(5), 2023, 12916-12928.
- 79) K. Wang, Y. W. Wang, & Q. J. Wang. *Will monetary policy affect energy security? Evidence from Asian countries*. **Journal of Asian Economics**, 81, 2022, 101506.
- 80) Y. Jin, S. Wang, L. Bu, & P. Zhai. *Unconventional, conventional monetary policies, and optimal energy supply structure in China*. **Finance Research Letters**, 54, 2023, 103732.
- 81) S. F. Razmi, M. H. Moghadam, & M. Behname. *Time-varying effects of monetary policy on Iranian renewable energy generation*. **Renewable Energy**, 177, 2021, 1161-1169.
- 82) B. Pirgaip, & B. Dinçergök. *Economic policy uncertainty, energy consumption and carbon emissions in G7 countries: evidence from a panel Granger causality analysis*. **Environmental Science and Pollution Research**, 27, 2020, 30050-30066.

- 83) L. Kónya. *Exports and growth: Granger causality analysis on OECD Countries with a panel data approach*. **Economic Modelling**, 23,2006, 978–992.

Lead City University Ibadan DO NOT COPY

Chapter Three

Methodology

This chapter of the study focuses on the research methodology employed to examine the nexus between monetary policy, energy consumption and economic growth in Nigeria. This describes the specification of empirical models, a-priori expectations, data sources, estimation techniques, diagnostic tests, and data measurements.

3.1 Model Specification

The empirical models in this section are developed for each specific objections in chapter one.

3.1.1 Model for Examining the Effect of Monetary Policy on Energy Consumption

Building upon the conceptual framework outlined in the preceding chapter, the empirical model assessing the impact of monetary policy variables on energy consumption in Nigeria is constructed in alignment with previous research endeavors^{1,2,3}. These studies posit monetary policy variables as key determinants of energy usage, contending that monetary policy instruments govern factors influencing economic activities, thereby fostering enhanced energy consumption. Consequently, the model is formulated functionally as follows:

$$EC_t = f(Y_t, K_t, MPR_t, MS_t, LR_t) \quad (3.1)$$

Therefore, the model incorporating control variables is specified as follows:

$$\ln EC_t = \phi_0 + \phi_1 \ln Y_t + \phi_2 \ln K_t + \phi_3 MPR_t + \phi_4 \ln MS_t + \phi_5 \ln LR_t + e_t \quad (3.2)$$

Where: EC denotes energy consumption; Y represents output growth; K is capital investment; MPR is monetary policy rate, MS denotes money supply, and LR represents liquidity ratio. Also,

ϕ_0 is constant, and ϕ_{1-5} are the parameters of energy consumption with respect to output, capital, monetary policy rate, money supply and liquidity ratio respectively; t is time; and e is error term. These variables are integral to the model as they capture the key elements influencing economic dynamics. Energy consumption (EC) directly affects output growth (Y), while capital investment (K), monetary policy rate (MPR), money supply (MS), and liquidity ratio (LR) shape the economic environment, impacting both energy demand and overall growth.

3.1.2 Model for Investigating the Effect of Monetary Policy on Economic Growth

Following the theoretical model developed in the previous chapter, the empirical model that establishes the effects of monetary policy variables on economic growth in Nigeria is based on previous works^{4,5,6}. These studies express monetary policy variables as a determinant of economic growth. It is argued that monetary policy instruments regulate factors that influence economic activities to achieve growth and development. Thus, the model is specified as:

$$Y_t = AK_t^\alpha L_t^\beta MPR_t^{\phi_1} MS_t^{\phi_2} LR_t^{\phi_3} \quad (3.3)$$

Hence, the model with the inclusion of control variables is specified as follows:

$$\ln Y_t = \ln A + \alpha \ln K_t + \beta \ln L_t + \phi_1 \ln MPR_t + \phi_2 \ln MS_t + \phi_3 \ln LR_t + v_t \quad (3.4)$$

Where: MPR is monetary policy rate, MS denotes money supply, and LR represents liquidity ratio. Also, $\alpha, \beta, \phi_1, \phi_2, \phi_3$ are the elasticity of output with respect to capital, labour, monetary policy rate, money supply and liquidity ratio respectively; t is time; and v is error term.

3.1.3 Model for Determining the Effect of Energy Consumption on Economic Growth

The theoretical model solved in the last section of the previous chapter is employed for analyzing the effects of energy consumption on economic growth in Nigeria. Also, previous studies give credence to Romer argument on importance of energy consumption on economic growth^{7,8,9,10}. These studies consider economic growth as a function on energy consumption, capital, and labour. The model is functionally stated as:

$$Y_t = AK_t^\alpha, L_t^\beta, REN_t^{\phi_1}, NEN_t^{\phi_2} \quad (3.5)$$

Hence, the empirical model for this study is specified as:

$$\ln Y_t = \ln A + \alpha \ln K_t + \beta \ln L_t + \phi_1 \ln REN_t + \phi_2 \ln NEN_t + u_t \quad (3.6)$$

Where: K is capital; L is labour; REN is renewable energy, and NEN is non-renewable energy.

Also, $\alpha, \beta, \phi_1, \phi_2$ are the elasticity of output with respect to capital, labour, renewable energy, and non-renewable energy, respectively. More so, t is time, and u denotes error term.

3.1.4 Model for Examining the Causal Links among Monetary Policy, Energy Consumption and Economic Growth

The study utilizes the unrestricted vector autoregressive (VAR) approach introduced by Sims in 1980 to estimate a five-variable VAR model. This model incorporates an 8×1 vector matrix, denoted as X_t , which includes the variables $Y_t, K_t, L_t, REN_t, NEN_t, MPRT, MSt,$ and LR_t . In this context, A represents a matrix polynomial for the lag operator applied to the selected variables. Furthermore, the model includes a vector of un-estimated shocks associated with oil revenue and other control variables, which are assumed to be serially uncorrelated structural disturbances.

The matrix Ω is defined as a diagonal matrix, indicating that these structural disturbances are mutually uncorrelated. The model is stated as:

$$X_t = u + A_1 X_{t-1} + \dots + A_p X_{t-p} + \mu_t$$

(Figure 3.7 unrestricted vector autoregressive (VAR))

Where: X_t is an 8×1 vector matrix incorporating $Y_t, K_t, L_t, REN_t, NEN_t, MPR_t, MS_t, LR_t$ as variables; A is a matrix polynomial for the lag operator of considered variables; and μ_t is a vector of un-estimated shocks for each of the oil revenue and other controlling variables and it is assumed to be serially uncorrelated structural disturbance for $Var(\mu_t) = \Omega$. Where: Ω is a diagonal matrix, so the structural disturbances are assumed to be mutually uncorrelated.

3.2 A'Priori Expectation

For the first model, the theoretical expectation regarding energy consumption concerning output growth, capital investment, monetary policy rate, money supply, and liquidity ratio are presented as follows. Output growth expected that energy consumption will positively correlate with output growth. Higher levels of economic output typically require increased energy usage to fuel production processes and meet rising demand for goods and services. Energy consumption is anticipated to have a positive relationship with capital investment. Thus, greater investment in capital-intensive industries and infrastructure often leads to higher energy usage as machinery, equipment, and facilities require energy inputs to operate efficiently. The impact of the monetary policy rate on energy consumption is less straightforward. A higher policy rate, indicative of tighter monetary policy, may initially suppress economic activity and reduce energy consumption. Conversely, a lower policy rate, signaling accommodative monetary policy, may stimulate economic growth and lead to increased energy usage in the long run. Energy consumption is expected to have a positive association with the money supply. An expansionary monetary policy characterized by an increase in the money supply tends to stimulate economic activity and raise energy demand as businesses and consumers have access to more liquidity for spending. The liquidity ratio's effect on energy consumption is likely to be ambiguous. A higher liquidity ratio, indicating a more conservative approach to lending by financial institutions, may constrain economic activity and suppress energy demand. Conversely, a lower liquidity ratio, signaling a looser credit environment, may stimulate economic growth and boost energy usage.

The theoretical expectation hypothesizes that economic growth is primarily the outcome of endogenous forces and not external forces. As for renewable energy, increased use of renewable

energy sources, such as solar, wind, and hydroelectric power, is expected to have a positive impact on economic growth. Renewable energy investments can lead to job creation, technological innovation, and reduced environmental degradation, which can contribute to overall economic development and growth. The effects of non-renewable energy sources, such as oil, coal, and natural gas, on economic growth are more complex. While these resources can fuel economic growth in the short term through energy production and export revenues, their reliance poses risks due to price volatility, resource depletion, and environmental damage. Over-reliance on non-renewable energy may hinder long-term sustainable growth.

Concerning the monetary policy variables, the monetary policy rate, typically set by a central bank, influences interest rates in the economy. Lowering the policy rate can stimulate economic activity by reducing borrowing costs for businesses and consumers, leading to increased investment and consumption. Conversely, raising the policy rate can help control inflation but may also dampen economic growth by increasing borrowing costs. Further, an expansion in the money supply, often achieved through central bank interventions like quantitative easing, can stimulate economic growth by increasing liquidity in the financial system. This liquidity supports lending and investment activities, fostering economic expansion. However, excessive money supply growth can lead to inflationary pressures and financial instability, which may ultimately hinder long-term growth prospects. The liquidity ratio, which measures a bank's ability to meet short-term obligations, can impact economic growth by influencing the availability of credit in the economy. Higher liquidity ratios may indicate prudent risk management practices but could also restrict credit availability, potentially slowing investment and economic growth. Conversely, lower liquidity ratios may stimulate lending activity but raise concerns about financial stability.

As regards the key variable of growth, increased capital investment, including physical infrastructure, technology, and human capital, is widely regarded as a driver of economic growth. Capital accumulation enhances productivity, efficiency, and innovation, leading to higher output levels and improved living standards. Policies that promote investment in capital assets, such as education, research and development, and infrastructure development, are expected to foster long-term economic growth. Labour, comprising the workforce's skills, productivity, and participation rates, significantly influences economic growth. A skilled and productive workforce can drive innovation, increase production efficiency, and attract investment, contributing to economic expansion. Policies that enhance labor market flexibility, invest in education and training, and promote workforce participation are expected to support economic growth by maximizing the potential of the labor force.

3.3 Methods of Estimation

3.3.1. Pre-Estimation Test

3.3.1 Unit Root Test

This test is necessary to examine the stationarity level of individual variables. It indicates whether the variables are stationary or non-stationary. Shocks in stationary time series will be temporary and its effects over time eliminated as the series revert to their long run mean values. Meanwhile, non-stationary time series contain permanent components of shocks, and its means and variances depend on time. Different methods under the conventional and modified test were employed to carry out the tests.

3.3.1.1 Conventional Unit-root tests

The simplest and pioneer approach to test for a unit root referred to as Dickey-Fuller (DF) test begins with an AR(1) model:

$$Y_t = \theta + \phi Y_{t-1} + a_t \quad (3.8)$$

Where: $a_t \sim N(0, \delta_a^2)$. Equation 3.6 is simplified further for ease of computation and interpretation as:

$$Y_t - Y_{t-1} = \theta_0 - (1 - \phi)Y_{t-1} + a_t \quad (3.9)$$

Where: $(1 - \phi) = \delta$; equation 3.7 can be re-written as:

$$\Delta Y_t = \theta_0 - \delta Y_{t-1} + a_t \quad (3.10)$$

If $\delta = 0$, the system has a unit root $\Rightarrow H_0 : \delta = 0; H_1 : \delta < 0$.

Applying OLS method on the regression equation 3.8, the study test for unit root based on the test statistic given as:

$$t_{\phi=1} = \frac{\hat{\phi} - 1}{s.e(\hat{\phi})} \quad (3.11)$$

The test is a one-sided left tail test. If $\{Y_t\}$ is stationary (i.e; $|\phi| < 1$), it can be shown that:

$\sqrt{n}(\hat{\phi} - \phi) \rightarrow N(0, (1 - \phi^2))$. This means that under H_0 , the limiting distribution of $t_{\phi=1}$ is $N(0, 1)$.

1) Augmented Dickey Fuller (ADF)

Said and Dickey (1984) augment the basic autoregressive unit root test to accommodate general ARMA(p, q) models with unknown orders; their test is referred to as the Augmented Dickey-Fuller (ADF) test. If serial correlation exists in the DF test equation (i.e., if the true model is not AR(1)), then the AR(p) is used to get rid of the serial correlation.

$$\varphi_p(B)Y_t = \theta_0 + a_t \quad (3.12)$$

Where;

$\{a_t\} \sim WN(0, \delta_a^2)$ with $E(a_t^4) < \infty$ and $\varphi_p(B) = 1 - \varphi_1(B) - \dots - \varphi_p(B)$ may contain a unit root.

To test for unit root; the assumption assume that: $\varphi_p(B) = (1-B)\varphi_{p-1}(B)$

Where: $\varphi_{p-1}(B) = 1 - \varphi B - \dots - \varphi_{p-1}B^{p-1}$ has unit roots lying outside the unit circle.

$$\varphi_{p-1}(B)(1-B)Y_t = \theta_0 + a_t \quad (3.13)$$

$$\varphi_{p-1}(B)\Delta Y_t = \theta_0 + a_t$$

$$\Delta Y_t - \sum_{j=1}^{p-1} \varphi_j \Delta Y_{t-j} = \theta_0 + a_t$$

Hence, testing for a unit root is equivalent to testing $\varphi = 1$ in the following model:

$$Y_t = \varphi Y_{t-1} + \sum_{j=1}^{p-1} \varphi_j \Delta Y_{t-j} + \theta_0 + a_t \quad (3.14)$$

$$\text{Or; } \Delta Y_t = (\varphi - 1)Y_{t-1} + \sum_{j=1}^{p-1} \varphi_j \Delta Y_{t-j} + \theta_0 + a_t ; (\varphi - 1) = \delta \quad (3.15)$$

ADF test equation then becomes:

$$\Delta Y_t = \delta Y_{t-1} + \sum_{j=1}^{p-1} \varphi_j \Delta Y_{t-j} + \theta_0 + a_t \quad (3.16)$$

For ADF Hypothesis, we have:

$$H_0 : \varphi = 1 \quad H_0 : \delta = 0$$

$$H_1 : |\varphi| < 1 \quad H_1 : \delta < 1$$

Reject H_0 if $t_{\varphi=1} < CV$ and also reject H_0 if $t_{\delta=0} < CV$.

3.3.1.2 Efficient Unit Root Tests

1) Elliot, Rothenberg and Shock (1996) DF-GLS Test

Elliot, Rothenberg and Shock (ERS) (1996) modified the ADF test and show that their test referred to as DF-GLS has the limiting power function close to the point optimal test. ERS propose a family of tests whose power functions they showed is tangent to the power envelope at one point and never below. They call these tests $P_T = (0.5)$, signifying that they are optimal at 50% power. They also show that their DF-GLS has the limiting power function close to $P_T = (0.5)$.

The DF-GLS test regression is given as:

$$\Delta y_t^d = \gamma^* y_{t-1}^d + \sum_{j=1}^{p-1} \varphi_j \Delta y_{t-1}^d + \mu_t \quad (3.17)$$

Where: y_t^d is the detrended y_t and the null of a unit root is $H_0 : \gamma^* = 0$.

It should be noted that although DF-GLS has better power properties, the issue of lag length selection still remains. Ng and Perron (1996) find that ERS has poor size properties when the underlying Data Generating Process (DGP) has large negative moving average terms. They augment their test by using Modified Information Criteria (MIC) and show it overcomes this problem, if indeed there are large negative moving averages in the underlying DGP.

3.3.2 Bound Test for Cointegration

The ARDL bound estimator, based on the unrestricted ECM, presents the underlying model (equation 3.2, 3.4 and 3.6) as follows:

$$\Delta Y_t = C_0 + \sum_{i=1}^p \phi_i \Delta Y_{t-i} + \sum_{i=1}^p \varphi_i \Delta X_{t-i} + \gamma Y_{t-i} + \lambda X_{t-i} + v_t \quad (3.18)$$

Where: Y is outcome variables; X denotes the explanatory variables; Δ stands as the change operator sign i.e. the first difference operator; C_0 is drift; γ, λ are long-run parameters associated with the long-run relationships; ϕ_i, φ_i represent the short-run dynamic coefficients of the basic bound testing estimator in model (3.18); and v is the white noise error. The estimated F-statistics are used to test the null hypothesis of no cointegration against the alternative hypothesis of cointegration in order to determine the presence of cointegration. The null and alternative hypotheses can be derived from the equations described earlier as follows:

$H_0 : \gamma = 0, \lambda = 0$ [i.e., no co-integration]; and

$H_1 : \gamma \neq 0, \lambda \neq 0$ [i.e., there exists co-integration]

The tabulated upper and lower limits provided by Narayan in 2004 are being compared to the F-test values that have been calculated¹³. If the estimated F-values exceed the tabular values at the

upper bound, it indicates that the hypothesis of “no cointegration” is rejected, and hence, cointegration is accepted. Nevertheless, we do not dismiss the null hypothesis of “no cointegration” if the F-values are lower than the lower bound. However, the outcome becomes unpredictable if the F-values are within the two critical thresholds. The short-run equilibrium condition is expressed as the equilibrium condition for the ECM (Error Correction Model).

$$\Delta Y_t = C_0 + \sum_{i=1}^p \phi_i \Delta Y_{t-i} + \sum_{i=1}^p \varphi_i \Delta X_{t-i} + \pi ECT(-1) + v_t \quad (3.19)$$

The symbol $(-1)\pi$ indicates that the temporary imbalance caused by unexpected changes in all relevant factors will ultimately be resolved and restored to a stable long-term balance. The speed at which the dynamic model's equilibrium is restored through modification is demonstrated by the error correction term (ECT). The ECT coefficient, which measures the rate at which equilibrium is restored, should be both statistically significant and negative in value. Error correction procedures are employed to reestablish balance between the short-term and long-term behaviours of the outcome variable.

3.3.3 Estimation Technique

Auto-Regressive Distributed Lag (ARDL) Estimator

In this study, the Auto Regressive Distributed Lag (ARDL) will be used to estimate the short-run and long-run estimates of the existing relationship between institutions, government health spending and health outcomes. Three advantages for using this method are stated as: (a) small sample data (b) variables with mixed stationarity level either I(0) or I(1) and (c) both long- and short-run estimates can be derived simultaneously¹². The lag length is selected using the Akaike

information criteria (AIC). The calculated F-statistic value is used to make the decision about the cointegration. The significance of our calculated value is compared with the two tabulated values (upper bound and lower bound) computed by a scholar¹³. The decision criteria support cointegration if the calculated value is greater than the upper bound value; no cointegration if the value is lesser than the lower bound value; and inconclusive if the value lies between the two bounds values.

Causality Test

The fourth hypothesis is to examine the causal relationship between monetary policy, energy consumption and economic growth in Nigeria. This will be achieved by using the Toda and Yamamoto and Dolado and Lutkepohl (TYDL) augmented Vector autoregressive (VAR) procedure for estimating the causal estimates^{14,15}. It is noted that the method for causal interference derived from an augmented level VAR with integrated and cointegrated processes.

In a VAR form, the equation is written as:

$$Z_t = A_0 + \sum_{i=1}^k \Gamma_i Z_{t-i} + \mu_t \quad (3.20)$$

Where Z_t is a 8 by 1 dimensional vector of non-stationary endogenous variables of the model, A_0 is a 8 by 1 dimensional vector of constant; Γ is a vector of parameters; μ_t is k -dimensional vector of stochastic error term normally distributed with white noise properties $N(0, \sigma^2)$. A modified-Wald test will be used in the TYDL augmented VAR procedure. In this procedure, a VAR [$k + d(\max)$] that has k degree of freedom with a maximum order of cointegration for the series $d(\max)$ is estimated.

The TYDL augmented Vector Autoregressive (VAR) procedure is chosen for causality testing due to its robustness and effectiveness in analyzing causal relationships between variables in a time series framework. First, the TYDL augmented VAR procedure allows for the examination of causal relationships among the variables without making prior assumptions about the direction of causality. This is particularly beneficial when analyzing complex economic systems where the causal relationships between variables may not be readily apparent. Second, the TYDL procedure accounts for potential endogeneity issues and avoids the problem of omitted variable bias, which can distort causality test results. By including lagged values of the variables in the model, the TYDL procedure captures both contemporaneous and lagged effects, providing a more comprehensive analysis of causal relationships.

Additionally, the TYDL procedure allows for the incorporation of exogenous variables that may influence the causal relationships being examined. This enhances the flexibility of the causality testing framework and enables researchers to control for potential confounding factors that could affect the interpretation of causality test results. Furthermore, the TYDL procedure provides diagnostic tests to assess the validity of the causality results, including tests for model specification, stability, and residual autocorrelation. These diagnostic tests help ensure the reliability of the causality test findings and provide insights into the adequacy of the model specification.

3.4 Sources and Measurements of Data

Owing to the nature of the study, data from secondary sources will be adopted using both quantitative and descriptive analyses. Specifically, the study shall utilize secondary data compiled majorly by the Central Bank of Nigeria (CBN), Statistical Bulletin, and World

Development Indicators (WDI, 2022). The time-series data for analyzing the relationship among monetary policy, energy consumption and economic growth in Nigeria span from 1990 through 2022. The explanatory variables considered for this study include real gross domestic variable (Y), renewable energy (REN), non-renewable energy (NEN), monetary policy rate (MPR), money supply (MS), liquidity ratio (LR), capital (K), and labour (L).

Lead City University Ibadan DO NOT COPY

Table 3.1: Source of Data and Variable Measurement

Variables	Description	Measurement	Data source
<i>Y</i>	Economic growth is the monetary value of goods and services produced in a particular year using 2010 as the base year	It is measured in percentage	CBN statistical bulletin, 2022
<i>K</i>	Capital encompasses physical assets, technology, and human resources used to produce goods and services, crucial for economic growth.	It is measured as a ratio of GDP.	CBN statistical bulletin, 2022
<i>L</i>	Labour refers to the workforce's skills, productivity, and participation in the production process, influencing overall economic output and development.	It is measured in numbers	CBN statistical bulletin, 2022
<i>REN</i>	Renewable energy refers to energy derived from natural resources that are replenished naturally over time, such as sunlight, wind, rain, tides, waves, and geothermal heat.	It is measured in kilowatt-hours (kWh).	WDI, 2022
<i>NEN</i>	Non-renewable energy comes from sources that are finite and cannot be replenished within a human lifespan, such as coal, oil, natural gas, and nuclear fuels.	It is measured in kilowatt-hours (kWh).	WDI, 2022
<i>MPR</i>	The monetary policy rate denotes the interest rate set by a central bank to influence borrowing and spending in the economy.	It is measured in percentage	CBN statistical bulletin, 2022
<i>MS</i>	Money supply represents the total amount of money circulating in an economy, influencing inflation and economic activity.	Measured as a ratio of GDP	CBN statistical bulletin, 2022
<i>LR</i>	The liquidity ratio measures a bank's ability to meet short-term obligations and manage financial risks.	Measured as a ratio of GDP	CBN statistical bulletin, 2022

Source: Author's compilation (2024).

Endnotes

- 1) S. M. Hashmi, Q. R. Syed, & R. Inglesi-Lotz. *Monetary and energy policy interlinkages: The case of renewable energy in the US*. **Renewable Energy**, 201, (2022), 141-147.
- 2) M. Bildirici, S. Y. Genç, & Ö. Ö. Ersin. *Effects of fiscal and monetary policies, energy consumption and economic growth on CO2 emissions in the Turkish economy: Nonlinear bootstrapping NARDL and nonlinear causality methods*. **Sustainability**, 15(13), (2023), 10463.
- 3) M. T. Sohail, Y. Xiuyuan, A. Usman, M. T. Majeed, & S. Ullah. *Renewable energy and non-renewable energy consumption: assessing the asymmetric role of monetary policy uncertainty in energy consumption*. **Environmental Science and Pollution Research**, 28,(2021), 31575-31584.
- 4) G. Hunibachew. *The effect of monetary policy on economic growth in Ethiopia*. **International Journal of Finance and Banking Research**, 7(6), 2021, 133. <https://doi.org/10.11648/j.ijfbr.20210706.11>.
- 5) O. David, O. Ita, U. Eyo, & E. Ikenna. *An assessment of the impact of monetary policy on economic growth in Nigeria: Toda-Yamamoto approach*. **International Journal of Research and Innovation in Social Science**, 06(11), 2022, 537-547. <https://doi.org/10.47772/ijriss.2022.61126>.
- 6) E. Uju and P. Ugochukwu. *Effect of monetary policy on industrial growth in Nigeria*. **International Journal of Entrepreneurship and Business Innovation**, 4(1), 2021,47-60, 2021. <https://doi.org/10.52589/ijebi-1z4iybye>.
- 7) U. Umurzakov, B. Mirzaev, R. Salahodjaev, A. Isaeva, & S. Tosheva, *Energy consumption and economic growth: evidence from post-communist countries*. **International Journal of Energy Economics and Policy**, 10(6), 59-65, 2020. <https://doi.org/10.32479/ijeep.10003>.
- 8) N. Saqib. *Energy consumption and economic growth: empirical evidence from MENA region*. **International Journal of Energy Economics and Policy**, 11(6), 2021, 191-197. <https://doi.org/10.32479/ijeep.11931>.
- 9) S. Purnomo, N. Wani, S. Suharno, A. Arintoko, H. Sambodo, & L. Badriah. *The effect of energy consumption and renewable energy on economic growth in Indonesia*. **International Journal of Energy Economics and Policy**, 13(1), 2023, 22-30. <https://doi.org/10.32479/ijeep.13684>.
- 10) K. Munir and S. Nadeem. *Disaggregate energy consumption and economic growth in Pakistan: A sectoral analysis*. **International Journal of Energy Economics and Policy**, 12(1), 296-306, 2022. <https://doi.org/10.32479/ijeep.11615>.
- 11) C. A. Sims. *Macroeconomics and reality*. **Econometrica**, 1980, 1-48.

- 12) M. Shahbaz, S. A. Solarin, H. Mahmood, & M. Arouri. *Does financial development reduce CO2 emissions in Malaysian economy? A time series analysis.* **Economic Modelling**, 35, 2013, 93-108.
- 13) P. Narayan. *Reformulating critical values for the bounds F-statistics approach to cointegration: An application to the tourism demand model for Fiji.* Australia: Monash University, 2004.
- 14) H. Y. Toda, & T. Yamamoto. *Statistical inference in vector autoregressive with possibly integrated processes.* **Journal of Econometrics**, 66, 1995, 225-250
- 15) J. J. Dolado, & H. Lutkepohl. *Making Wald test work for cointegrated VAR systems.* **Econometrics Reviews**, 15, 1996, 369-386.

Lead City University Ibadan DO NOT COPY

Chapter Four

Results and Discussion of Finding

In this chapter, the study presents the details of data presentation, estimation, and the results of the empirical investigation of the links among monetary policy, energy consumption and economic growth in Nigeria. Also, it addresses the long-run and short-run relationship among monetary policy, energy consumption and economic growth in Nigeria. This is divided into descriptive analysis which shows the measure of central tendency which include the mean, median as well measures of variation, it also takes into consideration the trend analysis which shows the trend of the time series data used from 1990-2022 and econometric analysis which focuses on test for unit root, co-integration test using the autoregressive distributed lagged model.

4.1 Data Presentation

The data used for analyzing the relationship among monetary policy, energy consumption and economic growth in Nigeria is presented in the Appendix.

4.2 Presentation of Results

4.2.1 Summary Statistics

The summary of the preliminary analysis showing the mean, standard deviation, skewness and peakedness of the variables employed for analyzing the relationship among monetary policy, energy consumption and economic growth in Nigeria is presented in Table 4.1.

Table 4.1 Descriptive Statistics

Signs	Variable Measurements	Mean	Std Dev	Max.	Min.	Kurtosis	Skewness	Jarque-Bera	Prob.
Y	GDP growth	4.288	3.958	15.329	-2.035	0.662	0.487	1.398	0.497
MPR	Monetary Policy Rate	13.742	3.811	26	6	2.683	0.783	9.233	0.010
LR	Liquidity ratio	49.536	15.457	104.20	26.393	4.002	1.516	25.977	0.000
MS	Broad money (% of GDP)	18.181	6.140	27.379	9.063	-1.718	0.030	3.726	0.155
REN	Renewable energy consumption (% of total final energy consumption)	85.050	2.315	88.68	80.64	-0.991	-0.333	1.995	0.369
NEN	Fossil fuel energy consumption (% of total)	19.771	1.762	22.845	15.854	-0.788	-0.037	1.001	0.606
K	Gross fixed capital formation (annual % growth)	2.302	12.268	40.389	-23.747	2.424	0.303	5.399	0.067
L	Labor force participation rate, total (% of total population ages 15+) (national estimate)	58.914	6.284	76.34	55.4	3.439	2.151	33.666	0.000

Note: Std Dev. – standard deviation; Max. – maximum; Min. – minimum; Prob. – probability; Observation is 33.

Source: Author’s computation (2024).

The mean GDP growth rate of 4.29% indicates the average annual increase in Nigeria's gross domestic product during the time frame considered. This figure serves as a central measure of the country's economic performance over the period, indicating the overall trend in growth. The standard deviation of 3.96% reflects the degree of variability or dispersion in GDP growth rates around the mean. A higher standard deviation suggests greater volatility in economic growth, indicating fluctuations or instability in Nigeria's economic performance over time. In contrast, a lower standard deviation would imply more consistent or stable growth patterns. Similarly, the maximum GDP growth rate recorded of 15.33% represents the highest observed value during the period under analysis, indicating peak economic growth. Conversely, the minimum GDP growth rate of -2.04% reflects the lowest observed value, indicating periods of economic contraction or recession. The positive kurtosis values lesser than 3 suggests that the distribution of GDP growth rates is more flatted or platykurtic than a normal distribution, indicating the presence of extreme values or outliers. Similarly, the positive skewness coefficient indicates that the distribution of GDP growth rates is skewed to the right, with a longer tail on the positive side, suggesting that positive growth outliers are more common than negative ones. The relatively low Jarque-Bera test statistic of 1.398 and the high associated probability value of 0.497 suggest that the distribution of GDP growth rates in Nigeria may not significantly depart from a normal distribution.

As regards monetary policy rate, its mean of 13.74% indicates the average level of interest rates set by the central bank during the period under analysis. It serves as a central measure of the stance of monetary policy, indicating the general level of borrowing costs and the central bank's efforts to control inflation and stimulate economic activity. The standard deviation of 3.811

reflects the degree of variability or dispersion in Monetary Policy Rates around the mean. A higher standard deviation suggests greater volatility in interest rates, indicating fluctuations in the central bank's policy decisions over time. Likewise, the maximum monetary policy rate recorded of 26% represents the highest observed value during the period, indicating periods of tight monetary policy where interest rates were raised to curb inflation or stabilize the currency. Conversely, the minimum monetary policy rate of 6% reflects the lowest observed value, indicating periods of loose monetary policy where interest rates were lowered to stimulate economic growth or ease financial conditions. A positive kurtosis at 2.683 suggests that the distribution of interest rates is flat or platykurtic than a normal distribution, indicating the non-presence of extreme values or outliers. Similarly, a positive skewness coefficient of 0.783 indicates that the distribution of interest rates is skewed to the right, suggesting that higher interest rates are more common than lower ones. The Jarque-Bera test statistic and its associated probability value provide a formal test of whether the distribution of Monetary Policy Rates is normally distributed. In this case, the relatively high Jarque-Bera test statistic of 9.233 and the low associated probability value of 0.010 suggest that the distribution of interest rates may significantly depart from a normal distribution. This implies that the distribution of Monetary Policy Rates in Nigeria may exhibit characteristics such as skewness or kurtosis that deviate from a normal distribution.

Concerning liquidity ratio, its mean of 49.54% indicates the average level of liquidity maintained by financial institutions during the period under analysis. It shows the central measure of the liquidity position of the banking sector, indicating the proportion of liquid assets held as a buffer against short-term liabilities. The standard deviation of 15.45% reflects the degree of variability

or dispersion in Liquidity Ratios around the mean. A higher standard deviation suggests greater variability in liquidity positions across financial institutions, indicating differences in risk management practices or liquidity management strategies. The maximum liquidity ratio recorded of 104.2% represents the highest observed value during the period, indicating periods of ample liquidity where financial institutions hold a significant proportion of liquid assets relative to their liabilities. Conversely, the minimum Liquidity Ratio of 26.39% reflects the lowest observed value, indicating periods of tighter liquidity conditions where financial institutions may face challenges in meeting short-term obligations. Its kurtosis of 4.002 suggests that the distribution of liquidity ratios is more peaked or leptokurtic than a normal distribution, indicating the presence of extreme values or outliers. Similarly, the positive skewness coefficient indicates that the distribution of liquidity ratios is skewed to the right, suggesting that higher liquidity ratios are more common than lower ones. The Jarque-Bera test statistic and its associated probability value provide a formal test of whether the distribution of Liquidity Ratios is normally distributed. In this case, the relatively low Jarque-Bera test statistic of 25.977 and the extremely low associated probability value of 0.000 suggest that the distribution of liquidity ratios significantly departs from a normal distribution. This implies that the distribution of Liquidity Ratios in Nigeria may exhibit characteristics such as skewness or kurtosis that deviate from a normal distribution.

As for money supply as a percentage of GDP, its mean of 18.18% indicates the average proportion of broad money relative to the GDP during the period under analysis. It measures the depth and liquidity of the financial system, reflecting the extent to which money supply contributes to economic activity and financial intermediation. The standard deviation of 6.14% reflects the degree of variability or dispersion in Broad Money (% of GDP) around the mean.

The maximum Broad Money (% of GDP) recorded of 27.38% represents the highest observed value during the period, indicating periods of relatively high liquidity and financial intermediation. Conversely, the minimum Broad Money (% of GDP) of 9.06% reflects the lowest observed value, indicating periods of tighter monetary conditions and potentially lower levels of financial intermediation relative to GDP. The negative kurtosis of -1.718 suggests that the distribution of broad money relative to GDP is less peaked or platykurtic than a normal distribution, indicating a flatter distribution with fewer extreme values. Similarly, a positive skewness coefficient indicates that the distribution of Broad Money (% of GDP) is skewed to the right, suggesting that higher values are more common than lower ones. The Jarque-Bera test statistic and its associated probability value provide a formal test of whether the distribution of Broad Money (% of GDP) is normally distributed. In this case, the relatively low Jarque-Bera test statistic of 3.726 and the associated probability value of 0.155 suggest that the distribution of broad money relative to GDP may not significantly depart from a normal distribution.

Regarding the energy consumption indicators the mean of renewable energy consumption at 85.05% indicates that, on average, 85.050% of the total final energy consumption in Nigeria is derived from renewable sources. The relatively low standard deviation of 2.32% suggests that there is not much variability in the proportion of energy derived from renewables, indicating a consistent reliance on renewable sources over the period analyzed. The maximum value of 88.68% and minimum value of 80.64% show the range within which renewable energy consumption fluctuates. The negative kurtosis and skewness coefficients suggest a distribution with a flatter peak and a slight left skew, meaning that lower values are slightly more common than higher ones. The Jarque-Bera test statistic and its associated probability value indicate that

the distribution may not significantly deviate from normality. For fossil fuel energy consumption, the mean of 19.77% indicates that, on average, 19.771% of the total energy consumption in Nigeria comes from fossil fuels. The relatively low standard deviation of 1.76% suggests that there is not much variability in the proportion of energy derived from fossil fuels, indicating a consistent reliance on non-renewable sources over the period analyzed. The maximum value of 22.85% and minimum value of 15.85% show the range within which fossil fuel energy consumption fluctuates. The negative kurtosis and skewness coefficients suggest a distribution with a flatter peak and a slight left skew, meaning that lower values are slightly more common than higher ones. The Jarque-Bera test statistic and its associated probability value indicate that the distribution may not significantly deviate from normality.

As for the control variables, the mean growth rate of gross fixed capital formation as a ratio of GDP at 2.30% indicates the average annual increase in investment in fixed assets such as machinery, equipment, and infrastructure to GDP. The relatively high standard deviation of 12.27% suggests significant variability in investment growth rates over the period, indicating fluctuations in capital formation. The maximum growth rate of 40.39% reflects periods of robust investment expansion, while the minimum growth rate of -23.75% suggests contractions in investment, potentially indicating economic downturns or periods of low investor confidence. The positive kurtosis and skewness coefficients indicate a distribution with a flat surface and a skewness to the right, suggesting that positive growth outliers are more common than negative ones. The Jarque-Bera test statistic and its associated probability value indicate that the distribution of growth rates may not significantly depart from normality. For the labour force participation rate, the mean participation rate of 58.91% indicates the average proportion of the

working-age population that is economically active. The standard deviation of 6.28% suggests moderate variability in labour force participation rates over the period. The maximum participation rate of 76.34% represents the highest observed value, indicating periods of high labour force participation, while the minimum participation rate of 55.4% suggests lower levels of economic activity. The positive kurtosis and skewness coefficients indicate a distribution with a higher peak and a skewness to the right, suggesting that higher participation rates are more common than lower ones. The Jarque-Bera test statistic and its associated probability value suggest that the distribution of labour force participation rates may significantly depart from normality.

4.2.2 Correlation Analysis

The correlation analyses of the variables are presented in Table 4.2. The coefficients show that the level of association between the variables used to explain the existing relationship among monetary policy, energy consumption and economic growth in Nigeria.

From Table 4.2, the results show that the three monetary policy instruments (monetary policy rate, liquidity ratio and money supply) correlated negatively with economic growth measured by GDP growth rate. As to the energy consumption components, GDP growth is directly correlated with renewable energy consumption but relates negatively with non-renewable energy consumption. Concerning the key factors of output growth, GDP growth has a positive level of association with capital investment, but it indirectly relates with labour force participation rate. As to the main and control variables, their correlation relationships differ among themselves. Their correlation coefficients are moderates, therefore suggesting absence of multicollinearity

problem. Consequently, these results are just preliminary analysis subject to confirmation using the appropriate estimation method to reveal the parameter signs and magnitudes of the variables.

Lead City University Ibadan DO NOT COPY

Table 4.2: Correlation Matrix

	<i>Y</i>	<i>MPR</i>	<i>LR</i>	<i>MS</i>	<i>REN</i>	<i>NEN</i>	<i>K</i>	<i>L</i>
<i>Y</i>	1							
<i>MPR</i>	-0.178	1						
<i>LR</i>	-0.154	0.094	1					
<i>MS</i>	-0.172	-0.359	0.115	1				
<i>REN</i>	0.051	-0.007	-0.365	-0.439	1			
<i>NEN</i>	-0.121	0.489	0.307	0.038	-0.388	1		
<i>K</i>	0.206	-0.060	0.244	-0.122	-0.015	0.045	1	
<i>L</i>	-0.313	-0.092	0.138	0.587	-0.592	0.141	-0.052	1

Source: Author's computation (2024).

4.2.3 Trend Analysis

This sub-section of the study assesses the trend of monetary policy, energy consumption and economic growth in Nigeria for the period of 33 years i.e. 1990-2022. This enables to determine the trend and pattern of GDP growth, monetary policy rate, liquidity ratio, broad money (% of GDP), renewable energy consumption (% of total final energy consumption), fossil fuel energy consumption (% of total), gross fixed capital formation (annual % growth), and total labour force participation rate (% of total population ages 15+). The time series of monetary policy variables, energy consumption components and controlling variables plotted against economic growth are shown in Figures 4.1, 4.2, and 4.3.

The trend movement of GDP growth in Nigeria from 1990 to 2022 shows periods of both growth and contraction, reflecting the country's economic performance over the years. In the early 1990s, Nigeria experienced relatively high GDP growth rates, with peaks in 1990 (11.78%) and 1992 (4.63%). However, in 1993 and 1994, the economy contracted, with negative growth rates of -

2.04% and -1.82%, respectively. This period of economic downturn may have been influenced by various factors such as political instability, external shocks, and poor economic policies. From the late 1990s to the early 2000s, Nigeria witnessed a period of economic recovery and growth, with positive GDP growth rates. The economy expanded notably in 2002, recording a growth rate of 15.33%, which could be attributed to factors such as increased oil production and favorable global oil prices.

Lead City University Ibadan DO NOT COPY

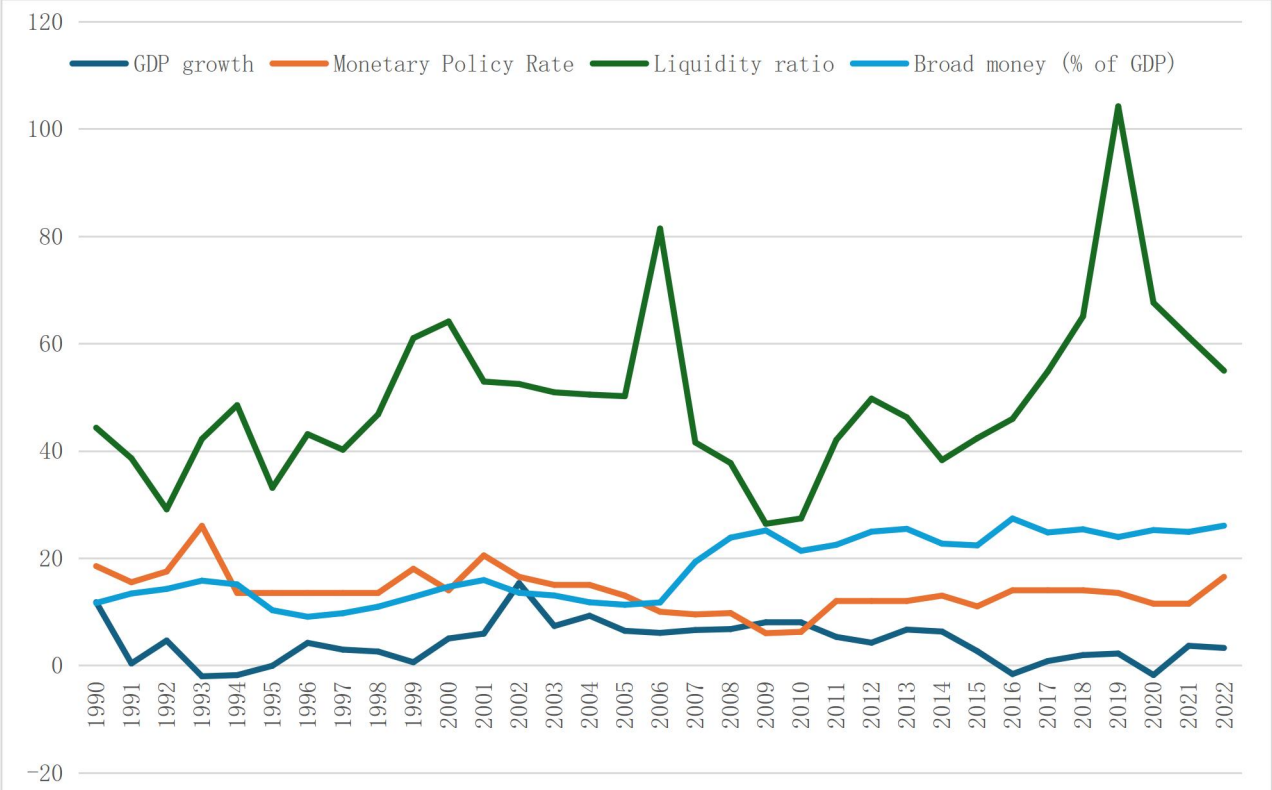


Figure 4.1: Monetary policy and economic growth in Nigeria
 Source: CBN Statistical bulletin (2022), WDI (2022)

Lead City University

In the mid-2000s to the late 2010s, Nigeria experienced relatively stable but moderate GDP growth rates, hovering around 5-7%. This period was characterized by various economic reforms, infrastructure development initiatives, and efforts to diversify the economy away from oil dependency. However, economic growth remained susceptible to fluctuations in global oil prices, internal security challenges, and governance issues. In more recent years, Nigeria faced economic challenges, including a recession in 2016 (-1.62%) and relatively low growth rates in 2020 (-1.79%) due to the COVID-19 pandemic and its impact on global economic activity. Despite these setbacks, Nigeria demonstrated resilience with positive growth rates in 2021 (3.65%) and 2022 (3.25%).

The trend movement of monetary policy variables in Nigeria from 1990 to 2022 in Figure 4.2 reveals fluctuations and shifts in key indicators such as the monetary policy rate (MPR), liquidity ratio (LR), and broad money (% of GDP) (MS). The monetary policy rate (MPR) reflects the central bank's benchmark interest rate, which influences borrowing and lending rates in the economy. From 1990 to the early 2000s, the MPR fluctuated within a relatively wide range, reflecting efforts to manage inflation and stimulate economic growth. However, there was a noticeable decline in the MPR from the mid-2000s to the early 2010s, indicating a period of monetary easing to support economic expansion. Subsequently, there were adjustments in the MPR in response to changing economic conditions, with increases observed in recent years, possibly aimed at curbing inflationary pressures.

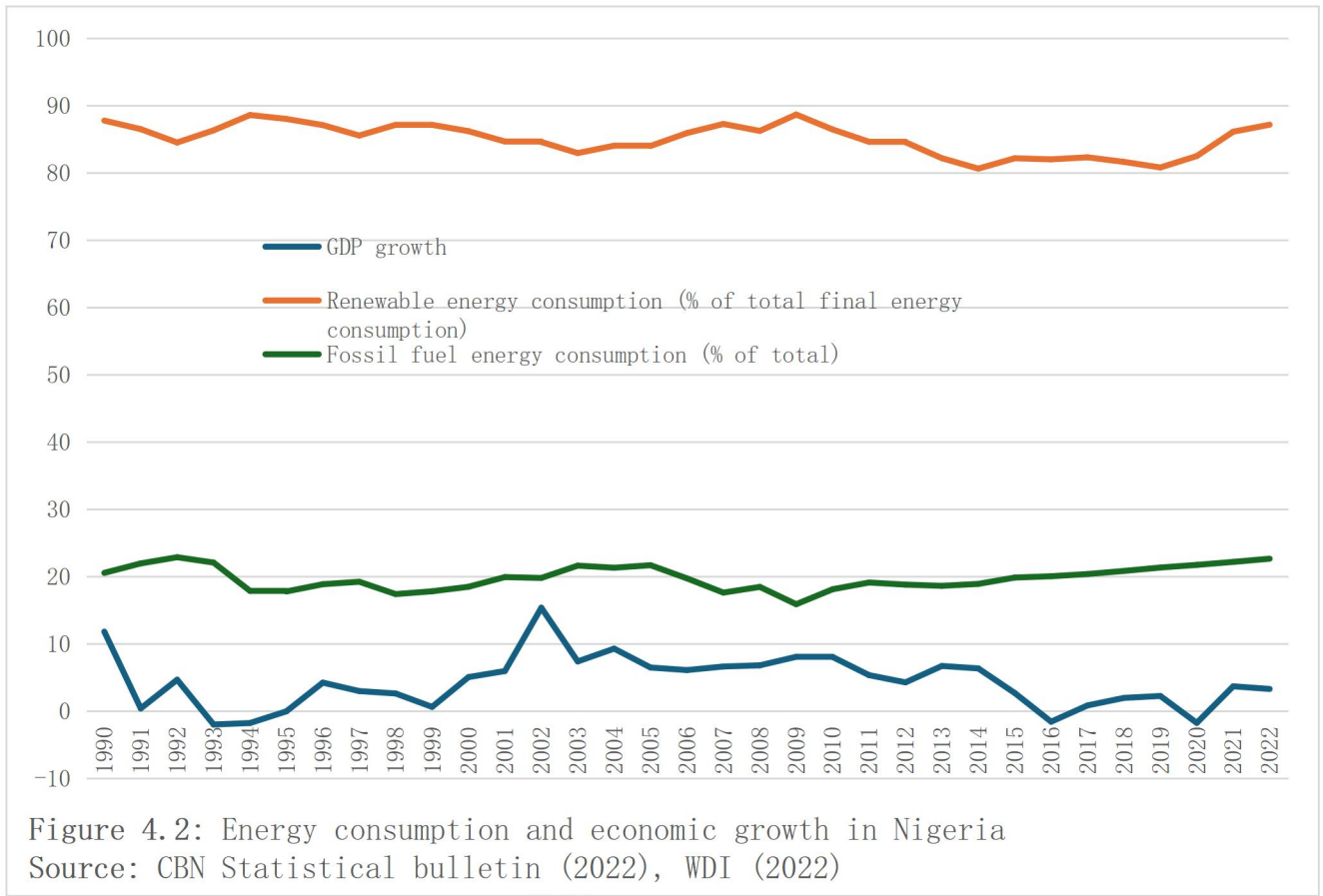
The liquidity ratio (LR) measures the proportion of liquid assets that financial institutions are required to hold as reserves. The LR in Nigeria experienced significant variability over the years, reflecting changes in liquidity management strategies by the central bank. There were periods of

tightening liquidity requirements, as evidenced by higher LR values, particularly during times of economic uncertainty or financial instability. Conversely, there were instances of loosening liquidity requirements to stimulate credit creation and support economic growth, as indicated by lower LR values. Broad money (% of GDP) (MS) represents the total supply of money circulating in the economy relative to the size of the economy. The trend movement of MS reflects changes in money supply dynamics, influenced by factors such as monetary policy decisions, banking regulations, and economic conditions. Over the period analyzed, MS exhibited fluctuations, with peaks and troughs corresponding to changes in monetary policy stance and economic performance. Generally, an increase in MS may signal expansionary monetary policy measures aimed at stimulating economic activity, while a decrease may indicate contractionary policy measures to contain inflation or stabilize financial markets.

The trend movement of renewable and non-renewable energy consumption in Nigeria from 1990 to 2022 in Figure 4.2 demonstrates fluctuations and shifts in the country's utilization of renewable and non-renewable energy sources over the years. In the early 1990s, Nigeria exhibited relatively high levels of renewable energy consumption, with values consistently above 85%. However, there was a gradual decline in the mid to late 1990s, reaching a low point around 2003. This decline may have been influenced by various factors such as changes in energy policies, technological advancements, and economic factors. From the mid-2000s to the early 2010s, Nigeria experienced some fluctuation in renewable energy consumption, with slight increases observed in certain years. These fluctuations may reflect efforts to promote renewable energy adoption, driven by concerns over energy security, environmental sustainability, and the potential for diversifying the energy mix. In more recent years, there has been a noticeable

upward trend in renewable energy consumption, particularly from 2019 to 2022. This trend suggests renewed efforts to prioritize renewable energy sources, possibly driven by a growing recognition of the need to mitigate climate change, reduce greenhouse gas emissions, and achieve sustainable development goals.

Furthermore, in the early 1990s, Nigeria exhibited relatively high levels of fossil fuel energy consumption, with values consistently above 20%. However, there was a slight decline observed in the mid-1990s, followed by a fluctuating pattern throughout the late 1990s and early 2000s. These fluctuations may have been influenced by various factors such as changes in energy policies, economic conditions, and technological advancements. From the mid-2000s to the late 2010s, Nigeria experienced a relatively stable trend in fossil fuel energy consumption, with minor fluctuations observed. Despite some variability, fossil fuel consumption remained relatively high, consistently above 15%. This indicates a continued reliance on fossil fuels, particularly oil and gas, as primary sources of energy in Nigeria's economy. In more recent years, there has been a slight upward trend in fossil fuel energy consumption, particularly from 2019 to 2022. This trend suggests a potential increase in fossil fuel usage, possibly driven by factors such as population growth, industrial development, and infrastructure expansion. However, it's essential to note that while fossil fuel consumption has increased, efforts to diversify the energy mix and promote renewable energy adoption are also underway.



The trend movement of investment, represented by Gross Fixed Capital Formation (annual % growth) (K), and labour force participation in Nigeria from 1990 to 2022 in Figure 4.3 demonstrates fluctuations and changes in the country's investment patterns and economic development. In the early 1990s, Nigeria experienced relatively high levels of investment growth, with values consistently above 0%. This period was characterized by positive investment growth rates, indicating robust economic activity and expansion in capital formation. However, there were some fluctuations observed during this period, reflecting changes in economic policies, external shocks, and domestic factors. From the mid-1990s to the early 2000s, Nigeria encountered a mixed trend in investment growth, with periods of both positive and negative growth rates. This period was marked by economic challenges, including political instability, fiscal imbalances, and external pressures, which contributed to the volatility in investment levels. From the mid-2000s to the late 2010s, Nigeria witnessed significant fluctuations in investment growth, with periods of both high and low growth rates. There were notable peaks in investment growth, particularly in 2003 and 2006, followed by downturns in subsequent years. These fluctuations may have been influenced by various factors, including changes in government policies, global economic conditions, and fluctuations in commodity prices, particularly oil. In more recent years, there has been a mixed trend in investment growth, with periods of both positive and negative growth rates. Despite challenges such as economic recession, fiscal constraints, and infrastructure gaps, Nigeria has continued to attract investment, albeit at varying levels.

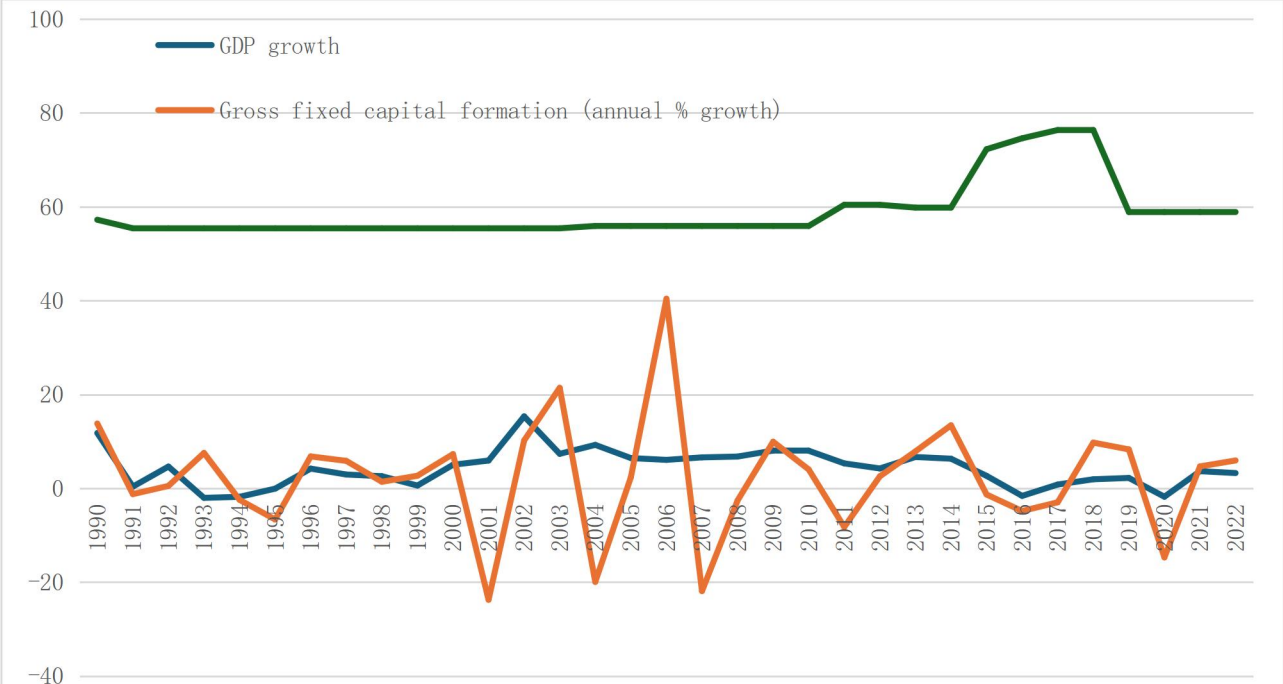


Figure 4.3: Investment, Labour and economic growth in Nigeria
 Source: CBN Statistical bulletin (2022), WDI (2022)

Lead City University Ibadan

Concerning labour participation, Nigeria experienced relatively stable labor force participation rates, with values hovering around 55.4% from 1990 to 2010. This period was characterized by consistent participation of the working-age population in the labor market, indicating a steady proportion of individuals actively seeking employment or engaged in economic activities. However, starting in 2011, there was a notable increase in the labor force participation rate, reaching 60.41% in that year. This rise suggests a surge in the proportion of the population actively participating in the labor market, potentially driven by factors such as population growth, demographic changes, and increased labor force mobilization initiatives. Subsequently, from 2013 to 2019, there were fluctuations observed in the labor force participation rate, with values fluctuating between 59.81% and 76.34%. These fluctuations may have been influenced by various factors, including changes in economic conditions, government policies, and structural shifts in the labor market. In 2015, there was a significant spike in the labor force participation rate, reaching 72.25%, followed by a further increase to 74.58% in 2016 and 76.34% in 2017. These higher participation rates may have been driven by factors such as population growth, urbanization, and increased labor force mobilization efforts. However, from 2019 onwards, there was a notable decline in the labor force participation rate, returning to levels observed in the early 2000s. This decline could be attributed to various factors, including changes in demographic trends, economic conditions, and social factors impacting labor force dynamics.

4.3 Pre-Estimation Tests (Unit Root Test)

This section presents the unit root test results as it examines the stationarity level of the variables. It is used to check for the presence of a unit root i.e. if the variables are not stationary at levels. This test is carried out using the Augmented Dickey Fuller (ADF), Phillip-Perron (PP), and Kwiatkowski–Phillips–Schmidt–Shin (KPSS) tests. This is the first test carried out before the co-integration analysis and is known as the pre-estimation test. The conventional methods used in this study were augmented Dickey–Fuller (ADF), Phillips–Perron (PP), and Kwiatkowski–Phillips–Schmidt–Shin (KPSS) to test the stationarity level at levels and first differences. Table 4.3 shows the results of the conventional unit root test methods.

Furthermore, the a priori expectation when using the ADF and PP tests is that a variable is stationary when the value of the ADF and PP test statistics are greater than the critical value at 5%. It is otherwise for KPSS estimator. From the test result reported in Table 4.3, capital investment to GDP was found not to accept the null hypothesis “they have unit root test” at 5% level. This implies that capital investment to GDP is stationary at levels. Thus, its series is integrated at order zero i.e. $I(0)$. However, the series of GDP growth, monetary policy rate, liquidity rate, money supply to GDP, renewable energy consumption, non-renewable energy consumption, capital investment, and labour force participation rate are not stationary at levels but they are integrated at order one i.e., $I(1)$. Therefore, GDP growth, monetary policy rate, liquidity rate, money supply to GDP, renewable energy consumption, non-renewable energy consumption, capital investment, and labour force participation rate were found not to reject the null hypothesis “no stationary” at level but after several iterations based on the number of lag

length and differencing, the series were found to reject the null hypothesis at first difference.

This indicates that the first difference of these series were stationary.

Table 4.3: Unit Root Test Results [Trend and Intercept]

Variables	Augmented Dickey Fuller (ADF)		Phillip-Perron (PP)		Kwiatkowski–Phillips–Schmidt–Shin (KPSS)		I(d)
	Levels	1stDifference	Levels	1stDifference	Levels	1stDifference	
	Y	-1.9368	-9.1197***	-3.6049**	–	0.1514	
MPR	-3.3552*	-7.7846***	-3.3348*	-8.6703***	0.1282	0.0901***	I(1)
LR	-3.3540*	-6.7948***	-3.4026*	-11.041***	0.0040***	–	I(1)
MS	-2.2634	-4.5166***	-1.9491	-6.4175***	0.1054	0.0646***	I(1)
REN	-1.8221	-4.8257***	-1.8221	-4.8229***	0.0589***	–	I(1)
NEN	-2.0158	-5.5926***	-1.9502	-6.1300***	0.1221	0.0561***	I(1)
K	-10.245***	–	–	–	0.0229***	–	I(0)
L	-4.8408***	–	12.462***	-2.1829	-4.9726***	0.0868***	I(1)

Note: ***, ** and * signify significance level at 1%, 5% and 10% respectively.

Sources: Author’s computation (2024).

4.4 Presentation of Results

4.4.1 Empirical Results of the Impact of Monetary Policy on Energy Consumption

Cointegration Test Result

The study tests the long-run relationship between the monetary policy, energy consumption (renewable and non-renewable energy), and other controlling variables using the autoregressive distributed lag (ARDL) bound cointegration tests in the stated hypotheses before estimating both the short-run and long-run parameters. For the first model showing the relationship among monetary policy, energy consumption and other controlling variables, the ARDL bound test is employed because it is suitable for variables at different order of integration. The F-statistics estimate for testing the existence of long-run relationship between monetary policy, energy consumption, and other controlling variables in Nigeria is presented in Table 4.4.

Table 4.4: Existence of long-run cointegration between monetary policy and energy consumption

Test Statistic	Value	K
F-statistics (ren k, l, mpr, ms, lr)	4.2445	5
F-statistics (nen k, l, mpr, ms, lr)	3.5319	5
Critical Value Bounds		
Significance	I0 Bound	I1 Bound
10%	2.08	3.00
5%	2.39	3.38
2.5%	2.70	3.73
1%	3.06	4.15

Source: Author's computation (2024).

From the table, the estimated F-statistics of the normalized equation ($F_{arb} = 4.2445$ and 3.5319) are greater than the lower and upper critical bound at 1% significance level. This implies that the null hypothesis of no long-run relationship is rejected at 1% significance level. The implication of the above estimation is that monetary policy instruments (monetary policy rate, money supply, and liquidity ratio), control variables (capital investment and labour participation rate) and energy consumption (renewable and non-renewable energy consumption), all have equilibrium condition that keep them together in the long-run. Thus, there exists a long-run relationship between monetary policy and energy consumption in Nigeria.

Results of Short-run and Long-run Estimates

A) Effect of Monetary Policy on Renewable Energy

The discussion in here examines the relationship between monetary policy and renewable energy consumption in Nigeria. It examines both the short-run and long-run relationship estimates of monetary policy and other controlling variables in Nigeria using the estimated ARDL approach described extensively in the previous chapter. The estimated ARDL model is a composite of short-run and long-run estimates of the interrelationship among considered series in this study. The clear evidence of our empirical estimates from monetary policy variables (monetary policy rate, money supply and liquidity), capital, and labour force participation rate are presented in Table 4.5.

Table 4.5: Results of estimated ARDL model of renewable energy consumption

Dependent Variable: Renewable energy (ren)				
Selected Model: ARDL(3, 2, 1, 1, 1, 1)				
Sample: 1990 2022		Included observations: 30		
<i>Short-Run Estimates</i>				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
$\Delta(\text{REN}(-1))$	0.589941	0.185323	3.183306	0.0062
$\Delta(\text{REN}(-2))$	0.349120	0.177941	1.961996	0.0686
$\Delta(\text{K})$	-0.080993	0.022855	-3.543696	0.0029
$\Delta(\text{K}(-1))$	0.074965	0.019312	3.881785	0.0015
$\Delta(\text{L})$	-0.070980	0.063365	-1.120178	0.2803
$\Delta(\text{MPR})$	-0.112355	0.061333	-1.831878	0.0869
$\Delta(\text{MS})$	0.238084	0.094788	2.511765	0.0239
$\Delta(\text{LR})$	0.018384	0.018229	1.008546	0.3292
ECT(-1)	-0.980661	0.209098	-4.689962	0.0003
<i>Long-run Estimates</i>				
K	-0.207054	0.098186	-2.108792	0.0522
L	-0.237192	0.069550	-3.410396	0.0039
MPR	0.030245	0.113784	0.265807	0.7940
MS	-0.021756	0.073894	-0.294421	0.7725
LR	-0.043406	0.028700	-1.512391	0.1512
C	101.4622	3.363231	30.16807	0.0000
R-squared	0.5852	F-stat	4.7867 (0.0024)	
Adj. R-squared	0.4271	D-Watson	1.7898	
Diagnostic Tests				
Serial Correlation: 0.5461 [0.5919]		Normality Test: 0.1227 [0.9405]		
Functional Form: 0.6952 [0.4983]		Heteroskedasticity Test: 0.5766 [0.8448]		
Source: Author's computation (2024).				

The short-run estimation results show the error correction mechanism which measures the speed or degree of adjustment. It is the rate of adjustment at which the dependent variable changes due to changes in the independent variables. The short run analysis shows the dynamic pattern in the model and to ensure that dynamics of the model have not been constrained by inappropriate lag length specification. The ARDL test automatically choose the lag length on all variables as the model was set at three to ensure sufficient degree of the freedom based on automatic selection of Akaike Information Criterion. The short-run estimates of the relationship between monetary policy and renewable energy consumption is presented in Table 4.5. The coefficient of the ECT is found to be negative and statistically significant at the conventional level. The ECT value (-0.9806) implied that the model corrects its short-run disequilibrium by 98.06% speed of adjustment in order to return to the long run equilibrium.

The coefficients of the short-run lags one and two of change in renewable energy consumption have positive and significant impact on the current changes in renewable energy consumption at 5% level. On average, this implies that renewable energy consumption is gradually improving in the country. The short-run parameter estimate of monetary policy rate was found to be negative and statistically significant at 10% level. The coefficient value of -0.11% suggests that a 1% increase in the monetary policy rate leads to a decrease in renewable energy consumption by approximately 0.11%. This indicates a potential negative relationship between the monetary policy rate and renewable energy consumption in the short run. The short run estimate of money supply (% of GDP) positively and significantly impact GDP growth. The coefficient value of 0.24% indicates that a 1% increase in the money supply (% of GDP) results in an increase in

renewable energy consumption by approximately 0.24%. This suggests a positive relationship between money supply and renewable energy consumption in the short run.

Likewise, liquidity ratio has a direct effect on renewable energy consumption, although not statistically significant at 5%. The parameter of 0.018% indicates that a 1% increase in the liquidity ratio leads to a slight increase in renewable energy consumption by approximately 0.018%. However, this effect is not statistically significant, suggesting that liquidity rate do not have a significant impact on renewable energy consumption in the short run. As to capital (% of GDP), its current and first lag coefficients represent the effects of current and lagged values of capital investment on renewable energy consumption. The negative coefficient for the current value (-0.081%) suggests that an increase in capital investment leads to a decrease in renewable energy consumption in the short run, and this effect is statistically significant at the 1% level. Conversely, the positive coefficient for the first lag of capital (0.075%) suggests that the lagged effect of capital investment positively influences renewable energy consumption, and this effect is statistically significant at the 1% level. Concerning the labour participation rate, the coefficient value of -0.071% indicates that a one-unit increase in labor force participation leads to a decrease in renewable energy consumption by approximately 0.071%. However, this effect is not statistically significant, suggesting that labour force participation may not have a significant impact on renewable energy consumption in the short run.

The long-run estimates from Table 4.5 indicated that all the monetary policy instrument do not have significant impact on long run energy consumption in Nigeria. None of the instruments follow the theoretical expectations. Specifically, renewable energy consumption is influenced positively by monetary policy rate, but negatively impacted by broad money supply (% of GDP)

and liquidity ratio respectively. A 10% changes in monetary policy rate, money supply (% of GDP) and liquidity ratio result to changes in renewable energy consumption by 0.3%, -0.22% and 0.43% correspondingly. As to the control variable, capital investment and labour participation rate negatively influence renewable energy consumption. Labour force participation rate was significant at 5% level while capital investment was significant at 10% level. A 10% increase in capital investment and labour participation rate lead to a reduction in renewable energy consumption by 2.07% and 2.37% correspondingly.

The coefficient of determination (Adjusted-R²) is high (42.71%) indicating that about 42.71% of the total variations in renewable energy consumption was explained by the monetary policy variables, investment, and labour force participation rate. It simply indicated that the variation of changes in renewable energy consumption was explained by 42.71% variations in monetary policy and other controlling variables. The overall test using the F-statistic (4.787) is statistically significant at 5% level of significance showing that model is well specified and statistically significant. The Durbin Watson statistic (1.7898) shows that there is absence of serial autocorrelation in the model.

Diagnostic Test

The estimated ARDL model is tested for heteroscedasticity, serial correlation, functional form misspecification, parameter stability and normality. The results from these tests are also shown in Table 4.5. The estimated ARDL model revealed that the model passed the serial correlation, normality test, and heteroskedasticity test. It means that the error terms are normally distributed with same variances and they are not serially correlated. Also, the Ramsey RESET test was satisfactory for the ARDL model indicating that the model is well distributed.

Additionally, the ARDL model passed the Ramsey RESET test, showing that the model is evenly specified. Additionally, the cumulative sum (CUSUM) and cumulative sum of squares (CUSUMSQ), respectively, as shown in Figures 4.4a and 4.4b are steady.

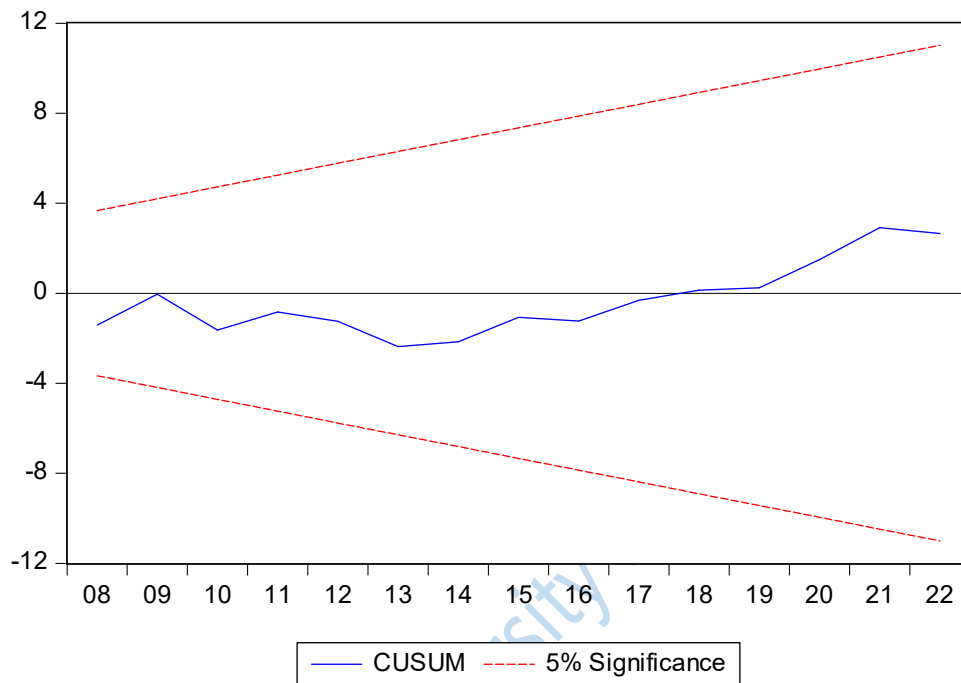


Figure 4.4a: Cumulative sum

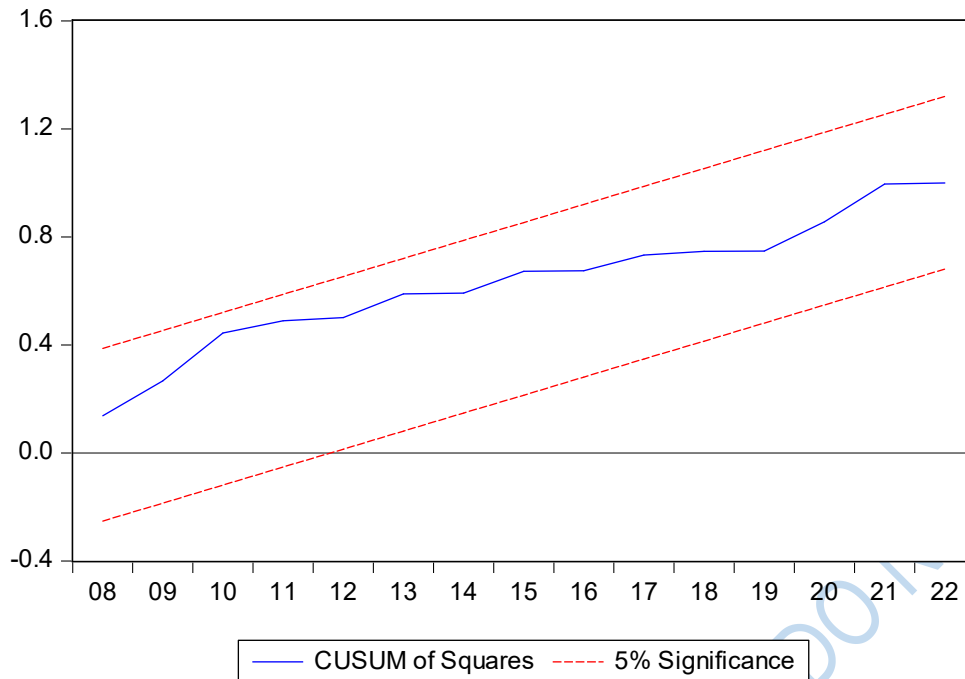


Figure 4.4b: Cumulative sum of squares

B) Effect of Monetary Policy on Non-Renewable Energy

The discussion in here answers the null hypothesis that monetary policy has no significant effect on the non-renewable energy consumption in Nigeria. It examines both the short-run and long-run relationship estimates of monetary policy and other controlling variables in Nigeria using the estimated ARDL approach described extensively in the previous chapter. The estimated ARDL model is a composite of short-run and long-run estimates of the interrelationship among considered series in this study. The clear evidence of our empirical estimates from monetary policy variables (monetary policy rate, liquidity ratio and money supply), capital, and labour force participation rate are presented in Table 4.6.

Table 4.6: Results of estimated ARDL model of non-renewable energy consumption

Dependent Variable: Non-renewable energy (nen)				
Selected Model: ARDL(3, 0, 0, 1, 2, 2)				
Sample: 1990 2022			Included observations: 30	
<i>Short-Run Estimates</i>				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
$\Delta(\text{NEN}(-1))$	0.120344	0.117044	1.028198	0.3192
$\Delta(\text{NEN}(-2))$	0.226954	0.118250	1.919268	0.0730
$\Delta(\text{MPR})$	0.151583	0.039668	3.821290	0.0015
$\Delta(\text{MS})$	-0.091618	0.063635	-1.439750	0.1692
$\Delta(\text{MS}(-1))$	-0.203791	0.066052	-3.085329	0.0071
$\Delta(\text{LR})$	0.012407	0.010531	1.178168	0.2560
$\Delta(\text{LR}(-1))$	-0.044711	0.011946	-3.742899	0.0018
$\text{ECT}(-1)$	-0.640225	0.109807	-5.830439	0.0000
<i>Long-run Estimates</i>				
K	-0.002465	0.026901	-0.091619	0.9281
L	0.041631	0.058150	0.715924	0.4844
MPR	0.084038	0.109898	0.764695	0.4556
MS	0.043219	0.073650	0.586821	0.5655
LR	0.082205	0.024602	3.341449	0.0041
C	11.29333	3.382300	3.338950	0.0042
R-squared	0.7642	F-stat	6.9534 (0.0002)	
Adj. R-squared	0.6892	D-Watson	2.0495	
Diagnostic Tests				
Serial Correlation: 3.0256 [0.0809]		Normality Test: 0.1257 [0.9391]		
Functional Form: 0.0742 [0.9418]		Heteroskedasticity Test: 1.0327 [0.4688]		
Source: Author's computation (2024).				

The short-run estimation results show the error correction mechanism which measures the speed or degree of adjustment. It is the rate of adjustment at which the dependent variable changes due to changes in the independent variables. The short run analysis shows the dynamic pattern in the model and to ensure that dynamics of the model have not been constrained by inappropriate lag length specification. The ARDL test automatically choose the lag length on all variables as the model was set at three to ensure sufficient degree of the freedom based on automatic selection of Akaike Information Criterion. The short-run estimates of the relationship between monetary policy and non-renewable energy consumption is presented in Table 4.6. The coefficient of the ECT is found to be negative and statistically significant at the conventional level. The ECT value (-0.6402) implied that the model corrects its short-run disequilibrium by 64.02% speed of adjustment in order to return to the long run equilibrium.

The coefficients of the short-run lags one and two of change in non-renewable energy consumption has positive and negative significant impact on the current changes in non-renewable energy consumption, albeit not significant at 5% level. As to the short-run of monetary policy rate, the coefficient value of 0.15% indicates that a 1% increase in the monetary policy rate leads to an increase in non-renewable energy consumption by approximately 0.15%. This effect is statistically significant at the 1% level, suggesting a positive relationship between the monetary policy rate and non-renewable energy consumption in the short run. Money supply has a negative effect on non-renewable energy consumption in the short. Their coefficients represent the effects of current and lagged values of money supply on non-renewable energy consumption. The coefficient value of -0.092% for current money supply level suggests that a 1% increase in the current money supply leads to a decrease in non-renewable energy

consumption by approximately 0.092%, although this effect is not statistically significant. Conversely, the coefficient value of -0.20% for its first lag indicates that the lagged effect of money supply negatively influences non-renewable energy consumption, and this effect is statistically significant at the 1% level. The effects of current and lagged values of liquidity ratio on non-renewable energy consumption are positive and negative respectively. The coefficient value of 0.012\$ for current liquidity ratio suggests that a 1% increase in the current liquidity ratio leads to a slight increase in non-renewable energy consumption by approximately 0.012%. However, this effect is not statistically significant at 5% level. Conversely, the coefficient value of -0.045% for the first lag indicates that the lagged effect of liquidity ratio negatively influences non-renewable energy consumption, and this effect is statistically significant at the 1% level.

The long-run estimates from Table 4.6 indicated that all monetary policy variables (monetary policy rate, liquidity ratio and money supply) have positive impact on the non-renewable energy consumption in Nigeria. The result shows that the three indicators were not in tandem with the theoretical expectations and only liquidity ratio was statistically significant at 5%. A 10% increase in monetary policy rate, money supply and liquidity ratio lead to an increase in non-renewable by 0.84%, 0.43% and 0.82% correspondingly. Meanwhile, investment and labour force participation rate have an insignificant effect on non-renewable energy consumption. Only labour force participation conforms to a priori expectations.

The coefficient of determination (adjusted- R^2) is high (68.92%) indicating that about 68.92% of the total variations in non-renewable energy consumption was explained by the variables in the model. It simply indicated that the variation of changes in non-renewable energy consumption was explained by 68.92% variations in monetary policy variables, investment and labour force

participation rate. The overall test using the F-statistic (6.953) is statistically significant at 5% level of significance showing that model is well specified and statistically significant. The Durbin Watson statistic (2.0495) shows that there is absence of serial autocorrelation in the model.

Diagnostic Test

The estimated ARDL model is tested for heteroscedasticity, serial correlation, functional form misspecification, parameter stability and normality. The results from these tests are shown in Table 4.6.

The estimated ARDL model revealed that the model passed the serial correlation, normality test, and heteroskedasticity test. It means that the error terms are normally distributed with same variances and they are not serially correlated. Also, the Ramsey RESET test was satisfactory for the ARDL model indicating that the model is well distributed.

Additionally, the ARDL model passed the Ramsey RESET test, showing that the model is evenly specified. Additionally, the cumulative sum (CUSUM) and cumulative sum of squares (CUSUMSQ), respectively, as shown in Figures 4.5a and 4.5b are steady.

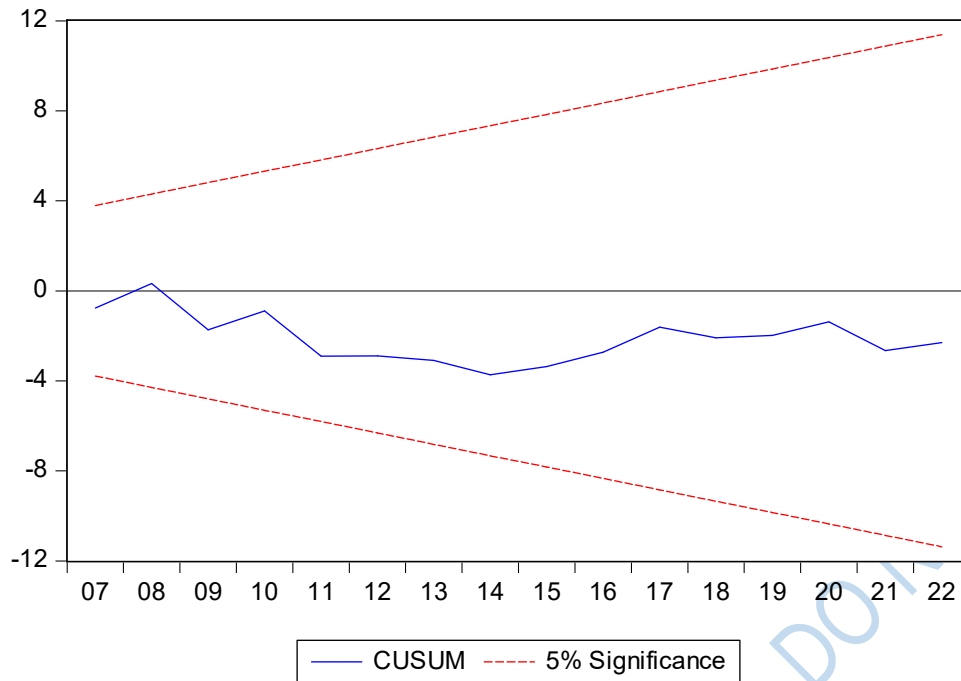


Figure 4.5a: Cumulative sum

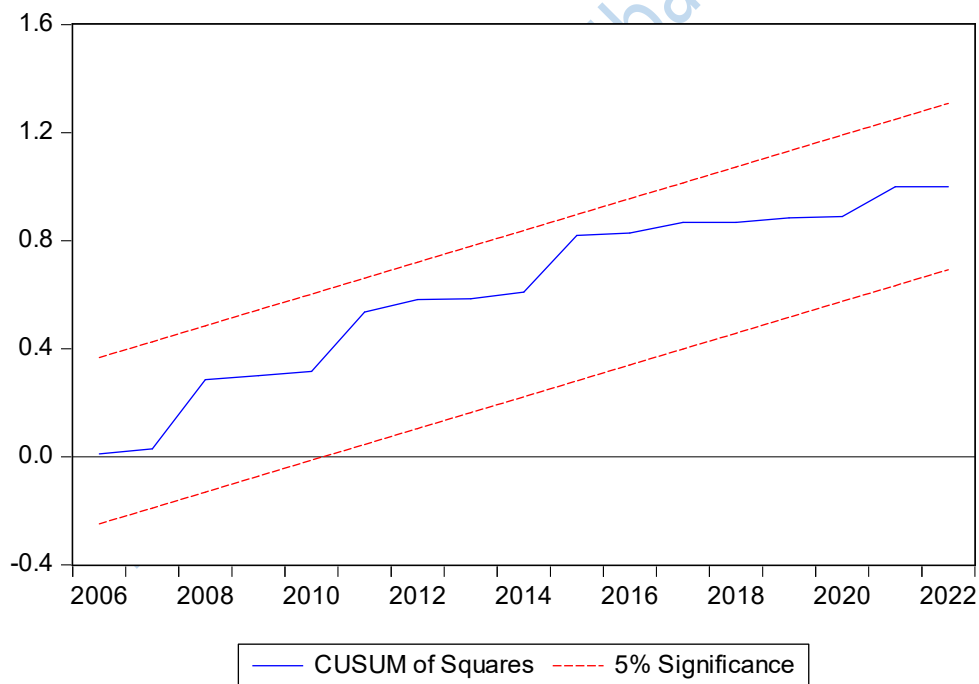


Figure 4.5b: Cumulative sum of squares

4.4.2 Empirical Results of the Effect of Monetary Policy on Economic Growth

Cointegration Results

In this section, the long-run relationship between the monetary policy, economic growth, and other controlling variables are tested using the autoregressive distributed lag (ARDL) bound cointegration tests prior to the estimation of both the short-run and long-run parameters. For the first model showing the relationship between monetary policy (monetary policy rate, liquidity ratio and money supply), capital investment, and labour force participation, the ARDL bound test is employed because it is suitable for variables at different order of integration. The F-statistics estimate for testing the existence of long-run relationship between monetary policy, economic growth and other controlling variables in Nigeria is presented in Table 4.7.

Table 4.7 showed that the estimated F-statistics of the normalized equation ($F_{arb} = 4.5282$) is greater than the lower and upper critical bound at 1% significance level. This implies that the null hypothesis of no long-run relationship is rejected at 1% significance level. The implication of the above estimation is that monetary policy variables (monetary policy rate, liquidity ratio and money supply), control variables (such as capital investment and labour force participation rate) and economic growth, all have equilibrium condition that keep them together in the long-run. Thus, there exists a long-run relationship between monetary policy and economic growth in Nigeria.

Table 4.7: Existence of long run cointegration between monetary policy and economic growth

Test Statistic	Value	K
F-statistics (y k, l, mpr, ms, lr)	4.5282	5
Critical Value Bounds		
Significance	I0 Bound	I1 Bound
10%	2.08	3.00
5%	2.39	3.38
2.5%	2.70	3.73
1%	3.08	4.15

Source: Author's computation (2024).

Results of Short-run and Long-run Estimates

In this sub-section, this discussion answers the null hypothesis that monetary policy has no significant effect on the economic growth of Nigeria. This examines both the short-run and long-run estimates of monetary policy and other controlling variables in Nigeria using the estimated ARDL approach described extensively in the previous chapter. The estimated ARDL model is a composite of short-run and long-run estimates of the interrelationship among considered series in this study. The clear evidence of our empirical estimates from monetary policy variables (monetary policy rate, liquidity ratio and money supply), capital, and labour force participation are presented in Table 4.8.

The short-run estimation results show the error correction mechanism which measures the speed or degree of adjustment. It is the rate of adjustment at which the dependent variable changes due to changes in the independent variables. The short run analysis shows the dynamic pattern in the model and to ensure that dynamics of the model have not been constrained by inappropriate lag

length specification. The ARDL test automatically choose the lag length on all variables as the model was set at three to ensure sufficient degree of the freedom based on automatic selection of Akaike Information Criterion. The short-run estimates of the relationship between monetary policy and economic growth is presented in Table 4.8. The coefficient of the ECT is found to be negative and statistically significant at the conventional level. The ECT value (-0.5153) implied that the model corrects its short-run disequilibrium by 51.53% speed of adjustment in order to return to the long run equilibrium.

Lead City University Ibadan DO NOT COPY

Table 4.8: Results of estimated ARDL model of Monetary Policy and economic growth**Dependent Variable:** Economic growth (Y)**Selected Model:** ARDL(3, 0, 3, 2, 3, 3)**Sample:** 1990 2022**Included observations:** 34

<i>Short-Run Estimates</i>				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
$\Delta(Y(-1))$	-0.124665	0.127110	-0.980760	0.3498
$\Delta(Y(-2))$	0.214940	0.096081	2.237074	0.0492
$\Delta D(L)$	-0.252412	0.102156	-2.470860	0.0331
$\Delta(L(-1))$	0.744946	0.119356	6.241381	0.0001
$\Delta(L(-2))$	0.345757	0.108470	3.187588	0.0097
$\Delta(MPR)$	0.012990	0.103114	0.125975	0.9022
$\Delta(MPR(-1))$	0.721256	0.115837	6.226485	0.0001
$\Delta(MS)$	-0.848450	0.168310	-5.041004	0.0005
$\Delta(MS(-1))$	-0.294346	0.186700	-1.576575	0.1460
$\Delta(MS(-2))$	0.668305	0.151953	4.398109	0.0013
$\Delta(LR)$	-0.071492	0.030462	-2.346947	0.0409
$\Delta(LR(-1))$	-0.102993	0.034536	-2.982159	0.0138
$\Delta(LR(-2))$	0.057156	0.024289	2.353205	0.0404
ECT(-1)	-0.515343	0.072364	-7.121530	0.0000
<i>Long-run Estimates</i>				
K	0.050044	0.100044	0.500217	0.6277
L	-0.500625	0.291319	-1.718477	0.1165
MPR	-1.220193	0.493207	-2.473996	0.0329
MS	-0.459050	0.350325	-1.310354	0.2194
LR	0.410280	0.151310	2.711516	0.0219
C	38.62768	12.52466	3.084130	0.0116
R-squared	0.8893	F-stat	5.1903 (0.0055)	
Adj. R-squared	0.7993	D-Watson	2.0553	
Diagnostic Tests				
Serial Correlation: 0.7960 [0.5010]		Normality Test: 0.9639 [0.6176]		
Functional Form: 1.0323 [0.3289]		Heteroskedasticity Test: 0.9262 [0.5771]		
Source: Author's computation (2024).				

The coefficient of the short-run lag two of change in output growth has positive and significant impact on the current changes in economic growth at 5% level. This means that the current level of output growth depends on those that are previously produced in the economy. The short run monetary policy rate has a direct impact on economic growth. The coefficient for short run monetary policy rate is 0.013%, indicating that a 1% increase in the current monetary policy rate has a negligible positive effect on GDP growth, although this effect is not statistically significant at the 5% level. However, the coefficient for its lag one is 0.72%, indicating a significant positive effect. This implies that a 1% increase in the lagged monetary policy rate leads to a substantial increase in GDP growth by approximately 0.72%. This effect is statistically significant at the 5% level. The coefficient for current money supply is -0.85%, indicating that a 1% increase in the current money supply leads to a significant decrease in GDP growth by approximately 0.85%. This effect is statistically significant at the 5% level. However, the coefficients for money supply at first and second lags are -0.29% and 0.67%, respectively. While the coefficient for money supply at first lag is not statistically significant, the coefficient for its second lag is statistically significant at the 5% level, indicating a positive effect on GDP growth.

The coefficient for current liquidity ratio is -0.072%, indicating that a 1% increase in the current liquidity ratio leads to a slight decrease in GDP growth by approximately 0.072%. This effect is statistically significant at the 5% level. Similarly, the coefficients for liquidity ratio at first and second lags are -0.10% and 0.057%, respectively. Both coefficients are statistically significant at the 5% level, indicating negative and positive effects on GDP growth, respectively. The short-run parameter estimate of current labour force participation was found to be negative, indicating that it influences changes in the GDP growth negatively. Thus, the coefficient is statistically

significant at 5%. Also, labour force participation rate at first and second lags have a direct and significant effect on economic growth and their impacts are significant statistically at 5% level.

The long-run estimates in Table 4.8 indicated that monetary policy rate and money supply have negative impact on economic growth. The coefficient of money supply did not corroborate the a priori expectation and also not statistically significant at 5%. As to monetary policy rate, its negative effect on economic growth is significant statistically at 5% level. In magnitude terms, a 1% changes in monetary policy rate and money supply will lead to -1.22% and -0.46% changes in economic growth respectively. However, the positive impact of liquidity ratio on GDP growth is significant statistically at 5% level. Also, on magnitude basis, 1% increase in liquidity ratio will cause a rise in the GDP growth by 0.41%. Also, investment has positive and insignificant impact on GDP growth in the long-run. On the contrary, labour force participation rate negatively impacted on the GDP growth of the Nigerian economy for the periods understudy, albeit not significant at 5%.

The coefficient of determination (Adjusted-R²) is high (79.93%) indicating that about 79.93% of the total variations in economic growth was explained by the variables in the model. It simply indicated that the variation of changes in economic growth was explained by 79.93% variations in monetary policy and other controlling variables. The overall test using the F-statistic (5.190) is statistically significant at 5% level of significance showing that model is well specified and statistically significant. The Durbin Watson statistic (2.0553) shows that there is absence of serial autocorrelation in the model.

Diagnostic Test

The estimated ARDL model is tested for heteroscedasticity, serial correlation, functional form misspecification, parameter stability and normality. The results from these tests are shown in Table 4.8.

The estimated ARDL model revealed that the model passed the serial correlation, normality test, and heteroskedasticity test. It means that the error terms are normally distributed with same variables and they are not serially correlated. Also, the Ramsey RESET test was satisfactory for the ARDL model indicating that the model is well distributed.

In addition, the ARDL model passed the Ramsey RESET test, showing that the model is evenly specified. Additionally, the cumulative sum (CUSUM) and cumulative sum of squares (CUSUMSQ), respectively, as shown in Figures 4.6a and 4.6b are steady.

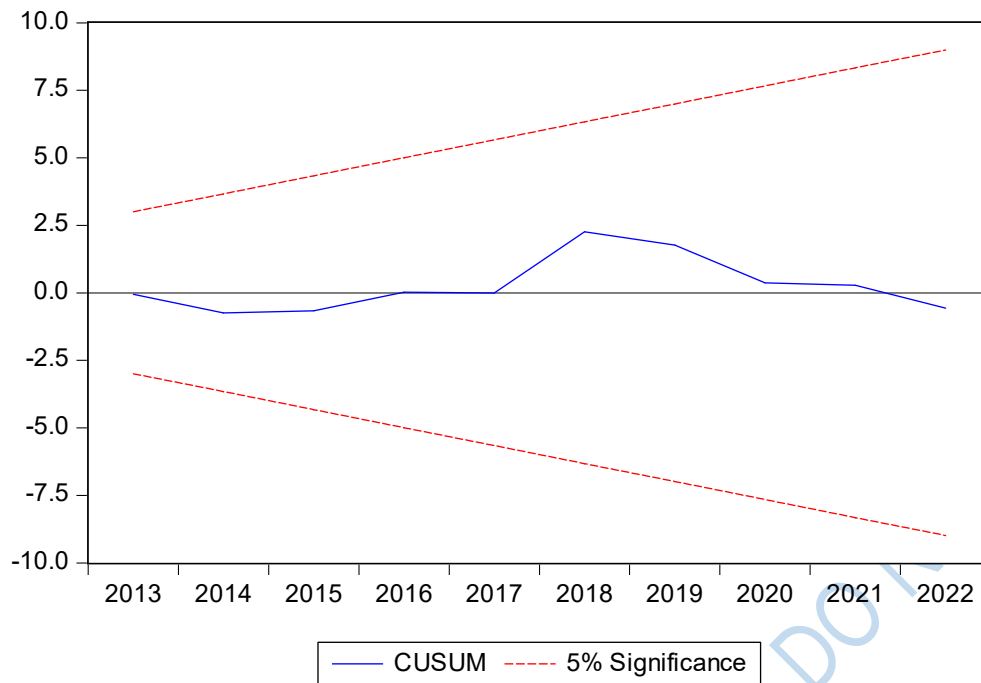


Figure 4.6a: Cumulative sum

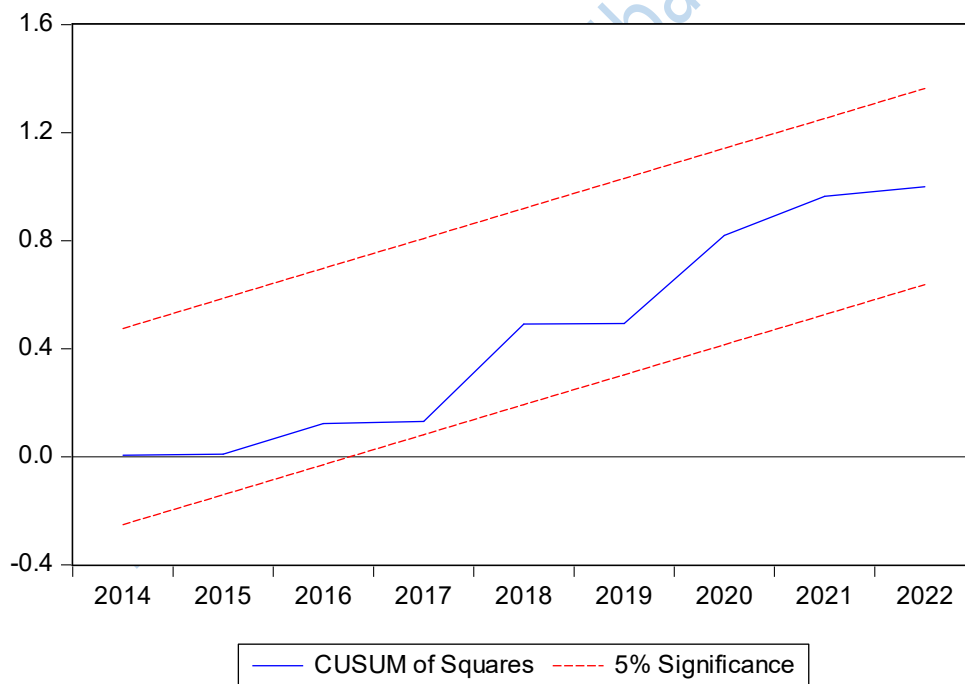


Figure 4.6b: Cumulative sum of squares

4.4.3 Empirical Results of the Effects of Energy Consumption on Economic Growth

Cointegration Test Result

Concerning this section, the study examines the long-run relationship between the energy consumption, economic growth and other control variables using the autoregressive distributed lag (ARDL) bound cointegration tests before the estimation of both the short-run and long-run parameters. For the first model showing the relationship between energy consumption, economic growth and other control variables, the ARDL bound test is employed because it is suitable for variables at different order of integration. The F-statistics estimate for testing the existence of long-run relationship between energy consumption, economic growth and other controlling variables in Nigeria is presented in Table 4.9.

From the table, the estimated F-statistics of the normalized equation ($F_{arb} = 6.2585$) is greater than the lower and upper critical bound at 5% significance level. This implies that the null hypothesis of no long-run relationship is rejected at 5% significance level. The implication of the above estimation is that energy consumption (renewable and non-renewable energy), control variables (capital investment and labour force participation rate) and economic growth, all have equilibrium condition that keep them together in the long-run. Thus, there exists a long-run relationship between energy consumption and economic growth in Nigeria.

Table 4.9: Existence of long run cointegration between energy consumption and economic growth

Test Statistic	Value	K
F-statistics (y k, l, ren, nen)	6.2585	4
Critical Value Bounds		
Significance	I0 Bound	I1 Bound
10%	2.20	3.09
5%	2.56	3.49
2.5%	2.88	3.87
1%	3.29	4.37

Source: Author's computation (2024).

Lead City University Ibadan DO NOT COPY

Results of Short-run and Long-run Estimates

The discussion in here answers the null hypothesis that energy consumption has no significant effect on the economic growth in Nigeria. It examines both the short-run and long-run relationship estimates of energy consumption and other controlling variables in Nigeria using the estimated ARDL approach described extensively in the previous chapter. The estimated ARDL model is a composite of short-run and long-run estimates of the interrelationship among considered series in this study. The clear evidence of our empirical estimates from energy consumption (renewable and non-renewable energy), capital investment and labour force participation rate are presented in Table 4.10.

The short-run estimation results show the error correction mechanism which measures the speed or degree of adjustment. It is the rate of adjustment at which the dependent variable changes due to changes in the independent variables. The short run analysis shows the dynamic pattern in the model and to ensure that dynamics of the model have not been constrained by inappropriate lag length specification. The ARDL test automatically choose the lag length on all variables as the model was set at three to ensure sufficient degree of the freedom based on automatic selection of Akaike Information Criterion. The short-run estimates of the relationship between renewable and non-renewable energy consumption and economic growth are presented in Table 4.10. The coefficient of the ECT is found to be negative and statistically significant at the conventional level. The ECT value (-0.3768) implied that the model corrects its short-run disequilibrium by 37.68% speed of adjustment in order to return to the long run equilibrium.

Table 4.10: Results of estimated ARDL model of economic growth

Dependent Variable: Economic growth (Y)				
Selected Model: ARDL(1, 3, 2, 3, 0)				
Sample: 1990 2022		Included observations: 35		
<i>Short-Run Estimates</i>				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
$\Delta(K)$	-0.139599	0.043335	-3.221411	0.0053
$\Delta(K(-1))$	0.577944	0.089099	6.486504	0.0000
$\Delta(K(-2))$	0.282085	0.049310	5.720668	0.0000
$\Delta(L)$	-0.216739	0.096737	-2.240489	0.0396
$\Delta(L(-1))$	0.335873	0.103674	3.239701	0.0051
$\Delta(REN)$	-0.051236	0.277602	-0.184566	0.8559
$\Delta(REN(-1))$	0.504209	0.251093	2.008055	0.0618
$\Delta(REN(-2))$	1.341185	0.277100	4.840069	0.0002
ECT(-1)	-0.376844	0.053679	-7.020358	0.0000
<i>Long-run Estimates</i>				
K	-2.901226	1.513389	-1.917039	0.0733
L	-1.342431	0.534077	-2.513551	0.0230
REN	-4.972410	2.263306	-2.196967	0.0431
NEN	-3.625560	1.987606	-1.824083	0.0869
C	582.8718	258.2346	2.257141	0.0383
R-squared	0.7651	F-stat	5.0720 (0.0015)	
Adj. R-squared	0.6756	D-Watson	2.2017	
Diagnostic Tests				
Serial Correlation: 0.1788 [0.9145]		Normality Test: 0.1788 [0.9145]		
Functional Form: 0.3792 [0.7099]		Heteroskedasticity Test: 0.7006 [0.7384]		
Source: Author's computation (2024).				

The coefficients of the short-run lags one and two of change in renewable energy consumption has significant positive impact on the current changes in economic growth at 10% and 5% respectively. The short run renewable energy consumption negatively and insignificantly impact on GDP growth in Nigeria at 5% level. The short-run parameter estimates of current capital investment was found to be negative and statistically significant at 5% indicating that it influences changes in economic growth. Meanwhile, its first and second lags have direct and significant impact on GDP growth in Nigeria. As to labour force participation rate, the current value negatively and significantly influences GDP growth at 5% level. For the first lag of labour force participation rate, the parameter is positive and significant implying that labour participation rate influences the Nigeria's economic growth positively.

The long-run estimates from Table 4.10 indicated that renewable and non-renewable energy consumption have negative impact on the economic growth in Nigeria. The result shows that the two indicators were not in tandem with the theoretical expectations but the coefficients are significant at 5% and 10% level respectively. Also, on magnitude basis, 1% increase in renewable and non-renewable energy consumption will cause GDP growth to reduce by 4.97% and 3.63% respectively. Also, labour force participation rate and investment have indirect and significant effects on economic growth at 5% and 10% level correspondingly. A 1% increase in labour force participation rate and investment reduce GDP growth by 1.34% and 2.9% in the same way.

The coefficient of determination (Adjusted-R²) is high (67.56%) indicating that about 67.56% of the total variations in GDP growth was explained by the variables in the model. It simply indicated that the variation of changes in GDP growth was explained by 67.56% variations in

energy consumption and other controlling variables. The overall test using the F-statistic (5.072) is statistically significant at 5% level of significance showing that model is well specified and statistically significant. The Durbin Watson statistic (2.2017) shows that there is absence of serial autocorrelation in the model.

Diagnostic Test

The estimated ARDL model is tested for heteroscedasticity, serial correlation, functional form misspecification, parameter stability and normality. The results from these tests are shown in Table 4.10. The estimated ARDL model revealed that the model passed the serial correlation, normality test, and heteroskedasticity test. It means that the error terms are normally distributed with same variables and they are not serially correlated. Also, the Ramsey RESET test was satisfactory for the ARDL model indicating that the model is well distributed.

Additionally, the ARDL model passed the Ramsey RESET test, showing that the model is evenly specified. Additionally, the cumulative sum (CUSUM) and cumulative sum of squares (CUSUMSQ), respectively, as shown in Figures 4.7a and 4.7b are steady.

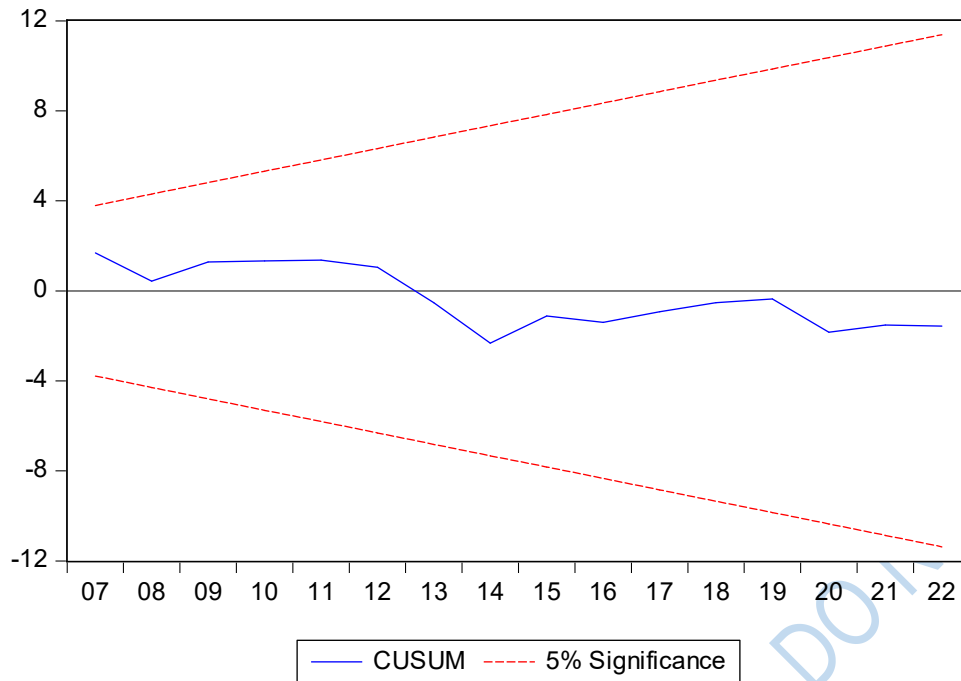


Figure 4.7a: Cumulative sum

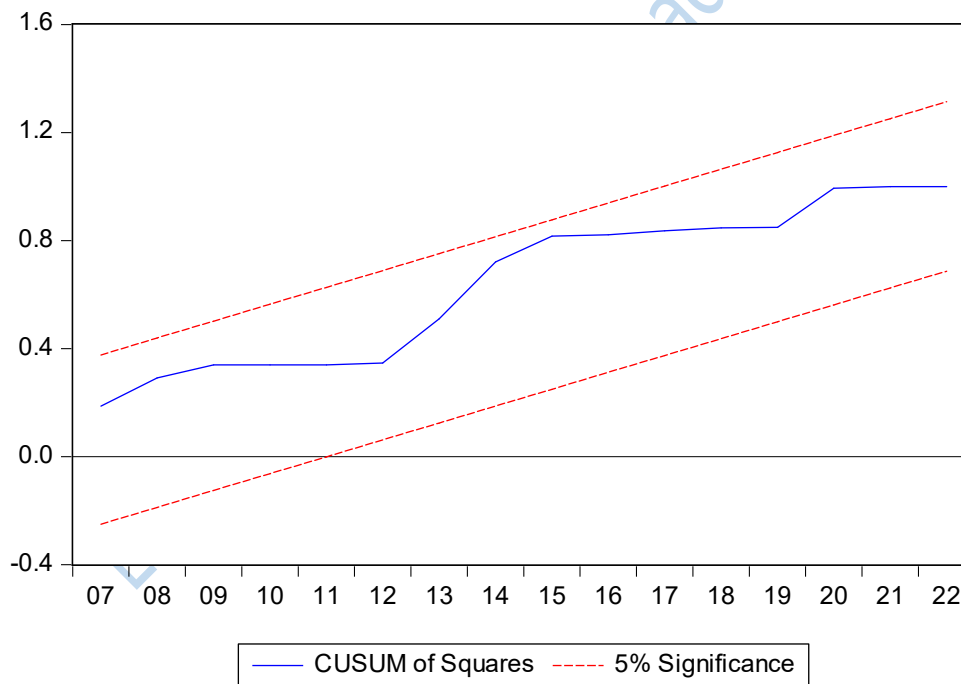


Figure 4.7b: Cumulative sum of squares

4.3.4 Results of the Causal Relationship between Monetary Policy, Energy Consumption and Economic Growth

This sub-section provides answers to the fourth null hypothesis that there is no significant causal relationship among monetary policy, energy consumption, and economic growth in Nigeria. It is achieved by computing the Granger causality test using both the VECM and the Toda and Yamamoto and Dolado and Lutkepohl (TYDL) augmented VAR procedure of the causal relationship among monetary policy, energy consumption, and economic growth measured by GDP growth in Nigeria between 1990 and 2022. The result is reported for both short- and long-run causal estimates which are presented in Tables 4.11 and 4.12 respectively.

The short-run causality result in Table 4.11 based on the TYDL procedure indicated that there exists a one-way causal links between energy consumption and economic growth in Nigeria. It shows that economic growth granger cause renewable and non-renewable energy consumption. However, the table shows that there is no feedback from the energy consumption components to output growth. Also, a uni-causal link existed between monetary policy and economic growth in Nigeria. Specifically, a uni-directional causal link exists from output growth to monetary policy rate and money supply. As regards liquidity ratio, it granger causes GDP growth. Also, liquidity ratio granger causes renewable energy, non-renewable energy, and money supply. The table also shows that renewable and non-renewable energy consumption granger cause money supply. There exit no causal relationship between renewable and non-renewable energy consumption in Nigeria.

Table 4.11: Short-run Granger Causality Results based on TYDL Procedure and VECM

Dependent Variables	Results based on an Augmented VEC Model [Short run lagged differences (F-statistics)]					
	Independent Variables					
	$\Delta(Y)$	$\Delta(REN)$	$\Delta(NEN)$	$\Delta(MPR)$	$\Delta(MS)$	$\Delta(LR)$
$\Delta(Y)$		1.6103 (0.4470)	0.5458 (0.7612)	1.7791 (0.4109)	1.8076 (0.5541)	4.9327 (0.0849)
$\Delta(REN)$	16.925 (0.0002)		2.6290 (0.2686)	0.3065 (0.8579)	1.1805 (0.5542)	14.567 (0.0007)
$\Delta(NEN)$	8.1534 (0.0170)	2.6785 (0.2620)		0.8456 (0.6552)	0.1146 (0.9443)	7.0759 (0.0291)
$\Delta(MPR)$	9.0292 (0.0109)	0.1543 (0.9258)	4.2177 (0.1214)		1.4694 (0.4797)	0.3408 (0.8433)
$\Delta(MS)$	4.6933 (0.0957)	9.8257 (0.0074)	10.186 (0.0061)	2.0247 (0.3634)		6.9637 (0.0308)
$\Delta(LR)$	0.1398 (0.9325)	2.9467 (0.2292)	0.2277 (0.8924)	3.8128 (0.1486)	2.8405 (0.2417)	

Note: Values in parenthesis are probability values. The bolded values are found statistically significant at 1%, 5% and 10% significance level.

Source: Author's computation (2024).

Table 4.12: Long-run Granger Causality Results based on TYDL Procedure and VAR

Dependent Variables	Results based on Augmented VAR Model (TYDL Procedure) (Modified Wald-statistics)					
	Independent Variables					
	<i>Y</i>	<i>REN</i>	<i>NEN</i>	<i>MPR</i>	<i>MS</i>	<i>LR</i>
<i>Y</i>		6.0999 (0.0474)	7.3674 (0.0251)	1.9267 (0.3816)	0.0193 (0.9904)	8.1840 (0.0167)
<i>REN</i>	1.1270 (0.5692)		7.0426 (0.0296)	3.4415 (0.1789)	1.7904 (0.4085)	1.0721 (0.5851)
<i>NEN</i>	0.7493 (0.6875)	3.2100 (0.2009)		2.6515 (0.2656)	4.0497 (0.1320)	3.4602 (0.1773)
<i>MPR</i>	7.6149 (0.0222)	0.4309 (0.8062)	7.1099 (0.0286)		2.3162 (0.3141)	1.9509 (0.3770)
<i>MS</i>	0.1369 (0.9339)	1.2467 (0.5361)	3.6058 (0.1648)	8.7737 (0.0124)		5.0660 (0.0794)
<i>LR</i>	0.4486 (0.7991)	0.0313 (0.9845)	0.7975 (0.6712)	0.8691 (0.6476)	0.3601 (0.8352)	

Note: Values in parenthesis are probability values. The bolded values are found statistically significant at 1%, 5% and 10% significance level.

Source: Author's computation (2024).

Table 4.12 presented the long-run Granger causal results using the TYDL augmented VAR procedure to explain whether there is a causal relationship among monetary policy, energy consumption and economic growth in the long-run. The result shows that renewable energy consumption, non-renewable energy consumption and liquidity ratio granger cause economic growth in Nigeria. Meanwhile, the result showed that output growth granger causes monetary policy rate. Concerning the energy consumption components, non-renewable energy granger causes renewable energy consumption. A uni-directional relationship exists from non-renewable consumption to monetary policy rate. In addition, a uni-directional relation was reported from monetary policy rate to money supply.

4.5 Discussion of Findings

This research study investigates the link among monetary policy (monetary policy rate, money supply, and liquidity), energy consumption (renewable and non-renewable energy) and economic growth (measured by GDP growth) in Nigeria. As for the first objective, the findings showed that there is a long run relationship between monetary policy and energy consumption in Nigeria. The results suggest that in the short run, changes in monetary policy rate (MPR) have a negative and significant impact on renewable energy consumption in Nigeria at the 10% level. It is in tandem with the findings that implementing expansionary monetary policy has a positive impact on the development and adoption of renewable energy sources in the short run^{1,2}. It goes against the results that the expansionary monetary policy of the G7 countries demonstrates an unfavourable reaction against investment in renewable energy generation³. Also, it is contrary to the results that there is a positive link between the real interest rate and energy security⁴. This implies that when the central bank increases the MPR, it becomes more expensive for businesses and consumers to borrow money, leading to reduced investment in renewable energy projects. The negative impact could be attributed to the fact that higher interest rates discourage investment in long-term projects like renewable energy, as they increase the cost of financing.

Conversely, the positive and significant impact of money supply on short-run renewable energy consumption at the 5% level indicates that an increase in the money supply stimulates investment in renewable energy projects. When there is more money circulating in the economy, businesses and consumers have greater access to funds, which can be used to finance renewable energy initiatives. This suggests that expansionary monetary policies, which aim to increase the money supply, could contribute to the growth of the renewable energy sector by providing easier

access to financing. The absence of a short-run relationship between liquidity ratio and renewable energy consumption implies that changes in the liquidity ratio, which measures the proportion of liquid assets held by banks, do not have an immediate impact on renewable energy investment in Nigeria. This could be due to various factors, including the priorities of banks in lending decisions, the availability of alternative investment opportunities, and the specific characteristics of the renewable energy market.

The lack of significant long-term impact of monetary policy instruments, including the monetary policy rate, money supply, and liquidity ratio, on renewable energy consumption in Nigeria suggests challenges in promoting sustained investment in the renewable energy sector. It is against the results of previous studies^{1,3}. This indicates that the market may still be immature or constrained by structural barriers that limit the effectiveness of monetary measures over time. The findings underscore the need for complementary policies beyond monetary tools, such as fiscal incentives, regulatory reforms, and targeted investment strategies, to create an enabling environment for long-term growth in renewable energy consumption. Achieving sustainable energy transitions in Nigeria may require a coordinated and multi-dimensional policy framework that addresses structural barriers and fosters long-term investments in renewable energy infrastructure and technologies.

The short-run positive impact of the monetary policy rate on non-renewable energy consumption suggests that lower interest rates may stimulate increased investment and economic activity in sectors reliant on non-renewable energy sources. However, the negative influence of liquidity ratio and money supply on non-renewable energy consumption implies that tighter monetary conditions may constrain economic growth and investment in these sectors. In the long run, the

positive impact of liquidity ratio on non-renewable energy consumption suggests that a higher liquidity ratio may lead to increased access to credit and investment opportunities in non-renewable energy projects.

Concerning the second objective, the findings showed that there is a long run relationship between monetary policy and economic growth in Nigeria. The lagged effect of the monetary policy rate on short-run economic growth suggests that changes in interest rates take time to exert their full impact on economic activity, indicating that monetary policy decisions have a delayed but direct influence on the economy. It aligns with the results that the growth rate was considerably impacted in a negative manner by the monetary policy rate^{5,6,7,8,9}. It contradicts the findings that monetary policy rate and cash reserve ratio demonstrate an inverse association with the GDP⁹. The negative impact of current and lagged money supply on short-run economic growth implies that an expansion of the money supply may lead to inflationary pressures or other adverse effects that dampen economic growth in the short term. The statistical significance of the growth effects of interest rate and money supply align with previous empirical studies¹⁰. It contradicts the findings that the money supply does not demonstrate a significant influence¹¹. Also, it opposes the money supply has a significant positive impact on the GDP^{8,12}.

Additionally, the mixed effects of liquidity ratio on economic growth suggest that while current and lagged liquidity ratios may indirectly influence economic activity through their impact on credit availability and financial conditions, the second lag of liquidity ratio has a positive effect on economic growth, possibly indicating a longer-term stimulative effect on economic activity. The finding that only liquidity ratio positively impacts long-run economic growth in Nigeria suggests that financial stability and the availability of credit may be crucial drivers of sustained

economic expansion over extended periods. The lack of significant long-run effects from monetary policy rate and money supply implies that while short-term adjustments in interest rates and money supply may affect economic activity, their influence may dissipate over time, highlighting the importance of other factors such as structural reforms, investment climate, and institutional quality in driving long-term economic growth.

Findings from the third objective show that a long run relationship exists between energy consumption and economic growth in Nigeria. The finding that lagged renewable energy consumption positively influences short-run economic growth in Nigeria suggests that investments in renewable energy infrastructure and technologies may have immediate positive effects on economic activity, possibly through job creation, energy efficiency gains, and reduced reliance on fossil fuels. It aligns with the results that there is a positive and statistically significant relationship between energy consumption and economic growth^{13,14,15,16,17}. However, the long-run impact of renewable energy consumption on economic growth may be indirect, indicating that while sustainable energy sources contribute to economic development over time, their effects are mediated through various channels such as increased productivity, environmental sustainability, and enhanced energy security. Similarly, the indirect impact of non-renewable energy consumption on long-run economic growth underscores the importance of transitioning towards cleaner and more sustainable energy sources to mitigate the adverse environmental and economic consequences associated with fossil fuel dependency.

The findings from the fourth objective report the causal relationship among monetary policy, energy consumption and economic growth in Nigeria. The finding that economic growth Granger causes both renewable and non-renewable energy consumption suggests that as the

economy expands, there is a corresponding increase in energy demand, driven by factors such as industrial activity, transportation needs, and household consumption. It aligns with the findings that there exist a one-way causal relationship from economic growth to energy consumption^{18,19}. A study found a unidirectional causal relationship, wherein economic growth influences the usage of renewable energy²⁰. This underscores the role of economic development as a driver of energy consumption patterns. The uni-directional causal link from output growth to monetary policy rate and money supply implies that economic expansion influences the decisions of monetary authorities regarding interest rates and money supply levels, highlighting the role of central bank policy in responding to changes in economic conditions. Additionally, the causality from liquidity ratio to GDP growth suggests that the availability of liquid assets in the financial system may impact economic activity, potentially reflecting the importance of liquidity conditions in supporting investment and consumption. Furthermore, the causality from liquidity ratio to renewable energy, non-renewable energy, and money supply underscores the interconnectedness between financial market conditions, energy consumption patterns, and monetary policy dynamics, highlighting the complex interactions within the economy.

The long-run implications of the causality test results for Nigeria reveal several significant economic dynamics. The finding that renewable energy consumption, non-renewable energy consumption, and liquidity ratio Granger cause economic growth suggests that these factors play crucial roles in driving long-term economic development in the country. It aligns with the finding of a unidirectional causal relationship from energy consumption to economic growth²¹. As both renewable and non-renewable energy sources are essential inputs for various economic activities, their sustained consumption is likely to contribute positively to overall output growth over time.

The causal link from output growth to monetary policy rate indicates that economic expansion influences the decisions of monetary authorities regarding interest rate adjustments in the long run, reflecting the central bank's responsiveness to changes in the broader economic environment. A study found a unidirectional association was observed between monetary policy rates and economic growth in the long run, which contradicts the findings of this study⁵. Furthermore, the causality from non-renewable energy consumption to renewable energy consumption underscores the interdependence between different energy sources, with non-renewable energy consumption potentially driving the utilization of renewable alternatives. Additionally, the unidirectional relationship from non-renewable energy consumption to monetary policy rate suggests that energy consumption patterns may influence the formulation of monetary policy strategies over the long term. Lastly, the uni-directional causality from monetary policy rate to money supply highlights the role of monetary policy in influencing the supply of money in the economy, indicating the transmission mechanism through which changes in interest rates affect broader monetary conditions.

Endnotes

- 1) S. M. Hashmi, Q. R. Syed, & R. Inglesi-Lotz. *Monetary and energy policy interlinkages: The case of renewable energy in the US*. **Renewable Energy**, 201, 2022, 141-147.
- 2) R. Bhowmik, F. Durani, M. Sarfraz, Q. R. Syed, & G. Nasseif. *Does sectoral energy consumption depend on trade, monetary, and fiscal policy uncertainty? Policy recommendations using novel bootstrap ARDL approach*. **Environmental Science and Pollution Research**, 30(5), 2023, 12916-12928.
- 3) C. Sun, A. Khan, Y. Liu, & N. Lei. *An analysis of the impact of fiscal and monetary policy fluctuations on the disaggregated level renewable energy generation in the G7 countries*. **Renewable Energy**, 189, 2022, 1154-1165.
- 4) K. Wang, Y. W. Wang, & Q. J. Wang. *Will monetary policy affect energy security? Evidence from Asian countries*. **Journal of Asian Economics**, 81, 2022, 101506.
- 5) M. Donkor, Y. Kong, M. Musa, M. Hafeez, & S. Antwi. *Nexus of monetary policy on economic growth: a study of Ghana*. **The Economics and Finance Letters**, 8(2), 2021, 251-265. <https://doi.org/10.18488/journal.29.2021.82.251.265>
- 6) A. O. Jacob, O. J. Umoh, & A. K. Akpan. *Effects of monetary policy on economic growth in Nigeria*. **Economic Growth and Environment Sustainability**, 1(1), 2022, 10-15. <https://doi.org/10.26480/egnes.01.2022.10.15>.
- 7) A. K. Toriola, O. O. Adeniwura, F. O. Lawale, A. V. Eyeke, F. C. Nwakpa, & I. Adeniran. *Monetary policy shocks and economic growth in Nigeria*. **Indonesian Journal of Contemporary Education**, 4(2), 2022, 71-79. <https://doi.org/10.33122/ijoce.v4i2.37>
- 8) M. Idris. *Monetary policy and economic growth in developing countries: evaluating the policy nexus in Nigeria*. **International Journal of Business and Economics Research**, 8(5), 2019, 290-300. <https://doi.org/10.11648/j.ijber.20190805.17>
- 9) C. Daniel and V. Inim. *An evaluation of monetary policy and economic growth in Nigeria(2000 – 2017)*. **International Journal of Advances in Scientific Research and Engineering**, 6(1), 2020, 101-107. <https://doi.org/10.31695/ijasre.2020.33686>.
- 10) P. Okoye, I. Molokwu, & I. Onwuteaka. *Effect of monetary policy on economic growth in Nigeria*. **International Journal of Trend in Scientific Research and Development**, 3(3), 2019, 590-597. <https://doi.org/10.31142/ijtsrd22984>.
- 11) N. Nwoko, J. Ihemeje, & E. Anumadu. *The impact of monetary policy on the economic growth of Nigeria*. **African Research Review**, 10(3), 2016, 192. <https://doi.org/10.4314/afrrrev.v10i3.13>.
- 12) C. Omodero and M. Okafor. *Monetary policy mechanisms and economic growth stability in Nigeria*. **Research in World Economy**, 11(6), 2020, 225-241. <https://doi.org/10.5430/rwe.v11n6p225>
- 13) S. Purnomo, N. Wani, S. Suharno, A. Arintoko, H. Sambodo, & L. Badriah. *The effect of energy consumption and renewable energy on economic growth in Indonesia*.

- International Journal of Energy Economics and Policy**, 13(1), 2023, 22-30.
<https://doi.org/10.32479/ijeep.13684>
- 14) D. Peković. *The effects of energy consumption on economic growth in post-transition countries*. **Ecologica**, 30(109), 2023, 76-80.
<https://doi.org/10.18485/ecologica.2023.30.109.11>
- 15) M. Alshami. *A VAR based study on energy consumption and economic growth*. **International Journal of Energy Economics and Policy**, 13(1), 2023, 317-321.
<https://doi.org/10.32479/ijeep.13767>
- 16) L. U. Okoye, A. Omankhanlen, J. I. Okoh, N. B. Adeleye, F. N. Ezeji, G. K. Ezu, & B. Ehikioya. *Analyzing the energy consumption and economic growth nexus in Nigeria*. **International Journal of Energy Economics and Policy**, 11(1), 2021, 378-387.
<https://doi.org/10.32479/ijeep.10768>
- 17) C. Chen, M. Pinar, & T. Stengos. *Renewable energy consumption and economic growth nexus: Evidence from a threshold model*. **Energy Policy**, 139, 2020, 111295.
<https://doi.org/10.1016/j.enpol.2020.111295>
- 18) U. Umurzakov, B. Mirzaev, R. Salahodjaev, A. Isaeva, & S. Tosheva. *Energy consumption and economic growth: Evidence from post-communist countries*. **International Journal of Energy Economics and Policy**, 10(6), 2020, 59-65. <https://doi.org/10.32479/ijeep.10003>
- 19) H. Khobai, S. Abel, & P. Roux. *A review of the nexus between energy consumption and economic growth in the BRICS countries*. **International Journal of Energy Economics and Policy**, 11(3), 2021, 424-431. <https://doi.org/10.32479/ijeep.6373>
- 20) H. Khobai. *Renewable energy consumption and economic growth in Argentina: A multivariate co-integration analysis*. **International Journal of energy Economics and Policy**, 11(3), 2021, 563-570. <https://doi.org/10.32479/ijeep.6375>
- 21) P. Ekeocha, D. Penzin, & J. Ogbuabor. *Energy consumption and economic growth in Nigeria: a test of alternative specifications*. **International Journal of energy Economics and Policy**, 10(3), 2020, 369-379. <https://doi.org/10.32479/ijeep.8902>

Chapter Five

Conclusion

5.1 Summary

In this study, the existing relationship among monetary policy, energy consumption and economic growth in Nigeria is investigated to understand the effect of monetary policy on energy consumption, the impact of monetary policy on economic growth, the effect of energy consumption on economic growth, and the causal relationship among monetary policy, energy consumption and economic growth. Understudying this research study became necessary because it makes enquiries on the findings of past studies which can best be described as inconclusive. The study is conducted for developing countries in sub-Saharan countries such as Nigeria. The datasets employed were obtained from the Central Bank of Nigeria (2022) and World Development Indicators (2023) which spans from 1990 to 2022. The ARDL and TYDL estimators were used to evaluate the parameters were based on the characteristics of the datasets.

For the first objective, a long-run relationship was found between monetary policy and energy consumption. The short-run parameter estimate of monetary policy rate was found to be negative and statistically significant at 10% level. The short run estimate of money supply (% of GDP) positively and significantly impact GDP growth. Liquidity ratio has a direct effect on renewable energy consumption, although not statistically significant at 5%. In the long run, the three monetary policy instruments do not have significant impact on long run energy consumption in Nigeria. In the short run, monetary policy rate leads to an increase in non-renewable energy consumption in Nigeria. Money supply has a negative effect on non-renewable energy consumption in the short. The first lag indicates that the lagged effect of liquidity ratio negatively

influences non-renewable energy consumption significantly. All monetary policy variables (monetary policy rate, liquidity ratio and money supply) have positive impact on the long run non-renewable energy consumption in Nigeria, although only liquidity ratio was statistically significant at 5%.

Regarding the second objective, the results show that there exists a long-run relationship between monetary policy and economic growth in Nigeria. The short run monetary policy rate has a negligible positive effect on GDP growth, although this effect is not statistically significant at the 5% level. Money supply leads to a significant decrease in GDP growth in the short run. Also, liquidity ratio leads to a slight decrease in short run GDP growth. In the long run, monetary policy rate and money supply have negative impact on economic growth. The positive impact of liquidity ratio on GDP growth is significant statistically at 5% level.

Concerning the third objective, the study found that a long run relationship between energy consumption and economic growth in Nigeria. The short-run lags one and two of change in renewable energy consumption has significant positive impact on the current changes in economic growth at 10% and 5% respectively. In the long run, renewable and non-renewable energy consumption have negative impact on the economic growth in Nigeria. Their coefficients are significant at 5% and 10% level respectively.

As regards the fourth objective, it shows that economic growth granger cause renewable and non-renewable energy consumption. However, there is no feedback from the energy consumption components to output growth. A uni-directional causal link exists from output growth to monetary policy rate and money supply. As regards liquidity ratio, it granger causes GDP growth. Also, liquidity ratio granger causes renewable energy, non-renewable energy, and money supply.

Renewable and non-renewable energy consumption granger causes money supply. There exit no causal relationship between renewable and non-renewable energy consumption in Nigeria. In the long run, renewable energy consumption, non-renewable energy consumption and liquidity ratio granger cause economic growth in Nigeria. Meanwhile, output growth granger causes monetary policy rate. Concerning the energy consumption components, non-renewable energy granger causes renewable energy consumption. A uni-directional relationship exists from non-renewable consumption to monetary policy rate. In addition, a uni-directional relation was reported from monetary policy rate to money supply.

5.2 Conclusion

This study investigates the relationship between monetary policy (monetary policy rate, money supply and liquidity ratio), energy consumption (renewable and non-renewable) and economic growth (measured by the output growth) over the periods of 1990 to 2022 using the ARDL and TYDL approaches. In the empirical model, findings showed that monetary policy rate have a negative and significant impact on short run renewable energy consumption at 10% level. However, money supply positively and significantly impacted short run renewable energy consumption at 5%. There is no short run relationship between liquidity ratio and renewable energy in the short run. In the long run, the three monetary policy instruments (monetary policy rate, money supply and liquidity ratio) have no significant impact on renewable energy consumption in Nigeria. Non-renewable energy consumption is positively impacted by monetary policy rate but negatively influenced by liquidity ratio and money supply in the short run. Only liquidity ratio positively impacted non-renewable energy consumption in the long run.

Furthermore, the lagged of monetary policy rate have a direct impact on short run economic growth. Current and second lag of money supply negatively affect economic growth in the short run. Current and lag one of liquidity ratio indirectly influenced economic growth, while the second lag has positive effect. Only liquidity ratio positively impact long run economic growth, while monetary policy rate and money supply have no significant impact in the long run. Also, the lagged renewable energy consumption positively influence economic growth in the short run. In the long run, both renewable and non-renewable energy consumption indirectly impact economic growth in Nigeria.

As regards the causality test results, economic growth granger cause renewable and non-renewable energy consumption. A uni-directional causal link exists from output growth to monetary policy rate and money supply. However, liquidity ratio granger causes GDP growth. Also, liquidity ratio granger causes renewable energy, non-renewable energy, and money supply. Renewable and non-renewable energy consumption granger causes money supply. In the long run, renewable energy consumption, non-renewable energy consumption and liquidity ratio granger cause economic growth in Nigeria. Meanwhile, output growth granger causes monetary policy rate. Concerning the energy consumption components, non-renewable energy granger causes renewable energy consumption. A uni-directional relationship exists from non-renewable consumption to monetary policy rate. In addition, a uni-directional relation was reported from monetary policy rate to money supply.

5.3 Recommendations

Following the reported findings discussed in the subsequent parts of the chapter in this research study, the following policy recommendations are discussed below:

- a) Given the significant impact of monetary policy rate and money supply on short-run renewable energy consumption, policymakers should consider implementing measures to incentivize investment in renewable energy projects. This could include offering tax incentives, subsidies, and favorable financing options to attract private sector participation in renewable energy development. Additionally, enhancing public awareness campaigns and capacity-building initiatives can help accelerate the adoption of renewable energy technologies.
- b) There is need in strengthening monetary policy transmission towards economic growth. To support short-run economic growth, policymakers should focus on enhancing the effectiveness of monetary policy transmission mechanisms. Addressing factors that hinder the timely and efficient transmission of monetary policy signals, such as improving financial infrastructure, enhancing the effectiveness of monetary policy communication, and ensuring the stability of financial institutions, can help maximize the impact of monetary policy rate adjustments on economic activity.
- c) Also, given the positive impact of liquidity ratio on both renewable and non-renewable energy consumption in the long run, policymakers should prioritize measures to improve liquidity management in the financial system. This could involve implementing prudent liquidity management practices, strengthening regulatory oversight of financial institutions, and enhancing liquidity forecasting and monitoring mechanisms to ensure stability and resilience in the financial sector.
- d) Recognizing the positive influence of renewable and non-renewable energy consumption on economic growth, policymakers should prioritize investments in energy infrastructure

development. This includes upgrading and expanding energy generation, transmission, and distribution networks to ensure reliable and affordable access to electricity for households and businesses. Investing in renewable energy projects and promoting energy efficiency initiatives can also help mitigate the adverse effects of energy shortages and fluctuations in energy prices on economic growth.

- e) Building on the findings of the causality tests, policymakers should adopt a holistic approach to promoting sustainable development that integrates economic, environmental, and social objectives. This includes implementing policies and regulations that encourage the adoption of clean energy technologies, promote energy conservation and efficiency, and support the transition to a low-carbon economy. Additionally, fostering partnerships with the private sector, civil society organizations, and international stakeholders can help mobilize resources and expertise to support sustainable development initiatives across various sectors of the economy.

5.4 Contribution to Knowledge

This study contributes to the existing body of knowledge in the following ways:

- a) Unlike previous research, which often treated energy consumption as a singular construct, this study decomposed it into two distinct components: renewable and non-renewable. Simultaneously, monetary policy was disentangled into three key instruments: monetary policy rate, money supply and liquidity ratio. This decomposition provides a granular understanding of the diverse channels through which monetary policy may influence various components of energy consumption.

- b) The findings of this study contribute novel insights to the literature by revealing that the individual impact of monetary policy and energy consumption on economic growth is not uniform across different components. Moreover, the study sheds light on the dynamics over an extended period, demonstrating that the long-run effects of energy consumption, particularly through renewable energy, play a positive and significant role in enhancing economic growth.

5.5. Suggestions for Further Studies

The findings of this study open avenues for further research in several key areas to deepen our understanding of the intricate relationship monetary policy, energy consumption and economic growth. These are some suggestions for areas of future studies:

- a) Investigate the effects of specific energy policies, regulations, or interventions on sector output growth. This could include an analysis of the influence of policy changes in energy consumption and policy operations on sectoral outputs and activities.
- b) Explore the role of investor behaviour and sentiment in influencing the relationship between energy sector development and economic performance. Understanding how investor decisions impact energy investments and, subsequently, performance can provide insights for policy interventions.

Bibliography

Books Publication

- Auclert, A., Monnery, H., Rognlie, M., & Straub, L. *Managing an energy shock: Fiscal and monetary policy* (No. w31543). National Bureau of Economic Research, 2023.
- Dykas, P., Tokarski, T., & Wisła, R. *The Solow model of economic growth: Application to contemporary macroeconomic issues*. 1st Edition. Routledge, 2022.
- Narayan, P. *Reformulating critical values for the bounds F-statistics approach to cointegration: An application to the tourism demand model for Fiji*. Australia: Monash University, 2004.

Journals Publications

- Abille, A. B. & Mpuure, D. M. *Effect of monetary policy on economic growth in Ghana*. **Applied Economics Journal**, 27(2), 2020, 110-24.
- Akinlo, T. & Apanisile, O. T. *The impact of volatility of oil price on the economic growth in Sub-Saharan Africa*. **British Journal of Economics, Management and Trade**, 5(3), 2015, 338-349.
- Akintola, T. & Cole, A. *Monetary policy and Nigeria economic growth (1981-2014)*. **The International Journal of Business & Management**, 8(1), 2020, 336-340. <https://doi.org/10.24940/theijbm/2020/v8/i1/bm2001-024>
- Akram, R., Chen, F., Khalid, F., Ye, Z. & Majeed, M. T. *Heterogeneous effects of energy efficiency and renewable energy on carbon emissions: Evidence from developing countries*. **Journal of Cleaner Production**, 247, 2020, 119122.
- Alege, P. O., Oluwasogo, S. A. & Ogundipe, A. A. **Pollutant emissions, energy consumption and economic growth**. **International Journal of Energy Economics and Policy**, 6(2), 2016, 202-207.
- Aliyev, J., Mukhtarov, S., Haydarov, K., & Isgandarov, M. *Does monetary policy boost economic growth? the case of small open economy*. **Research in World Economy**, 11(3), 2020, 216. <https://doi.org/10.5430/rwe.v11n3p216>
- Aliyu, S. U. R. *Impact of oil price shock and exchange volatility on economic growth in Nigeria: An empirical investigation*. **Research Journal of International Studies**, 11, 2009, 4-15.
- Alsaedi, M. A., Abnisa, F., Alaba, P. A. & Farouk, H. U. *Investigating the relevance of Environmental Kuznets curve hypothesis in Saudi Arabia: Towards energy efficiency and minimal carbon dioxide emission*. **Clean Technologies and Environmental Policy**, 24(4), 2022, 1285-300.
- Alshami, M. *A VAR based study on energy consumption and economic growth*. **International Journal of Energy Economics and Policy**, 13(1), 2023, 317-321. <https://doi.org/10.32479/ijeep.13767>

- Al-Zuhair, M. & Al-Bazali, T. *Causality between energy consumption and economic growth: the case of Kuwait*. **International Journal of Energy Economics and Policy**, 12(6), 2022, 22-29. <https://doi.org/10.32479/ijeep.13477>
- Amran, M., Makul, N., Fediuk, R., Lee, Y. H., Vatin, N. I., Lee, Y. Y. & Mohammed, K. *Global carbon recoverability experiences from the cement industry*. **Case Studies in Construction Materials**, 2022, 1;17:e01439.
- Aydin, A. & Iqbal, Z. *Islamic finance approach to financial inclusion to enhance shared-prosperity*. **Financial Inclusion for Poverty Alleviation**, 174(196), 2018, 174-196.
- Balachandran, B. & Williams, B. *Effective governance, financial markets, financial institutions & crises*. **Pacific-Basin Finance Journal**, 50, 2018, 1-15.
- Balcilar, M., Gupta, R., Ma, W. & Makena, P. *Income inequality and economic growth: A re-examination of theory and evidence*. **Review of Development Economics**, 25(2), 2021, 737-57.
- Bhowmik, R., Durani, F., Sarfraz, M., Syed, Q. R., & Nasseif, G. *Does sectoral energy consumption depend on trade, monetary, and fiscal policy uncertainty? Policy recommendations using novel bootstrap ARDL approach*. **Environmental Science and Pollution Research**, 30(5), 2023, 12916-12928.
- Bildirici, M., Genç, S. Y. & Ersin, Ö. Ö. *Effects of fiscal and monetary policies, energy consumption and economic growth on CO₂ emissions in the Turkish economy: Nonlinear bootstrapping NARDL and nonlinear causality methods*. **Sustainability**, 15(13), (2023), 10463.
- Buckles, K., Hungerman, D. & Lugauer, S. *Is fertility a leading economic indicator?* **The Economic Journal**, 131(634), 2021, 541-565.
- Chen, C., Pinar, M., & Stengos, T. *Renewable energy consumption and economic growth nexus: Evidence from a threshold model*. **Energy Policy**, 139, 2020, 111295. <https://doi.org/10.1016/j.enpol.2020.111295>
- Chen, J., Wu, Y., Xu, C., Song, M. & Liu, X. *Global non-fossil fuel consumption: Driving factors, disparities, and trends*. **Management Decision**, 57(4), 2019, 791-810.
- Chugunov, I., Pasichnyi, M., Kaneva, T., Nepytyaliuk, A. & Koroviy, V. *The influence of inflation targeting on economic growth in the OECD and developing countries*. **Montenegrin Journal of Economics**, 17(2), 2021, 173-86.
- Chugunov, I., Pasichnyi, M., Koroviy, V., Kaneva, T. & Nikitishin, A. *Fiscal and monetary policy of economic development*. **European Journal of Sustainable Development**, 10(1), 2021, 42-42.
- Daniel, C. & Inim, V. *An evaluation of monetary policy and economic growth in Nigeria(2000 – 2017)*. **International Journal of Advances in Scientific Research and Engineering**, 6(1), 2020, 101-107. <https://doi.org/10.31695/ijasre.2020.33686>.

- Dat, N., Hoang, N., Huyen, M., Huy, D. & Lan, L. *Energy consumption and economic growth in Indonesia*. **International Journal of Energy Economics and Policy**, 10(5), 2020, 601-607. <https://doi.org/10.32479/ijeep.10243>
- David, O., Ita, O., Eyo, U. & Ikenna, E. *An assessment of the impact of monetary policy on economic growth in Nigeria: Toda-Yamamoto approach*. **International Journal of Research and Innovation in Social Science**, 6(11), 2022, 537-547. <https://doi.org/10.47772/ijriss.2022.61126>
- Dogah, K. E. *The impact of oil price shocks on the macroeconomy of Ghana*. **Journal of Poverty Investment and Development**, 9, 2015, 37-54.
- Doladao, J. J. & Lutkepohl, H. *Making Wald test work for cointegrated VAR systems*. **Econometrics Reviews**, 15, 1996, 369-386.
- Donkor, M., Kong, Y., Musa, M., Hafeez, M. & Antwi, S. *Nexus of monetary policy on economic growth: a study of Ghana*. **The Economics and Finance Letters**, 8(2), 2021, 251-265. <https://doi.org/10.18488/journal.29.2021.82.251.265>
- Ebele, E. *Oil price volatility and economic growth in Nigeria: An empirical investigation*. **European Journal of Humanities and Social Sciences**, 34, 2015, 1900-1918.
- Egbichi, C., Abuh, O., Okafor, V, A. Godwin, & O. Adedoyin. *Dynamic impact of energy consumption on the growth of the Nigerian economy (1986-2016): Evidence from symmetrical ARDL model*. **International Journal of Energy Economics and Policy**, 8(2), 2018, 188-195.
- Ekeocha, P., Penzin, D. & Ogbuabor, J. *Energy consumption and economic growth in Nigeria: a test of alternative specifications*. **International Journal of Energy Economics and Policy**, 10(3), 2020, 369-379. <https://doi.org/10.32479/ijeep.8902>
- Ezeibekwe, O. F. *Monetary policy and domestic investment in Nigeria: The role of the inflation rate*. **Economics and Business**, 34(1), 2020, 139-55.
- Ferdaus, J., Appiah, B. K., Majumder, S. C. & Martial, A. A. *A panel dynamic analysis on energy consumption, energy prices and economic growth in next 11 countries*. **International Journal of Energy Economics and Policy**, 10(6), 2020, 87-99. <https://doi.org/10.32479/ijeep.9880>
- Haller, A. P. *Concepts of economic growth and development: Challenges of crisis and of knowledge*. **Economy Transdisciplinarity Cognition**, 15(1), 2012, 66-71.
- Harahap, I. & Tambunan, K. *The effect of SBI and SBIS as monetary instruments on the Indonesian economy. Share*. **Jurnal Ekonomi Dan Keuangan Islam**, 11(1), 2022, 1-9.
- Hasan, M., Islam, M., Hasnat, M. & Wadud, A. *The relative effectiveness of monetary and fiscal policies on economic growth in Bangladesh*. **Economics**, 5(1), 2016, 1-21. <https://doi.org/10.11648/j.eco.20160501.11>
- Hashmi, S. M., Syed, Q. R. & Inglesi-Lotz, R. *Monetary and energy policy interlinkages: The case of renewable energy in the US*. **Renewable Energy**, 201, (2022), 141-147.

- Hindriks, F. & Guala, F. *The functions of institutions: Etiology and teleology*. **Synthese**, 198(3), 2021, 2027-2043.
- Hunibachew, G. *The effect of monetary policy on economic growth in Ethiopia*. **International Journal of Finance and Banking Research**, 7(6), 2021, 133. <https://doi.org/10.11648/j.ijfbr.20210706.11>
- Ibukun, C. O., Osinubi, T. T. & Oladunjoye, O. N. *Growth-Led Energy Hypothesis In Nigeria: An Asymmetric Investigation*. **Ilorin Journal of Economic Policy**, 8(1), 2021, 31-45.
- Idris, M. *Monetary policy and economic growth in developing countries: evaluating the policy nexus in Nigeria*. **International Journal of Business and Economics Research**, 8(5), 2019, 290-300. <https://doi.org/10.11648/j.ijber.20190805.17>
- Islam, M. S., Hossain, M. E., Chakroborty, S. & Ema, N. S. *Does the monetary policy have any short-run and long-run effect on economic growth? A developing and a developed country perspective*. **Asian Journal of Economics and Banking**, 6(1), 2021, 26-49.
- Jacob, A. O., Umoh, O. J. & Akpan, A. K. *Effects of monetary policy on economic growth in Nigeria*. **Economic Growth and Environment Sustainability**, 1(1), 2022, 10-15. <https://doi.org/10.26480/egnes.01.2022.10.15>.
- Jin, Y., Wang, S., Bu, L., & Zhai, P. *Unconventional, conventional monetary policies, and optimal energy supply structure in China*. **Finance Research Letters**, 54, 2023, 103732.
- Joseph, T. & Charles, A. *Renewable energy consumption, environmental sustainability, and economic growth in developing countries*. **Asian Bulletin of Energy Economics and Technology**, 6(1), 2021, 43-49. <https://doi.org/10.20448/journal.507.2021.61.43.49>
- Joshi, U. *Impact of monetary policy on economic growth in Nepal: an empirical analysis*. **International Research Journal of MMC**, 3(3), 2022, 54-65. <https://doi.org/10.3126/irjmmc.v3i3.48635>
- Jothr, O. A., Jummaa, A. I., & Ambariyani, A. *The impact of monetary policy instruments on sustainable development*. **Revenue Journal: Management and Entrepreneurship**, 1(1), 2023, 22-26.
- Khobai, H. *Renewable energy consumption and economic growth in Argentina: A multivariate co-integration analysis*. **International Journal of Energy Economics and Policy**, 11(3), 2021, 563-570. <https://doi.org/10.32479/ijeep.6375>
- Khobai, H., Abel, S. & Roux, P. *A review of the nexus between energy consumption and economic growth in the BRICS countries*. **International Journal of Energy Economics and Policy**, 11(3), 2021, 424-431. <https://doi.org/10.32479/ijeep.6373>
- Kim, D. W., Yu, J. S. & Hassan, M. K. *Financial inclusion and economic growth in OIC countries*. **Research in International Business and Finance**, 43, 2018, 1-14.
- Kónya, L. *Exports and growth: Granger causality analysis on OECD Countries with a panel data approach*. **Economic Modelling**, 23, 2006, 978–992.

- Manasseh, C. O., Ogbuabor, J. E., Abada, F. C., Okoro, E. U. O., Egele, A. E., Onwumere, J. U. *Analysis of oil price oscillations, exchange rate dynamics and economic performance. International Journal of Energy Economics and Policy*, 9(1), 2019, 95-106.
- Munir, K. & Nadeem, S. *Disaggregate energy consumption and economic growth in Pakistan: A sectoral analysis. International Journal of Energy Economics and Policy*, 12(1), 2022, 296-306. <https://doi.org/10.32479/ijeeep.11615>
- Mutumba, G., Mubiinzi, G., Kaddu, M., & Otim, J. *Renewable energy consumption and economic growth in Uganda. Journal of Energy Research and Reviews*, 10(2), 2022, 36-50. <https://doi.org/10.9734/jenrr/2022/v10i230252>
- Nathaniel, S. P., Murshed, M. & Bassim, M. *The nexus between economic growth, energy consumption, international trade and ecological footprints: the role of environmental regulations in N11 countries. Energy, Ecology and Environment*, 6(6), 2021, 496-512.
- Nwoko, N. M. *The Impact of Monetary Policy on the Economic Growth of Nigeria. African Research Review*, 10(3), 2016, 192-206.
- Nwoko, N., Ihemeje, J. & Anumadu, E. *The impact of monetary policy on the economic growth of Nigeria. African Research Review*, 10(3), 2016, 192. <https://doi.org/10.4314/afrrrev.v10i3.13>.
- Okoye, L. U., Omarkhanlen, A. E., Okoh, J. I., Adeleye, N. B., Ezeji, F. N., Ezu, G. K. & Ehikioya, B. I. *Analyzing the energy consumption and economic growth nexus in Nigeria. International Journal of Energy Economics and Policy*, 11(1), 2021, 378-387.
- Okoye, P., Molokwu, I. & Onwuteaka, I. *Effect of monetary policy on economic growth in Nigeria. International Journal of Trend in Scientific Research and Development*, 3(3), 2019, 590-597. <https://doi.org/10.31142/ijtsrd22984>.
- Olanrele, L. A. & Awode, S. S. *Assessing the nexus among energy consumption, foreign direct investment and economic growth in sub-Saharan Africa. Central Bank of Nigeria Journal of Applied Statistics*, 13(1), 2022, 27-53. <https://doi.org/10.33429/cjas.13122.2/9>
- Omodero C. & Okafor, M. *Monetary policy mechanisms and economic growth stability in Nigeria. Research in World Economy*, 11(6), 2020, 225-241. <https://doi.org/10.5430/rwe.v11n6p225>
- Peković, D. *The effects of energy consumption on economic growth in post-transition countries. Ecologica*, 30(109), 2023, 76-80. <https://doi.org/10.18485/ecologica.2023.30.109.11>
- Pirgaip, B., & Dinçergök, B. *Economic policy uncertainty, energy consumption and carbon emissions in G7 countries: evidence from a panel Granger causality analysis. Environmental Science and Pollution Research*, 27, 2020, 30050-30066.
- Purewal, K. & Haini, H.. *Re-examining the effect of financial markets and institutions on economic growth: evidence from the OECD countries. Economic Change and Restructuring*, 55(1), 2022, 311-333.

- Purnomo, S., Wani, N., Suharno, S., Arintoko, A., Sambodo, H. & Badriah, L. *The effect of energy consumption and renewable energy on economic growth in Indonesia*. **International Journal of Energy Economics and Policy**, 13(1), 2023, 22-30. <https://doi.org/10.32479/ijeep.13684>
- Qianqian, Z. *The impact of international oil price fluctuation on China's economy*. **Energy Procedia**, 5, 2011, 1360-1364.
- Qingquan, J., Khattak, S. I., Ahmad, M. & Ping, L. *A new approach to environmental sustainability: assessing the impact of monetary policy on CO2 emissions in Asian economies*. **Sustainable Development**, 28(5), 2020, 1331-46.
- Razmi, S. F., Moghadam, M. H., & Behname, M. *Time-varying effects of monetary policy on Iranian renewable energy generation*. **Renewable Energy**, 177, 2021, 1161-1169.
- Salman, M., Long, X., Dauda, L. & Mensah, C. N. *The impact of institutional quality on economic growth and carbon emissions: Evidence from Indonesia, South Korea and Thailand*. **Journal of Cleaner Production**, 241, 2019, 118331.
- Saqib, N. *Energy consumption and economic growth: empirical evidence from MENA region*. **International Journal of Energy Economics and Policy**, 11(6), 2021, 191-197. <https://doi.org/10.32479/ijeep.11931>
- Schoenmaker, D. *Greening monetary policy*. **Climate Policy**, 21(4), 2021, 581-592.
- Shahbaz, M., Raghutla, C., Chittedi, K. R., Jiao, Z. & Vo, X. *The effect of renewable energy consumption on economic growth: Evidence from the renewable energy country attractive index*. **Energy**, 207, 2020, 118162. <https://doi.org/10.1016/j.energy.2020.118162>
- Shahbaz, M., Solarin, S. A., Mahmood, H. & Arouri, M. *Does financial development reduce CO2 emissions in Malaysian economy? A time series analysis*. **Economic Modelling**, 35, 2013, 93-108.
- Shrestha, P. *The effect of monetary policy on economic growth of selected SAARC countries*. **The Lumbini Journal of Business and Economics**, 10(1-2), 2022, 122-132. <https://doi.org/10.3126/ljbe.v10i1-2.54210>.
- Sims, C. A. *Macroeconomics and reality*. **Econometrica**, 1980, 1-48.
- Sohail, M. T., Xiuyuan, Y., Usman, A., Majeed, M. T., & Ullah, S. *Renewable energy and non-renewable energy consumption: assessing the asymmetric role of monetary policy uncertainty in energy consumption*. **Environmental Science and Pollution Research**, 28, 2021, 31575-31584.
- Srithilat, K., Khamthoummabounmy, T., Lienpaserth, V., Chanthavixay, P. & Douangty, V. *The effect of monetary policy on economic growth in Lao PDR*. **International Journal of Economics and Financial Issues**, 12(1), 2022, 67-74. <https://doi.org/10.32479/ijefi.10557>
- Sule, A. *Pass-through effect of monetary policy tools on economic growth in Nigeria*. **Journal of Public Affairs**, 22(3), 2021. <https://doi.org/10.1002/pa.2588>.

- Sun, C., Khan, A., Liu, Y., & Lei, N. *An analysis of the impact of fiscal and monetary policy fluctuations on the disaggregated level renewable energy generation in the G7 countries.* **Renewable Energy**, 189, 2022, 1154-1165.
- Tah, N. *Environmental degradation, energy consumption and economic growth in Cameroon.* **International Journal of Social Science and Economic Research**, 5(5), 2020, 1271-1294. <https://doi.org/10.46609/ijsser.2020.v05i05.012>
- Talha, M., Sohail, M., Tariq, R. & Ahmad, M. T. *Impact of oil prices, energy consumption and economic growth on the inflation rate in Malaysia.* **Cuadernos de Economía**, 44(124), 2021, 26-32.
- Toda, H. Y. & Yamamoto, T. *Statistical inference in vector autoregressive with possibly integrated processes.* **Journal of Econometrics**, 66, 1995, 225-250.
- Toriola, A. K., Adeniwura, O. O., Lawale, F. O., Eyeke, A. V., Nwakpa, F. C. & Adeniran, I. *Monetary policy shocks and economic growth in Nigeria.* **Indonesian Journal of Contemporary Education**, 4(2), 2022, 71-79. <https://doi.org/10.33122/ijoce.v4i2.37>
- Tule, M., Ogundele, O. & Apinran, M. *Efficacy of monetary policy instruments on economic growth: evidence from Nigeria.* **Asian Economic and Financial Review**, 8(10), 2018, 1239-1256. <https://doi.org/10.18488/journal.aefr.2018.810.1239.1256>
- Twinoburyo, E. N. & Odhiambo, N. M. *Monetary policy and economic growth: A review of international literature.* **Journal of Central Banking Theory and Practice**, 2, 2018, pp. 123-137.
- Uçan, O., Budak, H., & Aktekin-Gök, E. *Analysis of relationship between economic growth and energy consumption in developed countries.* **Journal of Human Earth and Future**, 3(1), 2022, 82-89. <https://doi.org/10.28991/hef-2022-03-01-06>
- Uju, E. & Ugochukwu, P. *Effect of monetary policy on industrial growth in Nigeria.* **International Journal of Entrepreneurship and Business Innovation**, 4(1), 2021, 47-60. <https://doi.org/10.52589/ijebi-1z4iybye>.
- Umurzakov, U., Mirzaev, B., Salahodjaev, R., Isaeva, A. & Tosheva, S. *Energy consumption and economic growth: Evidence from post-communist countries.* **International Journal of Energy Economics and Policy**, 10(6), 2020, 59-65. <https://doi.org/10.32479/ijeep.10003>
- Wang, K., Wang, Y. W., & Wang, Q. J. *Will monetary policy affect energy security? Evidence from Asian countries.* **Journal of Asian Economics**, 81, 2022, 101506.
- Wauk, G. & Adjorlolo, G.. *The game of monetary policy, inflation and economic growth.* **Open Journal of Social Sciences**, 7(3), 2019, 255-271. <https://doi.org/10.4236/jss.2019.73022>
- Wu, J., Yang, C., & Chen, L. *Examining the non-linear effects of monetary policy on carbon emissions.* **Energy Economics**, 131, 2024, 107206.
- Xiang, L., Tang, M. & Yin, Z. *The COVID-19 pandemic and economic growth: theory and simulation.* **Frontiers in Public Health**, 9, 2021, 741525.

- Xie, P., Zhu, Z., Hu, G. & Huang, J. *Renewable energy and economic growth hypothesis: Evidence from N-11 countries*. **Economic Research-Ekonomska istraživanja**, 36(1), 2023.
- Yang, L., Zhou, X. & Feng, X. *Renewable energy led Economic Growth Hypothesis: Evidence from novel panel methods for N-11 economies*. **Renewable Energy**, 197, 2022, 790-797.
- Zhe, L., Yüksel, S., Dinçer, H., Mukhtarov, S. & Azizov, M. *The positive influences of renewable energy consumption on financial development and economic growth*. **Sage Open**, 11(3), 2021, Doi: 21582440211040133.

Online Sources

- Adrian, S. T. *Central bank independence and the development of payments and CBDCs*. International Symposium on Central Bank Independence, 2023. Available at <https://www.imf.org/en/News/Articles/2023/01/10/sp-central-bank-independence-development-payments-and-cbdc>
- Board of Governors of the Federal Reserve System. *Federal Reserve Board - Monetary policy: What are its goals? How does it work?* Board of Governors of the Federal Reserve System, July 29th, 2021. Available at https://en.wikipedia.org/wiki/Monetary_policy#cite_note-2
- Central Bank of Nigeria (CBN). Statistical bulletin, 2021.
- Central Bank of Nigeria (CBN). *What is monetary policy?* Monetary Policy Department, CBN, 2006. Available at <https://www.cbn.gov.ng/out/eduseries/series1.pdf>
- REPSOL. *Towards more sustainable household energy consumption*. REPSOL, 11th September, 2023. Available at <https://www.repsol.com/en/energy-and-the-future/future-of-the-world/energy-consumption/index.cshhtml#:~:text=Energy%20consumption%20is%20the%20total,diesel%2C%20oil%2C%20and%20biomass>
- Reserve Bank of Australia. *Economic growth*. Available at <https://www.rba.gov.au/education/resources/explainers/pdf/economic-growth.pdf>
- Worldometer. *Nigeria energy statistics*. Worldometer, 2024. Available at <https://www.worldometers.info/energy/nigeria-energy/>

Appendices

Appendix I: Data presentation

Years	GDP growth (Y)	Monetary Policy Rate (MPR)	Liquidity ratio (LR)	Broad money (% of GDP) (MS)	Renewable energy consumption (% of total final energy consumption) (REN)	Fossil fuel energy consumption (% of total) (NEN)	Gross fixed capital formation (annual % growth) (K)	Labor force participation rate, total (% of total population ages 15+) (national estimate) (L)
1990	11.77689	18.5	44.3	11.63537	87.78	20.51768	13.80424	57.22
1991	0.358353	15.5	38.6	13.39988	86.51	21.92551	-1.2394	55.4
1992	4.631193	17.5	29.1	14.24738	84.52	22.84479	0.512945	55.4
1993	-2.03512	26	42.2	15.78772	86.33	22.04813	7.533617	55.4
1994	-1.81492	13.5	48.5	15.09194	88.61	17.83639	-2.45882	55.4
1995	-0.07266	13.5	33.1	10.28191	88.03	17.7523	-6.64314	55.4
1996	4.195924	13.5	43.1	9.063329	87.11	18.83062	6.793911	55.4
1997	2.937099	13.5	40.2	9.725269	85.56	19.19587	5.845782	55.4
1998	2.581254	13.5	46.8	10.93903	87.15	17.36211	1.393454	55.4
1999	0.584127	18	61	12.76339	87.15	17.77525	2.675391	55.4
2000	5.015935	14	64.1	14.66963	86.21	18.4483	7.285385	55.4
2001	5.917685	20.5	52.9	15.90097	84.67	19.88929	-23.7467	55.4
2002	15.32916	16.5	52.45	13.527	84.6	19.76046	10.19303	55.4
2003	7.347195	15	50.9	13.02659	82.95	21.59308	21.40866	55.4
2004	9.250558	15	50.475	11.75879	84.05	21.2808	-19.9368	55.9
2005	6.438517	13	50.175	11.30051	84.01	21.65634	2.342505	55.9
2006	6.059428	10	81.42032	11.72897	85.93	19.69781	40.38866	55.9
2007	6.59113	9.5	41.55516	19.29109	87.28	17.58054	-21.8953	55.9
2008	6.764473	9.75	37.7155	23.81187	86.25	18.42964	-2.60106	55.9
2009	8.036925	6	26.39276	25.14416	88.68	15.85414	9.924205	55.9
2010	8.005656	6.25	27.38945	21.35585	86.46	18.0815	4.01246	55.9
2011	5.307924	12	42.02	22.47905	84.63	19.0819	-8.24668	60.41
2012	4.230061	12	49.71872	24.92823	84.57	18.76894	2.551734	60.41

2013	6.671335	12	46.23471	25.44805	82.19	18.58926	7.864836	59.81
2014	6.309719	13	38.26655	22.68961	80.64	18.87677	13.42649	59.81
2015	2.652693	11	42.34715	22.36683	82.18	19.82023	-1.3197	72.25
2016	-1.61687	14	45.95	27.37879	82.02	20.01453	-4.8405	74.58
2017	0.805887	14	54.7897	24.78142	82.32	20.34231	-2.97726	76.34
2018	1.922757	14	65.04402	25.36246	81.64	20.80364	9.73767	76.34
2019	2.208429	13.5	104.2024	23.92961	80.81	21.31071	8.290431	58.87
2020	-1.79425	11.5	67.59854	25.22161	82.51	21.70295	-14.7159	58.87
2021	3.647187	11.5	61.195	24.88618	86.13	22.14727	4.664448	58.87
2022	3.251681	16.5	54.93409	26.03932	87.17	22.62226	5.93322	58.87

Source: CBN statistical bulletin (2022) and WDI (2022).

Appendix II: Statistical Outputs

Null Hypothesis: Y has a unit root
 Exogenous: Constant, Linear Trend
 Lag Length: 1 (Fixed)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-1.936782	0.6115
Test critical values:		
1% level	-4.284580	
5% level	-3.562882	
10% level	-3.215267	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
 Dependent Variable: D(Y)
 Method: Least Squares
 Date: 04/13/24 Time: 04:00
 Sample (adjusted): 1992 2022
 Included observations: 31 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Y(-1)	-0.331163	0.170986	-1.936782	0.0633
D(Y(-1))	-0.210215	0.161039	-1.305367	0.2028
C	1.632987	1.429450	1.142389	0.2633
@TREND("1990")	-0.014340	0.063977	-0.224142	0.8243
R-squared	0.275901	Mean dependent var		0.093333
Adjusted R-squared	0.195445	S.D. dependent var		3.535058
S.E. of regression	3.170840	Akaike info criterion		5.265784
Sum squared resid	271.4640	Schwarz criterion		5.450815
Log likelihood	-77.61965	Hannan-Quinn criter.		5.326099
F-statistic	3.429237	Durbin-Watson stat		1.844401
Prob(F-statistic)	0.031057			

Null Hypothesis: D(Y) has a unit root
 Exogenous: Constant, Linear Trend
 Lag Length: 0 (Automatic - based on SIC, maxlag=8)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-9.119686	0.0000
Test critical values:		
1% level	-4.284580	
5% level	-3.562882	
10% level	-3.215267	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
 Dependent Variable: D(Y,2)
 Method: Least Squares
 Date: 04/13/24 Time: 04:28
 Sample (adjusted): 1992 2022
 Included observations: 31 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(Y(-1))	-1.357274	0.148829	-9.119686	0.0000
C	0.227075	1.290498	0.175959	0.8616
@TREND("1990")	-0.013379	0.067044	-0.199550	0.8433
R-squared	0.750797	Mean dependent var		0.355582
Adjusted R-squared	0.732997	S.D. dependent var		6.430843
S.E. of regression	3.322965	Akaike info criterion		5.331358
Sum squared resid	309.1787	Schwarz criterion		5.470131
Log likelihood	-79.63604	Hannan-Quinn criter.		5.376594
F-statistic	42.17920	Durbin-Watson stat		1.898795
Prob(F-statistic)	0.000000			

Null Hypothesis: Y has a unit root
 Exogenous: Constant, Linear Trend
 Bandwidth: 1 (Used-specified) using Bartlett kernel

	Adj. t-Stat	Prob.*
Phillips-Perron test statistic	-3.604903	0.0453
Test critical values:		
1% level	-4.273277	
5% level	-3.557759	
10% level	-3.212361	

*MacKinnon (1996) one-sided p-values.

Residual variance (no correction)	10.78480
HAC corrected variance (Bartlett kernel)	10.92894

Phillips-Perron Test Equation
 Dependent Variable: D(Y)
 Method: Least Squares
 Date: 04/13/24 Time: 04:31
 Sample (adjusted): 1991 2022
 Included observations: 32 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Y(-1)	-0.556097	0.154581	-3.597445	0.0012
C	1.755366	1.452120	1.208830	0.2365
@TREND("1990")	0.023068	0.066197	0.348475	0.7300
R-squared	0.314272	Mean dependent var		-0.266413
Adjusted R-squared	0.266980	S.D. dependent var		4.029251
S.E. of regression	3.449706	Akaike info criterion		5.403515
Sum squared resid	345.1136	Schwarz criterion		5.540928
Log likelihood	-83.45624	Hannan-Quinn criter.		5.449063
F-statistic	6.645413	Durbin-Watson stat		1.843065
Prob(F-statistic)	0.004209			

Null Hypothesis: Y is stationary
 Exogenous: Constant, Linear Trend
 Bandwidth: 3 (Newey-West automatic) using Bartlett kernel

	LM-Stat.
Kwiatkowski-Phillips-Schmidt-Shin test statistic	0.151401
Asymptotic critical values*:	
1% level	0.216000
5% level	0.146000
10% level	0.119000

*Kwiatkowski-Phillips-Schmidt-Shin (1992, Table 1)

Residual variance (no correction)	15.10117
HAC corrected variance (Bartlett kernel)	32.23525

KPSS Test Equation
 Dependent Variable: Y
 Method: Least Squares
 Date: 04/13/24 Time: 04:32
 Sample: 1990 2022
 Included observations: 33

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	4.797911	1.364761	3.515568	0.0014
@TREND("1990")	-0.031886	0.073299	-0.435008	0.6666
R-squared	0.006067	Mean dependent var		4.287737
Adjusted R-squared	-0.025995	S.D. dependent var		3.958301
S.E. of regression	4.009419	Akaike info criterion		5.673862
Sum squared resid	498.3387	Schwarz criterion		5.764559
Log likelihood	-91.61872	Hannan-Quinn criter.		5.704379
F-statistic	0.189232	Durbin-Watson stat		1.013449
Prob(F-statistic)	0.666570			

Null Hypothesis: D(Y) is stationary
 Exogenous: Constant, Linear Trend
 Bandwidth: 1 (Used-specified) using Bartlett kernel

	LM-Stat.
Kwiatkowski-Phillips-Schmidt-Shin test statistic	0.090009
Asymptotic critical values*:	
1% level	0.216000
5% level	0.146000
10% level	0.119000

*Kwiatkowski-Phillips-Schmidt-Shin (1992, Table 1)

Residual variance (no correction)	15.59765
HAC corrected variance (Bartlett kernel)	10.01468

KPSS Test Equation

Dependent Variable: D(Y)

Method: Least Squares

Date: 04/13/24 Time: 04:33

Sample (adjusted): 1991 2022

Included observations: 32 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.910421	1.476590	-0.616570	0.5422
@TREND("1990")	0.039031	0.078095	0.499788	0.6209
R-squared	0.008258	Mean dependent var		-0.266413
Adjusted R-squared	-0.024801	S.D. dependent var		4.029251
S.E. of regression	4.078909	Akaike info criterion		5.709997
Sum squared resid	499.1248	Schwarz criterion		5.801606
Log likelihood	-89.35996	Hannan-Quinn criter.		5.740363
F-statistic	0.249788	Durbin-Watson stat		2.491919
Prob(F-statistic)	0.620871			

Null Hypothesis: MPR has a unit root
 Exogenous: Constant, Linear Trend
 Lag Length: 0 (Automatic - based on SIC, maxlag=8)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-3.355199	0.0757
Test critical values: 1% level	-4.273277	
5% level	-3.557759	
10% level	-3.212361	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
 Dependent Variable: D(MPR)
 Method: Least Squares
 Date: 04/13/24 Time: 04:36
 Sample (adjusted): 1991 2022
 Included observations: 32 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
MPR(-1)	-0.601918	0.179399	-3.355199	0.0022
C	9.491699	3.294210	2.881328	0.0074
@TREND("1990")	-0.080864	0.073414	-1.101480	0.2797
R-squared	0.288823	Mean dependent var		-0.062500
Adjusted R-squared	0.239777	S.D. dependent var		3.775451
S.E. of regression	3.291845	Akaike info criterion		5.309834
Sum squared resid	314.2511	Schwarz criterion		5.447246
Log likelihood	-81.95734	Hannan-Quinn criter.		5.355382
F-statistic	5.888749	Durbin-Watson stat		1.994379
Prob(F-statistic)	0.007140			

Null Hypothesis: D(MPR) has a unit root
 Exogenous: Constant, Linear Trend
 Lag Length: 0 (Automatic - based on SIC, maxlag=8)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-7.784624	0.0000
Test critical values: 1% level	-4.284580	
5% level	-3.562882	
10% level	-3.215267	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
 Dependent Variable: D(MPR,2)
 Method: Least Squares
 Date: 04/13/24 Time: 04:37
 Sample (adjusted): 1992 2022
 Included observations: 31 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(MPR(-1))	-1.386863	0.178154	-7.784624	0.0000
C	-0.696951	1.402452	-0.496952	0.6231
@TREND("1990")	0.037756	0.072914	0.517814	0.6087
R-squared	0.684101	Mean dependent var		0.258065
Adjusted R-squared	0.661536	S.D. dependent var		6.235812
S.E. of regression	3.627848	Akaike info criterion		5.506922
Sum squared resid	368.5158	Schwarz criterion		5.645695
Log likelihood	-82.35729	Hannan-Quinn criter.		5.552158
F-statistic	30.31790	Durbin-Watson stat		2.134610
Prob(F-statistic)	0.000000			

Null Hypothesis: D(MPR) has a unit root
 Exogenous: Constant, Linear Trend
 Bandwidth: 4 (Newey-West automatic) using Bartlett kernel

	Adj. t-Stat	Prob.*
Phillips-Perron test statistic	-8.670262	0.0000
Test critical values:		
1% level	-4.284580	
5% level	-3.562882	
10% level	-3.215267	

*MacKinnon (1996) one-sided p-values.

Residual variance (no correction)	11.88761
HAC corrected variance (Bartlett kernel)	7.208611

Phillips-Perron Test Equation
 Dependent Variable: D(MPR,2)
 Method: Least Squares
 Date: 04/13/24 Time: 04:38
 Sample (adjusted): 1992 2022
 Included observations: 31 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(MPR(-1))	-1.386863	0.178154	-7.784624	0.0000
C	-0.696951	1.402452	-0.496952	0.6231
@TREND("1990")	0.037756	0.072914	0.517814	0.6087
R-squared	0.684101	Mean dependent var		0.258065
Adjusted R-squared	0.661536	S.D. dependent var		6.235812
S.E. of regression	3.627848	Akaike info criterion		5.506922
Sum squared resid	368.5158	Schwarz criterion		5.645695
Log likelihood	-82.35729	Hannan-Quinn criter.		5.552158
F-statistic	30.31790	Durbin-Watson stat		2.134610
Prob(F-statistic)	0.000000			

Null Hypothesis: MPR is stationary
 Exogenous: Constant, Linear Trend
 Bandwidth: 3 (Newey-West automatic) using Bartlett kernel

	LM-Stat.
Kwiatkowski-Phillips-Schmidt-Shin test statistic	0.128229
Asymptotic critical values*:	
1% level	0.216000
5% level	0.146000
10% level	0.119000

*Kwiatkowski-Phillips-Schmidt-Shin (1992, Table 1)

Residual variance (no correction)	11.26854
HAC corrected variance (Bartlett kernel)	21.20904

KPSS Test Equation

Dependent Variable: MPR
 Method: Least Squares
 Date: 04/13/24 Time: 04:39
 Sample: 1990 2022
 Included observations: 33

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	16.56061	1.178922	14.04724	0.0000
@TREND("1990")	-0.176136	0.063318	-2.781762	0.0091
R-squared	0.199756	Mean dependent var		13.74242
Adjusted R-squared	0.173942	S.D. dependent var		3.810699
S.E. of regression	3.463458	Akaike info criterion		5.381104
Sum squared resid	371.8617	Schwarz criterion		5.471801
Log likelihood	-86.78821	Hannan-Quinn criter.		5.411621
F-statistic	7.738198	Durbin-Watson stat		1.189389
Prob(F-statistic)	0.009118			

Null Hypothesis: D(MPR) is stationary
 Exogenous: Constant, Linear Trend
 Bandwidth: 5 (Newey-West automatic) using Bartlett kernel

	LM-Stat.
Kwiatkowski-Phillips-Schmidt-Shin test statistic	0.090074
Asymptotic critical values*:	
1% level	0.216000
5% level	0.146000
10% level	0.119000

*Kwiatkowski-Phillips-Schmidt-Shin (1992, Table 1)

Residual variance (no correction)	13.63246
HAC corrected variance (Bartlett kernel)	3.746408

KPSS Test Equation

Dependent Variable: D(MPR)

Method: Least Squares

Date: 04/13/24 Time: 04:40

Sample (adjusted): 1991 2022

Included observations: 32 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.812500	1.380439	-0.588581	0.5605
@TREND("1990")	0.045455	0.073009	0.622584	0.5383
R-squared	0.012756	Mean dependent var		-0.062500
Adjusted R-squared	-0.020153	S.D. dependent var		3.775451
S.E. of regression	3.813304	Akaike info criterion		5.575331
Sum squared resid	436.2386	Schwarz criterion		5.666939
Log likelihood	-87.20529	Hannan-Quinn criter.		5.605696
F-statistic	0.387611	Durbin-Watson stat		2.677346
Prob(F-statistic)	0.538262			

Null Hypothesis: LR has a unit root
 Exogenous: Constant, Linear Trend
 Lag Length: 0 (Automatic - based on SIC, maxlag=8)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-3.353980	0.0759
Test critical values: 1% level	-4.273277	
5% level	-3.557759	
10% level	-3.212361	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
 Dependent Variable: D(LR)
 Method: Least Squares
 Date: 04/13/24 Time: 04:41
 Sample (adjusted): 1991 2022
 Included observations: 32 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LR(-1)	-0.558852	0.166624	-3.353980	0.0022
C	22.05809	8.107911	2.720564	0.0109
@TREND("1990")	0.355334	0.278389	1.276395	0.2119
R-squared	0.279489	Mean dependent var		0.332315
Adjusted R-squared	0.229798	S.D. dependent var		15.32859
S.E. of regression	13.45255	Akaike info criterion		8.125274
Sum squared resid	5248.160	Schwarz criterion		8.262687
Log likelihood	-127.0044	Hannan-Quinn criter.		8.170822
F-statistic	5.624598	Durbin-Watson stat		1.948538
Prob(F-statistic)	0.008626			

Null Hypothesis: D(LR) has a unit root
 Exogenous: Constant, Linear Trend
 Lag Length: 0 (Automatic - based on SIC, maxlag=8)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-6.794748	0.0000
Test critical values:		
1% level	-4.284580	
5% level	-3.562882	
10% level	-3.215267	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
 Dependent Variable: D(LR,2)
 Method: Least Squares
 Date: 04/13/24 Time: 04:41
 Sample (adjusted): 1992 2022
 Included observations: 31 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LR(-1))	-1.245549	0.183311	-6.794748	0.0000
C	1.121822	6.014262	0.186527	0.8534
@TREND("1990")	-0.027123	0.313186	-0.086603	0.9316
R-squared	0.622826	Mean dependent var		-0.018094
Adjusted R-squared	0.595885	S.D. dependent var		24.52645
S.E. of regression	15.59148	Akaike info criterion		8.423092
Sum squared resid	6806.636	Schwarz criterion		8.561864
Log likelihood	-127.5579	Hannan-Quinn criter.		8.468328
F-statistic	23.11814	Durbin-Watson stat		2.046962
Prob(F-statistic)	0.000001			

Null Hypothesis: LR has a unit root
 Exogenous: Constant, Linear Trend
 Bandwidth: 2 (Newey-West automatic) using Bartlett kernel

	Adj. t-Stat	Prob.*
Phillips-Perron test statistic	-3.402593	0.0688
Test critical values:		
1% level	-4.273277	
5% level	-3.557759	
10% level	-3.212361	

*MacKinnon (1996) one-sided p-values.

Residual variance (no correction)	164.0050
HAC corrected variance (Bartlett kernel)	173.2753

Phillips-Perron Test Equation
 Dependent Variable: D(LR)
 Method: Least Squares
 Date: 04/13/24 Time: 04:42
 Sample (adjusted): 1991 2022
 Included observations: 32 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LR(-1)	-0.558852	0.166624	-3.353980	0.0022
C	22.05809	8.107911	2.720564	0.0109
@TREND("1990")	0.355334	0.278389	1.276395	0.2119
R-squared	0.279489	Mean dependent var		0.332315
Adjusted R-squared	0.229798	S.D. dependent var		15.32859
S.E. of regression	13.45255	Akaike info criterion		8.125274
Sum squared resid	5248.160	Schwarz criterion		8.262687
Log likelihood	-127.0044	Hannan-Quinn criter.		8.170822
F-statistic	5.624598	Durbin-Watson stat		1.948538
Prob(F-statistic)	0.008626			

Null Hypothesis: D(LR) has a unit root
 Exogenous: Constant, Linear Trend
 Bandwidth: 14 (Newey-West automatic) using Bartlett kernel

	Adj. t-Stat	Prob.*
Phillips-Perron test statistic	-11.04070	0.0000
Test critical values:		
1% level	-4.284580	
5% level	-3.562882	
10% level	-3.215267	

*MacKinnon (1996) one-sided p-values.

Residual variance (no correction)	219.5689
HAC corrected variance (Bartlett kernel)	37.35289

Phillips-Perron Test Equation
 Dependent Variable: D(LR,2)
 Method: Least Squares
 Date: 04/13/24 Time: 04:50
 Sample (adjusted): 1992 2022
 Included observations: 31 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LR(-1))	-1.245549	0.183311	-6.794748	0.0000
C	1.121822	6.014262	0.186527	0.8534
@TREND("1990")	-0.027123	0.313186	-0.086603	0.9316
R-squared	0.622826	Mean dependent var		-0.018094
Adjusted R-squared	0.595885	S.D. dependent var		24.52645
S.E. of regression	15.59148	Akaike info criterion		8.423092
Sum squared resid	6806.636	Schwarz criterion		8.561864
Log likelihood	-127.5579	Hannan-Quinn criter.		8.468328
F-statistic	23.11814	Durbin-Watson stat		2.046962
Prob(F-statistic)	0.000001			

Null Hypothesis: LR is stationary
 Exogenous: Constant, Linear Trend
 Bandwidth: 2 (Newey-West automatic) using Bartlett kernel

	LM-Stat.
Kwiatkowski-Phillips-Schmidt-Shin test statistic	0.094027
Asymptotic critical values*:	
1% level	0.216000
5% level	0.146000
10% level	0.119000

*Kwiatkowski-Phillips-Schmidt-Shin (1992, Table 1)

Residual variance (no correction)	198.1669
HAC corrected variance (Bartlett kernel)	335.6695

KPSS Test Equation

Dependent Variable: LR

Method: Least Squares

Date: 04/13/24 Time: 04:50

Sample: 1990 2022

Included observations: 33

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	39.80935	4.943869	8.052266	0.0000
@TREND("1990")	0.607889	0.265528	2.289357	0.0290
R-squared	0.144619	Mean dependent var		49.53558
Adjusted R-squared	0.117026	S.D. dependent var		15.45674
S.E. of regression	14.52418	Akaike info criterion		8.248199
Sum squared resid	6539.509	Schwarz criterion		8.338896
Log likelihood	-134.0953	Hannan-Quinn criter.		8.278716
F-statistic	5.241157	Durbin-Watson stat		1.114207
Prob(F-statistic)	0.029027			

Null Hypothesis: MS has a unit root
 Exogenous: Constant, Linear Trend
 Lag Length: 0 (Automatic - based on SIC, maxlag=8)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-2.263346	0.4407
Test critical values:		
1% level	-4.273277	
5% level	-3.557759	
10% level	-3.212361	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
 Dependent Variable: D(MS)
 Method: Least Squares
 Date: 04/13/24 Time: 04:52
 Sample (adjusted): 1991 2022
 Included observations: 32 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
MS(-1)	-0.293548	0.129697	-2.263346	0.0313
C	2.939714	1.437929	2.044408	0.0501
@TREND("1990")	0.168195	0.083944	2.003667	0.0545
R-squared	0.150899	Mean dependent var		0.450123
Adjusted R-squared	0.092340	S.D. dependent var		2.472193
S.E. of regression	2.355288	Akaike info criterion		4.640263
Sum squared resid	160.8740	Schwarz criterion		4.777676
Log likelihood	-71.24420	Hannan-Quinn criter.		4.685811
F-statistic	2.576884	Durbin-Watson stat		1.482764
Prob(F-statistic)	0.093306			

Null Hypothesis: D(MS) has a unit root
 Exogenous: Constant, Linear Trend
 Lag Length: 0 (Automatic - based on SIC, maxlag=8)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-4.516578	0.0057
Test critical values:		
1% level	-4.284580	
5% level	-3.562882	
10% level	-3.215267	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
 Dependent Variable: D(MS,2)
 Method: Least Squares
 Date: 04/13/24 Time: 04:52
 Sample (adjusted): 1992 2022
 Included observations: 31 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(MS(-1))	-0.837730	0.185479	-4.516578	0.0001
C	0.057249	0.985568	0.058087	0.9541
@TREND("1990")	0.016536	0.051197	0.322988	0.7491
R-squared	0.422253	Mean dependent var		-0.019722
Adjusted R-squared	0.380985	S.D. dependent var		3.240200
S.E. of regression	2.549307	Akaike info criterion		4.801286
Sum squared resid	181.9711	Schwarz criterion		4.940059
Log likelihood	-71.41994	Hannan-Quinn criter.		4.846523
F-statistic	10.23206	Durbin-Watson stat		1.928495
Prob(F-statistic)	0.000462			

Null Hypothesis: MS has a unit root
 Exogenous: Constant, Linear Trend
 Bandwidth: 7 (Newey-West automatic) using Bartlett kernel

	Adj. t-Stat	Prob.*
Phillips-Perron test statistic	-1.949126	0.6058
Test critical values:		
1% level	-4.273277	
5% level	-3.557759	
10% level	-3.212361	

*MacKinnon (1996) one-sided p-values.

Residual variance (no correction)	5.027313
HAC corrected variance (Bartlett kernel)	3.264523

Phillips-Perron Test Equation
 Dependent Variable: D(MS)
 Method: Least Squares
 Date: 04/13/24 Time: 04:53
 Sample (adjusted): 1991 2022
 Included observations: 32 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
MS(-1)	-0.293548	0.129697	-2.263346	0.0313
C	2.939714	1.437929	2.044408	0.0501
@TREND("1990")	0.168195	0.083944	2.003667	0.0545
R-squared	0.150899	Mean dependent var		0.450123
Adjusted R-squared	0.092340	S.D. dependent var		2.472193
S.E. of regression	2.355288	Akaike info criterion		4.640263
Sum squared resid	160.8740	Schwarz criterion		4.777676
Log likelihood	-71.24420	Hannan-Quinn criter.		4.685811
F-statistic	2.576884	Durbin-Watson stat		1.482764
Prob(F-statistic)	0.093306			

Null Hypothesis: D(MS) has a unit root
 Exogenous: Constant, Linear Trend
 Bandwidth: 30 (Newey-West automatic) using Bartlett kernel

	Adj. t-Stat	Prob.*
Phillips-Perron test statistic	-6.417483	0.0000
Test critical values:		
1% level	-4.284580	
5% level	-3.562882	
10% level	-3.215267	

*MacKinnon (1996) one-sided p-values.

Residual variance (no correction)	5.870036
HAC corrected variance (Bartlett kernel)	0.609576

Phillips-Perron Test Equation
 Dependent Variable: D(MS,2)
 Method: Least Squares
 Date: 04/13/24 Time: 04:53
 Sample (adjusted): 1992 2022
 Included observations: 31 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(MS(-1))	-0.837730	0.185479	-4.516578	0.0001
C	0.057249	0.985568	0.058087	0.9541
@TREND("1990")	0.016536	0.051197	0.322988	0.7491
R-squared	0.422253	Mean dependent var		-0.019722
Adjusted R-squared	0.380985	S.D. dependent var		3.240200
S.E. of regression	2.549307	Akaike info criterion		4.801286
Sum squared resid	181.9711	Schwarz criterion		4.940059
Log likelihood	-71.41994	Hannan-Quinn criter.		4.846523
F-statistic	10.23206	Durbin-Watson stat		1.928495
Prob(F-statistic)	0.000462			

Null Hypothesis: MS is stationary
 Exogenous: Constant, Linear Trend
 Bandwidth: 3 (Newey-West automatic) using Bartlett kernel

	LM-Stat.
Kwiatkowski-Phillips-Schmidt-Shin test statistic	0.105498
Asymptotic critical values*:	
1% level	0.216000
5% level	0.146000
10% level	0.119000

*Kwiatkowski-Phillips-Schmidt-Shin (1992, Table 1)

Residual variance (no correction)	10.01534
HAC corrected variance (Bartlett kernel)	23.78056

KPSS Test Equation

Dependent Variable: MS

Method: Least Squares

Date: 04/13/24 Time: 04:55

Sample: 1990 2022

Included observations: 33

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	9.523361	1.111435	8.568526	0.0000
@TREND("1990")	0.541081	0.059694	9.064302	0.0000
R-squared	0.726055	Mean dependent var		18.18066
Adjusted R-squared	0.717218	S.D. dependent var		6.140212
S.E. of regression	3.265193	Akaike info criterion		5.263207
Sum squared resid	330.5061	Schwarz criterion		5.353904
Log likelihood	-84.84291	Hannan-Quinn criter.		5.293724
F-statistic	82.16156	Durbin-Watson stat		0.574055
Prob(F-statistic)	0.000000			

Null Hypothesis: D(MS) is stationary
 Exogenous: Constant, Linear Trend
 Bandwidth: 3 (Used-specified) using Bartlett kernel

	LM-Stat.
Kwiatkowski-Phillips-Schmidt-Shin test statistic	0.064600
Asymptotic critical values*:	
1% level	0.216000
5% level	0.146000
10% level	0.119000

*Kwiatkowski-Phillips-Schmidt-Shin (1992, Table 1)

Residual variance (no correction)	5.915368
HAC corrected variance (Bartlett kernel)	5.169092

KPSS Test Equation

Dependent Variable: D(MS)

Method: Least Squares

Date: 04/13/24 Time: 04:56

Sample (adjusted): 1991 2022

Included observations: 32 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.319051	0.909329	0.350864	0.7281
@TREND("1990")	0.007944	0.048093	0.165175	0.8699
R-squared	0.000909	Mean dependent var		0.450123
Adjusted R-squared	-0.032394	S.D. dependent var		2.472193
S.E. of regression	2.511917	Akaike info criterion		4.740431
Sum squared resid	189.2918	Schwarz criterion		4.832039
Log likelihood	-73.84689	Hannan-Quinn criter.		4.770796
F-statistic	0.027283	Durbin-Watson stat		1.664047
Prob(F-statistic)	0.869914			

Null Hypothesis: REN has a unit root
 Exogenous: Constant, Linear Trend
 Lag Length: 0 (Automatic - based on SIC, maxlag=8)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-1.822080	0.6703
Test critical values:		
1% level	-4.273277	
5% level	-3.557759	
10% level	-3.212361	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
 Dependent Variable: D(REN)
 Method: Least Squares
 Date: 04/13/24 Time: 04:57
 Sample (adjusted): 1991 2022
 Included observations: 32 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
REN(-1)	-0.283765	0.155737	-1.822080	0.0788
C	24.37206	13.66312	1.783784	0.0849
@TREND("1990")	-0.016710	0.038522	-0.433769	0.6677
R-squared	0.130120	Mean dependent var		-0.019062
Adjusted R-squared	0.070128	S.D. dependent var		1.574806
S.E. of regression	1.518584	Akaike info criterion		3.762493
Sum squared resid	66.87678	Schwarz criterion		3.899906
Log likelihood	-57.19989	Hannan-Quinn criter.		3.808041
F-statistic	2.168967	Durbin-Watson stat		1.527108
Prob(F-statistic)	0.132483			

Null Hypothesis: D(REN) has a unit root
 Exogenous: Constant, Linear Trend
 Lag Length: 0 (Automatic - based on SIC, maxlag=8)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-4.825677	0.0027
Test critical values:		
1% level	-4.284580	
5% level	-3.562882	
10% level	-3.215267	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
 Dependent Variable: D(REN,2)
 Method: Least Squares
 Date: 04/13/24 Time: 04:57
 Sample (adjusted): 1992 2022
 Included observations: 31 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(REN(-1))	-0.906045	0.187755	-4.825677	0.0000
C	-0.344441	0.630139	-0.546612	0.5890
@TREND("1990")	0.021808	0.032808	0.664711	0.5117
R-squared	0.454070	Mean dependent var		0.074516
Adjusted R-squared	0.415075	S.D. dependent var		2.113509
S.E. of regression	1.616420	Akaike info criterion		3.890070
Sum squared resid	73.15878	Schwarz criterion		4.028843
Log likelihood	-57.29609	Hannan-Quinn criter.		3.935307
F-statistic	11.64430	Durbin-Watson stat		1.980852
Prob(F-statistic)	0.000209			

Null Hypothesis: REN has a unit root
 Exogenous: Constant, Linear Trend
 Bandwidth: 0 (Newey-West automatic) using Bartlett kernel

	Adj. t-Stat	Prob.*
Phillips-Perron test statistic	-1.822080	0.6703
Test critical values:		
1% level	-4.273277	
5% level	-3.557759	
10% level	-3.212361	

*MacKinnon (1996) one-sided p-values.

Residual variance (no correction)	2.089899
HAC corrected variance (Bartlett kernel)	2.089899

Phillips-Perron Test Equation
 Dependent Variable: D(REN)
 Method: Least Squares
 Date: 04/13/24 Time: 04:58
 Sample (adjusted): 1991 2022
 Included observations: 32 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
REN(-1)	-0.283765	0.155737	-1.822080	0.0788
C	24.37206	13.66312	1.783784	0.0849
@TREND("1990")	-0.016710	0.038522	-0.433769	0.6677
R-squared	0.130120	Mean dependent var		-0.019062
Adjusted R-squared	0.070128	S.D. dependent var		1.574806
S.E. of regression	1.518584	Akaike info criterion		3.762493
Sum squared resid	66.87678	Schwarz criterion		3.899906
Log likelihood	-57.19989	Hannan-Quinn criter.		3.808041
F-statistic	2.168967	Durbin-Watson stat		1.527108
Prob(F-statistic)	0.132483			

Null Hypothesis: D(REN) has a unit root
 Exogenous: Constant, Linear Trend
 Bandwidth: 1 (Newey-West automatic) using Bartlett kernel

	Adj. t-Stat	Prob.*
Phillips-Perron test statistic	-4.822850	0.0027
Test critical values:		
1% level	-4.284580	
5% level	-3.562882	
10% level	-3.215267	

*MacKinnon (1996) one-sided p-values.

Residual variance (no correction)	2.359961
HAC corrected variance (Bartlett kernel)	2.340870

Phillips-Perron Test Equation
 Dependent Variable: D(REN,2)
 Method: Least Squares
 Date: 04/13/24 Time: 04:58
 Sample (adjusted): 1992 2022
 Included observations: 31 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(REN(-1))	-0.906045	0.187755	-4.825677	0.0000
C	-0.344441	0.630139	-0.546612	0.5890
@TREND("1990")	0.021808	0.032808	0.664711	0.5117
R-squared	0.454070	Mean dependent var		0.074516
Adjusted R-squared	0.415075	S.D. dependent var		2.113509
S.E. of regression	1.616420	Akaike info criterion		3.890070
Sum squared resid	73.15878	Schwarz criterion		4.028843
Log likelihood	-57.29609	Hannan-Quinn criter.		3.935307
F-statistic	11.64430	Durbin-Watson stat		1.980852
Prob(F-statistic)	0.000209			

Null Hypothesis: REN is stationary
 Exogenous: Constant, Linear Trend
 Bandwidth: 2 (Newey-West automatic) using Bartlett kernel

	LM-Stat.
Kwiatkowski-Phillips-Schmidt-Shin test statistic	0.058869
Asymptotic critical values*:	
1% level	0.216000
5% level	0.146000
10% level	0.119000

*Kwiatkowski-Phillips-Schmidt-Shin (1992, Table 1)

Residual variance (no correction)	3.514994
HAC corrected variance (Bartlett kernel)	6.596702

KPSS Test Equation

Dependent Variable: REN
 Method: Least Squares
 Date: 04/13/24 Time: 04:59
 Sample: 1990 2022
 Included observations: 33

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	87.23005	0.658436	132.4807	0.0000
@TREND("1990")	-0.136253	0.035364	-3.852916	0.0005
R-squared	0.323808	Mean dependent var		85.05000
Adjusted R-squared	0.301995	S.D. dependent var		2.315310
S.E. of regression	1.934365	Akaike info criterion		4.216127
Sum squared resid	115.9948	Schwarz criterion		4.306824
Log likelihood	-67.56610	Hannan-Quinn criter.		4.246644
F-statistic	14.84496	Durbin-Watson stat		0.666581
Prob(F-statistic)	0.000549			

Null Hypothesis: NEN has a unit root
 Exogenous: Constant, Linear Trend
 Lag Length: 0 (Automatic - based on SIC, maxlag=8)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-2.015787	0.5709
Test critical values:		
1% level	-4.273277	
5% level	-3.557759	
10% level	-3.212361	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
 Dependent Variable: D(NEN)
 Method: Least Squares
 Date: 04/13/24 Time: 05:01
 Sample (adjusted): 1991 2022
 Included observations: 32 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
NEN(-1)	-0.272184	0.135026	-2.015787	0.0532
C	5.017792	2.675566	1.875413	0.0708
@TREND("1990")	0.024549	0.024660	0.995474	0.3277
R-squared	0.143143	Mean dependent var		0.065768
Adjusted R-squared	0.084049	S.D. dependent var		1.343702
S.E. of regression	1.285994	Akaike info criterion		3.430001
Sum squared resid	47.95963	Schwarz criterion		3.567414
Log likelihood	-51.88001	Hannan-Quinn criter.		3.475549
F-statistic	2.422311	Durbin-Watson stat		1.735183
Prob(F-statistic)	0.106456			

Null Hypothesis: D(NEN) has a unit root
 Exogenous: Constant, Linear Trend
 Lag Length: 0 (Automatic - based on SIC, maxlag=8)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-5.592575	0.0004
Test critical values:		
1% level	-4.284580	
5% level	-3.562882	
10% level	-3.215267	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
 Dependent Variable: D(NEN,2)
 Method: Least Squares
 Date: 04/13/24 Time: 05:01
 Sample (adjusted): 1992 2022
 Included observations: 31 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(NEN(-1))	-1.025190	0.183313	-5.592575	0.0000
C	-0.539470	0.525910	-1.025785	0.3138
@TREND("1990")	0.033134	0.027497	1.205005	0.2383
R-squared	0.529010	Mean dependent var		-0.030092
Adjusted R-squared	0.495368	S.D. dependent var		1.908070
S.E. of regression	1.355445	Akaike info criterion		3.537903
Sum squared resid	51.44248	Schwarz criterion		3.676675
Log likelihood	-51.83749	Hannan-Quinn criter.		3.583139
F-statistic	15.72461	Durbin-Watson stat		2.073732
Prob(F-statistic)	0.000026			

Null Hypothesis: NEN has a unit root
 Exogenous: Constant, Linear Trend
 Bandwidth: 4 (Newey-West automatic) using Bartlett kernel

	Adj. t-Stat	Prob.*
Phillips-Perron test statistic	-1.950171	0.6053
Test critical values:		
1% level	-4.273277	
5% level	-3.557759	
10% level	-3.212361	

*MacKinnon (1996) one-sided p-values.

Residual variance (no correction)	1.498738
HAC corrected variance (Bartlett kernel)	1.406494

Phillips-Perron Test Equation
 Dependent Variable: D(NEN)
 Method: Least Squares
 Date: 04/13/24 Time: 05:02
 Sample (adjusted): 1991 2022
 Included observations: 32 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
NEN(-1)	-0.272184	0.135026	-2.015787	0.0532
C	5.017792	2.675566	1.875413	0.0708
@TREND("1990")	0.024549	0.024660	0.995474	0.3277
R-squared	0.143143	Mean dependent var		0.065768
Adjusted R-squared	0.084049	S.D. dependent var		1.343702
S.E. of regression	1.285994	Akaike info criterion		3.430001
Sum squared resid	47.95963	Schwarz criterion		3.567414
Log likelihood	-51.88001	Hannan-Quinn criter.		3.475549
F-statistic	2.422311	Durbin-Watson stat		1.735183
Prob(F-statistic)	0.106456			

Null Hypothesis: D(NEN) has a unit root
 Exogenous: Constant, Linear Trend
 Bandwidth: 7 (Newey-West automatic) using Bartlett kernel

	Adj. t-Stat	Prob.*
Phillips-Perron test statistic	-6.129973	0.0001
Test critical values:		
1% level	-4.284580	
5% level	-3.562882	
10% level	-3.215267	

*MacKinnon (1996) one-sided p-values.

Residual variance (no correction)	1.659435
HAC corrected variance (Bartlett kernel)	0.742554

Phillips-Perron Test Equation
 Dependent Variable: D(NEN,2)
 Method: Least Squares
 Date: 04/13/24 Time: 05:02
 Sample (adjusted): 1992 2022
 Included observations: 31 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(NEN(-1))	-1.025190	0.183313	-5.592575	0.0000
C	-0.539470	0.525910	-1.025785	0.3138
@TREND("1990")	0.033134	0.027497	1.205005	0.2383
R-squared	0.529010	Mean dependent var		-0.030092
Adjusted R-squared	0.495368	S.D. dependent var		1.908070
S.E. of regression	1.355445	Akaike info criterion		3.537903
Sum squared resid	51.44248	Schwarz criterion		3.676675
Log likelihood	-51.83749	Hannan-Quinn criter.		3.583139
F-statistic	15.72461	Durbin-Watson stat		2.073732
Prob(F-statistic)	0.000026			

Null Hypothesis: NEN is stationary
 Exogenous: Constant, Linear Trend
 Bandwidth: 3 (Newey-West automatic) using Bartlett kernel

	LM-Stat.
Kwiatkowski-Phillips-Schmidt-Shin test statistic	0.122046
Asymptotic critical values*:	
1% level	0.216000
5% level	0.146000
10% level	0.119000

*Kwiatkowski-Phillips-Schmidt-Shin (1992, Table 1)

Residual variance (no correction)	2.954501
HAC corrected variance (Bartlett kernel)	7.055156

KPSS Test Equation

Dependent Variable: NEN
 Method: Least Squares
 Date: 04/13/24 Time: 05:03
 Sample: 1990 2022
 Included observations: 33

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	19.37002	0.603661	32.08755	0.0000
@TREND("1990")	0.025058	0.032422	0.772882	0.4454
R-squared	0.018905	Mean dependent var		19.77095
Adjusted R-squared	-0.012743	S.D. dependent var		1.762254
S.E. of regression	1.773447	Akaike info criterion		4.042419
Sum squared resid	97.49855	Schwarz criterion		4.133117
Log likelihood	-64.69992	Hannan-Quinn criter.		4.072936
F-statistic	0.597347	Durbin-Watson stat		0.574620
Prob(F-statistic)	0.445446			

Null Hypothesis: D(NEN) is stationary
 Exogenous: Constant, Linear Trend
 Bandwidth: 3 (Used-specified) using Bartlett kernel

	LM-Stat.
Kwiatkowski-Phillips-Schmidt-Shin test statistic	0.056099
Asymptotic critical values*:	
1% level	0.216000
5% level	0.146000
10% level	0.119000

*Kwiatkowski-Phillips-Schmidt-Shin (1992, Table 1)

Residual variance (no correction)	1.708737
HAC corrected variance (Bartlett kernel)	1.229952

KPSS Test Equation

Dependent Variable: D(NEN)

Method: Least Squares

Date: 04/13/24 Time: 05:04

Sample (adjusted): 1991 2022

Included observations: 32 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.293310	0.488729	-0.600149	0.5529
@TREND("1990")	0.021762	0.025848	0.841929	0.4065
R-squared	0.023083	Mean dependent var		0.065768
Adjusted R-squared	-0.009481	S.D. dependent var		1.343702
S.E. of regression	1.350057	Akaike info criterion		3.498632
Sum squared resid	54.67960	Schwarz criterion		3.590240
Log likelihood	-53.97811	Hannan-Quinn criter.		3.528997
F-statistic	0.708844	Durbin-Watson stat		1.999015
Prob(F-statistic)	0.406490			

Null Hypothesis: K has a unit root
 Exogenous: Constant, Linear Trend
 Lag Length: 1 (Automatic - based on SIC, maxlag=8)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-10.24540	0.0000
Test critical values:		
1% level	-4.284580	
5% level	-3.562882	
10% level	-3.215267	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
 Dependent Variable: D(K)
 Method: Least Squares
 Date: 04/13/24 Time: 05:04
 Sample (adjusted): 1992 2022
 Included observations: 31 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
K(-1)	-2.261545	0.220738	-10.24540	0.0000
D(K(-1))	0.701951	0.134480	5.219745	0.0000
C	5.164387	3.434611	1.503631	0.1443
@TREND("1990")	-0.036724	0.176517	-0.208050	0.8368
R-squared	0.831795	Mean dependent var		0.231375
Adjusted R-squared	0.813106	S.D. dependent var		20.29718
S.E. of regression	8.774730	Akaike info criterion		7.301543
Sum squared resid	2078.889	Schwarz criterion		7.486574
Log likelihood	-109.1739	Hannan-Quinn criter.		7.361859
F-statistic	44.50615	Durbin-Watson stat		2.097025
Prob(F-statistic)	0.000000			

Null Hypothesis: K has a unit root
 Exogenous: Constant, Linear Trend
 Bandwidth: 5 (Newey-West automatic) using Bartlett kernel

	Adj. t-Stat	Prob.*
Phillips-Perron test statistic	-12.46231	0.0000
Test critical values:		
1% level	-4.273277	
5% level	-3.557759	
10% level	-3.212361	

*MacKinnon (1996) one-sided p-values.

Residual variance (no correction)	130.5434
HAC corrected variance (Bartlett kernel)	25.46302

Phillips-Perron Test Equation
 Dependent Variable: D(K)
 Method: Least Squares
 Date: 04/13/24 Time: 05:05
 Sample (adjusted): 1991 2022
 Included observations: 32 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
K(-1)	-1.322719	0.173368	-7.629558	0.0000
C	2.433321	4.379359	0.555634	0.5827
@TREND("1990")	0.013051	0.230020	0.056738	0.9551
R-squared	0.668074	Mean dependent var		-0.245969
Adjusted R-squared	0.645182	S.D. dependent var		20.14888
S.E. of regression	12.00200	Akaike info criterion		7.897083
Sum squared resid	4177.389	Schwarz criterion		8.034496
Log likelihood	-123.3533	Hannan-Quinn criter.		7.942631
F-statistic	29.18441	Durbin-Watson stat		2.460682
Prob(F-statistic)	0.000000			

Null Hypothesis: L has a unit root
 Exogenous: Constant, Linear Trend
 Lag Length: 8 (Automatic - based on SIC, maxlag=8)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-4.840796	0.0038
Test critical values: 1% level	-4.394309	
5% level	-3.612199	
10% level	-3.243079	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
 Dependent Variable: D(L)
 Method: Least Squares
 Date: 04/13/24 Time: 05:07
 Sample (adjusted): 1999 2022
 Included observations: 24 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
L(-1)	-7.004537	1.446980	-4.840796	0.0003
D(L(-1))	6.582887	1.365965	4.819222	0.0003
D(L(-2))	6.778853	1.423430	4.762337	0.0004
D(L(-3))	6.630021	1.433116	4.626299	0.0005
D(L(-4))	8.862854	1.829736	4.843789	0.0003
D(L(-5))	8.400056	1.875837	4.478030	0.0006
D(L(-6))	7.956575	1.831785	4.343620	0.0008
D(L(-7))	7.957708	1.815988	4.382027	0.0007
D(L(-8))	-2.046453	1.093988	-1.870637	0.0841
C	381.8212	80.40308	4.748837	0.0004
@TREND("1990")	0.438751	0.122685	3.576235	0.0034
R-squared	0.890641	Mean dependent var		0.144583
Adjusted R-squared	0.806519	S.D. dependent var		4.610618
S.E. of regression	2.028049	Akaike info criterion		4.555588
Sum squared resid	53.46878	Schwarz criterion		5.095529
Log likelihood	-43.66706	Hannan-Quinn criter.		4.698835
F-statistic	10.58746	Durbin-Watson stat		1.171457
Prob(F-statistic)	0.000101			

Null Hypothesis: L has a unit root
 Exogenous: Constant, Linear Trend
 Bandwidth: 0 (Newey-West automatic) using Bartlett kernel

	Adj. t-Stat	Prob.*
Phillips-Perron test statistic	-2.182905	0.4825
Test critical values:		
1% level	-4.273277	
5% level	-3.557759	
10% level	-3.212361	

*MacKinnon (1996) one-sided p-values.

Residual variance (no correction)	13.21480
HAC corrected variance (Bartlett kernel)	13.21480

Phillips-Perron Test Equation
 Dependent Variable: D(L)
 Method: Least Squares
 Date: 04/13/24 Time: 05:08
 Sample (adjusted): 1991 2022
 Included observations: 32 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
L(-1)	-0.294409	0.134870	-2.182905	0.0373
C	15.57088	7.164675	2.173284	0.0381
@TREND("1990")	0.110654	0.091794	1.205470	0.2378
R-squared	0.141649	Mean dependent var		0.051562
Adjusted R-squared	0.082453	S.D. dependent var		3.986503
S.E. of regression	3.818619	Akaike info criterion		5.606715
Sum squared resid	422.8736	Schwarz criterion		5.744127
Log likelihood	-86.70743	Hannan-Quinn criter.		5.652263
F-statistic	2.392865	Durbin-Watson stat		1.626790
Prob(F-statistic)	0.109179			

Null Hypothesis: D(L) has a unit root
 Exogenous: Constant, Linear Trend
 Bandwidth: 2 (Newey-West automatic) using Bartlett kernel

	Adj. t-Stat	Prob.*
Phillips-Perron test statistic	-4.972610	0.0019
Test critical values:		
1% level	-4.284580	
5% level	-3.562882	
10% level	-3.215267	

*MacKinnon (1996) one-sided p-values.

Residual variance (no correction)	15.66277
HAC corrected variance (Bartlett kernel)	15.25323

Phillips-Perron Test Equation
 Dependent Variable: D(L,2)
 Method: Least Squares
 Date: 04/13/24 Time: 05:08
 Sample (adjusted): 1992 2022
 Included observations: 31 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(L(-1))	-0.934510	0.187673	-4.979456	0.0000
C	0.497714	1.606941	0.309728	0.7591
@TREND("1990")	-0.022898	0.083647	-0.273746	0.7863
R-squared	0.469868	Mean dependent var		0.058710
Adjusted R-squared	0.432001	S.D. dependent var		5.525383
S.E. of regression	4.164244	Akaike info criterion		5.782712
Sum squared resid	485.5459	Schwarz criterion		5.921485
Log likelihood	-86.63204	Hannan-Quinn criter.		5.827949
F-statistic	12.40850	Durbin-Watson stat		1.996877
Prob(F-statistic)	0.000138			

Null Hypothesis: L is stationary
 Exogenous: Constant, Linear Trend
 Bandwidth: 3 (Newey-West automatic) using Bartlett kernel

	LM-Stat.
Kwiatkowski-Phillips-Schmidt-Shin test statistic	0.086774
Asymptotic critical values*:	
1% level	0.216000
5% level	0.146000
10% level	0.119000

*Kwiatkowski-Phillips-Schmidt-Shin (1992, Table 1)

Residual variance (no correction)	25.54397
HAC corrected variance (Bartlett kernel)	59.29728

KPSS Test Equation
 Dependent Variable: L
 Method: Least Squares
 Date: 04/13/24 Time: 05:09
 Sample: 1990 2022
 Included observations: 33

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	52.91380	1.774988	29.81078	0.0000
@TREND("1990")	0.374990	0.095332	3.933509	0.0004
R-squared	0.332939	Mean dependent var		58.91364
Adjusted R-squared	0.311421	S.D. dependent var		6.284103
S.E. of regression	5.214591	Akaike info criterion		6.199490
Sum squared resid	842.9509	Schwarz criterion		6.290188
Log likelihood	-100.2916	Hannan-Quinn criter.		6.230007
F-statistic	15.47249	Durbin-Watson stat		0.588416
Prob(F-statistic)	0.000439			

Objective 1

Monetary policy and renewable energy

Dependent Variable: REN
 Method: ARDL
 Date: 04/13/24 Time: 06:08
 Sample (adjusted): 1993 2022
 Included observations: 30 after adjustments
 Maximum dependent lags: 3 (Automatic selection)
 Model selection method: Akaike info criterion (AIC)
 Dynamic regressors (2 lags, automatic): K L MPR MS LR
 Fixed regressors: C
 Number of models evaluated: 729
 Selected Model: ARDL(3, 2, 1, 1, 1, 1)

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
REN(-1)	0.609280	0.222097	2.743309	0.0151
REN(-2)	-0.240821	0.273425	-0.880756	0.3923
REN(-3)	-0.349120	0.229788	-1.519309	0.1495
K	-0.080993	0.043869	-1.846233	0.0847
K(-1)	-0.047092	0.033760	-1.394924	0.1834
K(-2)	-0.074965	0.038345	-1.955021	0.0695
L	-0.070980	0.097537	-0.727727	0.4780
L(-1)	-0.161624	0.099034	-1.632013	0.1235
MPR	-0.112355	0.089080	-1.261275	0.2265
MPR(-1)	0.142015	0.097728	1.453156	0.1668
MS	0.238084	0.124653	1.909979	0.0754
MS(-1)	-0.259419	0.129450	-2.004017	0.0635
LR	0.018384	0.033101	0.555400	0.5868
LR(-1)	-0.060951	0.031708	-1.922257	0.0738
C	99.50001	29.90734	3.326942	0.0046
R-squared	0.817102	Mean dependent var	84.92800	
Adjusted R-squared	0.646398	S.D. dependent var	2.357887	
S.E. of regression	1.402105	Akaike info criterion	3.820679	
Sum squared resid	29.48846	Schwarz criterion	4.521277	
Log likelihood	-42.31018	Hannan-Quinn criter.	4.044806	
F-statistic	4.786648	Durbin-Watson stat	1.789772	
Prob(F-statistic)	0.002346			

*Note: p-values and any subsequent tests do not account for model selection.

ARDL Long Run Form and Bounds Test

Dependent Variable: D(REN)

Selected Model: ARDL(3, 2, 1, 1, 1, 1)

Case 2: Restricted Constant and No Trend

Date: 04/13/24 Time: 06:10

Sample: 1990 2022

Included observations: 30

Conditional Error Correction Regression				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	99.50001	29.90734	3.326942	0.0046
REN(-1)*	-0.980661	0.293537	-3.340841	0.0045
K(-1)	-0.203050	0.104868	-1.936247	0.0719
L(-1)	-0.232605	0.080530	-2.888405	0.0113
MPR(-1)	0.029660	0.110065	0.269473	0.7912
MS(-1)	-0.021335	0.074424	-0.286673	0.7783
LR(-1)	-0.042566	0.035339	-1.204501	0.2471
D(REN(-1))	0.589941	0.231342	2.550079	0.0222
D(REN(-2))	0.349120	0.229788	1.519309	0.1495
D(K)	-0.080993	0.043869	-1.846233	0.0847
D(K(-1))	0.074965	0.038345	1.955021	0.0695
D(L)	-0.070980	0.097537	-0.727727	0.4780
D(MPR)	-0.112355	0.089080	-1.261275	0.2265
D(MS)	0.238084	0.124653	1.909979	0.0754
D(LR)	0.018384	0.033101	0.555400	0.5868

* p-value incompatible with t-Bounds distribution.

Levels Equation				
Case 2: Restricted Constant and No Trend				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
K	-0.207054	0.098186	-2.108792	0.0522
L	-0.237192	0.069550	-3.410396	0.0039
MPR	0.030245	0.113784	0.265807	0.7940
MS	-0.021756	0.073894	-0.294421	0.7725
LR	-0.043406	0.028700	-1.512391	0.1512
C	101.4622	3.363231	30.16807	0.0000

$$EC = REN - (-0.2071 * K - 0.2372 * L + 0.0302 * MPR - 0.0218 * MS - 0.0434 * LR + 101.4622)$$

F-Bounds Test		Null Hypothesis: No levels relationship		
Test Statistic	Value	Signif.	I(0)	I(1)
F-statistic	4.244463	10%	2.08	3
K	5	5%	2.39	3.38
		2.5%	2.7	3.73
		1%	3.06	4.15

Asymptotic:
n=1000

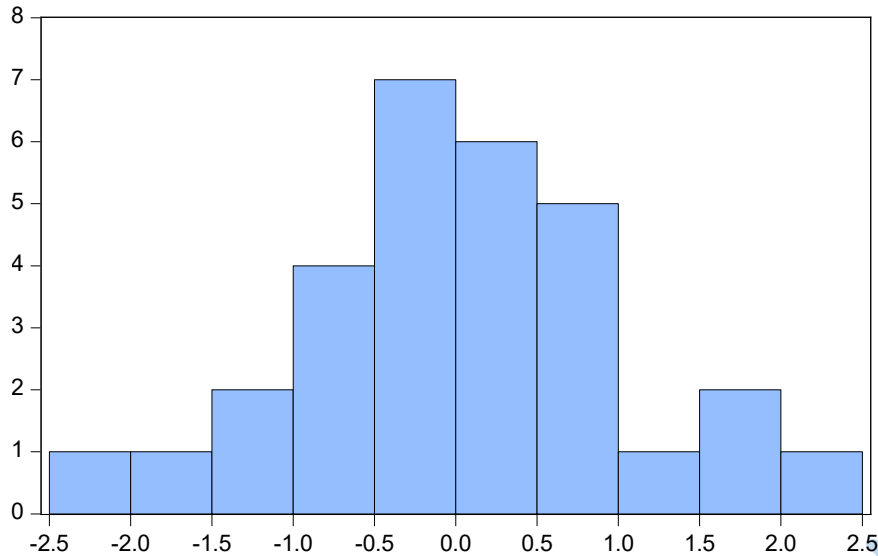
Actual Sample Size	30		Finite Sample: n=30	
		10%	2.407	3.517
		5%	2.91	4.193
		1%	4.134	5.761

ARDL Error Correction Regression
 Dependent Variable: D(REN)
 Selected Model: ARDL(3, 2, 1, 1, 1, 1)
 Case 2: Restricted Constant and No Trend
 Date: 04/13/24 Time: 06:10
 Sample: 1990 2022
 Included observations: 30

ECM Regression				
Case 2: Restricted Constant and No Trend				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(REN(-1))	0.589941	0.185323	3.183306	0.0062
D(REN(-2))	0.349120	0.177941	1.961996	0.0686
D(K)	-0.080993	0.022855	-3.543696	0.0029
D(K(-1))	0.074965	0.019312	3.881785	0.0015
D(L)	-0.070980	0.063365	-1.120178	0.2803
D(MPR)	-0.112355	0.061333	-1.831878	0.0869
D(MS)	0.238084	0.094788	2.511765	0.0239
D(LR)	0.018384	0.018229	1.008546	0.3292
CointEq(-1)*	-0.980661	0.209098	-4.689962	0.0003
R-squared	0.585166	Mean dependent var		0.088333
Adjusted R-squared	0.427134	S.D. dependent var		1.565633
S.E. of regression	1.184995	Akaike info criterion		3.420679
Sum squared resid	29.48846	Schwarz criterion		3.841038
Log likelihood	-42.31018	Hannan-Quinn criter.		3.555155
Durbin-Watson stat	1.789772			

* p-value incompatible with t-Bounds distribution.

F-Bounds Test		Null Hypothesis: No levels relationship		
Test Statistic	Value	Signif.	I(0)	I(1)
F-statistic	4.244463	10%	2.08	3
K	5	5%	2.39	3.38
		2.5%	2.7	3.73
		1%	3.06	4.15



Series: Residuals	
Sample 1993 2022	
Observations 30	
Mean	9.97e-15
Median	0.050583
Maximum	2.122634
Minimum	-2.276140
Std. Dev.	1.008387
Skewness	-0.152344
Kurtosis	2.926837
Jarque-Bera	0.122735
Probability	0.940477

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	0.546073	Prob. F(2,13)	0.5919
Obs*R-squared	2.325009	Prob. Chi-Square(2)	0.3127

Heteroskedasticity Test: Breusch-Pagan-Godfrey

F-statistic	0.576582	Prob. F(14,15)	0.8448
Obs*R-squared	10.49596	Prob. Chi-Square(14)	0.7251
Scaled explained SS	2.528000	Prob. Chi-Square(14)	0.9997

Ramsey RESET Test

Equation: UNTITLED

Specification: REN REN(-1) REN(-2) REN(-3) K K(-1) K(-2) L L(-1)

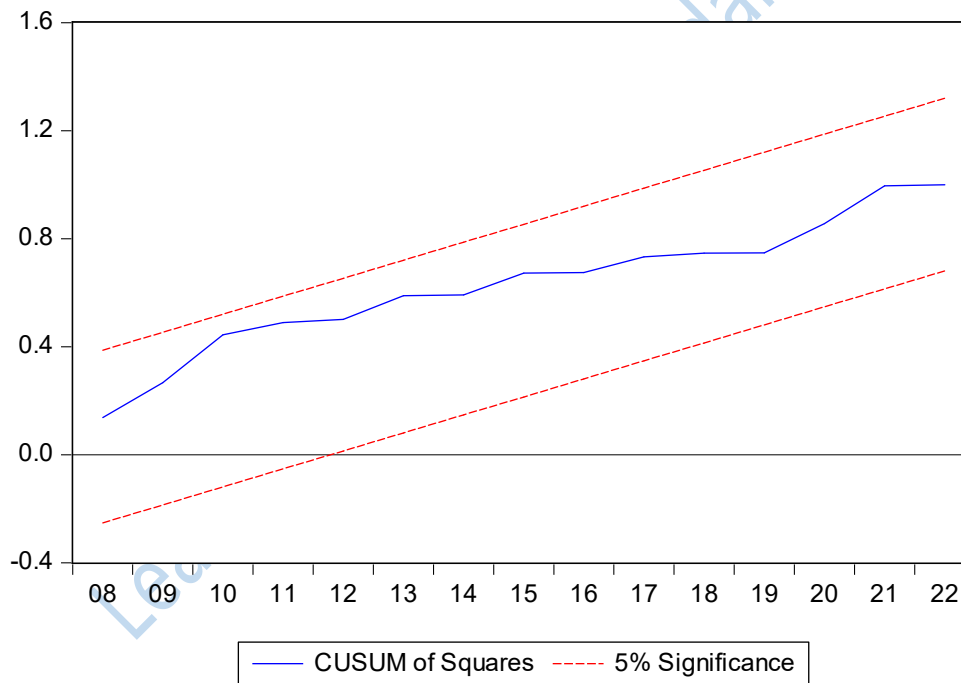
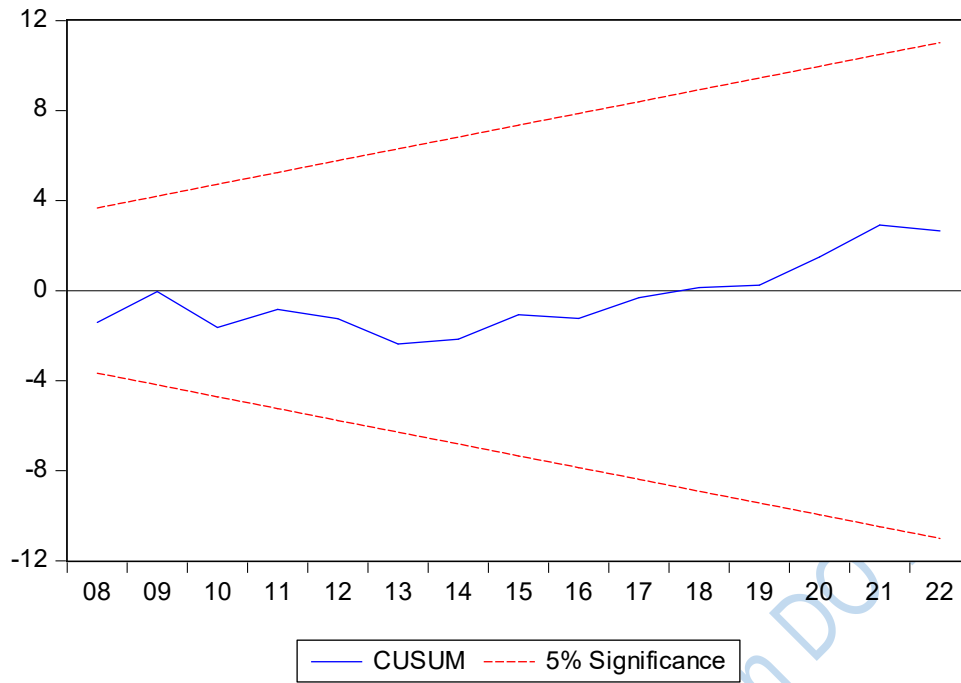
MPR MPR(-1) MS MS(-1) LR LR(-1) C

Omitted Variables: Squares of fitted values

	Value	df	Probability
t-statistic	0.695199	14	0.4983
F-statistic	0.483302	(1, 14)	0.4983

F-test summary:

	Sum of Sq.	df	Mean Squares
Test SSR	0.984017	1	0.984017
Restricted SSR	29.48846	15	1.965897
Unrestricted SSR	28.50444	14	2.036032



Monetary policy and non-renewable energy

Dependent Variable: NEN
 Method: ARDL
 Date: 04/13/24 Time: 08:01
 Sample (adjusted): 1993 2022
 Included observations: 30 after adjustments
 Maximum dependent lags: 3 (Automatic selection)
 Model selection method: Akaike info criterion (AIC)
 Dynamic regressors (3 lags, automatic): K L MPR MS LR
 Fixed regressors: C
 Number of models evaluated: 3072
 Selected Model: ARDL(3, 0, 0, 1, 2, 2)

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
NEN(-1)	0.480119	0.179852	2.669522	0.0168
NEN(-2)	0.106609	0.193345	0.551396	0.5890
NEN(-3)	-0.226954	0.152125	-1.491886	0.1552
K	-0.001578	0.017205	-0.091714	0.9281
L	0.026653	0.036243	0.735400	0.4727
MPR	0.151583	0.057914	2.617360	0.0187
MPR(-1)	-0.097779	0.069420	-1.408529	0.1781
MS	-0.091618	0.090368	-1.013834	0.3257
MS(-1)	-0.084503	0.133021	-0.635260	0.5342
MS(-2)	0.203791	0.089552	2.275664	0.0370
LR	0.012407	0.015854	0.782616	0.4453
LR(-1)	-0.004488	0.019222	-0.233509	0.8183
LR(-2)	0.044711	0.014731	3.035243	0.0079
C	7.230276	3.087405	2.341862	0.0325
R-squared	0.849615	Mean dependent var		19.57178
Adjusted R-squared	0.727427	S.D. dependent var		1.697249
S.E. of regression	0.886108	Akaike info criterion		2.900770
Sum squared resid	12.56301	Schwarz criterion		3.554662
Log likelihood	-29.51155	Hannan-Quinn criter.		3.109956
F-statistic	6.953350	Durbin-Watson stat		2.049481
Prob(F-statistic)	0.000237			

*Note: p-values and any subsequent tests do not account for model selection.

ARDL Long Run Form and Bounds Test

Dependent Variable: D(NEN)

Selected Model: ARDL(3, 0, 0, 1, 2, 2)

Case 2: Restricted Constant and No Trend

Date: 04/13/24 Time: 08:02

Sample: 1990 2022

Included observations: 30

Conditional Error Correction Regression				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	7.230276	3.087405	2.341862	0.0325
NEN(-1)*	-0.640225	0.153395	-4.173691	0.0007
K**	-0.001578	0.017205	-0.091714	0.9281
L**	0.026653	0.036243	0.735400	0.4727
MPR(-1)	0.053803	0.074706	0.720200	0.4818
MS(-1)	0.027670	0.047942	0.577157	0.5719
LR(-1)	0.052630	0.015609	3.371851	0.0039
D(NEN(-1))	0.120344	0.151126	0.796320	0.4375
D(NEN(-2))	0.226954	0.152125	1.491886	0.1552
D(MPR)	0.151583	0.057914	2.617360	0.0187
D(MS)	-0.091618	0.090368	-1.013834	0.3257
D(MS(-1))	-0.203791	0.089552	-2.275664	0.0370
D(LR)	0.012407	0.015854	0.782616	0.4453
D(LR(-1))	-0.044711	0.014731	-3.035243	0.0079

* p-value incompatible with t-Bounds distribution.

** Variable interpreted as $Z = Z(-1) + D(Z)$.

Levels Equation				
Case 2: Restricted Constant and No Trend				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
K	-0.002465	0.026901	-0.091619	0.9281
L	0.041631	0.058150	0.715924	0.4844
MPR	0.084038	0.109898	0.764695	0.4556
MS	0.043219	0.073650	0.586821	0.5655
LR	0.082205	0.024602	3.341449	0.0041
C	11.29333	3.382300	3.338950	0.0042

$$EC = NEN - (-0.0025 * K + 0.0416 * L + 0.0840 * MPR + 0.0432 * MS + 0.0822 * LR + 11.2933)$$

F-Bounds Test		Null Hypothesis: No levels relationship		
Test Statistic	Value	Signif.	I(0)	I(1)
F-statistic	3.531846	10%	2.08	3
k	5	5%	2.39	3.38
		2.5%	2.7	3.73
		1%	3.06	4.15

Asymptotic:
n=1000

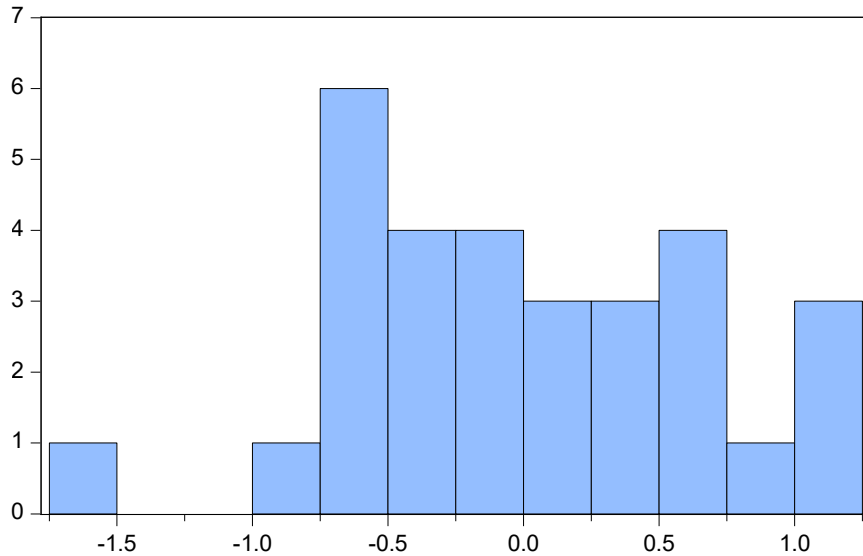
Actual Sample Size	30		Finite Sample: n=30	
		10%	2.407	3.517
		5%	2.91	4.193
		1%	4.134	5.761

ARDL Error Correction Regression
 Dependent Variable: D(NEN)
 Selected Model: ARDL(3, 0, 0, 1, 2, 2)
 Case 2: Restricted Constant and No Trend
 Date: 04/13/24 Time: 08:03
 Sample: 1990 2022
 Included observations: 30

ECM Regression				
Case 2: Restricted Constant and No Trend				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(NEN(-1))	0.120344	0.117044	1.028198	0.3192
D(NEN(-2))	0.226954	0.118250	1.919268	0.0730
D(MPR)	0.151583	0.039668	3.821290	0.0015
D(MS)	-0.091618	0.063635	-1.439750	0.1692
D(MS(-1))	-0.203791	0.066052	-3.085329	0.0071
D(LR)	0.012407	0.010531	1.178168	0.2560
D(LR(-1))	-0.044711	0.011946	-3.742899	0.0018
CointEq(-1)*	-0.640225	0.109807	-5.830439	0.0000
R-squared	0.764213	Mean dependent var		-0.007418
Adjusted R-squared	0.689190	S.D. dependent var		1.355465
S.E. of regression	0.755676	Akaike info criterion		2.500770
Sum squared resid	12.56301	Schwarz criterion		2.874422
Log likelihood	-29.51155	Hannan-Quinn criter.		2.620305
Durbin-Watson stat	2.049481			

* p-value incompatible with t-Bounds distribution.

F-Bounds Test		Null Hypothesis: No levels relationship		
Test Statistic	Value	Signif.	I(0)	I(1)
F-statistic	3.531846	10%	2.08	3
k	5	5%	2.39	3.38
		2.5%	2.7	3.73
		1%	3.06	4.15



Series: Residuals	
Sample 1993 2022	
Observations 30	
Mean	4.28e-15
Median	-0.016197
Maximum	1.173524
Minimum	-1.614030
Std. Dev.	0.658185
Skewness	-0.043644
Kurtosis	2.695095
Jarque-Bera	0.125733
Probability	0.939069

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	3.025571	Prob. F(2,14)	0.0809
Obs*R-squared	9.053562	Prob. Chi-Square(2)	0.0108

Heteroskedasticity Test: Breusch-Pagan-Godfrey

F-statistic	1.032744	Prob. F(13,16)	0.4688
Obs*R-squared	13.68771	Prob. Chi-Square(13)	0.3962
Scaled explained SS	3.299836	Prob. Chi-Square(13)	0.9966

Ramsey RESET Test

Equation: UNTITLED

Specification: NEN NEN(-1) NEN(-2) NEN(-3) K L MPR MPR(-1) MS

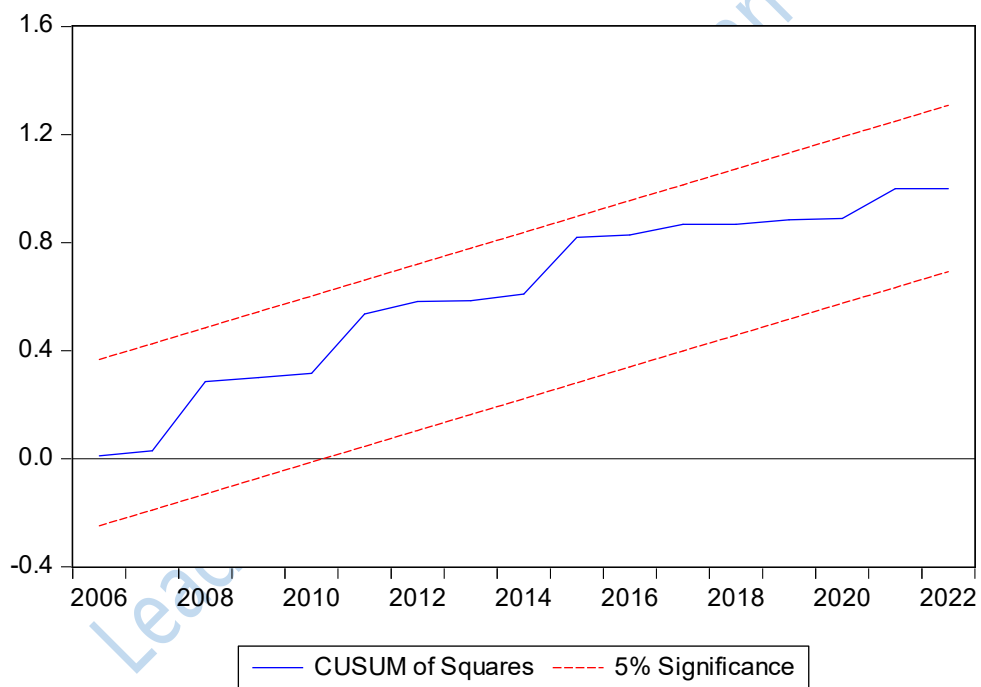
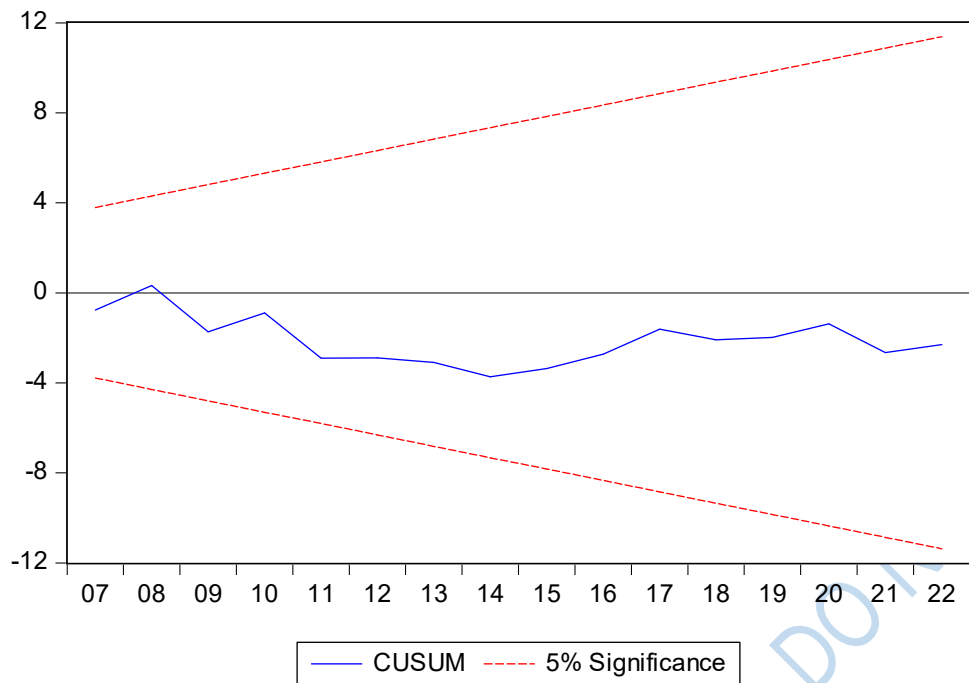
MS(-1) MS(-2) LR LR(-1) LR(-2) C

Omitted Variables: Squares of fitted values

	Value	df	Probability
t-statistic	0.074184	15	0.9418
F-statistic	0.005503	(1, 15)	0.9418

F-test summary:

	Sum of Sq.	df	Mean Squares
Test SSR	0.004607	1	0.004607
Restricted SSR	12.56301	16	0.785188
Unrestricted SSR	12.55840	15	0.837227



Objective 2

Dependent Variable: Y
 Method: ARDL
 Date: 04/13/24 Time: 08:14
 Sample (adjusted): 1993 2022
 Included observations: 30 after adjustments
 Maximum dependent lags: 3 (Automatic selection)
 Model selection method: Akaike info criterion (AIC)
 Dynamic regressors (3 lags, automatic): K L MPR MS LR
 Fixed regressors: C
 Number of models evaluated: 3072
 Selected Model: ARDL(3, 0, 3, 2, 3, 3)

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
Y(-1)	0.359992	0.194429	1.851535	0.0938
Y(-2)	0.339605	0.218090	1.557176	0.1505
Y(-3)	-0.214940	0.139632	-1.539332	0.1547
K	0.025790	0.051373	0.502012	0.6265
L	-0.252412	0.150129	-1.681299	0.1236
L(-1)	0.739365	0.196396	3.764661	0.0037
L(-2)	-0.399189	0.212717	-1.876618	0.0900
L(-3)	-0.345757	0.176527	-1.958659	0.0786
MPR	0.012990	0.179892	0.072209	0.9439
MPR(-1)	0.079448	0.167196	0.475179	0.6449
MPR(-2)	-0.721256	0.182222	-3.958109	0.0027
MS	-0.848450	0.276912	-3.063965	0.0120
MS(-1)	0.317535	0.398958	0.795912	0.4446
MS(-2)	0.962651	0.370203	2.600334	0.0265
MS(-3)	-0.668305	0.205070	-3.258906	0.0086
LR	-0.071492	0.060972	-1.172538	0.2682
LR(-1)	0.179934	0.059101	3.044537	0.0124
LR(-2)	0.160150	0.049656	3.225169	0.0091
LR(-3)	-0.057156	0.034027	-1.679739	0.1239
C	19.90651	7.099909	2.803770	0.0187
R-squared	0.907932	Mean dependent var		4.157630
Adjusted R-squared	0.733002	S.D. dependent var		3.847200
S.E. of regression	1.987920	Akaike info criterion		4.446776
Sum squared resid	39.51826	Schwarz criterion		5.380907
Log likelihood	-46.70164	Hannan-Quinn criter.		4.745613
F-statistic	5.190262	Durbin-Watson stat		2.055299
Prob(F-statistic)	0.005450			

*Note: p-values and any subsequent tests do not account for model selection.

ARDL Long Run Form and Bounds Test

Dependent Variable: D(Y)

Selected Model: ARDL(3, 0, 3, 2, 3, 3)

Case 2: Restricted Constant and No Trend

Date: 04/13/24 Time: 08:14

Sample: 1990 2022

Included observations: 30

Conditional Error Correction Regression

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	19.90651	7.099909	2.803770	0.0187
Y(-1)*	-0.515343	0.143837	-3.582834	0.0050
K**	0.025790	0.051373	0.502012	0.6265
L(-1)	-0.257994	0.161746	-1.595057	0.1418
MPR(-1)	-0.628818	0.204988	-3.067585	0.0119
MS(-1)	-0.236568	0.155189	-1.524387	0.1584
LR(-1)	0.211435	0.059011	3.583006	0.0050
D(Y(-1))	-0.124665	0.204261	-0.610320	0.5553
D(Y(-2))	0.214940	0.139632	1.539332	0.1547
D(L)	-0.252412	0.150129	-1.681299	0.1236
D(L(-1))	0.744946	0.177394	4.199398	0.0018
D(L(-2))	0.345757	0.176527	1.958659	0.0786
D(MPR)	0.012990	0.179892	0.072209	0.9439
D(MPR(-1))	0.721256	0.182222	3.958109	0.0027
D(MS)	-0.848450	0.276912	-3.063965	0.0120
D(MS(-1))	-0.294346	0.275560	-1.068174	0.3105
D(MS(-2))	0.668305	0.205070	3.258906	0.0086
D(LR)	-0.071492	0.060972	-1.172538	0.2682
D(LR(-1))	-0.102993	0.047743	-2.157225	0.0564
D(LR(-2))	0.057156	0.034027	1.679739	0.1239

* p-value incompatible with t-Bounds distribution.

** Variable interpreted as $Z = Z(-1) + D(Z)$.

Levels Equation

Case 2: Restricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
K	0.050044	0.100044	0.500217	0.6277
L	-0.500625	0.291319	-1.718477	0.1165
MPR	-1.220193	0.493207	-2.473996	0.0329
MS	-0.459050	0.350325	-1.310354	0.2194
LR	0.410280	0.151310	2.711516	0.0219
C	38.62768	12.52466	3.084130	0.0116

$$EC = Y - (0.0500*K - 0.5006*L - 1.2202*MPR - 0.4590*MS + 0.4103*LR + 38.6277)$$

F-Bounds Test

Null Hypothesis: No levels relationship

Test Statistic	Value	Signif.	I(0)	I(1)
----------------	-------	---------	------	------

Asymptotic:

F-statistic	4.528232	10%	n=1000	2.08	3
K	5	5%		2.39	3.38
		2.5%		2.7	3.73
		1%		3.06	4.15
Actual Sample Size	30		Finite Sample: n=30		
		10%		2.407	3.517
		5%		2.91	4.193
		1%		4.134	5.761

ARDL Error Correction Regression
 Dependent Variable: D(Y)
 Selected Model: ARDL(3, 0, 3, 2, 3, 3)
 Case 2: Restricted Constant and No Trend
 Date: 04/13/24 Time: 08:15
 Sample: 1990 2022
 Included observations: 30

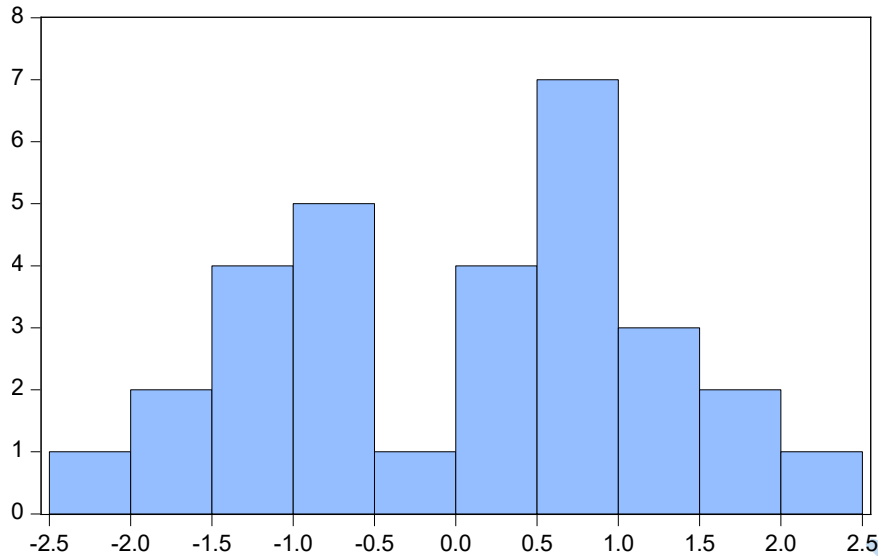
ECM Regression					
Case 2: Restricted Constant and No Trend					
Variable	Coefficient	Std. Error	t-Statistic	Prob.	
D(Y(-1))	-0.124665	0.127110	-0.980760	0.3498	
D(Y(-2))	0.214940	0.096081	2.237074	0.0492	
D(L)	-0.252412	0.102156	-2.470860	0.0331	
D(L(-1))	0.744946	0.119356	6.241381	0.0001	
D(L(-2))	0.345757	0.108470	3.187588	0.0097	
D(MPR)	0.012990	0.103114	0.125975	0.9022	
D(MPR(-1))	0.721256	0.115837	6.226485	0.0001	
D(MS)	-0.848450	0.168310	-5.041004	0.0005	
D(MS(-1))	-0.294346	0.186700	-1.576575	0.1460	
D(MS(-2))	0.668305	0.151953	4.398109	0.0013	
D(LR)	-0.071492	0.030462	-2.346947	0.0409	
D(LR(-1))	-0.102993	0.034536	-2.982159	0.0138	
D(LR(-2))	0.057156	0.024289	2.353205	0.0404	
CointEq(-1)*	-0.515343	0.072364	-7.121530	0.0000	
R-squared	0.889258	Mean dependent var	-0.045984		
Adjusted R-squared	0.799279	S.D. dependent var	3.507865		
S.E. of regression	1.571589	Akaike info criterion	4.046776		
Sum squared resid	39.51826	Schwarz criterion	4.700668		
Log likelihood	-46.70164	Hannan-Quinn criter.	4.255962		
Durbin-Watson stat	2.055299				

* p-value incompatible with t-Bounds distribution.

F-Bounds Test		Null Hypothesis: No levels relationship		
Test Statistic	Value	Signif.	I(0)	I(1)
F-statistic	4.528232	10%	2.08	3
k	5	5%	2.39	3.38

2.5%	2.7	3.73
1%	3.06	4.15

Lead City University Ibadan DO NOT COPY



Series: Residuals	
Sample 1993 2022	
Observations 30	
Mean	0.000000
Median	0.087709
Maximum	2.287148
Minimum	-2.178107
Std. Dev.	1.167347
Skewness	0.047703
Kurtosis	2.127081
Jarque-Bera	0.963863
Probability	0.617589

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	0.796013	Prob. F(2,5)	0.5010
Obs*R-squared	7.003728	Prob. Chi-Square(2)	0.0301

Heteroskedasticity Test: Breusch-Pagan-Godfrey

F-statistic	0.926218	Prob. F(19,10)	0.5771
Obs*R-squared	19.12970	Prob. Chi-Square(19)	0.4485
Scaled explained SS	1.197818	Prob. Chi-Square(19)	1.0000

Ramsey RESET Test

Equation: UNTITLED

Specification: Y Y(-1) Y(-2) Y(-3) K L L(-1) L(-2) L(-3) MPR MPR(-1)

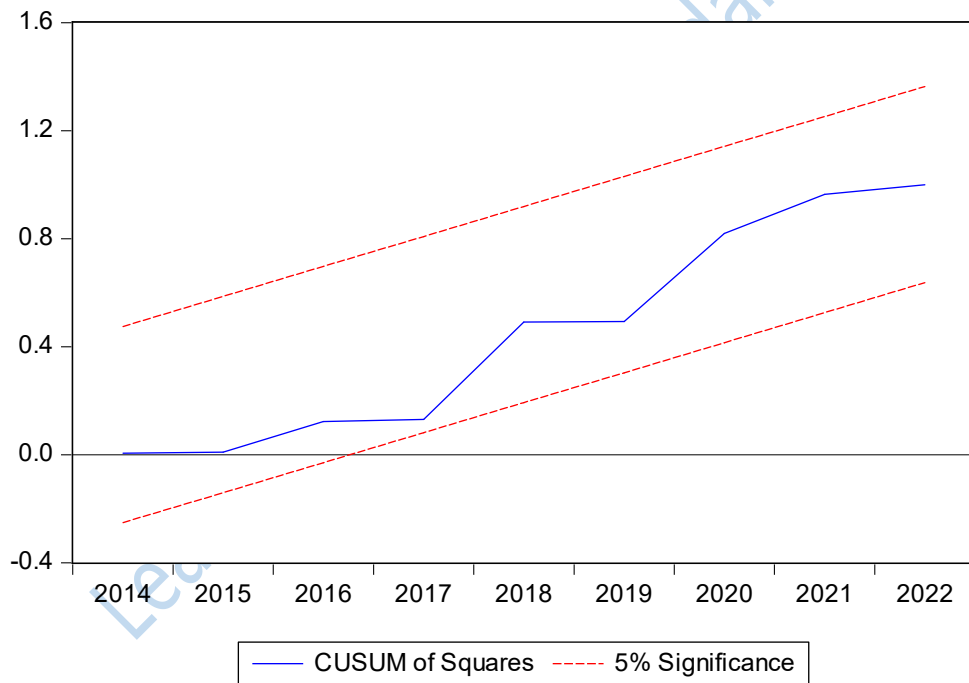
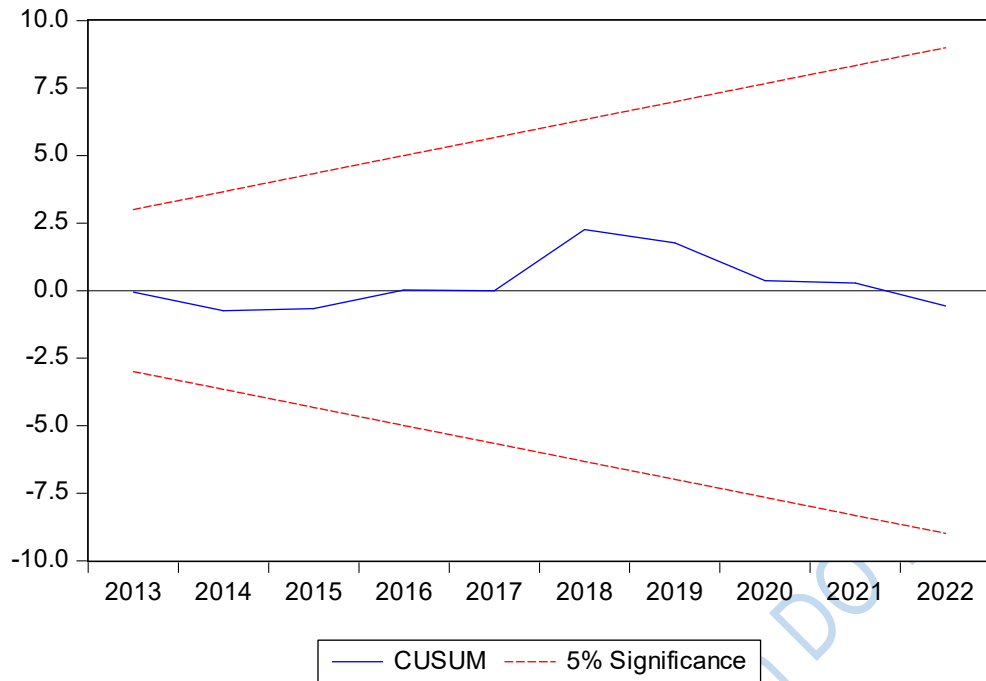
MPR(-2) MS MS(-1) MS(-2) MS(-3) LR LR(-1) LR(-2) LR(-3) C

Omitted Variables: Squares of fitted values

	Value	df	Probability
t-statistic	1.032319	9	0.3289
F-statistic	1.065682	(1, 9)	0.3289

F-test summary:

	Sum of Sq.	df	Mean Squares
Test SSR	4.183908	1	4.183908
Restricted SSR	39.51826	10	3.951826
Unrestricted SSR	35.33435	9	3.926039



Objective 3

Dependent Variable: Y
 Method: ARDL
 Date: 04/13/24 Time: 08:21
 Sample (adjusted): 1993 2022
 Included observations: 30 after adjustments
 Maximum dependent lags: 3 (Automatic selection)
 Model selection method: Akaike info criterion (AIC)
 Dynamic regressors (3 lags, automatic): K L REN NEN
 Fixed regressors: C
 Number of models evaluated: 768
 Selected Model: ARDL(1, 3, 2, 3, 0)

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
Y(-1)	0.623156	0.165141	3.773481	0.0017
K	-0.139599	0.057966	-2.408269	0.0284
K(-1)	-0.375769	0.076076	-4.939389	0.0001
K(-2)	-0.295859	0.072595	-4.075466	0.0009
K(-3)	-0.282085	0.066664	-4.231423	0.0006
L	-0.216739	0.129374	-1.675289	0.1133
L(-1)	0.046724	0.169588	0.275512	0.7864
L(-2)	-0.335873	0.143626	-2.338522	0.0327
REN	-0.051236	0.469614	-0.109102	0.9145
REN(-1)	-1.318381	0.497230	-2.651453	0.0174
REN(-2)	0.836976	0.445976	1.876731	0.0789
REN(-3)	-1.341185	0.373209	-3.593653	0.0024
NEN	-1.366272	0.386338	-3.536472	0.0027
C	219.6520	65.04442	3.376954	0.0038
R-squared	0.804726	Mean dependent var		4.157630
Adjusted R-squared	0.646067	S.D. dependent var		3.847200
S.E. of regression	2.288788	Akaike info criterion		4.798647
Sum squared resid	83.81681	Schwarz criterion		5.452539
Log likelihood	-57.97970	Hannan-Quinn criter.		5.007832
F-statistic	5.072024	Durbin-Watson stat		2.201706
Prob(F-statistic)	0.001484			

*Note: p-values and any subsequent tests do not account for model selection.

ARDL Long Run Form and Bounds Test

Dependent Variable: D(Y)
 Selected Model: ARDL(1, 3, 2, 3, 0)
 Case 2: Restricted Constant and No Trend
 Date: 04/13/24 Time: 08:21
 Sample: 1990 2022
 Included observations: 30

Conditional Error Correction Regression				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	219.6520	65.04442	3.376954	0.0038
Y(-1)*	-0.376844	0.165141	-2.281959	0.0365
K(-1)	-1.093311	0.231087	-4.731176	0.0002
L(-1)	-0.505888	0.178224	-2.838495	0.0119

REN(-1)	-1.873825	0.598901	-3.128770	0.0065
NEN**	-1.366272	0.386338	-3.536472	0.0027
D(K)	-0.139599	0.057966	-2.408269	0.0284
D(K(-1))	0.577944	0.124855	4.628917	0.0003
D(K(-2))	0.282085	0.066664	4.231423	0.0006
D(L)	-0.216739	0.129374	-1.675289	0.1133
D(L(-1))	0.335873	0.143626	2.338522	0.0327
D(REN)	-0.051236	0.469614	-0.109102	0.9145
D(REN(-1))	0.504209	0.375948	1.341164	0.1986
D(REN(-2))	1.341185	0.373209	3.593653	0.0024

* p-value incompatible with t-Bounds distribution.

** Variable interpreted as $Z = Z(-1) + D(Z)$.

Levels Equation
Case 2: Restricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
K	-2.901226	1.513389	-1.917039	0.0733
L	-1.342431	0.534077	-2.513551	0.0230
REN	-4.972410	2.263306	-2.196967	0.0431
NEN	-3.625560	1.987606	-1.824083	0.0869
C	582.8718	258.2346	2.257141	0.0383

$$EC = Y - (-2.9012 * K - 1.3424 * L - 4.9724 * REN - 3.6256 * NEN + 582.8718)$$

F-Bounds Test Null Hypothesis: No levels relationship

Test Statistic	Value	Signif.	I(0)	I(1)
Asymptotic: n=1000				
F-statistic k	6.258466 4	10%	2.2	3.09
		5%	2.56	3.49
		2.5%	2.88	3.87
		1%	3.29	4.37
Finite Sample: n=30				
Actual Sample Size	30	10%	2.525	3.56
		5%	3.058	4.223
		1%	4.28	5.84

ARDL Error Correction Regression

Dependent Variable: D(Y)

Selected Model: ARDL(1, 3, 2, 3, 0)

Case 2: Restricted Constant and No Trend

Date: 04/13/24 Time: 08:22

Sample: 1990 2022

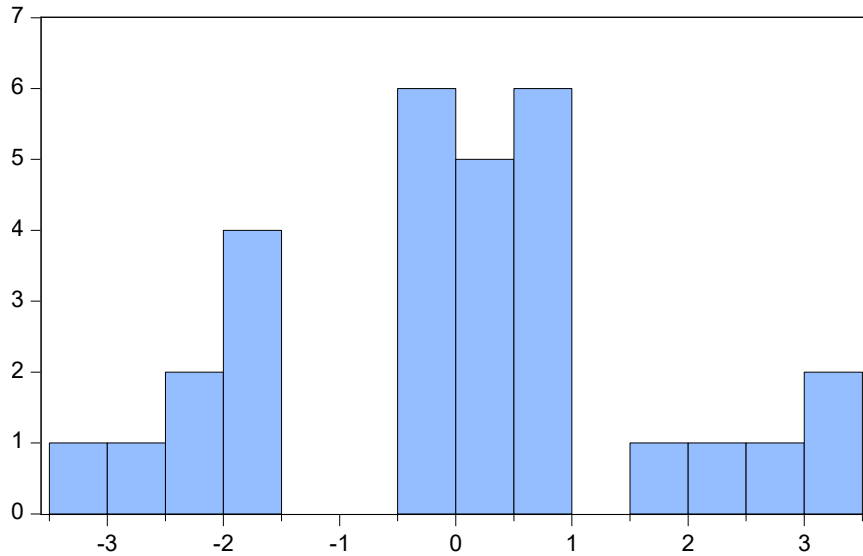
Included observations: 30

ECM Regression
Case 2: Restricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(K)	-0.139599	0.043335	-3.221411	0.0053
D(K(-1))	0.577944	0.089099	6.486504	0.0000
D(K(-2))	0.282085	0.049310	5.720668	0.0000
D(L)	-0.216739	0.096737	-2.240489	0.0396
D(L(-1))	0.335873	0.103674	3.239701	0.0051
D(REN)	-0.051236	0.277602	-0.184566	0.8559
D(REN(-1))	0.504209	0.251093	2.008055	0.0618
D(REN(-2))	1.341185	0.277100	4.840069	0.0002
CointEq(-1)*	-0.376844	0.053679	-7.020358	0.0000
R-squared	0.765119	Mean dependent var	-0.045984	
Adjusted R-squared	0.675641	S.D. dependent var	3.507865	
S.E. of regression	1.997818	Akaike info criterion	4.465313	
Sum squared resid	83.81681	Schwarz criterion	4.885672	
Log likelihood	-57.97970	Hannan-Quinn criter.	4.599790	
Durbin-Watson stat	2.201706			

* p-value incompatible with t-Bounds distribution.

F-Bounds Test		Null Hypothesis: No levels relationship		
Test Statistic	Value	Signif.	I(0)	I(1)
F-statistic	6.258466	10%	2.2	3.09
k	4	5%	2.56	3.49
		2.5%	2.88	3.87
		1%	3.29	4.37



Series: Residuals	
Sample 1993 2022	
Observations 30	
Mean	-2.65e-14
Median	0.095660
Maximum	3.438342
Minimum	-3.357997
Std. Dev.	1.700069
Skewness	0.042085
Kurtosis	2.631258
Jarque-Bera	0.178819
Probability	0.914471

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	0.259083	Prob. F(2,14)	0.7754
Obs*R-squared	1.070726	Prob. Chi-Square(2)	0.5855

Heteroskedasticity Test: Breusch-Pagan-Godfrey

F-statistic	0.700551	Prob. F(13,16)	0.7384
Obs*R-squared	10.88195	Prob. Chi-Square(13)	0.6207
Scaled explained SS	2.524624	Prob. Chi-Square(13)	0.9992

Ramsey RESET Test

Equation: UNTITLED

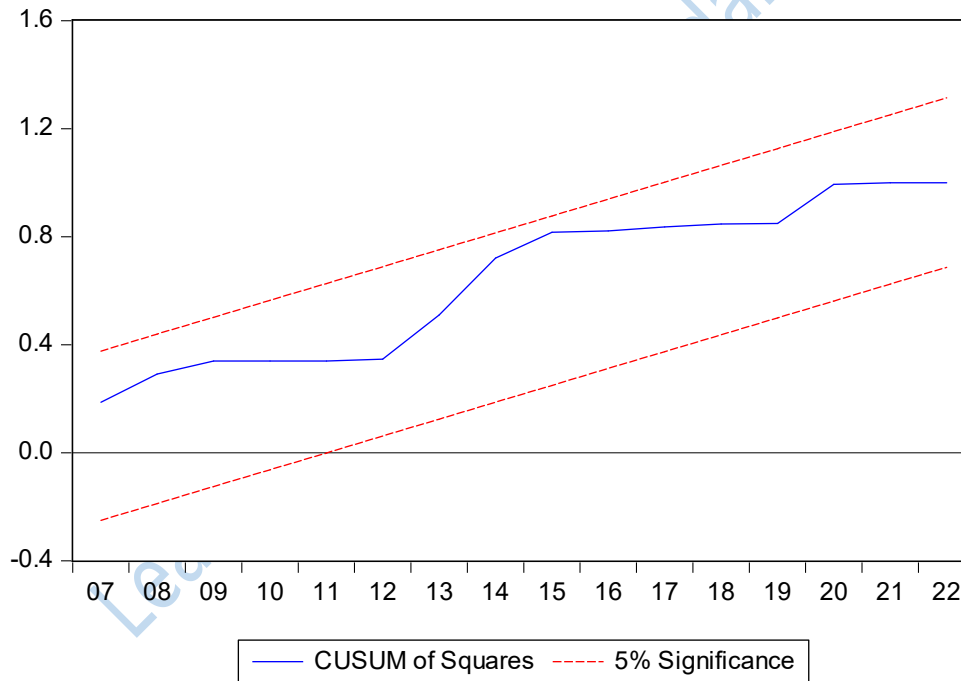
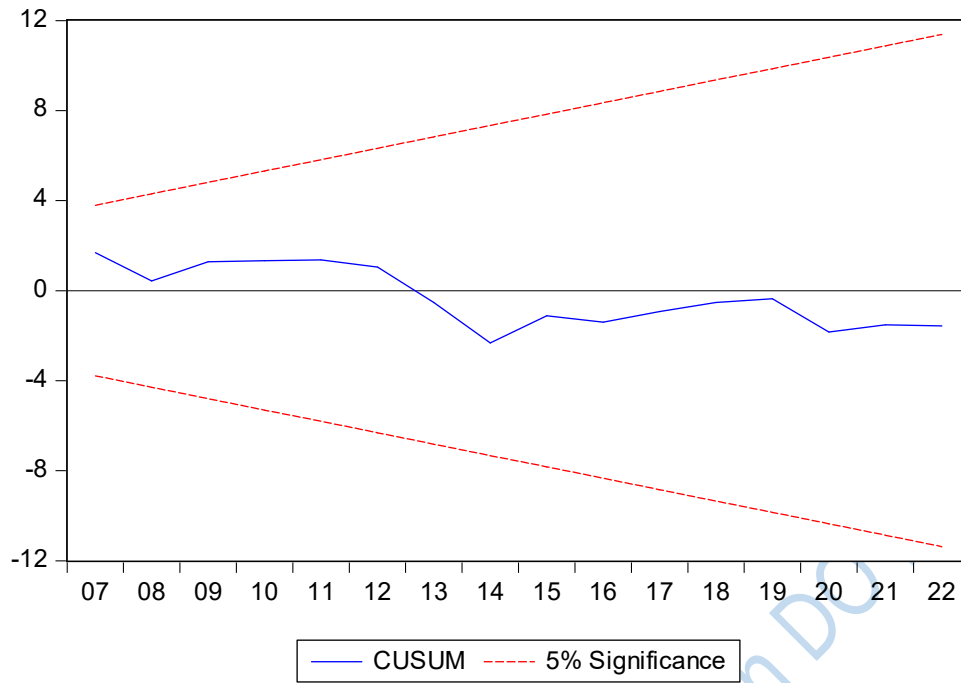
Specification: Y Y(-1) K K(-1) K(-2) K(-3) L L(-1) L(-2) REN REN(-1)
REN(-2) REN(-3) NEN C

Omitted Variables: Squares of fitted values

	Value	df	Probability
t-statistic	0.379153	15	0.7099
F-statistic	0.143757	(1, 15)	0.7099

F-test summary:

	Sum of Sq.	df	Mean Squares
Test SSR	0.795660	1	0.795660
Restricted SSR	83.81681	16	5.238550
Unrestricted SSR	83.02115	15	5.534743



Objective 4

VAR Lag Order Selection Criteria

Endogenous variables: Y K L REN NEN MPR MS LR

Exogenous variables: C

Date: 04/13/24 Time: 08:29

Sample: 1990 2022

Included observations: 31

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-716.3171	NA	2.72e+10	46.73014	47.10020	46.85077
1	-594.7928	172.4861	7.63e+08	43.01889	46.34944*	44.10457
2	-486.1742	98.10711*	1.10e+08*	40.14027*	46.43131	42.19100*

* indicates lag order selected by the criterion

LR: sequential modified LR test statistic (each test at 5% level)

FPE: Final prediction error

AIC: Akaike information criterion

SC: Schwarz information criterion

HQ: Hannan-Quinn information criterion

Long run causality tests

VAR Granger Causality/Block Exogeneity Wald Tests

Date: 04/13/24 Time: 08:31

Sample: 1990 2022

Included observations: 31

Dependent variable: Y

Excluded	Chi-sq	df	Prob.
REN	6.099909	2	0.0474
NEN	7.367361	2	0.0251
MPR	1.926672	2	0.3816
MS	0.019250	2	0.9904
LR	8.184002	2	0.0167
All	17.80710	10	0.0583

Dependent variable: REN

Excluded	Chi-sq	df	Prob.
Y	1.126955	2	0.5692
NEN	7.042639	2	0.0296
MPR	3.441490	2	0.1789
MS	1.790360	2	0.4085
LR	1.072111	2	0.5851

All	16.38367	10	0.0892
-----	----------	----	--------

Dependent variable: NEN

Excluded	Chi-sq	df	Prob.
Y	0.749268	2	0.6875
REN	3.209980	2	0.2009
MPR	2.651446	2	0.2656
MS	4.049655	2	0.1320
LR	3.460239	2	0.1773
All	19.78535	10	0.0313

Dependent variable: MPR

Excluded	Chi-sq	df	Prob.
Y	7.614909	2	0.0222
REN	0.430888	2	0.8062
NEN	7.109938	2	0.0286
MS	2.316165	2	0.3141
LR	1.950941	2	0.3770
All	19.00490	10	0.0402

Dependent variable: MS

Excluded	Chi-sq	df	Prob.
Y	0.136876	2	0.9339
REN	1.246725	2	0.5361
NEN	3.605749	2	0.1648
MPR	8.773708	2	0.0124
LR	5.065992	2	0.0794
All	20.95968	10	0.0214

Dependent variable: LR

Excluded	Chi-sq	df	Prob.
Y	0.448639	2	0.7991
REN	0.031276	2	0.9845
NEN	0.797522	2	0.6712
MPR	0.869079	2	0.6476
MS	0.360144	2	0.8352
All	9.689436	10	0.4681

Short run causality tests

VEC Granger Causality/Block Exogeneity Wald Tests

Date: 04/13/24 Time: 09:14

Sample: 1990 2022

Included observations: 30

Dependent variable: D(Y)

Excluded	Chi-sq	df	Prob.
D(REN)	1.610268	2	0.4470
D(NEN)	0.545828	2	0.7612
D(MPR)	1.779046	2	0.4109
D(MS)	1.180762	2	0.5541
D(LR)	4.932715	2	0.0849
All	12.20979	10	0.2713

Dependent variable: D(REN)

Excluded	Chi-sq	df	Prob.
D(Y)	16.92497	2	0.0002
D(NEN)	2.629030	2	0.2686
D(MPR)	0.306472	2	0.8579
D(MS)	1.180457	2	0.5542
D(LR)	14.56709	2	0.0007
All	30.73828	10	0.0006

Dependent variable: D(NEN)

Excluded	Chi-sq	df	Prob.
D(Y)	8.153428	2	0.0170
D(REN)	2.678492	2	0.2620
D(MPR)	0.845560	2	0.6552
D(MS)	0.114639	2	0.9443
D(LR)	7.075869	2	0.0291
All	17.24662	10	0.0691

Dependent variable: D(MPR)

Excluded	Chi-sq	df	Prob.
D(Y)	9.029151	2	0.0109
D(REN)	0.154261	2	0.9258
D(NEN)	4.217732	2	0.1214
D(MS)	1.469357	2	0.4797
D(LR)	0.340806	2	0.8433
All	15.91534	10	0.1021

Dependent variable: D(MS)

Excluded	Chi-sq	df	Prob.
D(Y)	4.693385	2	0.0957
D(REN)	9.825725	2	0.0074
D(NEN)	10.18636	2	0.0061
D(MPR)	2.024646	2	0.3634
D(LR)	6.963675	2	0.0308
All	15.34600	10	0.1199

Dependent variable: D(LR)

Excluded	Chi-sq	df	Prob.
D(Y)	0.139745	2	0.9325
D(REN)	2.946742	2	0.2292
D(NEN)	0.227743	2	0.8924
D(MPR)	3.812763	2	0.1486
D(MS)	2.840454	2	0.2417
All	8.175395	10	0.6117

Lead City University Ibadan DO NOT COPY

Bio-Data

SURNAME: Akinwale
OTHER NAMES: Obiwumi Gboyega
DATE OF BIRTH: 21st May, 1982
SEX: Male
STATE OF ORIGIN: Osun State
HOME TOWN: Ipetumodu
PLACE OF BIRTH: Ibadan, Nigeria
MARITAL STATUS: Married
NATIONALITY: Nigerian
Email Address : Gboyega.akinwale@gmail.com

SCHOOLS ATTENDED	QUALIFICATION	DATES
Ladoke Akintola University Ogbomosho	PGDE	2012
Joseph Ayo Babalola University	BSC	2014
Federal Polytechnic, Offa	H.N.D Banking & Finance	2006
Federal Polytechnic, Offa	O.N.D Banking & Finance	2003
L A Secondary Grammar School Ipetumodu	S.S.C.E	1998
St Augustine Pry School Ipetumodu	PRIMARY CERTIFICATE	1992

WORK EXPERIENCE

ESTABLISHMENT	POST HELD	DATE
Accion Microfinance bank	Head Facilities Mgt & Admin	June 2023-till date
Fidelity Bond Group Lagos	GH, Bus. Dev Research & Planning,	Jan -May 2023
Total Secure Nigeria Ltd Abuja	GH, Admin,	Sept – Dec 2022

Head Admin & Facilities Management

Accion Microfinance bank – 154 Ikorodu Ososun road Onipanu Lagos

Facilities management

- To manage the delivery of a range of facilities management services, including office premises, furniture, equipment and vehicle to ensure that the premises provide a high quality, comfortable, safe and efficient working environment for all staff, customers and visitors.
- To oversee the management of outsourced cleaning and security staff and services.
- To ensure that the premises comply with corporate guidelines, values, health and safety legislation and are fit for purpose and safe for staff, customers and visitors.
- Maintenance of continuous, high quality service delivery including periodic reviews of premises and its furniture and equipment to monitor standards (good condition and well maintained); repairs instigated or improvements proposed as necessary
- Maintenance, safety, security and management of office premises and ACCION International appointed staff accommodation in accordance with management and maintenance plans
- Quarterly reviews of outsourced security and cleaning services performance to ensure all duties carried out in accordance with contract. Outsourced staff managed to Accion MfB standards
- Fixed asset and inventories are accurate and up to date. At least one annual inventory check carried out and the quality of inventory record keeping monitored each quarter.
- Service Level of Agreement updated and annual review carried out to make sure agreed service levels are met or exceeded. Annual survey on internal and external customer satisfaction carried out and improvements proposed as necessary as part of annual concession renewal process.
- Advice provided to the GHO on relevant legislation relating to facilities management and leases where necessary.

Administration

- To manage the delivery of a range of administration services, including office contracts and provision of admin management information. To contribute to building and maintaining relationships with stakeholders (customers, business partners and Vendors) which enhance Accion MfB's operation. To ensure that staff and other stakeholders are

satisfied with services provided.

- Coordinate the vendors presentations on contracts to be issued to new vendors by the bank on behalf of various stakeholders
- Property register and preferred Vendors contracts list meet corporate standards. Corporate prices negotiated and contracts and leases prepared for AI appointed and contracted staff for MD/CEO approval when required. Ensure new Vendors to be added to the Approved Preferred Vendors list within 5 working days of contract signing or approval by MD/CEO.
- Office premises leases, contracts and service level agreements are administered according to Corporate Guideline and provide demonstrable value for money with preferred Vendors used, quotations analyzed and financial threshold requirement met.
- At least one review of service contracts conducted every year to ensure value for money and to manage Vendors' performance to ensure agreed standards of services are provided
- Office contacts database regularly updated and relationships well maintained. Feedback obtained from customers, business partners and other stakeholders is acted on
- Coordinate the CBN memo approval for the registration of new locations or change of locations to the HOD
- Review and regular update the Business Continuity Plan, and ensure its effective communication and understanding across the operation
- Effective coordination of outsourced staff, their welfare and remuneration
- The office vehicle is kept in good condition at all times. Weekly check of the vehicle log for journeys, repair, maintenance and other expenses for audit purposes.

Environmental Framework and Business Risk Management

- Health, Safety, Risk Management policy, and practices implemented for current premises and premises related projects. Emergency evacuation drill carried out at least twice a year.
- Briefing on Health & Safety for all staff done annually, First Aid Officer and Fire Fighting Officers training organized annually. Fire extinguishers, alarm system and other security systems checked monthly
- Ensure regular certification of the Building for fire safety

Monitoring and Forecasting

- Annual preparation & coordination of financial budgets for the general admin and facilities of the bank
- Budget allowances for all ACCION International Appointed staff related to housing, facilities and related services monitored by checking monthly management account reports.
- Approvals are obtained for all expenditure and in line with the approved budgets
- Office premises and general running costs monitored by checking monthly management account reports.

Branch Expansion Officer

Accion Microfinance bank – 154 Ikorodu Ososun road Onipanu Lagos

Maintains of all bank equipment (AMFB Nigeria), monitoring conditions and arranging for procurement, disposal, and reallocation as necessary.

Procurement of all bank assets

Updates office and residential property inventories and procures office supplies.

Manages vendors at all properties, including works scheduling, supervision, and branch Renovation & remodeling.

Property management on maintenance and projects across the bank.

Updates emergency plans and rosters while conducting weekly inspections of health and safety systems to ensure peak operating efficiency.

Executes BOQ, purchase order requisitioning and receiving and provides first level support to other staff within the accounting and PO management system.

Contributes to development of Bank business plan.

Secretary to Bank committee on Branch Expansion programs

Participates in monthly Post Management Committee meetings and assists with implementing decisions taken during PMC.

GROUP ADMINISTRATIVE EXECUTIVE.

Total Secure Nigeria Ltd, / Transblue Nigeria Ltd /Virtual Switch Ltd -Abuja.

Ensure organized office operations and procedures.

Procurement of Company assets.

Manage contract and price negotiations with office vendors, service providers.

Maintain a safe and secure working environment.

Manage relationships with vendors and ensuring that all items are invoiced and paid on time.

Daily spot check of office facilities and ensuring that the office is in good working condition.

Participate actively in the planning and execution of company events.

Monitor and maintain office supplies inventory.

Coordinate repairs and maintenance of office facilities and office equipment.

Oversee and supervise office janitorial activities.

Repair and maintenance of company vehicles.

Supervise the refueling of all vehicles.

Supervise and coordinates operational activities of engaged outsourced workers.

Review monthly fuel reports for all company vehicles and track generator diesel consumption.

Supervise drivers, receptionists, and office assistants, and manage the office equipment.

Ensure that all company vehicles are serviced as at when due.

Ensure that all vehicle documents are up to date, and renewals made on or before expiry date.

Organizing travel arrangement for staff and management.

Partner with HR to maintain office policies as necessary.

Ensuring proper protocol and logistics arrangement (hotel accommodation, airport pick-up) for all staff, consultants and senior management team.

Arrange hotel accommodation for staff and expatriates.

Coordinate staff travel, book tickets per the itinerary, and assist with hotel pickup.

Review accuracy and completeness of specifications of goods to be procured.

Prepare requests for quotes (RFQ) to be sent out to approved vendors.

Receive quotation on the approved purchase request form (PRF) for purchasing goods

and services.

Review, compare, and analyze products to be supplied by vendors and make recommendations.

Prepare purchase orders (PO) and process payments to vendors upon complete delivery of goods.

Maintain procurement database including vendor list and standards of goods and service.

Monitors the market for goods and services to determine current prices.

Prepare the weekly procurement status report for the department.

REGIONAL CORPORATE SERVICE OFFICER/FACILITIES MANAGER

United Bank for Africa, Ibadan.

Maintains equipment and furnishing at the office (UBA Southwest Zone), monitoring conditions and arranging for procurement, disposal, and reallocation as necessary.

Procurement of all bank assets

Arrange for executive escorts for senior management team across Southwest zone.

Arrange for armed police and private security guards for all UBA southwest zone branch.

Updates office and residential property inventories and procures office supplies.

Manages vendors at all properties, including works scheduling, supervision, and escorting.

Liaises with the property management on maintenance and projects in the business office.

Updates emergency plans and rosters while conducting weekly inspections of health and safety systems to ensure peak operating efficiency.

Executes purchase order requisitioning and receiving and provides first level support to other staff within the accounting and PO management system.

Contributes to development of Corporate Services business plan.

Participates in monthly Post Management Committee meetings and assists with implementing decisions taken during PMC.

Supports the Corporate Service Director by ensuring an efficient and smoothly running business office.

Updates induction materials and rosters and participates in the onboarding of new staff, including full-time employees, temporary staff, short-term assignments, and interns.

Assists with staff/management officer arrivals, departures, unaccompanied air freight, and heavy baggage.

Assists with large purchases and compliance, bidding for medium to large projects in the office in compliance with procurement guidance.

Assists with researching suitable rental accommodation, both temporary and permanent.

Liaises with occupants and vendors on maintenance works scheduling and execution.

Supports a well-managed security environment at Post by working with staff to ensure that physical and information security procedures are understood and in compliance, escalating concerns or gaps in security to the Corporate Service Director.

Updates Post crisis management annex as directed while maintaining up-to-date rosters, phone trees, and contact information for all staff. In a crisis, assumes IT and logistics responsibilities reporting to Corporate Service Director's crisis role.

CUSTOMER SERVICE OFFICER & ACCOUNT OFFICER

United Bank for Africa, Ibadan.

Communicating with customers to resolve issues or concerns regarding products or accounts, such as opening new accounts or transferring funds between accounts.

Acquisition of (sustainable) new to Bank business Account

Identifying market opportunities and engagement for acquisition drive

Processing transactions such as deposits, withdrawals, or loan payments on behalf of customers.

Processing wire transfers and other complex transactions.

Reviewing account statements and other financial documents to ensure accuracy of entries.

Performing cash handling duties, such as processing payments from customers using automated tellermachines (ATMs) or hand-held devices.

Business Development and Strategy Formation.

Weekly Tracking of business activities.

Rendition of Weekly Report to Regional head.

Product tweaking to meet Clients-demand while ensuring maximum return on assets for bank.

Providing information about bank products and services to potential clients.

Processing account transactions such as deposits, withdrawals, or loan payments on behalf of customers.

Responding to inquiries about account balances and other general customer service inquiries.

Maintaining accurate records of account activity and transactions to ensure compliance with industrystandards and regulations

BANK TELLER

United Bank for Africa, Ibadan.

Recording transactions, which involves logging checks and preparing transaction reports.

Opening new accounts and helping with loan applications.

Foreign currency exchange.

Reconciling cash drawers.

Counting and packaging currency.

Independently executes tasks related to general office administration.

Filling out paperwork/deposit and withdrawal slips.

Overseeing ATM deposits and withdrawals.

Balancing numbers at the end of the business day.

Money gram and western union payment.

Issuing of receipt to customers.

EDUCATION:

Lead City University, Ibadan.

MSc. In View. Economics (2023)

Josph Ayo Babalola University, Arakeji, Osun State.

BSc. Economics (2014)

Federal Polytechnic, Offa, Kwara State.

HND Banking & Finance (2006)

PROFESSIONAL CERTIFICATION :

Chartered Institute of Professional Manager and Administration- FIPMA & FAISM

Fellow on the Institute (2023)

Chartered Institute of Contract Project and Facility Management. - FCICPFM

Fellow on the Institute (2023)

Project Management Professional – PMP.

Chartered Institute of Human Resources Manager - FCIHRM

Fellow on the Institute (2023)

Certified Personnel Manager - CPM..

TECHNICAL SKILLS:

- Procurement procedures, Logistics, Administrative procedures, Inventory management, Budgeting, Fleet management, Proficient in MS Office (MS Word, Excel, PowerPoint, Outlook),Facilities management

INTER-PERSONAL SKILLS:

- Excellent communication skills, Proactive, Team player, English language proficiency, Resourcefulness, Time management skills, Self-motivated, Attention to detail
- Problem-solving, Ability to prioritize multiple responsibilities, and work with minimal or no supervision.

RESEARCH HANDLED

1. Monetary Policy, Energy Consumption and Economic Growth in Nigeria
2. Implication of interest rate reforms on private investment and economic growth in Nigeria (1980 – 2011)
3. Importance & effect of CBN recapitalization on Nigeria economy

Student

Date

University Compliance Certification

This is to certify that this thesis written by Obiwumi Gboyega AKINWALE with Matric No. LCU/PG/003121 in Department of Economics and Development Studies, Faculty of Management and Social Sciences Lead City University, Ibadan, Oyo State, is in full compliance with the approved University format and style.

Signature

Date