<table>
<thead>
<tr>
<th>Author</th>
<th>ASOGWA, Fredrick Onyebuchi</th>
</tr>
</thead>
<tbody>
<tr>
<td>PG/Ph.D/04/35693</td>
<td></td>
</tr>
<tr>
<td>Faculty</td>
<td>Social Sciences</td>
</tr>
<tr>
<td>Department</td>
<td>Economics</td>
</tr>
<tr>
<td>Date</td>
<td>August, 2008</td>
</tr>
</tbody>
</table>
MACROECONOMIC VARIABLES, VOLATILITY AND ECONOMIC GROWTH IN NIGERIA (1970 – 2005)

A Ph.D. THESIS

BY

ASOGWA, FREDRICKONYEBUCHI
PG/Ph.D/04/35693

DEPARTMENT OF ECONOMICS
UNIVERSITY OF NIGERIA, NSUKKA

SUPERVISOR: PROFESSOR C.C. AGU

AUGUST, 2008
MACROECONOMIC VARIABLES, VOLATILITY
AND ECONOMIC GROWTH IN NIGERIA
(1970-2005)

A Ph.D Thesis Report Presented to the Department of
Economics, University of Nigeria, Nsukka.

In Partial fulfillment for the award of Doctor of
Philosophy (Ph.D) in Economics

By

ASOGWA, FREDRICK ONYEBUCHI
PG/Ph.D/04/35693
APPROVAL PAGE

Prof C.C. Agu
Supervisor

Prof Ekezie Onah
Head, Department of Economics

Internal Examiner

External Examiner

28.08.08
# TABLE OF CONTENTS

List of Tables........................................................................................................... i  
List of graphs........................................................................................................... ii  
Abstract................................................................................................................... iii  

## CHAPTER ONE

1.1.1 Background of the study............................................................................. 1  
1.1.2 Statement of research problem................................................................. 3  
1.1.3 Research objectives.................................................................................... 8  
1.5 Research hypothesis...................................................................................... 8  
1.6 Significance of the Study.............................................................................. 8  

## CHAPTER TWO

Review of Related literature................................................................................. 9  
2.1 Theoretical Literature.................................................................................. 9  
2.1.1 Stylized Facts of Growth.......................................................................... 9  
2.1.2 Harrod- Domar Growth Model.................................................................. 10  
2.1.3 The Solow-Swan Growth Model............................................................... 12  
2.1.4 The endogenous Growth Model.................................................................. 16  
2.2 Empirical Review......................................................................................... 18  
2.3 Shortcomings of previous work..................................................................... 31  

## CHAPTER THREE

METHODOLOGY
3.1 Methodological Framework......................................................................... 32  
3.2 The Models.................................................................................................. 33  
3.3 Unit Root Test.............................................................................................. 34  
3.4 Cointegration Test......................................................................................... 34  
3.5 Model Specification...................................................................................... 35  
3.5.1 Exponential GARCH (EGARCH) Model.................................................... 35  
3.5.2 Vector Error Correction (VEC) Model..................................................... 36  
3.6 Estimation.................................................................................................... 38  
3.7 Data............................................................................................................. 38  

## CHAPTER FOUR

PRESENTATION AND ANALYSIS OF RESULTS..................................................... 39  
4.1 Battery Test................................................................................................. 39  
4.1.1 Unit Root Test.......................................................................................... 39  
4.1.2 Cointegration Test.................................................................................... 43  
4.2 Results of the GARCH Models...................................................................... 45  
4.3 Results of the VAR Model............................................................................ 46  
4.4 The results of the VEC Model....................................................................... 48  
4.5 Evaluation of Hypothesis.............................................................................. 50  

## CHAPTER FIVE

SUMMARY, POLICY IMPLICATIONS AND CONCLUSION................................. 53  
5.1 Summary.................................................................................................... 53  
5.2 Policy implications....................................................................................... 54  
5.3 Conclusion.................................................................................................. 55  

REFERENCES.................................................................................................... 57  
APPENDIX......................................................................................................... 64
LIST OF TABLES

- Summary of related empirical literature .................................................. 27
- Unit root test .................................................................................................. 39
- Johansen cointegration test under the assumption of deterministic trend .. 44
- Cointegration test summary .......................................................................... 44
- Result, of EGARCH Model ........................................................................... 44
- Variance Equation .......................................................................................... 45
- Results of the Component GARCH Model ................................................... 46
- Degree of Trade Openness ............................................................................ 47
- Investment Ratio function ............................................................................. 48
- Fluctuation in the Degree of Trade Openness ............................................. 49
- Inflation Rate .................................................................................................. 49
Abstract

Low output growth in Nigeria have been attributed to a number of factors such as poor technology, demographic factors, social conditions, poor macroeconomic policies, insufficient infrastructural facilities and high dependence on primary products. What however, attracts lesser attention is the interface between output growth and macroeconomic fluctuations. It is not only that output growth is low but it fluctuates beyond the expectations of different macroeconomic analysts. There have been varying results among different existing empirical studies on the determinants of output growth in Nigeria. Most of these studies used cross-country regression to estimate the determinants of output growth. Cross country regressions suffer from measurement and specification bias because of the heterogeneous nature of macroeconomic data among less developed countries.

The current study adds to the existing literature by capturing the volatility clustering of economic growth and its determinants using country specific regression. It also addresses the problem of the relationship between current shock on economic growth and conditional volatility of other periods ahead. This is useful for forecasting volatility of economic growth and other macroeconomic variables. It further addresses the problem of determining the factors that are responsible for economic growth and how structural shocks are transmitted among macroeconomic variables in Nigeria. The study adopted two approaches: The Exponential Generalized Autoregressive Conditional Heteroscedasticity (EGARCH) and Vector Error Correction (VEC) models. EGARCH model was used to trace the determinants of economic fluctuations and the volatility clustering of economic growth. The VEC model traced the transmission of structural shocks among the variables.

The results show that fluctuations in economic growth is positively determined by the level of inflation rate, real interest rate, unemployment rate, but negatively influenced by investment ratio, per capita income, real exchange rate and the degree of trade openness. It further shows that there is transmission of structural shocks between economic growth and its determinants. However, the transmission mechanism of these shocks is complex and difficult to determine. The result of the conditional variance shows that there is high degree of volatility clustering between economic growth and its determinants. The News Impact Curve (NIC) indicates that the current shock is influenced by the previous shocks and its effect on other period ahead decays exponentially.
DEDICATION

To my beloved wife Asogwa Loveline Ndidiamaka; my children Favour, Peculiar, Bright and Princess; and my beloved mother Mrs. Angelina Asogwa
ACKNOWLEDGEMENT

My sincere gratitude goes to the Almighty God for making it possible for this work to be accomplished. To God be the glory. I wish to express my immeasurable appreciation to my able supervisor, Professor Cletus C. Agu for his contribution in making this work a success. Almighty God will continue to shower his blessings on you and your family. I thank the Head, department of Economics, Professor Felix E. Onah for his academic and fatherly contribution towards successful completion of this work. The Almighty God will reward you abundantly. I also owe much to Rev. Fr. Dr. H.E. Ichoku, Dr. M.W. Fonta and other academic and non-academic staff of this department for their efforts in making this work a success.
CHAPTER ONE
INTRODUCTION

1.1 Background of the study

Macroeconomic policy in Nigeria has been characterized by inefficiency, highly volatile and unsustainable public spending while fiscal decentralization has failed efficient public finance management and effective macroeconomic stabilization. Misalignment among federal, states, and local government income and expenditure has rendered the traditional instrument of economic management ineffective. Government spending, at all levels is characterized by pension crisis, arrears of salaries of civil servants, huge external and domestic debts and misallocation and mismanagement of resources. The worst situation is obtained at the state level where institutions are weak, economic governance is poor and debts are accumulated at unsustainable level. (NEEDS, 2004).

Nigeria, a country blessed with abundant natural resources, is seen as one of the countries that have the most volatile economy. This is in order with NEEDS (2004) which says that “between 1975 and 2000, Nigeria’s broad macroeconomic aggregates – growth, the terms of trade, the real exchange rate, government revenue and spending were among the most volatile in the developing world. Over the past three decades, high macroeconomic volatility has become a key determinant as well as consequence of poor economic management”. The economy has found itself in a low growth trap made up of low savings – investment equilibrium. Our economy is still far below the minimum investment rate of about 30% of GDP required to minimize poverty

Aggregate annual GDP growth between 1999 and 2003 was about 5 percent and estimates of growth in 2003 was 10.2 percent. This marked the highest rate of growth in three decades. Nigeria’s per capita GDP was one of the lowest in the world in the 1980s and 1990s. Between 1999 and 2003, annual per capita GDP grew at about 2.2% which is far from 4.2% required to address poverty. GDP growth rate in Nigeria can be summarized with the aid of table 1.1
Table 1.1 Economic performance in Nigeria (1960 – 2004).

<table>
<thead>
<tr>
<th>Period</th>
<th>GDP growth rate (%)</th>
<th>Population growth rate (%)</th>
<th>Growth of per capita income (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1960 – 1966</td>
<td>2.9</td>
<td>3.5</td>
<td>- 0.6</td>
</tr>
<tr>
<td>1993</td>
<td>1.3</td>
<td>3.0</td>
<td>- 1.7</td>
</tr>
<tr>
<td>200 – 2004</td>
<td>5.96</td>
<td>2.8</td>
<td>3.16</td>
</tr>
</tbody>
</table>

Source: National planning Commission, Abuja

Foreign direct investment (FDI) was going direct to the oil and extractive sector from 1960 to 1999. Foreign direct investment gets itself in non-oil sector only from 1999. This has caused unemployment’s rate to fall from about 20% in 1999 to 10.8% in 2003. In spite of FDI’s involvement in non oil sector, Nigerian economy is still highly undiversified. The oil sector still accounts for 95% of total export while manufacturing accounts for less than 1 percent.

Insignificant diversification and low productivity of the private sector of the economy emanates from a very hostile economic environment. The environment is characterized by inadequate infrastructure, poor security of lives and property, corruption and rent-seeking, high cost of finance and unstable macroeconomic policies (fiscal and trade policies). Implementation failures in Nigeria are persistent. In an economy where rents from oil are the major source of government revenue, a culture of rent seeking quickly develops. (NEEDS 2004)

*The government became an instrument for instant acquisition of wealth, distorting the incentive to work and to create wealth in the private sector with government as a major source of patronage and rent-seeking, the fight for public office became fierce”.*

There is need to note that rapid and broad-based growth required refused new policies to break the low-growth poverty trap. There is no doubt that economic
growth in Nigeria has been disappointing when compared to other developing nations.

1.2 STATEMENT OF RESEARCH PROBLEM

Economic growth in Nigeria has been very much insignificant in addition to its unpredictable fluctuations. Economic analysts have attributed Nigeria’s low economic growth to a number of factors such as backward technology, demographic factors, social conditions, unfavourable initial conditions, macroeconomic policies, dependence on primary commodities, insufficient infrastructure and unfavourable climate (Iyioha and Oriakhhu 2002, Easterly and Levine 2001). This problem persists in spite of different programmes designed to ameliorate the situation. Between 1960 and 1997, Nigeria had an average of 1.45% growth rate of per capita income which is unfavourable when compared to other countries like South Korea 6.8%, Singapore 6.7%, Taiwan 6.1% and Botswana 8%.

Agricultural output accounted for 71% of total exports in 1960s and remained the major earner of foreign exchange till 1970. The manufacturing sector accounted for less than 40% of GDP while the industrial sector gave only 7.7%. In this period, more than 85% of Nigerians were living in rural areas. The small monetized financial sector was coexisting with a large unorganized and not fully monetized rural informal sector. The above structure of the economy made it difficult for the people and the government to accelerate economic growth in accordance with the rate of population growth.

There have been significant changes in the sectoral contribution to GDP since 1970. Part of these changes in sectoral contribution to GDP is illustrated with the aid of table 1.2.
Table 1.2: Sectorial contribution to GDP (1981 – 89 SAP period)

<table>
<thead>
<tr>
<th>Year</th>
<th>Agriculture (₦)</th>
<th>Manufacturing (₦)</th>
<th>GDP (₦)</th>
<th>Agriculture (%)</th>
<th>Manufacturing (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1981</td>
<td>17840</td>
<td>6964.2</td>
<td>70395.9</td>
<td>25.34238</td>
<td>9.892906</td>
</tr>
<tr>
<td>1982</td>
<td>18224.7</td>
<td>7860.7</td>
<td>70243.1</td>
<td>25.94518</td>
<td>11.19071</td>
</tr>
<tr>
<td>1983</td>
<td>17724</td>
<td>5549.4</td>
<td>65958.0</td>
<td>26.87165</td>
<td>8.413536</td>
</tr>
<tr>
<td>1984</td>
<td>16920</td>
<td>4926.2</td>
<td>62474.2</td>
<td>27.08318</td>
<td>7.885175</td>
</tr>
<tr>
<td>1985</td>
<td>20977</td>
<td>5903.9</td>
<td>68286.2</td>
<td>30.71924</td>
<td>8.645817</td>
</tr>
<tr>
<td>1986</td>
<td>23345</td>
<td>5963.9</td>
<td>70806.4</td>
<td>32.97018</td>
<td>8.422826</td>
</tr>
<tr>
<td>1987</td>
<td>22411</td>
<td>5673.2</td>
<td>71194.9</td>
<td>31.47838</td>
<td>7.968548</td>
</tr>
<tr>
<td>1988</td>
<td>24831</td>
<td>6729.5</td>
<td>77733.2</td>
<td>31.94388</td>
<td>8.657176</td>
</tr>
<tr>
<td>1989</td>
<td>26072.6</td>
<td>6840.2</td>
<td>83179</td>
<td>31.34517</td>
<td>8.22347</td>
</tr>
</tbody>
</table>


The graphical illustrations of the contribution of agricultural and industrial sectors are illustrated in figure 1.1.

Figure 1.1: The contribution of agriculture and manufacturing sector to GDP.
Figure 1.1 shows that the contribution of agriculture to GDP is still greater than that of the manufacturing sector. The percentage contributions of these sectors are also shown with the aid of figure 2.

Figure 1.2: Percentage contribution of agriculture and manufacturing sectors to GDP

In the early 1980's, Nigeria experienced economic crisis which was attributed to oil price shocks, national policy bottleneck and increase in international interest rate. The contribution of industrial sector declined from 45.57% in 1980 to 26% in 1986. The introduction of structural adjustment programme (SAP) in 1986 to minimize economic crisis had negative shocks on the manufacturing sector and positive shocks on agriculture. SAP discouraged industrialization and created exposure of unemployment (Iyioha 2002).

In the post-SAP period, the contribution of oil and none oil to GDP and their rate of growth and their contribution are as illustrated with the aid of table 1.3.
Table 2: Contribution of oil and non-oil to GDP

<table>
<thead>
<tr>
<th>Year</th>
<th>Oil</th>
<th>Non-oil</th>
<th>GDP</th>
<th>Oil (%)</th>
<th>Non-oil (%)</th>
<th>Growth rate oil</th>
<th>Growth rate Non-oil</th>
</tr>
</thead>
<tbody>
<tr>
<td>1990</td>
<td>13542.2</td>
<td>78696.3</td>
<td>92238.5</td>
<td>14.66172</td>
<td>85.33828</td>
<td>-1.588539</td>
<td>1.588539</td>
</tr>
<tr>
<td>1991</td>
<td>12338.4</td>
<td>81896.9</td>
<td>94235.3</td>
<td>13.09318</td>
<td>86.90682</td>
<td>-0.055115</td>
<td>0.055115</td>
</tr>
<tr>
<td>1992</td>
<td>12649.2</td>
<td>84370.7</td>
<td>97019.9</td>
<td>13.03774</td>
<td>86.96226</td>
<td>-0.311668</td>
<td>0.311668</td>
</tr>
<tr>
<td>1993</td>
<td>12675.7</td>
<td>86928.5</td>
<td>99604.2</td>
<td>12.72607</td>
<td>87.27393</td>
<td>-0.492363</td>
<td>0.492363</td>
</tr>
<tr>
<td>1994</td>
<td>12348.3</td>
<td>88588.4</td>
<td>100936.7</td>
<td>12.25371</td>
<td>87.74629</td>
<td>0.027604</td>
<td>-0.027604</td>
</tr>
<tr>
<td>1995</td>
<td>12638.8</td>
<td>90439.9</td>
<td>103078.7</td>
<td>12.26134</td>
<td>87.73866</td>
<td>0.444444</td>
<td>-0.444444</td>
</tr>
<tr>
<td>1996</td>
<td>13544.4</td>
<td>93056.2</td>
<td>106600.6</td>
<td>12.70574</td>
<td>87.29426</td>
<td>-0.207984</td>
<td>0.207984</td>
</tr>
<tr>
<td>1997</td>
<td>13744.1</td>
<td>96228.4</td>
<td>109972.5</td>
<td>12.49776</td>
<td>87.50224</td>
<td>-0.126759</td>
<td>0.126759</td>
</tr>
<tr>
<td>1998</td>
<td>14042.2</td>
<td>99466.8</td>
<td>113509.0</td>
<td>12.37171</td>
<td>87.62829</td>
<td>-1.236507</td>
<td>1.236507</td>
</tr>
<tr>
<td>1999</td>
<td>12989</td>
<td>103666.5</td>
<td>116655.5</td>
<td>11.34419</td>
<td>88.65581</td>
<td>0.774445</td>
<td>-0.774445</td>
</tr>
<tr>
<td>2000</td>
<td>14434.2</td>
<td>106773.6</td>
<td>121207.8</td>
<td>12.90861</td>
<td>88.09136</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Central Bank of Nigeria Statistical Bulletin 2005

The contribution of the non-oil sectors to GDP in Nigeria is still dominating between the years 1990 to 2000 as shown in figure 3.
Much of the empirical literature on growth focused on estimating cross-country regressions to trace the existing relations among macroeconomic variables. This has made many studies to suffer from an inappropriate treatment of measurement and specification errors and lack of appreciation of the potential for simultaneity bias (Agenor 1999). The problem centres on the fact that the data necessary for testing the new models may not exist or very difficult to construct. Heterogeneity between developing countries’ growth patterns makes it inappropriate to estimate cross-country regressions. There are significant variations in data definitions and averaging does not represent typical behavioural equations. These problems call for specific country regressions (Easterly and Levine 2001, Barro 2000, Jalali-Naini 2005).

Based on the above discussions, this paper intends to address the following questions.

(i) What are the determinants of economic growth in Nigeria?

(ii) How do shocks transmit among economic growth and its determinants?
(iii) How do we capture the volatility clustering of economic growth and its determinants and
(iv) What are the relationship between current shock on growth and the conditional volatility of other periods ahead?

1.3: RESEARCH OBJECTIVES

The broad objective of this study is to estimate the impact of macroeconomic variables on economic growth and capture their volatility clustering. The specific objectives are:

(i) To estimate the determinants of economic growth in Nigeria, through country specific regression technique

(ii) To trace the transmission of structural shocks among economic growth and its determinants.

(iii) To capture the volatility clustering of economic growth and its determinants.

(iv) To estimate the relationship between current shock on economic growth and the conditional volatility of other periods ahead

1.4 Research Hypotheses

The research hypotheses of the study are:

(i) Economic growth in Nigeria has no specific determinants

(ii) There is no transmission of structural shocks among economic growth and its determinant

(iii) There is no volatility clustering among economic growth and its determinants.

(iv) Current shock on economic growth has no relationship with the conditional volatility of other periods ahead.
1.4 significance of the study

The interface between economic growth and key macroeconomic variables has been overlooked in the existing empirical literature in spite of Nigeria’s frequent economic fluctuations. The few empirical work on economic growth and its determinants are based on cross-country regression which is prone to biasedness as a result of the heterogeneous nature of data obtained in less developed countries.

This study will help to ginger policy debate on the causes of fluctuations in economic growth and the consequence of current shock on the volatility of other periods ahead. This is very vital for policy forecasting and adjustment especially in this era where every country is aiming at targeting rules.
CHAPTER TWO

REVIEW OF RELATED LITERATURE

2.1 Theoretical Literature

2.1.1 Stylized Facts of Growth

What determines the height and the slope of the potential growth path is a question which economists ask. The slope of the long run growth path is related to the rate of growth of the labour force and productivity while the growth of the growth path is related to the amount of accumulated capital per worker in the economy and the saving rate (Branson 1989, Ott et al 1975, Easterly and Levine 2001). The real output per unit of time is represented as

\[ Q_t = F (K_t, L_t) \]

Where: \( Q \) = real output per unit of time

\( K \) = capital input

\( L \) = labour input

\( t \) = time

The features of long run growth, showing, the relationship between growth rate of outputs and growth rate of inputs, between patterns of change in factor input prices and factor income share are explained by what we call the stylized factors of growth. These facts are:

*The growth rates of potential output and labour input are fairly steady

\[ \frac{dQ}{dL} > \frac{dt}{dt} \]

Where: \( \frac{Q}{L} \) = Trend growth rate of potential output

\[ \frac{dL}{dt} / L = I = \text{growth rate of available work hours} \]

*The growth rate of the capital stock is fairly steady with

\[ \frac{dK}{dt} / K > \frac{dL}{dt} / L \]
i.e. k is always positive

*The growth of output is almost the same with the growth rate of capital stock, Q = K, and capital output ratio is fairly steady.

*The ratio of profit, p, to the value of capital, k is roughly constant in the long run but shows substantial variation over the business cycle. Stylized facts of a constant capital output ratio and a constant profit rate in the long run implies a constant wage share and a constant long-run relative distribution of output (Branson 1989, Jalali-Naini 2003, Easterly and Levine 2001, Brock and Durlauf 2001).

The debate between the endogenous and the neo-classical models gave rise to what is called the modern stylized facts. These facts are centred on whether growth is driven by factor accumulation or productivity increased over time and the role of some macroeconomic variables such as human capital, national policies and institutions on growth.

### 2.1.2 Harrod – Domar Growth Model

In the Harrod – Domar model, the effect of investment on productive capacity and the need for labour and capital to be fully employed as the economy grows are taken into consideration. Output must grow at both the warranted rate, \( Q^* = \frac{s}{v} \), and at the natural rate, \( Q^* = g_L + \lambda \), for capital and labour to be fully employed respectively. Thus the Harrod – Domar condition states that

\[
g_L + \lambda = \frac{s}{v} \tag{2.2}
\]

since \( g_L + \lambda \) is exogenous whereas \( s \) and \( v \) are assumed to be endogenously determined, \( g_L + \lambda = \frac{s}{v} \) may not hold. If \( g_L + \lambda = \frac{s}{v} \), we have increasing unemployment of labour. If the reverse is the case, there will be excess capital which pushes the marginal productivity of capital to zero. This is why Harrod-Domar condition is seen as a knife edge case. The initial assumption behind this model is too rigid and its rigidity can be relieved through
- allowing substitution between capital and labour in the production function
- making saving ratio a function of profit rate. This makes the equilibrium saving ratio a function of the growth process. (Easterly and Levine 2007, Jalani- Naini 2003, Fatas and Mihov 2005, and Campbel 2004)

This model became an important instrument for policy because of the work of Harrod (1939) ad Dormar (1946). Harrod-Domar model is derived as:

\[ Y_t = C_t + S_t \] ........................................2.3
\[ I_t = S_t \] ........................................2.4

Equations 2.4 enables us to rewrite equation (2.3) as

\[ Y_t = C_t + I_t \] ........................................2.5

Where: \( Y = \) Output
\( S = \) Savings
\( I = \) Investment

Investment cumulates into capital stock which depreciates overtime

\[ K_{t+1} = (1 - S) K_t + I_t \] ........................................2.6

The savings rate \( S/Y_t = s \) and the capital – output ratio \( K_t/Y_t = t. \) are two concepts to be marked in the model combining equation 2.5 and 2.6 help in getting the famous equation in the Harrod-Domar model.

\[ S/\theta = g + \delta \] ........................................2.7

Equation 2.7 is influential because it links the growth rate of the economy to two fundamental variables – the ability to save and the capital output ratio. In this case, lowering the rate at which capital produces output \( \theta \), raises growth and increased saving also raises growth.

The model’s policy potency is obtained by linking savings – investment to growth. The model predicts that GDP growths will be proportional to the share of investment spending in GDP. If \( \theta \) and \( \delta \) are held constant then,

\[ Y_t = \lambda K_{t-1} \] ........................................2.8
and

\[ Y_t - Y_{t-1} = \lambda (K_{t-1} - K_{t-2}) \]

Dividing both sides by \( Y_{t-1} \)

\[ \frac{Y_t - Y_{t-1}}{Y_{t-1}} = \lambda \left( \frac{I_{t-1}}{Y_{t-1}} \right) \]

This model was designed to fit all economies that have surplus labour and left capital as the binding constraint on output growth (Soludo 2002, Domar 1946, Lewis 1954, Easterly 1995a).

The objection to this model is contained in the view of Easterly 1995a which says:

In sum, there is no theoretical or empirical justification for assuming a short run proportional relationship between investment and growth. There is no theoretical or empirical justification for calculating a “financial gap” between investment requirements and saving. There is no theoretical or empirical justification for using such a financing gap calculation to influence policy or the allocation of foreign aid.

Apart from the above criticism, the major objection to the Harrod-Domar model centres on its implicit assumption of the exogeneity of the parameters of capital – output ratio and the savings rate.

2.1.3 The Solow – Swan Growth Model

This model is built an aggregate constant return – to – scale production function which combines labour and capital. Saving is also a fixed proportion of output as seen in Harrod-Domar model while technology is assumed to be exogenous. In accordance with the neoclassical tradition, economies with lower stock of capital would have higher returns per unit of capital which shows that higher investment would mean higher growth. This means that in the transition to steady state, growth in capital scarce societies will be high because of high return
to capital. This conforms to the absolute convergence hypothesis. The model works under the assumption that:

production function is given as;

\[ y = Ak \]

Where:

- \( y \) = output
- \( k \) = capital per worker
  - There are identical consumers
  - The Producers are maximizing utility over an infinite horizon with a discount rate, \( \delta \).
  - Labour growth is zero
  - Technological growth is assumed to be endogeneous.

In this case, an optimal rate of growth is given as

\[ \frac{dy}{y} = AK^{\alpha - 1} - \delta \]

(See Easterly 1995)

The basic features of the Solow-Swan model are as put by Soludo (2002).

- The model shows that if population and technology grow at a constant rate, the steady state values of output per effective worker and the capital-effective labour ratio are also constant and proportional to the rate of technological change.
- The rate of savings in the Solow model does not affect the long run growth of capita income but certainly affects the long-run level of income.
- There is a steady state level of per capita income to which the economy must converge irrespective of its historical starting point. This means that countries will have similar standard of living in the long-run if they have similar saving rates, depreciation rates and population growths rate.
- The model focuses on the long run.

The neoclassical growths model centres its analysis on Solow-Dennison approach
\[ y = \alpha k + \beta l + \varepsilon \] 2.13

Where \( k \) = growth rate of capital
\( l \) = labour force
\( \varepsilon \) = Total factor productivity
\( \alpha \) = The share of capital in aggregate income
\( \beta \) = the share of labour in aggregate income

The growth rates of capital and labour force are weighted by their respective elasticities which are assumed to equal their marginal productivities. The difference between the actual growth rate of inputs is called "Solow residual".

The shortcomings of the Solow-Swan growth model are:

- It could not explain persisting variations in per capita income or growths
- The assumption of diminishing returns does not agree with the existing empirical work.
- The model failed to explain the mechanisms that generate steady-state growth and does not allow the assessment of the mechanism through which government policies affect growth process. (Agenor 1999)

The focus of the debate between the old and the new theories of economic growth is found in the neoclassical growth model developed independently by Solow (1956)\(^1\) and Swan (1956)\(^1\). The model analysed the effects of allocation of output between consumption and investment on capital accumulation, and the critical role played by the technological progress. Solow-swan model holds several assumptions and emphasized on the flow of output, \( Q \), the stock of capital, \( K \), labour, \( L \), and knowledge or the effectiveness of labour, \( A \)\(^3\)

\[ Q = f(K, AL) \] 2.14\(^4\)

\( K \) and \( A \) are assumed to be gross complements. It is only through \( K \), \( L \), and \( A \) that time enters into the model. Equation 2.14 is effective labour augmenting or what we call Harrod Neutral because \( A \) and \( L \) enter the model multiplicatively (Romer 1989, Agenor 1999, Brauson 1989 Colander 1986).

\(^{3}\) See Agenor 1999 for detail
Solow model claims that the capital output ratio of the Harrod-Domar model should not be regarded as endogenous – it proposed a growth model where the capital – output ratio, \( V \), is the adjusting variable that should lead an economy back to its steady – state growth path. When the technological progress and capital enter the model multiplicatively, we call it Solow Neutral

\[ Q = f(AK, L) \]  

It becomes Hicks neutral if the function is represented as

\[ Q = A f(K, L) \]

The Solow – Swan model assumes positive marginal product of capital \( f' > 0 \) and diminishing return to capital \( f'' < 0 \). The model has constant return to scale (CRS) in capital and effective labour. The intensive form production function is specified as:

\[ q = f(K) \]

where

\[ q = \frac{Q}{L}, \text{ and } K = \frac{K}{L} \]

Equation 2.1.6 is assumed to satisfy Inada conditions

\[ \lim_{k \to 0} f'(k) = \alpha \lim_{k \to \alpha} f''(k) = 0 \]

Inada conditions state that the marginal product of capital \( f'(k) \) is large when capital stock is small and becomes small when capital stock is large (Agenor 1999). These conditions are satisfied by the Cobb Douglas production function.

\[ Q = f(A, AL) = K^\alpha (AL) \text{ I - } \alpha \]

Where

\[ 0 < \alpha < 1 \]

Dividing through by AL,

\[ q = \left( \frac{k}{AL} \right)^\alpha = k^\alpha \]

Therefore, the marginal product of capital \( f'(k) \) becomes:

\[ f'(k) = \alpha k^{\alpha - 1} > 0 \]

and
\[ f'(k) = (1 - \alpha) \alpha k^{\alpha - 2} \]

In spite of strong prediction in the Solow – Swan model, it has the following shortcoming.

- It fails to predict association between changes in the accumulation of physical capital and cross country income differences in the steady state. Differences in the accumulation of physical capital are a significant factor that brings severe variation in cross country income differences in economic growths.

- Differences in physical capital per worker cannot bring about differences in output per worker. Stating that difference in output, \( q \), is a function of differences in capital, \( k \), without differences in the effectiveness of labour implies large variations in the rate of return on capital.

- The only source of variation in growth in the Solow- Swan model in the long run is the rate of growth of labour. The exact meaning of the effectiveness of labour is not specified and its behaviour is taken to be exogenous in the model (Lucas 1990, Agenor 1988, Colander 1986)

2.1.4 The Endogenous Growth Model

The endogenous growth models took place because of the shortcomings of the neoclassical growth models. The model extended the sources of growth to externalities and increasing returns to scale, human capital and knowledge. It introduced two techniques in order to overcome the assumption of diminishing return to capital.

- It sees all production input as a form of reproducible capital
- It introduces spillover effects or externalities in the growth process.

Rebello (1991) suggested a simple growth model in line with AK model

\[ Y_t = AK_t \]

Where: \( K \) = a composite measure of the physical and human capital stock.

The production function exhibit linearity and constant return to scale. If capital accumulation equation is given as

\[ \Delta k_t = s y_t \delta s \]

then the steady state growth per capita is given as;

\[ g = sA - \delta \]

In contrast with the neoclassical model, the Ak model holds that:

* an increase in the saving rate permanently raises the growth rate per capita

* poor countries whose production process is similar to other nation grow at the same rate as rich nations irrespective of their initial level of income. Therefore AK model does not predict convergence.

Spillover effect or externalities implies that doubled inputs by one firm will increase the productivity of others. This relaxes the assumption of diminishing returns to capital. With the exception of Lucas (1988) and Barro (1990), externalities are seen as a form of general technological knowledge which is available to all firms. Externalities are associated with public learning in Lucas (1988) but seen as a form of public investment in Barro (1990).

The Harrod-Domar model concentrates on the disequilibrium process while the neoclassical model focuses on the equilibrium process of growth. The later assumes that interest rates, profits and wage rates will adjust to equate a growing supply and demand. It demonstrates how growth can be a smooth process which is expected to continue overtime (Colander 1986).

The endogenous growth model recognizes the roles of knowledge accumulation, human capital, research and development in economic growth. It assumes that the extra output is used in activities that increase the rate of technical change and economic growth. The Mankiw-Romer-Weil model and the AK model
model made intensive extension of the Solow – Swan model. The Mankiw – Romer – Weil model accepts the idea of Solow – Swan’s assumptions of constant return to scale in all inputs, and strongly differs from it because relative small changes in the resources devoted to physical and human capital accumulation may lead to a large change in output per worker. Contrary to the Solow-Swan model the, AK model argues that poor countries with the same level of technology and the same structural forms with rich countries will grow at the same rate. This clearly shows that AK model predicts partial convergence. The new growth theories identify both structural and policy related factors responsible for alteration in the long-run growth process. Some of these factors are fiscal policy, public investment, increase in taxes, inflation rate, trade and trade openness, financial development, political stability and the country’s macroeconomic environment (Agenor, 1999, Hnatkovska et al 2000, Alesina 1996, Imbs 2002, Martin 1995).

In literature, old growth model assumes that capital scarcity implies high returns to capital while the new theory assumes that scarcity of capital implies low returns. Capital has a higher return where it is abundant because of different externalities to capital accumulation and resulting strategic complementarities. In this case, an economy can grow if it has a minimum threshold level of human and physical capital. This actually makes growth sensitive to shocks emanating from infusion of capital foreign aid, favourable terms of trade or civil war. It is pertinent to note that good luck on terms of trade good policies which attract investment and favourable environment could take the economy above the threshold (Easterly 1995, Soludo 2002). The new theories of investment and uncertainty brought deeper understanding of the usefulness of macro-economic fundamentals and institutional factors in the growth process.

2.2 Empirical Review

Economic growth in most of the less developed countries (LDCs) is unstable and shows significant periodic fluctuations. These fluctuations are
severely large with high degree of volatility and shock persistence. Jalali Naini (2003) assumed a time series $x_t$ that contains a unit root and presented it as

$$Vx_t = \mu = \psi(L) \Sigma \epsilon_t = n + \sum_{i=1}^{\sigma} \psi^i \epsilon_{t-i}$$

it implies that the effects of a shock ($\Sigma$) at time $t + k$, $\Delta x_{t+k}$ is equal to $\psi_k$. The impact of the same shock on the level of $x$ in period $t + k$, $x_{t+k}$ is equal to $1 + \psi_1 + \cdots + \psi_k$. The value of $\psi_1$ shows the degree of persistent shock on $x$. Jalali Naini (2003), from his model found out that human capital accumulation was not a significant contributing factor to economic growth. The Solow residual indicates that the growth process does affect productivity. He regressed unfiltered estimate of total factor productivity (TFP) on human capital, the rate of inflation, conventional measure of openness, the size of government and private investment and found out that human capital has a positive effect on TFP while inflation has a negative effect. Campbell and Mankiw (1987) used Autoregressive Moving Average (ARMA) as alternative measure of persistence. Their ARMA shows impulse response measure of $\Psi(1)$ by approximating $U(1)$ by a ratio of finite polynomials. The measure of persistence, $p$, is specified as:

$$p = \Psi(1) = \theta(1)/\phi(1) = (1 + \theta + \cdots + \theta \phi - \phi_1 - \cdots - \phi_p)$$

Alternative to this also exists due to the work of Cochrane (1998) on non-parametric measure as:

$$V_k = \left( \frac{1}{k+1} \right) \frac{\text{var}(X_{t+k} - X_t)}{\text{var}(X_{t+1} - X_t)}$$

Where: $V_k = \text{variance ratio}$

The Cochrane's measure of persistence is specified as

$$Pe = \left\{ \frac{\Pi f_{x_2}(0)}{V(\Delta x_t)} \right\}^t = \left\{ \frac{\delta^2}{V(\Delta x_t)} \right\}^t$$

Where: $\frac{\delta^2}{V(\Delta x_t)} = 1 - R^2$
\[ R^2 = \text{the estimated multiple correlation coefficient of the ARIMA (P, I, q) } \]

\[ P = \left(1 - R^2\right) P \]

(Jalali – Naini 2003)

Studies in developing countries show that growth potentials of these economies are limited because of poor or misplaced incentives, uncertainties and underdevelopment of institution for efficient allocation of resources.

Fatas and Mihow (2005) compiled annual data for 91 countries spanning the years from 1960 to 2000 to test the hypothesis that policy volatility exerts a negative impact on long term economic growth. They posit that the link between policy volatility and economic growth can be identified with the aid of modified standard growth regression

\[ \Delta y_t = \alpha + \lambda \log (\delta_t) + \beta x_t + \gamma y_t' Z_i + U_t \]

Where

\[ \Delta y_t = \text{average growth rate of output per capital for country}; \]

\[ \delta_t' = \text{the volatility of the exogenous shocks to government consumption} \]

\[ x_t = \text{the average openness to control for the effect of trade on economic growth} \]

\[ Z_i = \text{vector which comprises variables which entered the model to ensure that the link between policy volatility and growth is not due to variables omitted from the baseline specifications} \]

They also adopted a log-log model which is specified as

\[ \log (G)_{i,t} = \alpha_i + \beta_i \Delta \log (y_{i,t}) + \gamma_i \log (G)_{i,t-1} + \delta_i W_i,t + \varepsilon_{i,t} \]

Where: \( G = \text{real government consumption spending} \)

\( Y = \text{real GDP} \)

\( W = \text{controls like inflation and inflation squared} \)

Equation 2.2.7 was estimated by instrumental variables because of the possible reverse causality from government spending to growth. Fatas and Mihow (2005) concluded from their estimation that policy volatility exerts a strong and direct
negative impact on growth. Their analysis shows that an increase in the volatility of fiscal policy corresponding to one standard deviation in the sample reduces long-term economic growth by about 0.75 percent. This conclusion is a confirmation of Acemoglu et al (2002) and Easterly (1995) which conclude that macroeconomic policies (monetary, fiscal, trade) have an explanatory power for the cross country variation in growth rates and income per capital only because they serve as proxies for institutions.

Identifying the predictable and unpredictable components of real output growth using autoregressive forecasts vs. survey of professional forecasts (SPF) Campbell (2004) decomposed output growth and its variance as:

$$E\left(y_{t}, t + h | \Omega_t \right) + e^{\mu}_{t}, t + h \quad \quad 2.28$$

$$\text{var}(y_{t}, t + h) = \text{var}(E(y_{t}, t + h | \Omega_t)) + \text{var}(e^{\mu}_{t}, t + h) \quad \quad 2.29$$

where: $$y_{t}, t + h = h - \text{period of output growth}$$
$$E(y_{t}, t + h | \Omega_t) = \text{the conditional expectation of output growth based on the full time, t information set } \Omega_t$$
$$e^{\mu}_{t} = \text{the unpredictable component of real output growth}.$$ 

The variance of the real output growth is decomposed into the variance of its predictable and unpredictable components. A reduction in uncertainty arose as a result of a reduction in the variance of output growth from a change in E/\text{var}(e^{\mu}_{t}, t + h). Campbell's result shows that determining predictability has played a significant role in the creator moderation in United States of America.

Many researchers have focused on autoregressive specifications in modeling the conditional means of output growth. This takes the form:

$$y_{t}, t + h = \alpha + Py_{t - 1, t} + \delta \sigma_{t}, t + h \quad \quad 2.30$$

Where: $P = \text{the output that governs the persistence of real output growths}$

$$\alpha = \text{the mean of real output growth (holding P constant)}$$

$$\delta = \text{the volatility of real output growth shocks}.$$ 

large and significant decline after 1984 in the volatility of residuals from an AR (1) model in the case of quarterly real output growth between 1953 and 1999. Stock and Watson (2002) also find a decline in the volatility of residuals from an AR (4) model in the case of annual real output growth. The only compelling source of the volatility of growth shocks, $\delta$. McConnel et al. and Stock's tests for structural change in both the mean and persistence parameters of their models show no evidence in favour of structural change in any of these parameters. It is pertinent to note here that these studies did not indicate on whether volatility decline is because of changes in macroeconomic uncertainty or predictability.

In order to evaluate the relative predictive power of AR (1) and SPF Campbell (2004) estimated a forecast encompassing regression of the form:

$$y_{t,h} = \beta_0 + \beta_{AR} f_{t,h}^{AR} + \beta_{SPF} f_{t,h}^{SPF} + \beta_{1984:3} + \beta_{D(1984:3 \times f_{t,h}^{AR})} + \beta_{D(1984:3 \times f_{t,h}^{SPF})} + \eta_{t,h}$$

Where $f_{t,h}^{AR} = \alpha + P y_{t,h}$

$f_{t,h}^{SPF} = \text{quarterly or annual real output growth}$

Campbell found out that the decline in macroeconomic uncertainty as measured from the autoregressive model is overstated. His results indicate that using the decline in the total volatility of real output growth along with the standard CCAPM model overstates the decline in the future equality premium.

Differences in macroeconomic policies and institutional differences cause variation in macroeconomic performance. Acemoglu et al (2002) estimated the macroeconomic outcome of interest for a nation as:

$$X_{c,t-1} = Q^t \alpha + \beta_1 l_{c,t-1} + Z_{c,t-1}$$

$$+ \theta_1 m_{c,t-1} + \Sigma_{c,t-1}$$

$X_{c,t-1} = \text{the macroeconomic outcome of interest for country } c \text{ between time } t \text{ and } t-1.$

$Q^t_{c,t-1} = \text{vector of macroeconomic policies for country } c \text{ between time } t \text{ and } t-1$

$l_{c,t-0} = \text{measure of institution at the beginning of the sample}$
\( Z_{c,t} \) = a set of other controls.
\( \ln y_{c,t} \) = the log of initial income per capita

They used two-stage least squares (2SLS) with distinct and plausible instruments for both macro policy variables and institutions. Their results show that distortion macroeconomic policies are more likely to be symptoms of underlying institutional problems rather than the main cause of economic volatility. The effects of institutional differences on volatility do not appear to be primarily mediated by any of the standard macroeconomic variables (Acemoglu et al 2002).

Hnatkovska and Norman (2004) examined cross-country relationship between macroeconomic volatility and long-run economic growth. Their analysis starts by examining the simple correlation of the growth of per capita GDP. Various countries were grouped based on the criteria such as the level of overall development, financial depth, trade openness, institutional development and fiscal policy procyclicality. It analyses the link between volatility and growth by the use of corresponding growth regression which is given as:

\[
gr = \beta_0 + \beta_1 \text{vol}_i + \beta_2 x_i + \Sigma_i \quad 2.33
\]

Where: \( gr \) = average growth rate of per capital GDP

\( \text{vol} \) = volatility measure

\( x \) = a set of control variable

\( \Sigma \) = regression residual

\( i \) = a country index

The set of control variables includes the initial level of GDP which accounts for transitional convergence effect, the average ratio of domestic private credit to GDP which is used as a proxy for financial development, and the average secondary school enrollment ratio which accounts for human capital investment. The choice of these control variables are in order with their roles in recent empirical literature (see Barro 1991, Levine and Renelt 1992). Volatility is categorized into normal volatility and crisis volatility in order to evaluate the harmful impact of negative fluctuations and the effect of repeated but small
cyclical movement. The regression of the average growth rate per capital GDP becomes.

\[ gr = \beta_0 + \beta_1 \text{Normal vol} + \beta_2 \text{crisis vol} + \beta_3 x + \Sigma - - - - - 2.34 \]

Where: Normal vol = Normal component of volatility
Crisis vol = crisis component of volatility

Hnatkovska and Norman (2004) estimated the above model in two ways, both ignoring the potential endogeneity of the vitality components of accounting for such endogeneity. The study finds that:

- macroeconomic volatility and long-run economic growth are negatively related
- this negative relationship reflects the harmful effect from volatility to growth
- the negative effect of volatility on growth has become larger in the last two decades because of large recessions rather than normal cyclical fluctuations.

The methodology adopted by Hnatkovska et al is based on correlation and multiple regressions in structural form without estimating the order in which the exogenous variable will be accommodated in the model. This makes the robustness of the estimates questionable.

Easterly and Levine (2001) studied the stylized facts and growth models and found that:

- Total factor productivity rather than factor accumulation are responsible for most of the income and growth variation across countries
- Income diverges over the long run
- The growth path of countries exhibits remarkable variation
- Economic activity is highly concentrated with all factors of production flowing to the richest countries
- National policies are closely associated with long run economic
The main idea of comprehending growth is not through the process in which nations increase their rate of physical capital accumulation (Easterly and Levine (2001)). This is quite opposite of the work done by Lewis (1954) which says “The central problem in the theory of economic development is to understand the process by which a community which was previously saving and investing 4% or 5% of its national income or less converts itself into an economy where voluntary saving is running at about 12% to 15% of national income or more”. Easterly et al (2001) used the traditional growth account which has its base on Cobb-Douglas production function. They divided the output growth into component due to changes in the factors of production. Thus
\[
\frac{\Delta y}{y} = \frac{\Delta A}{A} + \alpha \left( \frac{\Delta k}{k} \right) + (1 - \alpha) \frac{\Delta n}{n} \quad \text{2.35}
\]

Where \( \Delta y = \) change in national output per person
\( \Delta A = \) change in technological progress
\( \Delta k = \) change in physical capital stock per person
\( \alpha = \) production function parameter

Empirical work done by Solow (1957), Denison (1962, 1967) show that rate of capital accumulation per person accounted for between one eighth and one fourth of GDP. Growth rate in developed nations while TFP accounts for more than half of GDP in other nations. Easterly and Levine (2001) further used variance decomposition to construct various indicators of the part of cross-country differences in economic growth rates accounted for by cross-country differences in TFP and factor growth. Their outcome shows that TFP growth accounts for more than 60% of output growth. Growth accounting model has different shortcomings.

- it is a mechanical process
- it does not sufficiently explain casual effect
- it does not test the statistical significance of the relationship between output growth and capital accumulation
Hall and Jones (1999) studied cross country differences in income per capita and physical capital per capita. Their results show that productivity differences across countries accounts for the most of the cross-country differences in output per worker. In an attempt to address this question of the part of cross country difference in income per capita that is accounted for by differences in physical capital per capita, Easterly and Levine (2001) used Denison – level accounting model and Mankiw, Romer, and Weil (MRW level accounting model. In the Denison level accounting, the ratio of two national incomes of output per person was specifies

\[
\frac{y_i}{y_j} = \left[ \frac{A_i}{A_j} \right] \left[ \frac{K_i}{k_j} \right]^\alpha \left[ \frac{n_i}{n_j} \right]^{1-\alpha} \quad 2.36
\]

The Mankiw, Romer, and Weil (MRW) model is in accordance with the Solow model in the steady state of the Solow model, output per person is given as:

\[
\frac{Y}{L} = \alpha \left[ \frac{s}{(x+\delta) + n} \right]^{\frac{\alpha}{1-\alpha}} \quad 2.37
\]

Where \( Y/L \) = output per person

- \( A \) = level of labour augmenting productivity
- \( S \) = the ratio of investment to GDP
- \( X \) = the rate of labour augmenting productivity growth
- \( \alpha \) = depreciation
- \( n \) = population growth
- \( \alpha \) = the share of capital income in GDP

Transforming equation 2.37 into log form.

\[
\ln (Y/L) = \ln A + \alpha/ (1 - \alpha) \ln s - \ln (x + \delta + n) \quad 2.38
\]

The second term here is called MRW model. The results of the above model refute the original MRW idea that productivity levels are the same across countries. They showed that south Asia and sub-Saharan Africa have significantly lower productivity than other regions while OECD has higher productivity than the rest of the world. Mankiw, Romer, and Weil (1992)
included a measure of human capital investment in order to explain cross-country income difference. They defined this as:

\[ \text{in } sn - \ln (x + \delta + n) \]--------2.39

Where \( sn \) = the flow of investments in human capital i.e. secondary school enrollment ratio times the proportion of the labour force of secondary school age. This idea was criticized by Klenow and Rodriguez – Clare (1997b) and Romer (1995) on the ground of overestimating the cross country variation in human capital by ignoring primary enrollment. The authors, their models, findings and weaknesses of the previous related empirical literature can be summarized with the aid of table 1

**Table 2.1: summary of related empirical work**

<table>
<thead>
<tr>
<th>Authors</th>
<th>Models</th>
<th>Findings</th>
<th>Weaknesses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mankiw, Romer and Weil (1992)</td>
<td>Mankiw – Romer – Weil (MRW) model. They included human capital investment in order to explain cross country income differences</td>
<td>Productivity levels are not the same across countries. South Asia and Sub-Sahara Africa have significantly lower productivity than other regions</td>
<td>Overestimating the cross-country variation in human capital by ignoring primary enrolment</td>
</tr>
<tr>
<td>Hall and Jones (1999)</td>
<td>Growth accounting model</td>
<td>Productivity differences across countries account for the most of the cross country differences in output per work.</td>
<td>- Inability to trace causal effect sufficiently - It is a mechanical process</td>
</tr>
<tr>
<td>Easterly and Levine (2001)</td>
<td>Traditional growth accounting model. Derision – level</td>
<td>- Total factor productivity is responsible for</td>
<td>- The model uses in this work has the</td>
</tr>
<tr>
<td>Author</td>
<td>Model</td>
<td>Changes in Income and Growth Across Countries</td>
<td>Following Shortcomings</td>
</tr>
<tr>
<td>-------------------------</td>
<td>----------------</td>
<td>-----------------------------------------------</td>
<td>------------------------</td>
</tr>
<tr>
<td>Stock and Watson (2002)</td>
<td>AR (4) model</td>
<td>A decline in the volatility of residuals in the case of annual real output growth. Tests for structural change did not show evidence in favour of structural change in any of the parameters</td>
<td>It did not show whether volatility decline is because changes in macroeconomic uncertainty or predictability.</td>
</tr>
<tr>
<td>Acemoglu</td>
<td>Multiple regression</td>
<td>Distortion</td>
<td>Using multi-</td>
</tr>
<tr>
<td>Author</td>
<td>Methodology</td>
<td>Findings</td>
<td>Notes</td>
</tr>
<tr>
<td>-------------</td>
<td>-------------------------------------------------</td>
<td>--------------------------------------------------------------------------</td>
<td>----------------------------------------------------------------------</td>
</tr>
<tr>
<td>(2002)</td>
<td>with 2SLS</td>
<td>Macroeconomic policies are symptoms of institutional problems. Institutional factor is the main cause of economic volatility</td>
<td>Regression has higher possibility of specification errors which makes the work serious. There was absence of battery tests to indicate the order through which the explanatory variables will enter into the model.</td>
</tr>
<tr>
<td>Dike Enwerem (1996)</td>
<td>Cubic parabolic model</td>
<td>Instability of export growth and investment expansion are the sources of GDP instability</td>
<td>This is not the appropriate model for capturing volatility clustering</td>
</tr>
<tr>
<td>Jalali-Naini (2003)</td>
<td>Unfiltered estimate of TFP using OLS</td>
<td>Human capital accumulation is not a significant contributing factor to economic growth. Human capital has a positive effect on TFP while inflation has a negative effect.</td>
<td>The degree of persistent shock on output growth was specified but the result was not clearly shown.</td>
</tr>
<tr>
<td>Campbell (2004)</td>
<td>AR and Survey of Professional</td>
<td>Decline in macroeconomic instability</td>
<td>Inability to trace long-run</td>
</tr>
<tr>
<td>Study</td>
<td>Methodology</td>
<td>Findings</td>
<td>Limitations</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>--------------------------------------</td>
<td>---------------------------------------------------------------------------</td>
<td>----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Hnatkovska et al (2004)</td>
<td>Forecast (SPF) models variance</td>
<td>Uncertainty is overstated. Decline predictability has placed a significant role in the greater moderation in USA.</td>
<td>Decline predictability has placed a significant role in the greater moderation in USA.</td>
</tr>
<tr>
<td></td>
<td>decomposition</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Correlation and multiple regression</td>
<td>Negative relationship between macroeconomic volatility and long run economic growth. Higher negative effect is as a result of large recession rather than normal cyclical fluctuations.</td>
<td>Inability to capture volatility of clustering and their excess kurtosis. The relationship between current shock on growth and the conditional volatility of periods ahead could not be traced. The order in which the exogenous variable will be accommodated was not estimated.</td>
</tr>
<tr>
<td>Fatas and Minov (2005)</td>
<td>Log-log model using instrumental</td>
<td>Policy volatility exerts a strong and direct negative impact on growth.</td>
<td>Inability to trace long-run relationship between policy</td>
</tr>
<tr>
<td></td>
<td>variable in estimating because</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### 2.3 Shortcoming of Previous Works

1. They did not treat the order in which the exogenous variables will be absorbed in the model.
2. Inability to handle country specific effect.
3. The previous work could not trace the sources of economic growth through country specific regression.
4. Available work received could not trace the transmission of structural shocks among economic growth and its sources.
5. The relationship between current shock on economic growth and conditional volatility of other periods ahead was not emphasized.

The issue of volatility clustering among economic growth and macroeconomic fundamentals is beyond the scope of growth accounting models which most of the studies used.
CHAPTER THREE
METHODOLOGY

3.1 Methodological Framework

Autoregressive conditional heteroscedasticity (ARCH) was introduced by Engle (1982) to capture the volatility clustering of financial time series. In the basic ARCH model the conditional variance of the shock, \( h_t \), is a linear function of the squares of the previous shocks, \( e_i^2 \)

\[
h_t = \Psi + \alpha_1 e_{t-1}^2 + \cdots + \alpha_p e_{t-p}^2 - - - - - - - - - - - - - - - - - 3.1
\]

where:

\( h_t \geq 0, \Psi > 0, \alpha \geq 0 \)

It is worthy to note that when \( \alpha_1 = 0 \), then \( h_t \) is constant and the series \( e_t \) becomes conditionally homoscedastic. In equation 3.1, large (small) \( e_{t-1} \) is usually followed by large (small) shocks of either sign (Frances and Dijk (2006)). ARCH model captures both the volatility clustering and their excess Kurtosis. ARCH (1.1) can be written as:

\[
e_{t}^2 = \Psi + \alpha e_{t-1}^2 + V_t - - - - 3.2
\]

where:

\( V_t = e_{t}^2 - h_t (Z_{t}^2 - 1) \)

ARCH (1.1.) cannot describe the required features of the empirical autocorrelations of the returned series simultaneously. One of the possibilities for allowing more persistent autocorrelations is to include additional lagged square shocks in the conditional variance function (Bollerslev 1986, Frances and Dijk, 2006).

\[
h_{t} = \Psi + \alpha_1 e_{t-1}^2 + \alpha_2 e_{t-2}^2 + \cdots + \alpha_q e_{t-q}^2 - - - - - - - - - 3.3
\]

Where \( \Psi > 0 \) and \( \alpha_j \geq 0 \) for all \( j\)’s 1, 2, \( -- q \) Equation 3.3 is an ARCH (q) model which can be written as ARCH (q) model for \( e_{t}^2 \)

\[
e_{t}^2 = \Psi + \alpha_j e_{t-1}^2 + \alpha_2 e_{t-2}^2 + \cdots + \alpha q e_{t-q}^2 + V_t - - - - - - - 3.4
\]
Bollerslev (1986) suggested lagged conditional variances, $h_t - \delta$ to the ARCH model which gives Generalized ARCH (GARCH) model of order (1,1)

$$h_t = \Psi + \alpha_1 e^2_{t-1} + \beta_1 h_{t-1} \tag{3.5}$$

where

$\Psi > 0$, $\alpha_1 > 0$ and $\beta_1 \geq 0$

$\alpha_1 > 0$ for $\beta_1$ to the identified

Therefore, GARCH (P, q) model is specified as

$$h_t = \Psi + \sum_{i=1}^{q} \alpha_i e^2_{t-i} + \sum_{i=1}^{p} \beta_i h_{t-i}$$

$$= \Psi + \alpha (L) e^2_t + \beta (L) h_t \tag{3.6}$$

where:

$$\alpha (L) = \alpha_0 + \cdots + \alpha_q L^q$$

$$\beta (L) = \beta_0 + \cdots + \beta_p L^p$$


In equation 3.6, if $\alpha + \beta = 1$, then we refer to the model as integrated GARCH (IGARCH). Fractionally integrated GARCH (FIGARCH) model specifies conditional variance as:

$$h_t = \Psi \left[ (1 - \beta_1) + 1 - (1 - L)^\delta \right] \beta (L) e^2_t$$

$$= \Psi / (1 - \beta_1) + \lambda (L) e^2_t \tag{3.7}$$

FIGARCH is applied in exchange rate (Baillie et al 1986) and in stock market reforms and opinion prices (Bollerslev and Mikkelsen 1996).

### 3.2 The Models

We adopted two models for the study in order to capture different hypothesis specified. These models are the Exponential GARCH model and the vector Autoregressive (VAR) which was transformed to vector Error correction after series of battery tests.
3.3. **Unit Root Test**

We have many ways of testing for unit root but we will concentrate on augmented Dicky Fuller (ADF) test. This test is more reliable, more robust and eliminates the presence of autocorrelation in the model. It is specified as

\[ y_t = \alpha_0 + \alpha_1 y_{t-1} + \sum_{i=1}^{\infty} \beta \Delta y_{t-i} + u_t \]  

Where \( y_t \) = individual variable in the model  
\( \alpha_0, \alpha_1, \beta_1 = \) parameters of the model  
A variable becomes stationary if it is integrated of order zero (0) otherwise it becomes stationary of order which it is differenced \( d \) (Adam 1992, Gujarati 1995)

3.4 **Cointegration Test**

We implement VAR based cointegration tests using the methodology developed by Johanson (1991, 1995). This is used to test the restrictions imposed by the cointegration on the unrestricted VAR involving non-stationary series. In specifying cointegration test, we write a VAR model of order \( p \) as

\[ Y_t = A_1 y_{t-1} + \cdots + A_p y_{t-p} + \beta x_t + \epsilon_t \]  

Where: \( y_t = k \) - vector of non stationary, 1 (1), variable  
\( x_t = d \) - vector of deterministic variables  
\( \epsilon = \) a vector of innovation

Equation 3.9 can be written as

\[ \Delta y_t = \Pi y_{t-1} + \sum_{i=1}^{p-1} \Pi_i \Delta y_{t-i} + \beta x_t + \Sigma_t \]  

where: \( \Pi = \sum_{i=1}^{p} A_i - 1 \)  
\( \Pi_i = \sum_{i=1}^{p} A_j \)
In accordance with the Granger’s representation theorem, if the coefficient matrix $\pi$ has reduced rank, $r < k$ there exist $k \times r$ matrices $\alpha$ and $\beta$ each with rank $r$ in a way that $\pi = \alpha \beta$ and $\beta_i \gamma_i$ is stationary. In this case, $r$ is the number of cointegrating relations (the cointegrating rank) while each column of $\beta$ is the cointegrating vector. In Johansen, we estimate the $\pi$ matrix in an unrestricted form and test whether we can reject the restriction in the reduced rank of $\pi$. It is pertinent to note that the cointegrating vector is not identified unless we impose some arbitrary normalization ($E$ - views 3.1 version)

3.5 Model Specification

3.5.1 Exponential GARCH (EGARCH) Model:
The Exponential GARCH (EGARCH) model was introduced by Nelson (1991). This model allows for asymmetric effects and it is specified as:

$$\ln(h_t) = w + \alpha_1 z_{t-1} + \gamma_1 (\left| z_{t-1} \right| - \mathbb{E}(\left| z_{t-1} \right|)) + \beta \ln(h_{t-1})$$

where: $\ln(h_t) = $ the logarithm of the conditional variance

$z_{t-1} = $ past shocks

$\alpha_1, \gamma_1$ and $\beta$ are the parameters which have no restriction in order to ensure that $h_t$ is non-negative.

EGARCH model shows the relationship between past shocks and the logarithm of the conditional variance. When we adopt the properties of shocks, $z_t$, then:

$$g(z_t) = \alpha_1 z_t + \gamma_1 (\left| z_t \right| - \mathbb{E}(\left| z_t \right|))$$

with zero mean and uncorrelated. The above function is piecewise linear in $z_t$ because it can be specified as:

$$g(z_t) = (\alpha_1 + \gamma_1) z_t I(z_t > 0) + (\alpha_1 - \gamma_1) z_t I(z_t < 0) - \gamma_1 \mathbb{E}(\left| z_{t-1} \right|)$$

where:

$\alpha_1 - \gamma_1 = $ the impact of negative shocks on the log of the conditional variance.

$\alpha_1 + \gamma_1 = $ the impact of positive shocks on the log of the conditional variance.

---

3. ECM was first used by Sargan. For detailed treatment of ECM see Sargan (1981): "Wages and prices in the United Kingdom." Blackwell, Oxford.
We used News Impact Curve (NIC) to show how new information is incorporated into volatility. NIC shows the relationship between the current shock, \( e_t \), and the conditional volatility of other periods ahead, \( h_{t-1} \), holding constant all other past and current information. In this model, NIC is specified as:

\[
A \exp \left( \alpha_1 + \lambda_1 \right) / \delta^* e_t \quad \text{for} \ e_t > 0
\]

\[
\text{NIC}(e/h_t = \delta^2) = A \exp \left( (\alpha_1 - \lambda_1) / \delta^* e_t \right) \quad \text{for} \ e_t < 0
\]

Where:

\[
A = \delta^{2 \eta} \exp(w - \lambda_1 (2/\pi)^{1/2})
\]

In this case, negative shocks have a larger effect on the conditional variance then positive shocks of the same size.

3.5.2 Vector Error Correction (VEC) Model

Vector Autoregressive (VAR) model specifies every endogeneous variable as a function of the lagged values of the endogeneous variables in the system. In this paper, VAR model is specified in accordance with the new endogenous growth model as:

\[
Y_{gt} = \lambda_1 + \alpha_{11} \Sigma y_{gt-1} + \alpha_{12} \Sigma JNF_{t-1} + \alpha_{13} \Sigma RER_{t-1} + \alpha_{14} \Sigma HK_t + \alpha_{15} \Sigma TO_t + \alpha_{16} \Sigma UNP_{t-1} + \alpha_{17} \Sigma IR_t + e_1 
\]

\[
\text{INF}_t = \lambda_2 + \alpha_{21} \Sigma y_{gt-1} + \alpha_{22} \Sigma INF_{t-1} + \alpha_{23} \Sigma RER_{t-1} + \alpha_{24} \Sigma HK_t + \alpha_{25} \Sigma TO_t + \alpha_{26} \Sigma UNP_{t-1} + \alpha_{27} \Sigma IR_t + e_2
\]

\[
R\Sigma R_t = \lambda_3 + \alpha_{31} \Sigma y_{gt-1} + \alpha_{32} \Sigma INF_{t-1} + \alpha_{33} \Sigma RER_{t-1} + \alpha_{34} \Sigma HK_t + \alpha_{35} \Sigma TO_t + \alpha_{36} \Sigma UNP_{t-1} + \alpha_{37} \Sigma IR_t + e_3
\]

\[
HK_t = \lambda_4 + \alpha_{41} \Sigma y_{gt-1} + \alpha_{42} \Sigma INF_{t-1} + \alpha_{43} \Sigma RER_{t-1} + \alpha_{44} \Sigma HK_t + \alpha_{45} \Sigma TO_t + \alpha_{46} \Sigma UNP_{t-1} + \alpha_{47} \Sigma IR_t + e_4
\]

\[
T\Sigma O_t = \lambda_5 + \alpha_{51} \Sigma y_{gt-1} + \alpha_{52} \Sigma INF_{t-1} + \alpha_{53} \Sigma RER_{t-1} + \alpha_{54} \Sigma HK_t + \alpha_{55} \Sigma TO_t + \alpha_{56} \Sigma UNP_{t-1} + \alpha_{57} \Sigma IR_t + e_5
\]
\[
UNP_t = \lambda_6 + \alpha_{61}\Sigma yg_{t-1} + \alpha_{62}\Sigma INF_{t-1} + \alpha_{63}\Sigma RER_{t-1} + \alpha_{64}\Sigma HK_{t-1} + \alpha_{65}\Sigma TO_{t-1} + \alpha_{66}\Sigma UNP + \alpha_{67}\Sigma HK_{t-1} + c_6 \tag{3.17}
\]

\[
IR_t = \lambda_7 + \alpha_{71}\Sigma yg_{t-1} + \alpha_{72}\Sigma INF_{t-1} + \alpha_{73}\Sigma RER_{t-1} + \alpha_{74}\Sigma HK_{t-1} + \alpha_{75}\Sigma TO_{t-1} + \alpha_{76}\Sigma UNP + \alpha_{77}\Sigma IR_{t-1} + e_7 \tag{3.18}
\]

Where:

- \( Yg \) = per capita output growth
- \( INF \) = inflation rate
- \( RER \) = Real Exchange rate
- \( HK \) = Human capital
- \( TO \) = Trade openness
- \( UNP \) = Unemployment
- \( IR \) = Investment ratio

A vector error correction (VEC) model is a restricted VAR that has cointegration in order with non stationary series that are cointegrated. It restricts the long-run behaviour of the explanatory variables to converge to their cointegration relationships while allowing a wide range of short-run dynamic (Sarte, 1997). A VEC model is specified as:

\[
\Delta y_{it} = \lambda_1 + \alpha_1 \Sigma \Delta y_{it-1} + \beta_1 \Sigma \Delta y_{it-1} + \gamma ECM_i + u_i \tag{3.19}
\]

\( \Delta y_i \) = change in individual variable in the model

\( \lambda_i = \lambda_1, \lambda_2 \)  
\( \beta \alpha_1, \alpha_{12}, \alpha_{21}, \alpha_{22} \)  
\( \gamma \) = error correction parameter.

ECM = Error correction term

3.6 **Estimation**

The models were estimated with OLS using Eviews 3.0 software version. This package is selected because it is a user friendly computer application which provides sophisticated data analysis, regression and forecasting.

3.7 **Data**

Data for the study was obtained from the central Bank of Nigeria (CBN) publications, National Bureau of statistics (NBS) and the World Bank publications. The annual data generated from 1970 to 2005 was interpolated in order to capture quarterly effect.
CHAPTER FOUR
PRESENTATION OF RESULTS AND ANALYSIS

4.1 BATTERY TESTS

This section discusses the necessary tests that were carried out on the data before estimating the models for the study. These tests are the unit root test and the Johansen cointegration test.

4.1.1 UNIT ROOT TEST

Macroeconomic data usually exhibit stochastic trend that can be removed through only differencing. The Augmented Dickey Fuller (ADF) test was employed for testing the order of integration of the variables in the model. The ADF unit root result shows that all the variables are integrated of order one $I(1)$ except investment ratio which is integrated of order two $I(2)$. This is in conformity with some of the existing empirical work in Nigeria (Iyoha 2002, Asogwa 2003). The result is illustrated with the aid of table 4.1.

Table 4.1: UNIT ROOT TEST

<table>
<thead>
<tr>
<th>Variables</th>
<th>Coefficients</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Level</td>
</tr>
<tr>
<td>TO</td>
<td>-1.348920</td>
</tr>
<tr>
<td>INF</td>
<td>-2.732706</td>
</tr>
<tr>
<td>RER</td>
<td>-1.514530</td>
</tr>
<tr>
<td>IR</td>
<td>-1.538997</td>
</tr>
<tr>
<td>RIR</td>
<td>-2.592647</td>
</tr>
<tr>
<td>UNP</td>
<td>-1.209083</td>
</tr>
<tr>
<td>PK</td>
<td>-0.492494</td>
</tr>
<tr>
<td>YG</td>
<td>-1.550141</td>
</tr>
</tbody>
</table>

The mean reversibility of the degree of trade openness, inflation rate, real exchange rate, investment ratio, real interest rate, unemployment, per capita income and output growth are shown with the aid of figures 4.1 – 4.8.

Figure 4.1: The degree of trade openness
FIGURE 4.2: Inflation rate in Nigeria
FIGURE 4.2: Inflation rate in Nigeria
Figure 4.3: real exchange rate in Nigeria

Figure 4.4: investment ratio in Nigeria
Figure 4.5: Real interest rate in Nigeria

Figure 4.6: Unemployment rate in Nigeria
4.1.2 COINTEGRATION TEST

We used the approach of Johansen and Juselius (1990) which contains likelihood ratio test of statistic, the maximum eigenvalue and the trace statistic in finding out the number of cointegrating vectors. Empirical evidence has shown that Johansen cointegration test is a more robust test than Engel Granger (EG) in
testing for cointegrating relationship. We estimated the cointegration test under the assumption of linear deterministic trend. The result of the cointegration test under the assumption of deterministic trend is shown in table 4.2.

Table 4.2: Johansen Cointegration test under the assumption of deterministic trend.

<table>
<thead>
<tr>
<th>Eigenvalue</th>
<th>Likelihood Ratio</th>
<th>5% Critical Value</th>
<th>1% Critical Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.414928</td>
<td>205.8284</td>
<td>156.00</td>
<td>168.36</td>
</tr>
<tr>
<td>0.209346</td>
<td>131.3215</td>
<td>124.24</td>
<td>133.57</td>
</tr>
<tr>
<td>0.205543</td>
<td>98.67118</td>
<td>94.15</td>
<td>103.18</td>
</tr>
<tr>
<td>0.187292</td>
<td>66.68782</td>
<td>18.52</td>
<td>76.07</td>
</tr>
<tr>
<td>0.113473</td>
<td>37.86149</td>
<td>47.21</td>
<td>54.46</td>
</tr>
<tr>
<td>0.084094</td>
<td>21.11979</td>
<td>29.68</td>
<td>35.65</td>
</tr>
<tr>
<td>0.048926</td>
<td>8.909806</td>
<td>15.41</td>
<td>20.04</td>
</tr>
<tr>
<td>0.013839</td>
<td>1.937049</td>
<td>3.76</td>
<td>6.64</td>
</tr>
</tbody>
</table>

The result of the loglikelihood ratio indicates three cointegrating equations at 5% level of significance. In order to include the five basic assumptions of the Johansen cointegration test, cointegration summary was conducted and its result is shown in table 4.3.
Table 4.3: Cointegration Test Summary

<table>
<thead>
<tr>
<th>Rank or No. of CE</th>
<th>No intercept No trend</th>
<th>Intercept No. trend</th>
<th>Intercept No. Trend (linear)</th>
<th>Intercept Trend (linear)</th>
<th>Intercept Trend (quadratic)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>-3735.258</td>
<td>-3775.258</td>
<td>-3774.207</td>
<td>-3774.207</td>
<td>-3768.665</td>
</tr>
<tr>
<td>1</td>
<td>-3740.548</td>
<td>-3737.998</td>
<td>-3736.953</td>
<td>-3736.061</td>
<td>-3730.943</td>
</tr>
<tr>
<td>2</td>
<td>-3724.320</td>
<td>-3721.609</td>
<td>-3720.628</td>
<td>-3717.269</td>
<td>-3713.854</td>
</tr>
<tr>
<td>3</td>
<td>-3709.824</td>
<td>-3705.558</td>
<td>-3704.637</td>
<td>-3701.131</td>
<td>-3697.724</td>
</tr>
<tr>
<td>4</td>
<td>-3700.605</td>
<td>-3691.133</td>
<td>-3690.223</td>
<td>-3685.631</td>
<td>-3684.777</td>
</tr>
<tr>
<td>5</td>
<td>-3693.968</td>
<td>-3682.724</td>
<td>-3681.853</td>
<td>-3677.011</td>
<td>-3676.331</td>
</tr>
<tr>
<td>6</td>
<td>-3690.160</td>
<td>-3676.088</td>
<td>-3675.748</td>
<td>-3670.816</td>
<td>-3670.145</td>
</tr>
<tr>
<td>7</td>
<td>3688.675</td>
<td>-3672.298</td>
<td>-3672.261</td>
<td>-3666.850</td>
<td>-3666.283</td>
</tr>
<tr>
<td>8</td>
<td>3688.619</td>
<td>-3671.293</td>
<td>-3671.293</td>
<td>-3665.785</td>
<td>-3665.783</td>
</tr>
</tbody>
</table>

Table 4.3 shows loglikelihood ratios from zero cointegrating coefficients to eight (8) normalized cointegrating coefficients. We adopted the assumption of linear intercept and no trend and found out that -3736.953, -3720.628, -3704.637, -3690.223, -3681.853, -3675.748, -3672.261 and -3671.293 represents loglikelihood of 1 to 8 normalized cointegrating equations.

4.1 RESULTS OF THE GARCH MODELS:

The Exponential GARCH models were estimated after interpolation. The result of the Exponential GARCH (EGARCH) shows that all the explanatory variables are highly significant in explaining output volatility. The result of the EGARCH model is shown in table 4.4.
Table 4.4: Result Of EGARCH Model

<table>
<thead>
<tr>
<th>Variables</th>
<th>Coefficients</th>
<th>Std. Error</th>
<th>Z - Statistic</th>
<th>Prob</th>
</tr>
</thead>
<tbody>
<tr>
<td>TO</td>
<td>-0.143294</td>
<td>0.045881</td>
<td>-3.123183</td>
<td>0.0018</td>
</tr>
<tr>
<td>INF</td>
<td>1.972222</td>
<td>0.187862</td>
<td>10.49824</td>
<td>0.0000</td>
</tr>
<tr>
<td>RER</td>
<td>-0.024630</td>
<td>0.007016</td>
<td>-3.510828</td>
<td>0.0004</td>
</tr>
<tr>
<td>RIR</td>
<td>1.937318</td>
<td>0.161858</td>
<td>11.96926</td>
<td>0.0000</td>
</tr>
<tr>
<td>IR</td>
<td>-30.11681</td>
<td>8.846179</td>
<td>-3.460455</td>
<td>0.0005</td>
</tr>
<tr>
<td>PK</td>
<td>-0.000368</td>
<td>0.000128</td>
<td>-2.860842</td>
<td>0.0042</td>
</tr>
<tr>
<td>UNP</td>
<td>1.722379</td>
<td>0.145117</td>
<td>11.86886</td>
<td>0.0000</td>
</tr>
</tbody>
</table>

Table 4.4 shows that trade openness, real exchange rate, and investment ratio and per-capita income have negative impacts on output growth. Trade openness, real exchange rate, investment ratio, and per capita income influence output growth by -0.143294, -0.024630, -30.611181 and -0.000368 respectively. Output fluctuation in the model is positively related to inflation. Real interest rate, and unemployment inflation rate, real interest rate and unemployment affect output fluctuation by 1.972222, 1.937318 and 1.722379 respectively. The variance equation of the EGARCH model shows that previous shocks affect conditional volatility of other periods. This illustrated in table 4.5.

Table 4.5: Variance Equation

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>-0.919442</td>
<td>0.200883</td>
<td>-4.576994</td>
<td>0.0000</td>
</tr>
<tr>
<td>Res/sqr.GARCH (1)</td>
<td>1.235595</td>
<td>0.199089</td>
<td>6.206237</td>
<td>0.0000</td>
</tr>
<tr>
<td>EGARCH (1)</td>
<td>1.006072</td>
<td>0.025992</td>
<td>8.70688</td>
<td>0.0000</td>
</tr>
</tbody>
</table>

The component GARCH model was also estimated and its results are shown in table 4.6
Table 4.6: Result of the component GARCH model

<table>
<thead>
<tr>
<th>Variables</th>
<th>Coefficients</th>
<th>Std. Errors</th>
<th>Z - Statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>TO</td>
<td>0.019399</td>
<td>0.089775</td>
<td>0.216089</td>
<td>0.8289</td>
</tr>
<tr>
<td>INF</td>
<td>1.789966</td>
<td>0.287530</td>
<td>6.225330</td>
<td>0.0000</td>
</tr>
<tr>
<td>RER</td>
<td>-0.033214</td>
<td>0.006498</td>
<td>-5.111163</td>
<td>0.0000</td>
</tr>
<tr>
<td>IR</td>
<td>-50.07986</td>
<td>14.52505</td>
<td>-3.447827</td>
<td>0.0006</td>
</tr>
<tr>
<td>RIR</td>
<td>1.633893</td>
<td>0.31838</td>
<td>5.239555</td>
<td>0.0000</td>
</tr>
<tr>
<td>UNP</td>
<td>1.667454</td>
<td>0.211842</td>
<td>7.871234</td>
<td>0.0000</td>
</tr>
<tr>
<td>PK</td>
<td>-0.000384</td>
<td>0.000143</td>
<td>-2.690882</td>
<td>0.0071</td>
</tr>
</tbody>
</table>

The result of the component GARCH model is very similar with the exponential GARCH model except the trade openness which is now positively influencing output volatility but not significant in the model. Other variables remain statistically significant in the model. The variance equation in component GARCH also indicates that previous shocks contribute significantly to the current output volatility and other periods ahead.

4.2 RESULT OF THE VAR MODEL

The result of the unrestricted vector autoregressive (VAR) model shows eight equations that were estimated simultaneously. The result indicates that output growth is positively influenced by the previous values of itself, inflation rate, investment ratio, real interest rate and per capita income while real exchange rate, unemployment rate and trade openness transmit negative shocks to output growth. The result shows that the impact of previous values of output growth on itself is more statistically significant than other variables in the model.

The degree of trade openness in Nigeria is negatively influenced by real exchange rate and unemployment rate while other variables show positive transmission of shocks. The result is illustrated in table 4.7.
Table 4.7: Degree of Trade openness.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Coefficient</th>
<th>Standard Error</th>
<th>t-Statistic</th>
</tr>
</thead>
<tbody>
<tr>
<td>YG - 1</td>
<td>0.0604</td>
<td>0.0241</td>
<td>2.5037</td>
</tr>
<tr>
<td>TO - 1</td>
<td>0.4217</td>
<td>0.1062</td>
<td>3.9723</td>
</tr>
<tr>
<td>TO - 2</td>
<td>0.4340</td>
<td>0.1066</td>
<td>4.0729</td>
</tr>
<tr>
<td>INF - 2</td>
<td>0.2370</td>
<td>0.1516</td>
<td>1.5633</td>
</tr>
<tr>
<td>IR - 1</td>
<td>-34.5204</td>
<td>18.3133</td>
<td>-1.8850</td>
</tr>
<tr>
<td>IR - 2</td>
<td>70.6416</td>
<td>18.884</td>
<td>3.7408</td>
</tr>
<tr>
<td>PK - 1</td>
<td>0.0003</td>
<td>0.0002</td>
<td>1.6538</td>
</tr>
</tbody>
</table>

Table 4.7 indicates that fluctuations in the degree of trade openness is statistically influenced by itself output growth, investment ratio, per capital income and inflation rate. Investment ratio contrast degree of trade openness by -34.54 while output growth, inflation and per capita income have 0.06, 0.24 and 0.0003 impacts respectively. The t-statistics in the misdeal presents output growth, previous values of trade openness and investment ratio as the principal determinants of fluctuations in the degree of trade openness in Nigeria.

Factors that are statistically significant in the investment ratio function are as shown with the aid of table 4.8

Table 4.8: Investment ratio function

<table>
<thead>
<tr>
<th>Variables</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-statistic</th>
</tr>
</thead>
<tbody>
<tr>
<td>YG - 1</td>
<td>0.000498</td>
<td>0.00018</td>
<td>2.69737</td>
</tr>
<tr>
<td>IR - 1</td>
<td>0.839392</td>
<td>0.14007</td>
<td>2.69262</td>
</tr>
<tr>
<td>IR - 2</td>
<td>0.355678</td>
<td>0.14144</td>
<td>2.46253</td>
</tr>
<tr>
<td>PK - 1</td>
<td>-2.69E06</td>
<td>13.E06</td>
<td>-2.09110</td>
</tr>
<tr>
<td>PK</td>
<td>2.36E06</td>
<td>1.3E06</td>
<td>1.80645</td>
</tr>
</tbody>
</table>

In table 4.8, investment is positively influenced by the previous values of itself, investment ratio and per capita income. The impulse response function exhibits a transmission of structural shocks among the variables in the model.
4.3 THE RESULT OF THE VEC MODEL

Vector Error correction model was estimated and its result shows that output in fluctuations in Nigeria is influenced by the previous values of itself, trade openness, inflation, real exchange rate, investment ratio, real interest rate, unemployment and per capital income. A unit charge in trade openness brings 175% change in output growth, while that of inflation bring about 75.4% change. The result of the t-statistic shows that the previous values of output growth is statistically significant in determining itself.

Fluctuation in the degree of trade openness is negatively influenced by the previous values of itself, output growth, inflation investment ratio and real interest rate but positively affected by per capita income. This is illustrated with the aid of table 4.9.

Table 4.9: Fluctuation in the degree of trade openness.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Coefficients</th>
<th>Std. 2000</th>
<th>t-statistic</th>
</tr>
</thead>
<tbody>
<tr>
<td>YG – 1</td>
<td>-0.054283</td>
<td>0.002520</td>
<td>-2.15442</td>
</tr>
<tr>
<td>YG – 2</td>
<td>-0.055093</td>
<td>0.02205</td>
<td>-2.49837</td>
</tr>
<tr>
<td>TO – 1</td>
<td>-0.782178</td>
<td>0.09900</td>
<td>-7.90058</td>
</tr>
<tr>
<td>TO – 2</td>
<td>-0.528596</td>
<td>0.09961</td>
<td>-5.30647</td>
</tr>
<tr>
<td>INF – 1</td>
<td>-0.458461</td>
<td>0.12809</td>
<td>-3.57915</td>
</tr>
<tr>
<td>INF – 2</td>
<td>-0.284615</td>
<td>0.12186</td>
<td>-2.33565</td>
</tr>
<tr>
<td>IR – 1</td>
<td>-59.96309</td>
<td>16.3578</td>
<td>-3.66573</td>
</tr>
<tr>
<td>RIR – 1</td>
<td>-0.447169</td>
<td>0.13476</td>
<td>-3.31836</td>
</tr>
<tr>
<td>RIR – 2</td>
<td>-0.307261</td>
<td>0.12630</td>
<td>-2.43286</td>
</tr>
<tr>
<td>PK – 1</td>
<td>0.000374</td>
<td>0.00015</td>
<td>-2.41659</td>
</tr>
</tbody>
</table>

A unit increase in output growth, inflation and real interest rate contrasts the degree of trade openness by 5.4%, 45.8% and 44.7% respectively. The inverse relationship between these variables and trade openness exhibits theoretical consistency. The t-statistic shows that the previous values of output growth, inflation rate, real interest rate and per capita income are the dragging factors in trade openness fluctuations.
VEC model result further shows that inflation rate is affected by the previous values of itself, real interest rate, output growth and trade openness. This is illustrated with the aid of table 4.10

Table 4.10: Inflation rate

<table>
<thead>
<tr>
<th>Variables</th>
<th>Coefficients</th>
<th>Std. Errors</th>
<th>t-statistic</th>
</tr>
</thead>
<tbody>
<tr>
<td>INF – 1</td>
<td>-0.933022</td>
<td>0.20726</td>
<td>-4.50172</td>
</tr>
<tr>
<td>INF – 2</td>
<td>-0.404776</td>
<td>0.19717</td>
<td>-2.05293</td>
</tr>
<tr>
<td>RIR – 1</td>
<td>-0.432114</td>
<td>0.21804</td>
<td>-1.98180</td>
</tr>
<tr>
<td>YG – 1</td>
<td>-0.042771</td>
<td>0.04077</td>
<td>-1.04912</td>
</tr>
<tr>
<td>TO – 1</td>
<td>-0.227632</td>
<td>0.16019</td>
<td>-1.42100</td>
</tr>
<tr>
<td>TO – 1</td>
<td>-0.241229</td>
<td>0.16118</td>
<td>-1.49665</td>
</tr>
</tbody>
</table>

Table 4.10 shows that inflation rate is negatively influenced by real interest rate, output growth and trade openness. The statistical test of significance shows that previous values of inflation rate and real interest rate are significant. A unit change in real interest rate brings about 43.2% changes in inflation while a change in output growth brings about 4.2% changes. An increase in trade openness contrasts inflation rate by 22.8%. Fluctuations in investment ratio in Nigeria is influenced by the previous values of itself output growth, trade openness, inflation rate, previous real interest rate, unemployment and per capita income. VEC result shows that investment ratio is positively influenced by output growth, trade openness inflation and real interest rate and negatively influenced by the previous values of itself and per capita income of the people. The result is shown in table 4.11.
Table 4.1: Investment ratio

<table>
<thead>
<tr>
<th>Variables</th>
<th>COEFFICIENTS</th>
<th>St. Errors</th>
<th>t-statistic</th>
</tr>
</thead>
<tbody>
<tr>
<td>YG - 1</td>
<td>0.000295</td>
<td>0.00021</td>
<td>1.38837</td>
</tr>
<tr>
<td>YG - 2</td>
<td>0.000533</td>
<td>0.00019</td>
<td>2.87030</td>
</tr>
<tr>
<td>TO - 2</td>
<td>0.001530</td>
<td>0.00084</td>
<td>1.82365</td>
</tr>
<tr>
<td>INF - 1</td>
<td>0.001706</td>
<td>0.00108</td>
<td>1.58121</td>
</tr>
<tr>
<td>IR - 2</td>
<td>-0.0701738</td>
<td>0.13973</td>
<td>-5.02195</td>
</tr>
<tr>
<td>RIR - 1</td>
<td>0.001911</td>
<td>0.00113</td>
<td>1.68339</td>
</tr>
<tr>
<td>UNP - 2</td>
<td>0.003828</td>
<td>0.00353</td>
<td>1.08361</td>
</tr>
<tr>
<td>PK - 1</td>
<td>-2.58 E-06</td>
<td>1.3 E-06</td>
<td>1.97689</td>
</tr>
</tbody>
</table>

The relationship between output growth and its determinants are illustrated graphically as shown with the aid of Appendix A.

4.4 EVALUATION OF HYPOTHESES

In this sector, we tested the four hypotheses in accordance with the analysis of the results.

TEST OF HYPOTHESIS ONE

Ho: Economic growth in Nigeria has no specific determinants

Hi: Economic growth in Nigeria has specific determinants.

The result of the exponential GARCH model shows that economic growth is determined by trade openness, inflation rate, real exchange rate, real interest rate, investment ratio, per capita income and unemployment rate in Nigeria. A unit increase in the degree of trade openness decreases output growth by 14.3 percent while an increase in real exchange rate decreases output growth by 2.5 percent. In the same way, an increase in investment ratio or per capita income decreases output growth by 30.6 or 0.0004 respectively. The component GARCH model also indicated that output growth is influenced by the above mentioned factors. These results are in accordance with the modern growth theory. We therefore reject the null hypothesis and accept the alternative hypothesis which says that economic growth has specific determinants in Nigeria.
TEST OF HYPOTHESIS TWO

Ho: There is no transmission of structural shocks among economic growth and its determinants

Hi: There is transmission of structural shocks among economic growth and its determinants.

The results of the parsimonious vector Error correction (VEC) model shows that there is transmission of structural shocks among variables in the model. The estimated impulse response function indicates a significant transmission of structural shock. Therefore, we reject the null hypothesis and accept that structural shocks are transmitted from one variable to another.

TEST OF HYPOTHESIS THREE

Ho: There is no volatility clustering among economic growth and its determinants

Hi: There is volatility clustering among economic growth and its determinants.

The residual actual and fitted trends exhibit presence of volatility clustering among the variables in the model. We further used scatter diagram with trends and the results show that the data used in this study exhibits mean reversibility and high degree of clustering within a range of time. This is in accordance with the behaviour of most of the macroeconomic data in less developed countries. We therefore reject the null hypothesis and accept the alternative hypothesis.

TEST OF HYPOTHESIS FOUR

Ho: Current shock on economic growth has no relationship with the conditional volatility of other periods ahead

We estimated an asymmetric quadratic function centered at $e_t = 0$ with different slopes for positive and negative shocks. This represents equation 3.1 in chapter three. The result of $NIC/e_t/h_t = \Psi + \alpha_1 e_t^2 + \beta_1 h$ for $e_t < 0$ shows $-0.2107$ and $-0.519$ for $e_t$ of ARCH and GARCH respectively. The result shows that negative shocks are not statistically significant in the model. For positive shocks, NIC
\( e_t / \text{ht} = h = \theta + ye_t^2 + \delta_t h \), the variance equation shows 0.999, 0.4799 and 0.0908 for perm$^2$Q-C, perm ARCH – GARCH and tran (ARCH-Q) respectively. The result shows that positive shocks are statistically significant. Therefore, current shock on economic growth has significant relationship with the conditional volatility of other periods.
CHAPTER FIVE
SUMMARY, CONCLUSION AND POLICY RECOMMENDATION

5.1 SUMMARY

The rate at which different macroeconomic variables are fluctuating has constituted severe problems for policy analysts. Low economic growth and unexpected fluctuation of macroeconomic variables are attributed to some factors such as demographic, social conditions, insufficient infrastructure and dependency on primary products. These factors have not actually x-rayed the determinants of economic growth in Nigeria. This is why the adoption of different programmes to minimize such fluctuations in the Nigerian economy could not achieve significant results. Although some of these programmes such as Operation Feed the Nation (OFN), Green Revolution, Directorate for food, Road and Rural Infrastructure (DIFRR), Structural Adjustment Programme (SAP), National Directorate of Employment (NDE), State Economic Empowerment and Development Strategy (SEEDS), National Economic Empowerment and Development Strategy (NEEDS) e.t.c. helped immensely in addressing both micro and macroeconomic problems, the fluctuation is still appreciating.

Precisely, many economic analysts have used cross-country regression to trace the determinants of volatility in many countries. This could not yield significant result because the technique suffers from inappropriate measurement and specification bias. The result obtained from this type of specification may not be robust because of the heterogeneity of the developing country's macroeconomic data.

This work adopted the Exponential GARCH (EGARCH) model and the Vector Autoregressive (VAR) model which was later transformed into VEC model. The result of the EGARCH model shows that economic growth in Nigeria is determined by the degree of trade openness, inflation rate, real exchange rate, real interest rate, investment ratio, per capita income and unemployment rate. Output fluctuations are negatively determined by trade openness, real exchange rate, investment ratio and per capita income while inflation rate, real interest rate and unemployment rate have positive impact. Similarly, the result of the
component GARCH model indicates that inflation rate, real exchange rate, investment ratio, real interest rate, per capita income and unemployment rate have significant impact on output growth fluctuation. The degree of trade openness gives insignificant impact on the volatility of output growth. With the exception of the degree of trade openness which is now positively influencing output growth, the result of the component GARCH model is consistent with the EGARCH results.

VAR model results and impulse response function show that there is transmission of structural shocks among economic growth and its determinants. The results show that previous values of output growth, inflation rate, investment ratio, real interest rate and per capital income transmit positive shocks to output growth fluctuation while trade openness transmit negative shocks. A significant impact of previous value of output growth on itself is consistent with the existing empirical findings in most of the less developed countries.

The result of the VEC model indicates a similar result with VAR. A unit change in the degree of trade openness brings about 175% change in output growth fluctuation while a unit change in inflation rate brings 75.4% change. This shows that trade openness creates more fluctuation in output growth than inflation rate in Nigeria. The degree of trade openness is negatively influenced by inflation rate, investment ratio and real interest rate but positively determined by per capita income.

Inflation rate function shows that it is negatively affected by real interest rate and trade openness. The statistical test of significance indicates that only interest rate is significant in this function. Investment ratio volatility in Nigeria is positively influenced by output growth, the degree of trade openness, inflation rate, and real interest rate but negatively affected by the per capita income of the people.

There is presence of volatility clustering among variables used in this work. The data exhibits mean reversibility and high degree of clustering within a range of time. The asymmetric EGARCH model shows that current shock on output fluctuation has significant relationship with the conditional volatility of
other periods. The GARCH impulse response function shows persistent shocks of the conditional volatility of other periods.

5.2 policy implication

* The determinants of output volatility such as inflation rate, real exchange rate, real interest rate, investment ratio, unemployment rate and per capita income are highly volatile and demand both monetary and fiscal policy measures.

* Output volatility in Nigeria goes in order with persistent inflation rate. This calls the need for inflation targeting rule to cushion its unexpected impact on the economy. This will address so many problems as we have output gap integrated in the inflation reaction function of Taylor's' rule.

* Government expenditure in Nigeria should be reallocated to favour industrialization, agriculture and other sectors of the economy. Federal government policy on checking embezzlement and corruption in public offices should be enhanced in order to minimize high rate of inflation in Nigeria.

* There is need for government to encourage Small and Medium scale Enterprises (SMEs) in order to increase the level of employment in Nigeria. This can be done through technical education and intensive research on the problems and prospects of Small and Medium scale Enterprises.

* The degree of trade openness should be checked in order not to expose the economy to external shocks.

* Current shocks on output volatility and its determinants are useful guideline for forecasting and policy adjustment.

5.3 CONCLUSION

Low output growth and sudden fluctuations in the in macroeconomic variables have constituted severe problems for policy makers and policy analysts in Nigeria for a number of years. Many policy analysts have come to a conclusion that Nigeria is poor because of low technology and its dependency in primary products. This notwithstanding, Nigeria is highly blessed with abundant resources which gave her a chance of being one of the richest nations in the whole world. Nigeria could not gain this beautiful opportunity because of sudden fluctuations in our macroeconomic variables.
The issue of addressing inflation targeting, unemployment rate, real exchange rate, trade openness, investment ratio, and interest rate targeting should not be taken for granted because they are the major determinants of economic growth and its fluctuations in Nigeria.

There are transmission of shocks among economic growth and its determinants in Nigeria. The rates of transmission of shocks among these variables are useful for policy adjustment. Fluctuations in inflation rate create unfavourable impacts on output growth and other factors that are responsible for output fluctuation in Nigeria. There is need for inflation targeting rule which enables policy analysts to work with a certain level of inflation rate to be achieved. Interest rate targeting is an alternative approach which is capable of correcting several fluctuations that may occur in macroeconomic variables. Inflation targeting will be more encompassing than that of interest rate reaction function.

Economic growth and its determinants are highly volatile. There is need to use the current shock on economic growth to forecast tomorrow’s fluctuations. This will give policy analysts the directions on how to handle complicated cases of fluctuations in the economy.
REFERENCES


Friedman (1977) Noble Laureate Lecture on Growth.


Imbs, Jean (2002) ‘Why the Link Between Volatility and Growth is both Positive and Negative’, *C.E. PR Discussion Papers* 3561 C.E.P.R.


Figure 1: output growth and inflation rate in Nigeria

Figure 2: output growth and real exchange rate in Nigeria
Figure 3: Output growth and real interest rate in Nigeria

Figure 4: Output growth and investment ratio in Nigeria
Figure 5: Output Growth and Unemployment rate in Nigeria

Figure 6: Output Growth and Per Capita Income in Nigeria
Figure 7: Output Growth and the degree of Trade Openness

Figure 8: Inflation Rate and its scatter diagram