MAIN REPORT

Occasional Paper No. 32

The Dynamics of Inflation In Nigeria

Research and Statistics Department
Central Bank of Nigeria
Abuja

August 2007

CENTRAL BANK OF NIGERIA

THE DYNAMICS OF INFLATION IN NIGERIA

PREPARED BY

C. N. O. Mordi
E. A. Essien
A. O. Adenuga
P. N. Omanukwue
M. C. Ononugbo
A. A. Oguntade
M. O. Abeng
O. M. Ajao

Special Reviewer: O. J. Nnanna, PhD

Research and Statistics
Central Bank of Nigeria
P. M. B. 0817
Abuja, Nigeria

This study was carried out under the supervision of Mr. C. N. O. Mordi, Ag. Director, Research and Statistics Department. The study team was led by Mr. Essien, Head, Modeling and Forecasting Office (MFO), prior to his secondment to the West African Monetary Institute, Ghana in 2006. The team members were Messrs Adenuga, Ononugbo, Oguntade, Abeng, Ms Omanukwue, and Miss Ajao, a former National Youth Service Corps (NYSC) member of the Office.

Table of Content

			Page
Preface`	.. ..		**ix**
Acknowledgement	.. ..		**x**
Executive Summary	.. ..		**xi**
I.	**Introduction**		**1**
II.	**Literature Review**		**2**
	II. 1 Conceptual Issues		2
	II. 2 Theoretical Review		5
	II.2.1 The Phillips Curve		5
	II.2.2 The Monetarist		6
	II.2.3 The Keynesian		7
	II.2.4 Neo-Keynesian		8
	II. 3 Empirical Literature		9
III.	**Stylized Facts on Inflation in Nigeria**		**13**
	III. 1 Component and Structure of CPI		13
	III.2 Institutional Framework and the Mandate of Price Stability		14
	III. 3 Relationship between Inflation Rate and Key Macroeconomic Variables		16
	III. 4 Trends in Inflation and Policy Response		24
	III. 5 Decomposition of CPI		28
IV.	**Modeling Inflation Dynamics**		**31**
	IV. 1 Trend Models		31

IV. 2 Autoregressive Integrated Moving Average (ARIMA) Models 32

IV. 3 Structural Models of Inflation 33

IV. 3.1 Mark-up Models 33

IV. 3.2 Monetarist Models 34

IV. 3.2.1 Money Gap 34

IV. 3.2.2 Open Economy Model 35

IV. 3.3 Phillips Curve Model 36

IV. 4 Estimation Technique/Specification 36

V. Empirical Model Specification for Nigeria 38

V. 1 Trend Model 38

V. 2 ARIMA Model 38

V. 3 Monetarist Model 39

V. 3.1 Monetary Gap Model 39

V. 3.2 Open Economy Model 39

V. 4 Phillips Curve Model for Nigeria 40

VI. Analysis and Major Findings 41

VI. 1 Results from the Time Trend Models 42

VI. 2 Results from the Autoregressive Integrated Moving Average (ARIMA) Models 43

VI. 3 Results from the Monetarist Models 44

VI. 3.1 Money Gap Model 44

VI. 3.2 Open Economy Model 49

VI. 4 Results from the Phillips Curve Model 60

VI. 5 In-Sample Performance of the Inflation Forecast .. 66

VI. 6 3-Quarter Ahead Inflation Forecast 72

VII. Summary, Conclusion and Recommendation 74

VII.1 Summary and Conclusion 74

VII.2 Concluding Remarks 77

VIII. Direction for Future Work 78

Bibliography 79

Appendix: Glossary and Definitions 86

List of Tables

Table		Page
1	Percentage Contribution of Items in the CPI Basket of Goods ..	15
2	Volatility of Headline, Core and Non-Core (Food) Inflation ..	31
3	Results from the Trend Models	42
4	Further Diagnostic Tests for the Time Trend Models	42
5	Forecasts of the CPI from the Trend Models	43
6	Results from the ARIMA Models	43
7	Further Diagnostic Tests for the ARIMA Models	44
8	Forecasts of the CPI from the ARIMA Models	44
9	Results from the Money Gap Models	46
10	Further Diagnostic Tests for the Money Gap Models	47
11	Forecast of the CPI from the Money Gap Models	49

12	Long Run Models for Inflation	51
13	Unit Root Test for the Variables Used in the Models	52
14	Unit Root Test of the Residual	52
15	Short Run Models for Inflation	56
16	Further Diagnostic Tests for Short Run Models	58
17	Forecast of the CPI from the Error Correction Models	60
18	Results from the Phillips Curve Models	61
19	Diagnostic Tests for the Phillips Curve Models	63
20	Forecast of the CPI from the Output Gap Models	66
21	Forecast of the CPI from the Agriculture/Industry Models ..	66
22	Forecast of Headline, Core and Food Inflation	67
23	Average In-Sample Forecast from all Models	71
24	Average Point and Interval Inflation Forecast	73

List of Figures

Figure		Page
1	Money Growth, Headline, Core, and Non-Core Inflation Rates, 1981-2005	16
2	Base Money, Headline, Core, and Non-Core Inflation Rates, 1981-2005	17
3	Bank Reserve, Headline, Core, and Non-Core Inflation Rates, 1981-2005	17
4	Government Expenditure, Headline, Core, and Non-Core Inflation Rates, 1981-2005	18

5	Exchange Rate, Headline, Core, and Non-Core Inflation Rates, 1981 - 2005	18
6	Headline Inflation, Savings, Deposit, and Prime Lending Rates, 1981-2005	19
7	Core Inflation Rate, Savings, Deposit, and Prime Lending Rates, 1981-2005	19
8	Non-Core Inflation Rate, Savings, Deposit, and Prime Lending Rate, 1981-2005	20
9	Headline Inflation, MRR, and Treasury Bill Rate, 1981-2005 ..	20
10	Core Inflation, MRR, and Treasury Bill Rate, 1981-2005 ..	21
11	Non-Core Inflation, MRR, and Treasury Bill Rate, 1981-2005 ..	21
12	Headline Inflation Rate, Credit to the Private Sector, and Aggregate Demand, 1981-2005	22
13	Core Inflation Rate, Credit to the Private Sector, and Aggregate Demand, 1981-2005	22
14	Food Inflation Rate, Credit to the Private Sector, and Aggregate Demand, 1981-2005	23
15	Headline Inflation, Real, and Food GDP, 1981-2005	23
16	Core Inflation, Real, and Food GDP, 1981-2005	24
17	Non-Core Inflation, Real, and Food GDP, 1981-2005	24
18	Headline Inflation Rate, 1981- 2005	25
19	Core Inflation Rate, 1981-2005	26
20	Food Inflation Rate, 1981-2005	27
21	Decomposition of Quarterly Changes in Inflation	29
21a	Disaggregated Headline Inflation Rate	30

21b	Disaggregated Core Inflation Rate	30
21c	Disaggregated Non-Core Inflation Rate	31
22	Flow Chart Representation of the Monetarist Price Determination	40
23	Graph of Actual, Fitted and Residual Plot for the Money Gap Models	47
24	Histogram Normality Test for Residuals of the Money Gap Models	48
25	Recursive Residual Test of Stability of the Money Gap Models	48
26	Actual, Fitted and Residual Charts for the Short Run Models	57
27	Histogram Normality Test for Residuals of the Short Run Models	58
28	Recursive Residual Test of Stability of the Short Run Models	59
29	Actual, Fitted and Residual Charts for the Phillips Curve Models	62
30	Histogram Normality Test for Residuals of Phillips Curve Models	63
31	Recursive Residual Test of Stability of the Phillips Curve Models	65

Preface

The inflationary forces that led to the collapse of the Bretton Woods system in the 1960s and 1970s greatly refocused the monetary policy from its primary function of providing finance for government and helping to stabilize the financial system to the maintenance of a stable domestic value of the currency. The question as to whether a central bank should be given the sole or primary task of assuring price stability or low inflation, considering that monetary policy affects both output and prices, in the short run is, however, debatable. The answer begins from the well known Phillips curve, in terms of the short run trade-off between output and inflation. Because this trade-off in itself depends on the average rate of inflation and is central to the monetary policy design and implementation, makes the fight against inflation a daunting one.

The costs of inflation are well documented. Perhaps the most important of them is that it frustrates long-term growth. However, it is important to note that the extent to which this happens depends on the institutional structure of an economy, the extent to which inflation has been anticipated and its dynamics understood. It is, therefore, not surprising that central banks devote considerable time and resources to study inflation in order to determine the optimal rate that would be consistent with economic activity, the type of monetary policies that can be designed to control it as well as the instruments to be used.

The Central Bank of Nigeria has long held the view that the dynamics of inflation in Nigeria, without which optimal targets can be set, have not been properly understood. This is why, in 2005, the Governor of the Central Bank of Nigeria re-iterated the need to unravel this mystery. He indeed, made the study of inflation a priority for 2006. In response to this call, the Research and Statistics Department made it a high priority study in its work programme with the twin aim of understanding the dynamics of inflation as well as developing a forecasting model that would give an indication of inflation in the future. The Modeling and Forecasting Office (MFO), in the Economic Modeling and Statistics Division (EMSD), undertook this assignment. The product of this exercise is documented in this report.

The study does not attempt to give answers to all the problems associated with inflation for that would be truly an onerous task. Rather the findings contained herein are intended to aid monetary policy design and implementation as well as provide the basis for more work in the area. Readers are, therefore, free to dispassionately make serious academic contributions to the understanding of inflation, using the preliminary work that the central bank has provided, as a working document.

O. J. Nnanna, PhD
Former Director
Research and Statistics Department
Central Bank of Nigeria
Abuja

Acknowledgement

The authors are indebted to several people whose cooperation and support facilitated the completion of this study. Our special thanks go to the Governor of the Central Bank of Nigeria, Prof. Chukwuma C. Soludo for making this study a key focus for 2006. The former Deputy Governor, Economic Policy, Dr. Obadiah Mailafia, whose responsibility it was to drive this process, for his support in making the study a reality. We cannot forget the former Director of Research and Statistics, Dr. O. J. Nnanna for providing the needed impetus and funding that led to the success and earliest completion of this exercise. He also painstakingly went through the manuscript and offered useful advice. Our gratitude also goes to the discussants and other staff of the Bank for their invaluable contributions during the presentation of the study at a seminar.

The authors deeply appreciate the efforts of the secretarial staff, Mrs. R. C. Arungwa for her diligence in typing the manuscript and Mr. N. Imhandebhor for secretarial assistance. Finally, we wish to thank God for his guidance and direction throughout the period of the study.

Executive Summary

Inflation remains a central issue to policy makers and analysts. Its importance is premised on the distortions that high inflation rate can exert on domestic macroeconomic conditions, with the potential to derail the economy from the path of sustainable growth and development. For a developing economy, like Nigeria, characterized by significant structural imbalances and uncertainties, an insight into the dynamics of inflation is very pertinent. This document would further serve as a guide to effective monetary policy design and implementation for policy makers and planners. It underscores the determinants of inflation and attempts to provide an effective way of predicting its future path. The measure of inflation employed in this study is the composite consumer price index (CPI), which is widely and commonly used in Nigeria.

This study has drawn from a wealth of theoretical and empirical literature from industrialized, emerging market and developing economies. In an attempt to understand the dynamics of inflation in Nigeria, a combination of historical, descriptive and empirical methodologies have been employed. The study uses available quarterly data series spanning 1981 to 2005. The preliminary investigation in this study is based on historical and descriptive analysis. It assesses the stylized facts of inflation in Nigeria, with emphasis on the trends in inflation, decomposition of the cyclical movements in the consumer price index (CPI) and the nexus between inflation and key macroeconomic variables. The various policy responses to the observed inflationary trends are also analyzed. The empirical analysis adopted is a synthesis of various models which examined the theoretical underpinnings of inflation taking cognizance of the structure and nature of the Nigerian economy. The models developed in this study are: Trend models, Autoregressive Integrated Moving Average (ARIMA) models, Structural models the Phillips curve model and Monetarist models (money gap and open economy models). These models are applied to the different variants of the CPI over the past twenty five years and are estimated to cover both the long run steady state relationships and short run dynamics.

An exploration of the decomposed consumer price index is conducted using the Census X12 seasonal adjustment filter. This is done for headline, core and non-core CPI series[1], with the aim of ascertaining whether the CPI exhibits strong seasonal factors, irregular variation, cyclical factors and/ or time trend. The trend and ARIMA models are estimated using ordinary least squares. The ARIMA models are estimated with the aim of obtaining a parsimonious representation of the process generating inflation and to be able to adequately forecast its future values based on such

[1] Where core inflation is measured as the percentage change in CPI less farm produce (non-food) and non- core (food) is the percentage change in food CPI.

information given that inflation follows an ARIMA process. The money gap models are estimated adopting simple dynamic framework incorporating inflation expectation and lag values for money gap, while the open economy models are estimated using an error correction mechanism. The Monetarists models are estimated based on the paradigm that inflation is always and everywhere a monetary phenomenon. The Phillips curve model is estimated using a disaggregated output gap, which took into account the sectoral contributions of agriculture and industry to the gross domestic output. Model validation using various standard diagnostic tests, residual tests and stability tests are conducted on all the model results. All tests are conducted at the 5 per cent and 10 per cent significance levels.

The analysis of findings from this study is based on the different analytical techniques adopted. Analysis of the decomposed CPI shows that the headline and core (non-food) CPI exhibits a pronounced upward trend particularly since 1990, while non-core CPI shows strong seasonal and irregular patterns revealing that the non-core CPI responds to vagaries of weather, natural disasters and domestic crises. Results from the historical and descriptive analysis reveal that monetary expansion, reflected either by an increase in domestic credit or government fiscal operations, is a major determinant of inflation. It further revealed that aggregate demand and inflation co-vary, albeit with a lag and that higher inflation is associated with the long run depreciation in the exchange rate. Increases in food output are also found to have a dampening effect on inflation. This further corroborates the findings from the decomposed non-CPI series. Inflation inertia is found to be prevalent and persistent, indicating that economic agents adopt a backward looking behavior when setting future prices, thus inducing pressure on domestic prices.

Headline inflation tends to peak more frequently during the fourth quarter, while troughs occur mostly in the first and third quarters during the period covered by the study. Also, high volatility occurs in the first quarter, while the least volatility is recorded in the second quarter. Core inflation peaks in the first quarter, but tends to be more volatile during the third quarter and less volatile during the first quarter. For non-core inflation, the peak occurs during the third quarter with frequent troughs in the first and second quarters. It is, however, more volatile in the second and fourth quarters with the least volatility occurring in the first quarter. Over the period of the study, non-core (food) inflation exhibited the most volatility, followed by the core inflation with the least volatile being headline inflation.

Following the extensive model building and analysis, the short-run error correction model shows that a one percent shock in money supply induces about a 0.25 per cent and 0.32 per cent change in headline and non-core inflation, respectively with a quarter lag. Invariably, this presupposes that a one per cent decline in the headline and non-core inflation rate requires money growth to decelerate by 4.0 per cent and 3.2 per cent, respectively, over a quarter. The empirical analysis further reveals that in the

short-run, changes in the monetary aggregates do not affect core inflation, whereas in the long-run, there is a significant impact of changes in money stock on core inflation with a one per cent change inducing a 0.42 per cent change in core inflation after about four quarters. The effects of other key variables, such as the exchange rate and output level on inflation from the study reveal that there exists a low exchange rate pass-through to inflation. In the short-run and long-run, a one per cent depreciation of the exchange rate would take on the average one quarter to induce a 0.07 per cent and 0.32 per cent increase in the inflation rate, respectively.

In the case of the money gap model, a combination of either the money gap and inflation inertia or money gap and interest rate appears to be the main driver of headline and non-core, and core inflation, respectively, during the period covered by the study. However, the explanatory power of the model is quite low. The output gap model shows that, unlike the headline and core inflation, non-core inflation responds less significantly to output level changes, whereas in the money gap model, headline and non-core inflation respond significantly to changes in the money stock, with a one per cent decline in the rate of headline, core and non-core inflation requiring a reduction in the money gap by 3.2, 5.9 and 3.0 per cent, respectively. The Phillips curve model, which incorporates the disaggregated output gap (agricultural and industrial output), is very robust in explaining the headline and core inflation, albeit not significant in explaining variations in non-core inflation.

In the open economy model, estimated within the framework of the Engle-Granger approach, factors such as exchange rate, money supply, real output, foreign prices, interest rate, inflation inertia, appear to be driving the headline inflation in the long and/or short-run with policy shocks, such as the adjustment of the pump price of petroleum products complementing these in the short-run. With regard to the core inflation, inflation inertia, exchange rate, real GDP and interest rate are the most significant determinants in the short-run, while in the long-run, exchange rate, monetary aggregates, real GDP, government spending, foreign prices, and interest rate play more dominant roles in influencing movements in the core inflation.

In order to test the performance of the models, point and interval in-sample inflation forecasts from the various models are derived. Given that monetary policy in Nigeria is conducted in an environment characterized by uncertainty as well as frequent policy changes, and in order to minimize errors associated with the adoption of a single model, a three-quarter ahead point and interval inflation forecasts, averaging the forecasts from all the models for 2006, are further derived with a confidence band of ±2.5 percentage points for the interval forecasts. The average forecasts (combined forecasts) from the various models, though varying across the individual models, are found to be satisfactory. The actual headline inflation rates (year- on- year) are 12.0 per cent, 8.5 per cent and 6.3 per cent for the first, second and third quarters of 2006, respectively. The interval forecasts for these corresponding periods are 5.0-10.0 per

cent, 3.8-8.8 per cent, and 0.2-5.2 per cent. The actual core inflation rates (year- on-year) are 16.3 per cent, 13.6 per cent and 10.6 per cent for the first, second and third quarters of 2006, respectively. The interval forecasts for these corresponding periods are 6.3-11.3 per cent, 4.5-9.5 per cent, and 7.3-12.3 per cent. The actual non-core inflation rates (year- on- year) are 9.3 per cent, 6.2 per cent and 4.3 per cent for the first, second and third quarters of 2006, respectively. The interval forecasts for these corresponding periods are 5.7-10.7 per cent, 5.7-10.7 per cent, and -3.6-1.4 per cent.

Overall, the study shows that it takes on the average two quarters for monetary aggregates to impact on domestic prices. It further shows that headline and food inflation can be tracked by changes in money stock in the short-run, while core inflation can be better tracked by the money gap as a policy variable. Results from the Phillips curve model bring to the fore the need to closely monitor real variables in the design of policies for the deceleration of headline and core inflation rates. Developments in monetary aggregates continue to provide information about future inflation, although the type of monetary aggregate used needs to be re-examined. The computation of the headline inflation from the composite consumer price index should be sustained, while the existing definition of core inflation is inadequate and should be expanded to account for other variable components of the CPI basket such as energy. Perhaps it may also be expedient to examine the behaviour of other definitions/measures of core inflation used around the world such as the "trimmed mean", among others.

This study has further reiterated the need for monetary policy to be forward looking in order to achieve price stability. In order to reduce forecast error variances and minimize policy errors, combined forecasts derived from well-specified models are preferable for generating inflation forecasts. Perhaps it needs to be emphasized that no central bank the world over uses a single model to generate inflation forecast. A common phenomenon is the use of a suite of models ranging from the most basic trend and ARIMA models to more complicated structural models, complemented by expert forecast or judgment. It is also worth mentioning that the quality of data remains important for modeling and the need to continuously improve on the quality of data generated in Nigeria remains paramount. In conclusion, the study identifies areas of future research on the inflation dynamics in Nigeria to include the following re-identifying the ARIMA model, specifying and estimating a VAR model, estimating a P-star model, amongst others.

THE DYNAMICS OF INFLATION IN NIGERIA

I. Introduction

For most countries, the maintenance of price stability continues to be the overriding objective of monetary policy. The emphasis given to price stability in the conduct of monetary policy is with a view to promoting sustainable growth and development as well as strengthening the purchasing power of the domestic currency amongst others. In order to do this, they employ monetary policy frameworks/instruments considered best suited for achieving this mandate.

The Central Bank of Nigeria (CBN) employs the monetary targeting framework in the conduct of its monetary policy. This is based on the assumption of a stable and predictable relationship between money supply and inflation. Consequently, the need to understand the dynamics of inflation is central to the success of monetary policy to ensure the achievement of price stability. Having understood its dynamics, consideration is then given to ascertaining its determinants as well as an effective way of predicting its future path.

The paper examines the dynamics of inflation with a view to developing an appropriate model for forecasting inflation in Nigeria. The model takes into account the structure of the economy as well as the reactions of economic agents. The outcome of the model provides timely information to enable monetary policy actions that would mitigate inflationary pressures to be undertaken.

The rest of the paper is structured into eight sections. Following this introduction, section two covers the literature review, examining conceptual and theoretical issues as well as empirical literature for industrialized, emerging market and developing countries, including Nigeria. Section three discusses stylized facts on inflation in five ways. First, it examines the different components and structure of the consumer price index (CPI) basket. Second, it discusses institutional framework and the mandate of price stability. Third, it explores the relationship between inflation and key macroeconomic variables. Fourth, it x-rays the historical trends in inflation as well as policy responses. Lastly, a decomposition of the CPI is carried out in order to unveil its time series properties. In section four, the empirical methodologies for modeling inflation are discussed. In doing so, the focus is on both time series and structural econometric models. Section five specifies the different models for Nigeria. Analysis and major findings are the subject of section six. The models are also validated in this section and forecasts generated. Section seven summarizes and concludes the paper. It also contains policy recommendations. Section VIII points the direction for future work.

II. Literature Review

II.1 Conceptual Issues

In the economics literature, the concept of inflation has been intrinsically linked to money, as captured by the often heard maxim "inflation is too much money chasing too few goods". Inflation has been widely described as an economic situation when the increase in money supply is “faster” than the new production of goods and services in the same economy (Hamilton, 2001). Usually, economists try to distinguish inflation from an economic phenomenon of a one time increase in prices or when there are price increases in a narrow group of economic goods or services (Piana, 2001). Thus, the term inflation describes a general and persistent increase in the prices of goods and services in an economy (Ojo, 2000; Melberg, 1992).

Inflation rate is measured as the percentage change in the price index (consumer price index, wholesale price index, producer price index, etc). The consumer price index (CPI), for instance, measures the price of a representative basket of goods and services purchased by the average consumer and calculated on the basis of periodic survey of consumer prices (Essien, 2002). Owing to the different weights in the basket, changes in the price of some goods and services have impact on measured inflation with varying degrees. There are several disadvantages of the CPI as a measure of the price level. First, it does not reflect goods and services bought by firms or government, such as machinery. Second, it does not reflect the change in the quality of goods which might have occurred over time. Third, changes in the price of substitutable goods are not captured. Lastly, CPI basket usually does not change often. Despite these limitations, the CPI is still the most widely used measurement of the general price level. This is because it is used for indexation purposes for many wage and salary earners (including government employees).

Another measure of price movements is the GDP deflator. This is available on an annual basis. However, it is rarely used as a measure of inflation. This is because the CPI represents the cost of living and is, therefore, more appropriate for measuring the welfare of the people. Furthermore, because the CPI is available on a more frequent basis, it is most useful for monetary policy purposes.

In recent times, there have been three dominant schools of thought on the causes of inflation; the neo-classical/monetarist, neo-Keynesian, and structuralists. The neo-classical/monetarists opine that inflation is driven mainly by growth in the quantum of money supply. However, practical experiences of the Federal Reserve in the United States (US) have shown that this may not be entirely correct. For instance, the US money supply growth rates increase faster than prices itself (Hamilton, 2001, Colander, 1995). This has been traced to the increased demand for the US dollar as a global trade currency.

The neo-Keynesians attribute inflation to diminishing returns of production. This occurs when there is an increase in the velocity of money and an excess of current consumption over investment. The structuralists attribute the cause of inflation to structural factors and underlying characteristics of an economy (Adamson, 2000). For instance, in developing countries, particularly those with a strong underground economy, prevalent hoarding or hedging, individuals expect future prices to increase above current prices and, hence, demand for goods and services are not only transactionary, but also precautionary. This creates artificial shortages of goods and reinforces inflationary pressures.

The literature is replete with those factors that could affect the level of inflation. These factors can be grouped into institutional, fiscal, monetary and balance of payments. Several studies (Melberg, 1992; Cukierman, Webb and Neyapti, 1992; Grilli, et al., 1991; Alesina and Summers, 1993; Posen; 1993, Pollard (1993); and Debelle and Fisher, 1995) have shown that the level of independence (legal, administrative, instrument, etc.) of the monetary authority is an important institutional factor that determines inflation, especially, in industrialized countries, while the rate of turnover of central bank governors in developing countries was seen as an important factor influencing inflation. However, caution should be exercised in the interpretation of these findings, given the difficulty in measuring the actual level of independence of a central bank.

The fiscal factors relate to the financing of budget deficits, largely through money creation process. Under this view, inflation is said to be caused by large fiscal imbalances, arising from inefficient revenue collection procedures and limited development of the financial markets, which tends to increase the reliance on seigniorage as a source of deficit financing (Agenor and Hoffmaister, 1997 and Essien, 2005). The monetary factors or demand side determinants include increases in the level of money supply in excess of domestic demand, monetization of oil receipts, interest rates, real income and exchange rate (Moser, 1995). Prudent monetary management was also found to aid the reduction in the level and variability in inflation (Alesina and Summers, 1993).

The balance of payments or supply side factors, relate to the effects of exchange rate movements on the price level. For instance, exchange rate devaluation or depreciation induces higher import prices, external shocks and accentuates inflationary expectations (Melberg, 1992; Odusola and Akinlo, 2001; and Essien, 2005).

There are three major types of inflation according to the neo-Keynesians. The first is the demand-pull inflation, which occurs when aggregate demand is in excess of available supply (capacity). This phenomenon is also known as the Phillips curve inflation. The output gap can result from an increase in government purchases,

increase in the foreign price level, or increase in money supply. The second is known as cost-push inflation, "commodity inflation" or "supply shock" inflation and occurs in the event of a sudden decrease in aggregate supply, owing to an increase in the price/cost of the commodity/production where there are no suitable alternatives (Thomas, 2006). This type of inflation is becoming more common today than before, as evident in the rising price of housing, energy and food. It is often reflected in price/wage spirals in firms, whereby workers try to keep up their wages with the change in the price level and employers pass on the burden of higher costs to consumers through increase in prices. The third type, referred to, as structural inflation, is the built-in inflation, usually induced by changes in monetary policy.

Within these broad typologies of inflation, there are other types of inflation with varying determinants, effects, and remedies, which are classified based on the intensity, severity and persistence of the price increase. Thus, we have: hyperinflation (an extreme acceleration of yearly price increases of three-digits percentage points), extremely high inflation (ranging between 50 per cent and 100 per cent); chronic inflation (15 30 per cent and lasting for at least 5 consecutive years); high inflation (with rates between 30 per cent and 50 per cent a year); moderate inflation (when the general price level ranges from 5 per cent to 25-30 per cent); and low inflation (when the change in the consumer price index ranges from 1-2 per cent to 5 per cent). For any inflation below zero, a country is regarded as experiencing deflation (Vegh, 1992 and Piana, 2001). It is pertinent to note that there exists no binding restriction on the ranges of these classifications of inflation. The classification is usually determined by the inflation histories of the respective countries.

There are basically six identified costs of inflation in the literature. These include: shoe leather costs, menu costs, unintended changes in tax liabilities, arbitrary redistribution of wealth, uncertainty, and increased variability of relative prices. The shoe leather costs occur when economic agents have an incentive to minimize their cash holdings and prefer to hold cash in interest bearing accounts due to the loss in the value of currency. Menu costs of inflation itemizes all the inconvenience that individuals and firms face as price lists are updated frequently and price labels are changed. This diverts the attention of economic agents from other more productive ventures. Unintended changes in tax liabilities, say a reduction may be treated as real gains when incomes are unadjusted. This arises because, with a progressive taxation, rising nominal incomes are taxed more. Wealth is redistributed between debtors and creditors, which may otherwise be unacceptable, with unexpected or incorrectly anticipated inflation. Uncertainty becomes a cost, when in periods of volatile inflation, investors/firms may be reluctant to invest in new equipment; individuals will be unwilling to spend as they are unsure of what government would do next. Through increased variability in relative prices, rising inflation would reduce the competitiveness of a country in the international market for goods and services. The negative effect of this on the balance of payments cannot be overemphasized.

II.2 Theoretical Review

II.2.1 The Phillips Curve

Two major goals of interest to economic policy makers are low inflation and low unemployment, but quite often, these goals conflict. The adoption of monetary and/or fiscal policy moves the economy along the short-run aggregate supply curve to a point of higher output and a higher price level. As higher output is recorded, this is followed by lower unemployment, as firms need more workers when they produce more and vice-versa. This trade-off between inflation and unemployment is described as the Phillips curve. This was an empirical discovery by Phillips (1958), which showed an inverse relationship between wage and unemployment rates, using United Kingdom data plotted over the period 1862-1957. The discovery is strengthened by the fact that movement in the money wages could be explained by the level and changes of unemployment. An argument in favour of the Phillips curve is the extension that establishes a relationship between prices and unemployment. This rests on the assumption that wages and prices move in the same direction. The strength of the Phillips curve is that it captures an economically important and statistically reliable empirical relationship between inflation and unemployment. However, the Phillips curve is not without its critique.

A major criticism of the Phillips curve is that it does not take into account the interactions in the underlying or structural behaviour of consumers and firms in the economy, but rather captures empirical regularities between unemployment and inflation rates based purely on correlations in historical data. The Lucas Critique, for instance, opined that this may not be entirely exploited by the monetary authority if inflationary expectations shift in a particular direction, which does not align with historical data. Perhaps, the greatest weakness of the Phillips curve is its lack of theoretical underpinnings. No known study has derived a Phillips curve from first principles, beginning with the fundamental concerns and constraints of consumers and firms. This is not to say that the empirical relationship makes no sense. For instance, labor costs account for about two-thirds of the total cost of production, so that pressures in the labor markets should strongly influence changes in wages and prices. As Fuhrer (1995) stated, "*still, some feel that this lack of rigorous theoretical foundations is a fatal flaw; many find this deficiency less life-threatening*".

Second, is the trade-off that exists between trying to keep the rate of inflation down and achieving a lower unemployment rate, (two objectives which governments desire to pursue simultaneously), which has raised concerns that some given level of unemployment rate, that would be consistent with some level of inflation has to be determined, if both objectives have to be pursued. Nevertheless, controversies rage on. This is primarily because the Phillips curve of the UK appears to be a special case, which remains to be validated unambiguously in other western industrialized

economies. This has rendered it an inconclusive guide to policy as to how inflation may be tackled, even in the highly industrialized economies. So far, issues pertaining to what rates of unemployment and inflation are to be regarded as tolerable, or what levels are to be regarded as consistent with the broad policy objective of full employment remain unresolved. Despite these shortcomings, the Phillips curve is still being used as a basis for forecasting inflation.

II.2.2 The Monetarist

The monetarists, following from the Quantity Theory of Money (QTM), have propounded that the quantity of money is the main determinant of the price level, or the value of money, such that any change in the quantity of money produces an exactly direct and proportionate change in the price level. The QTM is traceable to Irving Fisher's famous equation of exchange:

$$MV = PQ \qquad \text{----------} \quad (1)$$

where M stands for the stock of money; V for the velocity of circulation of money; Q is the volume of transactions which take place within the given period; while P stands for the general price level in the economy. Transforming the equation by substituting Y (total amount of goods and services exchanged for money) for Q, the equation of exchange becomes:

$$MV = PY \qquad \text{----------} \quad (2)$$

The introduction of Y provides the linkage between the monetary and the real side of the economy. In this framework, however, P, V and Y are endogenously determined within the system. The variable M is the policy variable, which is exogenously determined by the monetary authorities. The monetarists emphasize that any change in the quantity of money affects only the price level or the monetary side of the economy, with the real sector of the economy totally insulated. This indicates that changes in the supply of money do not affect the real output of goods and services, but their values or the prices at which they are exchanged only. An essential feature of the monetarist model is its focus on the long-run supply-side properties of the economy as opposed to short-run dynamics (Dornbusch, et al, 1996).

Nevertheless, the model's general weakness is found in its inadequacy to explain general price movement. The truism of direct proportion between change in the quantity of money and change in the price level can not be accepted in today's world (as there are other factors involved such as infrastructural and structural factors). Second, it is technically inconsistent to multiply two non-comparable factors as M relates to a point of time (static concept) and V to a period of time (dynamic concept). Furthermore, the velocity of circulation of money, V is highly unstable and would

change with variations in the stock of money or money income. Thus, it is unrealistic to assume V to be constant and independent of M.

In as much as the QTM analyses the relation between M and P in the long-run, it has been criticized for neglecting the short-run factors which influence this relationship. For instance, the Lucas "surprise price" shock posits that expectations are important in explaining relationships among variables and changes in policy could affect those expectations. Contrary to the monetarists' position that price levels vary in proportion to changes in monetary growth, Lucas opined that only unanticipated changes of money supply generate price variations that economic agents may misconstrue as relative price movements, which leads to price and output increase. In succinct terms, the Lucas "surprise price" shock assumes a positive correlation between output and inflation such that unexpected monetary expansion exerts a real effect on the economy in the short-run, while anticipated changes in money supply has no real economic effects. The QTM also gives undue importance to the price level, as if changes in prices were the most critical and important phenomenon of the economic system, overlooking factors such as the rate of interest as one of the causative factors between money and prices. Also, it places a misleading emphasis on the quantity of money as the principal cause of changes in the price level during the trade cycle. Thus, it has been argued that prices may not rise, despite an increase in the quantity of money during a depression; and they may not decline with reduction in the quantity of money during a boom. In addition, low prices during a depression are not caused by shortage of money, and high prices during a boom are not caused by abundance of money. Thus, the quantity theory is at best an imperfect guide to the cause of the trade cycle in the short period.

II.2.3 The Keynesians

The Keynesians opposed the monetarists' view of a direct and proportional relationship between the quantity of money and prices. According to this school, the relationship between changes in the quantity of money and prices is non-proportional and is indirect, through the rate of interest. The strength of the Keynesian theory is its integration of monetary theory and value theory on the one hand and the theory of output and employment through the rate of interest on the other hand. Thus, when the quantity of money increase, the rate of interest falls, leading to an increase in the volume of investment and aggregate demand, thereby raising output and employment. In other words, the Keynesians see a link between the real and monetary sectors of the economy an economic phenomenon that describes equilibrium in the goods and money market (IS-LM). Equally important about the Keynesian theory is that they examined the relationship between the quantity of money and prices both under unemployment and full employment situations. Accordingly, so long as there is unemployment, output and employment will change in the same proportion as the quantity of money, but there will be no change in prices.

At full employment, however, changes in the quantity of money will induce a proportional change in price. Thus, this approach has the virtue of emphasizing that the objectives of full employment and price stability may be inherently irreconcilable (Olofin, 2001).

Several weaknesses of the Keynesian postulation have been documented. For instance, Keynesians assume prices as fixed, so that the effect of money appears in terms of quantity of goods traded rather than their average prices. Keynesians also assume that monetary changes are largely absorbed by changes in the demand for money. They fail to appreciate the true nature of money and assume that money could be exchanged for bonds only. However, it is known that money can be exchanged for many different types of assets like, securities, physical assets, human wealth, etc.

II.2.4 Neo-Keynesian

The Neo-Keynesian theoretical exposition combines both aggregate demand and aggregate supply. It assumes a Keynesian view on the short-run and a classical view in the long-run. The simplistic approach is to consider changes in public expenditure or the nominal money supply and assume that expected inflation is zero. As a result, aggregate demand increases with real money balances and, therefore, decreases with the price level. Neo-Keynesian theory focuses on productivity, because, declining productivity signals diminishing returns to scale and, consequently, induces inflationary pressures, resulting mainly from over-heating of the economy and widening output gap. From the neo-Keynesian perspective, budget balancing and restraints on spending do not control inflation, and persistent budget deficits do not cause inflation. What causes inflation are increase in the velocity of money and the reduction in efficiency caused by excessive present consumption versus investment.

A major development under this theory is the concept of 'potential output', which at times is referred to as the natural output[1]. This level of output also corresponds to the natural rate of unemployment, or what is also referred to as the non-accelerating inflation rate of unemployment[2] (NAIRU). According to the neo-Keynesians, inflation depends on the level of potential output or the natural rate of unemployment. However, the exact level of potential output or natural rate of unemployment is generally unknown and tends to change over time.

---

[1] *This is a level of output where the economy is at its optimal level of production, given the institutional and natural constraints.*

[2] *NAIRU is the unemployment rate at which the inflation rate is neither rising nor falling or the natural rate of unemployment described as the normal rate of unemployment around which the unemployment rate fluctuates. It is the rate of unemployment that is beyond the influence of monetary policy and determined by structural factors of the labour market, wage bargaining process and social benefit system.*

The neo-Keynesians recognize the fact that most economic decisions are made under conditions of uncertainty. However, given their preoccupation with the dynamics of growth and long-run considerations, it is logical to expect that they cannot successfully, abstract from the reality of uncertainties surrounding dynamic analysis.

II.3 Empirical Literature

A review of the literature on inflation in industrialized, emerging market, and developing economies is the focus of this section. It seeks to reveal the dominant theoretical underpinning for assessing the dynamics of inflation and the methodology for forecasting its future trajectory.

De Brouwer and Ericsson (1995) developed an error correction model (ECM) for inflation in Australia. The model highlighted the relative importance of factors determining consumer price inflation over different time periods, between the 1980s and 1990s. Their results showed that the structure of the inflationary process in Australia did not appear to have changed. Rather, the recent fall in inflation was explained in terms of changes in those factors that determine inflation. The model was compared with existing models of Australian prices and found to encompass them. While it remained to be seen how the ECM would perform in the face of additional changes to the economy, continued low inflation through the 1990s appeared to lead to sustained low growth rates in unit labour costs and import prices.

Stock and Watson (1999) used the conventional Phillips curve (unemployment rate) to investigate forecasts of U.S. inflation at the 12-month horizon. The authors focused on three questions. First, has the U.S. Phillips curve been stable? If not, what are the implications of the instability for forecasting future inflation? Second, would an alternative Phillips curve provide better forecasts of inflation than the unemployment rate Phillips curve? Third, how do inflation forecasts from the Phillips curve stack up against time series forecasts made using interest rates, money, and other series? They found that inflation forecasts produced by the Phillips curve generally had been more accurate than forecasts based on other macroeconomic variables, including interest rates, money and commodity prices but relying on it to the exclusion of other forecasts was a mistake. Forecasting relations based on other measures of aggregate activity could perform as well or better than those based on unemployment, and combining these forecasts would produce optimal forecasts.

Callen and Chang (1999) revealed in their study on modeling and forecasting inflation in India that the Reserve Bank of India had shifted from broad money target toward a multiple indicator approach in the conduct of monetary policy. They used percentage changes in three different price indices: the wholesale price index (WPI); the consumer price index (CPI); and the GDP deflator as measures of inflation in order to determine which of them provided the most useful information about future

inflationary trends. The WPI was used in the analysis because it had a broader coverage and was published on a more frequent and timely basis than the CPI. However, the CPI remained important because it was used for indexation purposes for many wage and salary earners (including government employees). The sample period used in the estimation work was 1982Q2 to 1998Q2. The authors adopted a simple monetarist equation for the price level, applied the co-integration technique and derived a dynamic equation for inflation. The findings indicated that exchange rate and import prices were relevant for inflation. It was concluded that while the broad money target has been de-emphasized, developments in the monetary aggregates remain an important indicator of future inflation.

Williams and Adedeji (2004) examined price dynamics in the Dominican Republic by exploring the joint effects of distortions in the money and traded-goods markets on inflation, holding other potential influences constant. The study captured the remarkable macroeconomic stability and growth for the period 1991 to 2002. Using a parsimonious and empirically stable error-correction model, the paper found that the major determinants of inflation were changes in monetary aggregates, real output, foreign inflation, and the exchange rate. However, there was an incomplete pass-through of depreciation from the exchange rate to inflation. The authors established a long-run relationship in the money and traded-goods markets, observing that inflation was influenced only by disequilibrium in the money market.

Examining the relative importance of monetary factors and structuralist supply-side factors for inflation in Pakistan, Khan and Schimmelpfennig (2006) showed that monetary factors were the main drivers of inflation, while "wheat support price" affects inflation in the short-run. Using monthly data from 1998 to June 2005, a monetary perspective was considered by specifying a stylized inflation model that include monetary variables such as money supply, credit to private sector, the exchange rate, as well the "wheat support price" as a supply-side factor. A vector-error correction model (VECM) was estimated in growth rates as well as in log levels. The choice of sample periods reflected a trade-off between having sufficient observations and avoiding structural breaks that would complicate the empirical analysis. The findings indicated that monetary factors played a dominant role in recent inflation, affecting inflation with a lag of about one year and increases in the wheat support price influence inflation in the short-run. The conclusion of the study was that wheat support price mattered for inflation over the medium term only if accommodated by monetary policy. The study confirmed that a long-run relationship existed between the CPI and private sector credit.

In recent years, many emerging-market countries have experienced dramatic decline in inflation as a result of a combination of relatively benign external factors and the adoption of sound domestic policies (Bailliu, et al. 2002). Applying existing inflation models that have worked well in industrialized countries to Mexico, the performance

of these models was compared to a mark-up model that had been used extensively for the analysis of inflation in Mexico. Each model was estimated using quarterly data, over the period 1983 to 2001. The estimation and forecasting results suggest that the evolution of the exchange rate remained a very important factor for explaining inflation. Indeed, the best performing model, the mark-up model, was the one in which the exchange rate played the most significant role. The Phillips curve performed better when using actual values than forecasted values as explanatory variables.

Aron and Muellbauer (2000) examined multi-step models for inflation and output, four-quarters ahead for South Africa. The models confirmed the importance of the output gap and the exchange rate for forecasting inflation; and the influence from recent changes in the current account surplus to GDP ratio, which was also sensitive to short-term interest rates. However, a rise in interest rates increased inflation in the short-run, via a rise in mortgage interest payments (a component of the consumer price index). In order to measure long-run changes in the capacity to produce, the output model used a stochastic trend. On the demand side, there were important negative interest rate effects, though these had been altered by changes in the monetary policy regime. The trade surplus and government surplus to GDP ratios, which also responded to interest rate changes and improvements in the terms-of-trade, all had a positive effect on future output.

According to Sun (2004), the key innovation in developing an approach for forecasting core inflation in Thailand was to anchor the projections derived from the short-term time series properties of core inflation to its longer-run evolution. This involved combining a short-term model and an equilibrium-correction model. The author proceeded with a series of seasonally adjusted monthly per cent changes in Thailand's consumer price index, purged of its raw food and energy components. They selected a parsimonious specification of an unrestricted model of Thailand's core inflation. This was done following the general-to-specific methodology and the result was a promising model for forecasting Thai core inflation over horizons up to 10, 24, and 55 months, based on a root mean-squared error criterion as well as a mean absolute error criterion. The parsimonious model formulated generated out-of-sample forecasts that appeared to be broadly satisfactory. It was concluded that reliance on monthly variables in the model allowed for a prompt update of core inflation forecasts and, thus, could help in monetary policy evaluation in the context of IMF surveillance work on Thailand.

Lim and Papi (1997) attempted to shed some light on the determinants of inflation in Turkey by analyzing price determination within the framework of a multi-sector macroeconomic model during 1970-1995. The theoretical approach adopted incorporated both long and short-run dynamics comprising the goods, money, labour, and external sectors. The inflation equation was estimated for two sub periods (1970-

1980 and 1981-1995) to allow for structural shifts. The model was estimated with quarterly time series data from 1970 to 1995. The choice of the sample period was dictated by the desire to take a long-term view, while the rationale for quarterly data, as opposed to annual data, was to capture short-term inflation dynamics. The short-run general specification equations were estimated using ordinary least squares (OLS) and instrumental variables. The main findings were that monetary variables played a central role in the inflationary process. Public sector deficits contributed to inflationary pressures and inertia factors were important. The authors concluded that policy makers' commitment to active exchange rate depreciation on several occasions in the past 15 years had also contributed to the inflationary process. Their conclusions were broadly in line with the results from the other developing countries, albeit perhaps with the exchange rate having a stronger role in the inflationary process than was the case in several other countries.

In Africa, several studies have been conducted on the dynamics of inflation. Durevall and Ndung'u (1999), analyzed the dynamics of inflation in Kenya during 1974-1996, a period characterized by external shocks and internal disequlibria. From their parsimonious error correction model the paper found exchange rate, foreign prices, and terms of trade as having long-run effects on inflation, while money supply and interest rate only had short-run effects. Inflation inertia was also very important in the Kenyan economy up to 1993, when about 40 per cent of current inflation was transmitted to the next quarter. In the study by Ubide (1997) for Mozambique, results from the analyses of a decomposition of the components of CPI, estimation of a reduced form equation of the determinants of inflation, and the transmission mechanism embedded in a system of multivariate dynamic equations, showed that the rate of inflation was determined by a combination of economic factors, seasonal behaviour and a collection of irregular events, corresponding mainly to agro-climatic conditions.

In Nigeria, although a number of studies on inflation exist, there is no consensus on which theory of inflation determination is the most adequate. These studies explored all the dominant theories under a variety of modeling techniques. While some favour the structuralists, others adopted the monetarists, and some, the fiscalists approach, still others examined a combination of these theories. Odusola and Akinlo, (2001) showed that inflation in Nigeria was largely determined by the absence of fiscal prudence on the part of government, parallel exchange rate shocks and output. Asogu (1991) noted this view and concluded that industrial output, net exports, current money supply, exchange rate changes and domestic food prices were key determinants. Other Nigerian scholars like Fakiyesi (1996), Adamson (2000), and Masha (2000), concluded that backward and forward looking expectations, growth in broad money, rate of exchange of the naira vis-à-vis the dollar, growth of real income, and price volatility were some of the variables that influence inflation behaviour in Nigeria. Folorunso and Abiola (2000) investigated the long-run determinants of

inflation in an error correction framework. Their study revealed a significant effect of exchange rate, money supply, income and fiscal balance on inflation.

Overall, the empirical studies have not been conclusive as to the causative factors of inflation. However, there seem to be a consensus that entrenched fiscal imprudence may worsen inflation.

III. Stylized Facts on Inflation in Nigeria

III.1 Component and Structure of CPI

In Nigeria, inflation is derived from the Consumer Price Index (CPI). The National Bureau of Statistics (NBS), formerly known as the Federal Office of Statistics (FOS), is responsible for the computation of this index and reports it in its monthly publication, the "Statistical News". Officially, the CPI is called the "Composite Consumer Price Index" since it combines the rural and urban CPIs. The composite CPI measures the average level of retail prices of goods and services consumed by households living in all parts of the country. Information for the computation of the CPI, including the weights is obtained through surveys. The regular survey monitors and records price developments, while the survey to obtain the weights for the computation of the base period is conducted periodically. This is because of the huge resources required in reviewing the weights.

The NBS first revised the base period of the CPI from 1960 to 1975 following its National Consumer Expenditure Survey (NCES) of 1974/1975 when it commenced the computation of the indices on rural and urban basis. The generated rural and urban CPIs were subsequently used to compute the composite CPI. Further consumer expenditure surveys were conducted in 1980/1981 and 1996/1997, consequent upon the desire to update and improve the basket of goods used for the compilation of the CPI to reflect the reality of the evolution of purchasing power and the consumption patterns of the average consumer in Nigeria. This led to further revisions of the base period of the composite CPI to 1985 and May 2003, respectively.

After each NCES, the mix of commodity groups in the basket, inclusion of new items/groups and re-computation of weights are based on newly provided data on expenditure. For instance, the 1985-based CPI basket was reviewed to indicate new commodity groups such as medical care and health expenses, recreation, entertainment, education and cultural services, which were not included when the 1975 base was used. The recently compiled May 2003 base-year CPI is essentially, based on the classification of individual consumption by purpose (COICOP). With the approach, the old indices were revised, new weights derived and the basket structured into 12 commodity groups and eighty-five subgroups. Prices of the components of these groups are obtained both for urban and rural areas. The

components and weights of the composite CPI basket are given in Table 1. Expectedly, food and non-alcoholic beverage dominate the basket, representing 64.4 per cent of the consumption basket. Consequently, factors affecting food prices would be crucial in understanding the determinants of inflation in Nigeria.

In recent times, a number of countries, particularly those that have adopted price stability as the main objective of monetary policy and have an explicit inflation target, have developed measures of "underlying or core" inflation. This measure attempts to distinguish permanent trends in inflation by eliminating temporary or non-core fluctuations from the index. A distinguishing characteristic of these two types of inflation is that while non-core is generated by supply shocks, such as: drought, cyclone, oil price, etc, the core component is mainly influenced by demand shocks (Essien, 2002). Core inflation can be measured by merely removing (that is, excluding), in an *ad hoc* manner, the unwanted component or noise from the index used in computing the inflation rate. In Nigeria, until recently, core inflation was measured by excluding the farm produce component of CPI from the basket. However, a second measure of core inflation excludes both farm produce and energy. As shown in the table below, the two core components, (all items less farm produce and all items less farm produce and energy) are equally important in the basket at about 41 and 34 per cent, respectively. Generally, while the food component has declined in recent times, from about 70 per cent to 63.76 per cent, the core component has increased.

An important variable in the consumer basket is the housing, water, electricity, gas and other fuel group. Transport and communication is equally important. The least item in terms of weight in the basket is education.

III.2 Institutional Framework and the Mandate of Price Stability

One of the statutory responsibilities of the CBN is the formulation and implementation of monetary policy, with the overriding objective of maintaining stable prices consistent with the achievement of sustainable economic growth. Monetary policy formulation entails setting intermediate and operating targets in tandem with the assumed targets for GDP growth, inflation rate and balance of payments. Monetary policy in Nigeria is based on the assumption that there is a stable relationship between monetary variables (such as money and domestic credit), which falls under the purview of the monetary authorities, and non-monetary variables (such as real output and prices).

Prior to the liberalization of the banking system, the CBN relied on administrative measures like credit ceilings, cash and liquidity ratios, credit guidelines, etc; in the conduct of its monetary policy. Following liberalization, the monetary policy framework shifted in 1993 to the indirect approach. The open market operations thus

Table 1: Percentage Contribution of Items in the CPI Basket of Goods

Core (All Items less Farm Produce)	40.95
Core (All Items less Farm Produce a nd Energy)	33.59
Food	63.76
Food & Non -alcohol Beverage	64.41
Alcoholic Beverage, Tobacco and Kola	2.06
Clothing and Footwear	3.21
Housing Water, Electricity, Gas and Other Fuel	18.10
Furnishings & Household Equi pment Maintenance	3.82
Health	1.36
Transport and Communication	4.35
Recreation & Culture	0.89
Education	0.21
Restaurant & Hotels	1.29
Miscellaneous Goods & Services	0.30

Note: Transport and Communication are separate commodity groups in the NBS Statistical News
Source: NBS Statistical News

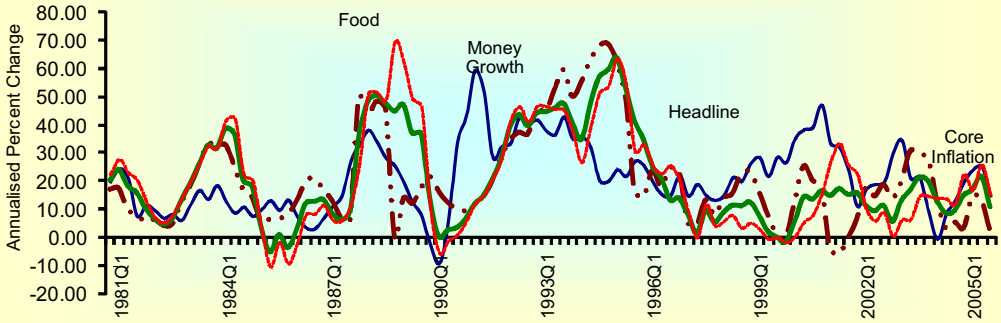
became the primary instrument for the conduct of monetary policy supported by discount window operations and reserve requirements. The minimum rediscount rate (MRR) complemented with the repurchase (REPO) rate is the key policy rate that sets the monetary policy stance. In recognition of the lag effects of monetary policy, the CBN, since fiscal 2002 shifted to a medium-term framework. Under this framework, money growth targets that are consistent with inflation and real output growth targets are set over a two-year period. In December 2006, a new monetary policy framework, which relies on short-term interest rate as a major operating target was adopted. The monetary policy rate (MPR) replaced the MRR in the new framework and, thus, became the anchor rate for other interest rates.

The success of monetary policy depends largely on the autonomy of the central bank. However, the achievement of these overall macroeconomic objectives was greatly hindered owing to the limited operational autonomy of the CBN. The instrument autonomy granted to the CBN in 1998, which repealed the CBN (Amendment) Decree No 3 of 1997 enabled the Bank to deploy monetary instruments at its disposal for the conduct of monetary policy. In 2007, a new CBN Act, which gave the Bank broader independence, was enacted to include the provision of a transparent and credible framework to lock-in inflationary expectations through the adoption of inflation target as the nominal anchor for monetary policy.

III.3 Relationship between Inflation Rate and Key Macroeconomic Variables

The figures below show the quarterly movements in the rate of inflation (decomposed into headline, core and non-core) and key macroeconomic variables from 1981 to 2005. All variables except interest rates were measured on annualized basis as the percentage change in their logarithmic form. Core inflation is defined as headline inflation less farm produce, while non-core refers basically to food inflation.

Fig. 1
Money Growth vs Headline, Core and Food Inflation Rates, 1981 - 2005



Specifically, Figure 1 shows movement in broad money growth and the three variants of inflation rate. The chart indicates a co-movement between growth in money stock and the rate of inflation, as suggested by theory. This is particularly discernible in the first half of the 1980s and mid-1990s. From the chart, it is obvious that the different variants of inflation respond to growth in the broad money stock with a lag. Visual inspection of the chart suggests that in the early 1980s, headline inflation responded to changes in the money stock after about a quarter. Thereafter, the lag varies ranging usually between two to three quarters between the late 1980s and mid-1990s. Beginning from 1997, all four variables record high frequency changes making the co-movement less apparent. A careful study of the chart reveals that, during this period, all three variants of inflation responded to changes in the money stock at different paces.

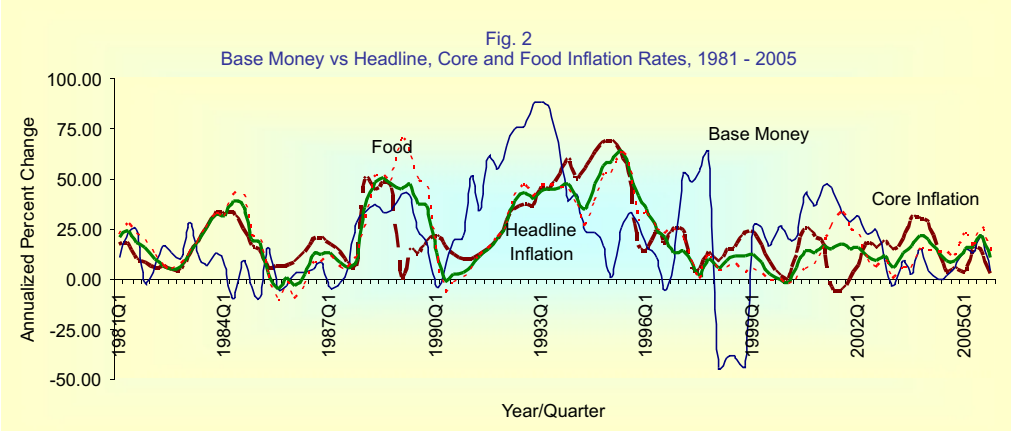
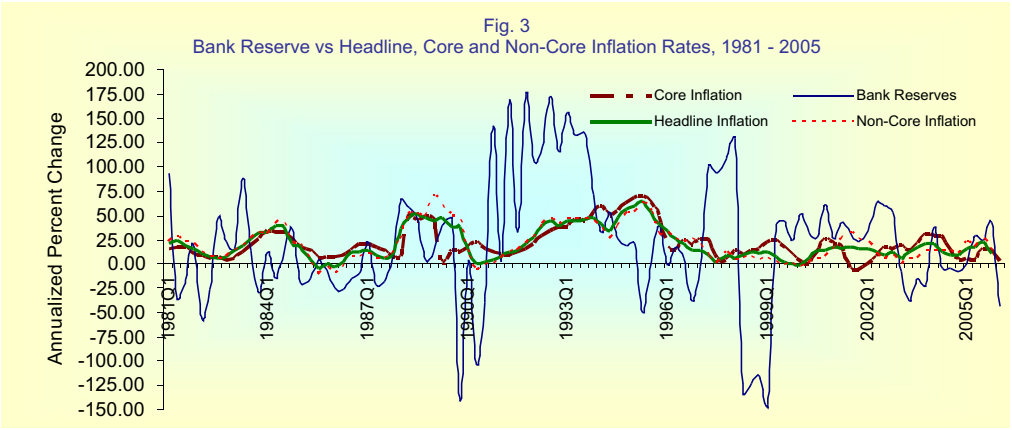
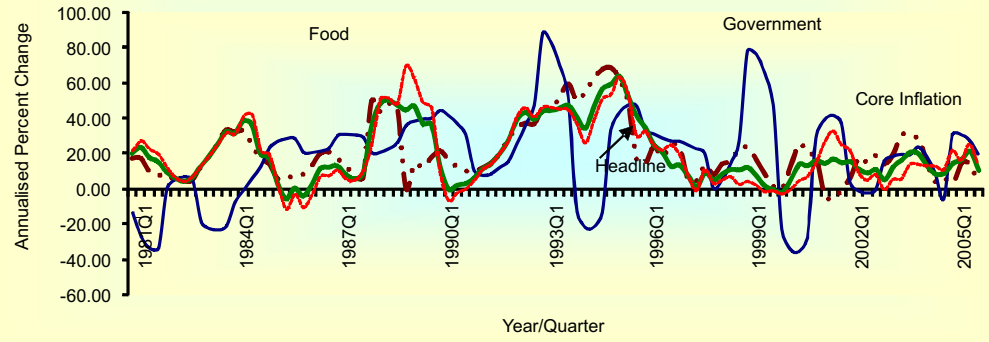


Figure 2 shows movement in base money vis-à-vis the three variants of inflation. The pattern as expected is similar to that of money supply. Base money exerts a considerable influence on inflation rate with a lag, except for the period 1996 and 1999 when movement in base money vis-à-vis inflation is obscure.



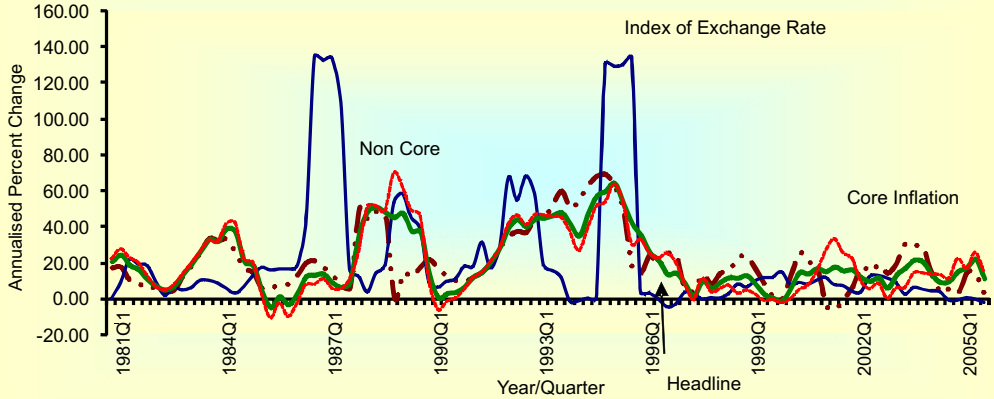
In Figure 3, the relationship between bank reserves and inflation rate is shown. A careful analysis of the chart indicates that, though bank reserves displays sharp oscillations, inflation rate responds less sharply. What is clearly seen is that in periods when bank reserves were high, the various measures of inflation generally maintained a rising trend. Though these variables move in sympathy, the lag at which inflation responds to changes in bank reserves varies for different periods.

Fig. 4
Government Expenditure vs Headline, Core and Food Inflation Rates, 1981 - 2005



The relationship between government expenditure and inflation rate is shown in Figure 4. From the chart, inflation tends to co-vary with government expenditure with a shorter lag. Beginning from 2002, however, inflation rate responds to increase in government expenditure with a lag of about one to two quarters. In Figure 5 below, the relationship between the exchange rate and various definitions of inflation is shown. From the chart, prior to the liberalization of the domestic currency, inflation rate led changes in the exchange rate.

Fig. 5
Exchange Rate vs Headline, Core and Non-Core Inflation Rates, 1981 - 2005



Thereafter, inflation responds to variability in the exchange rate with a lag of about one to two quarters. This is particularly discernible between 1986 and 1996. From 1999 to date, the exchange rate has been less volatile than it was before that time. During this period, inflation rate moved in sympathy with changes in the exchange rate. Though all three variants of inflation respond to changes in the exchange rate, core inflation seems to react faster to developments in the foreign exchange market than the other two.

Fig. 6
Headline Inflation Rate vs Savings, Deposit and Prime Lending Rates, 1981 - 2005

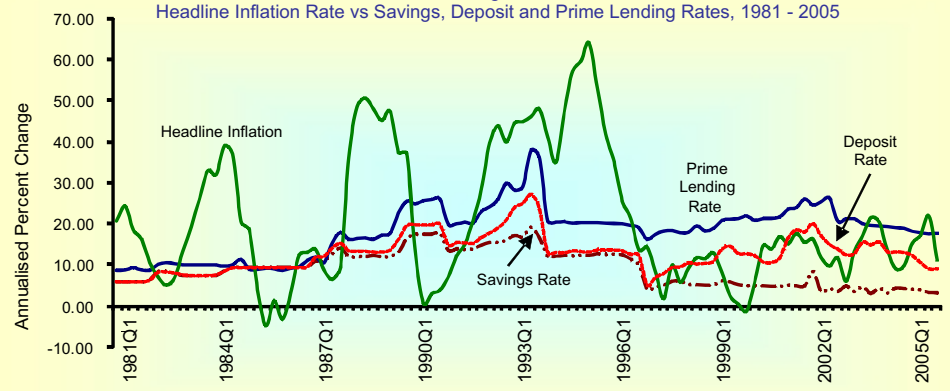
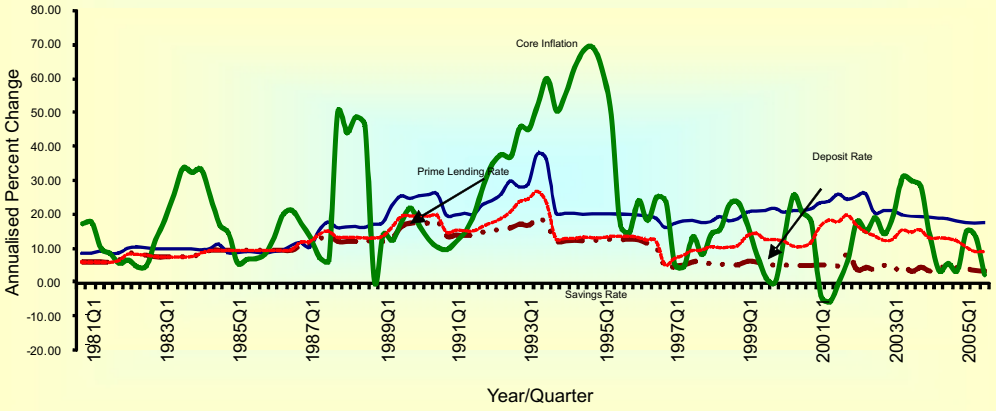


Fig. 7
Core Inflation Rate vs Savings, Deposit and Prime Lending Rates, 1981 - 2005



The relationship between market interest rates and inflation rate is depicted in Figures 6, 7 and 8. As expected the market interest rates savings, deposit, and prime lending rates move in the same direction. Similarly, the market interest rates co-vary with the three variants of inflation, though the relationship with the prime lending rate is most discernible. Core inflation responds more to changes in prime lending rate than headline and non-core inflation. The response lag of all three variants of inflation varied over the period under consideration, ranging from one to three quarters.

Fig. 8
Food Inflation Rate vs Savings, Deposit and Prime Lending Rates, 1981 - 2005

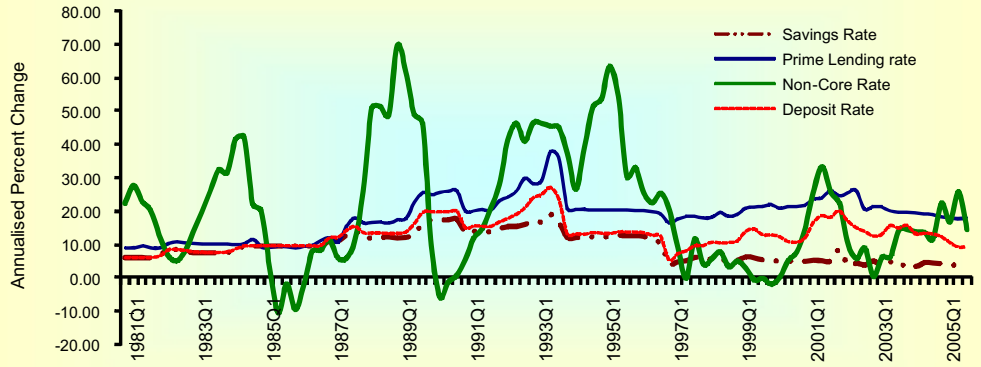
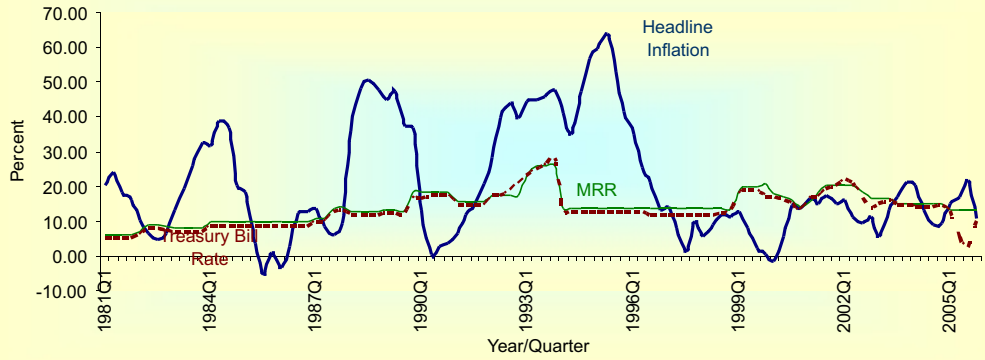


Fig. 9
Headline Inflation, MRR and Treasury Bill Rates, 1981 - 2005



Figures 9-11 show the relationship between policy rates MRR and TB rate - and inflation rate. A critical inspection of the chart reveals that the MRR and the TB rate show similar characteristics rising and falling almost simultaneously. Though, there exists a subtle relationship between the policy rates and inflation, the leads and lags are not very evident. From 1999 date, however, inflation appears to be leading the policy rates.

Fig. 10
Core Inflation, MRR and Treasury Bill Rates, 1981 - 2005

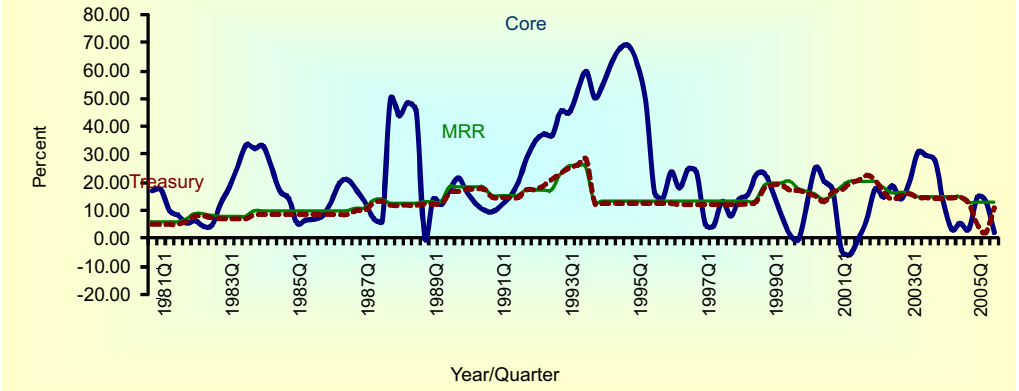
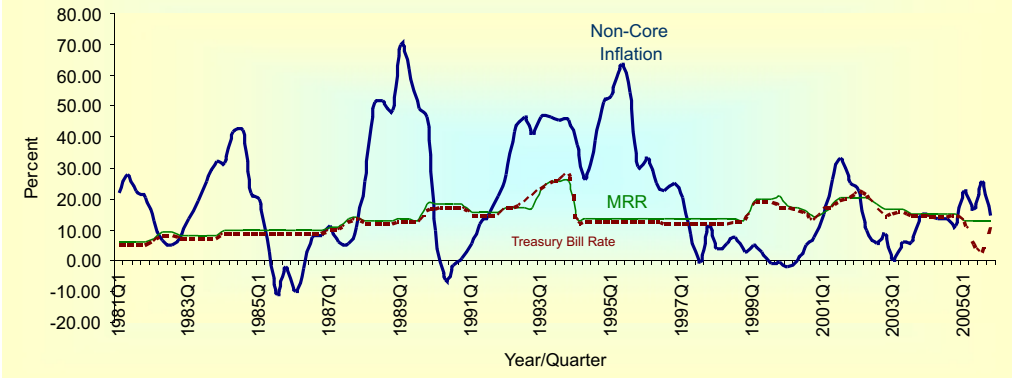


Fig. 11
Food Inflation, MRR and Treasury Bill Rates, 1981 - 2005



The various definitions of inflation are charted against credit to the private sector and aggregate demand in Figures 12-14. Credit to the private sector appears to move inversely with inflation in the charts; this is particularly most visible with core inflation. The reason for the inverse relationship is that private sector credit is expected to boost output production and reduce the pressure on prices. Suffice to note that private sector credit can also be used to boost aggregate consumption and not necessarily investment.

Fig. 12
Headline Inflation Rate vs Credit to the Private Sector and Aggregate Demand, 1981 - 2005

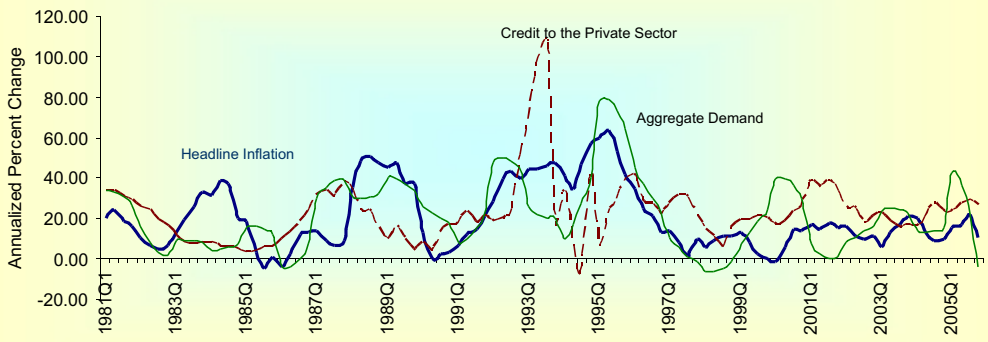
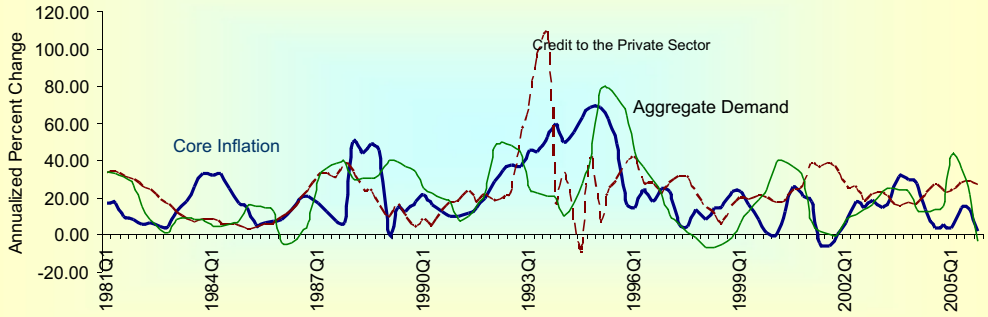


Fig. 13
Core Inflation Rate vs Credit to the Private Sector and Aggregate Demand, 1981 - 2005



However, between 1990-1992 and 2000-2002, growth in credit to the private sector co-varied directly with inflation rate. This could be due to the pass-through effect of the lending rate. Aggregate demand (Gross Domestic Product expenditure), on the other hand, appears to vary directly with inflation rate. Though, all three variants of inflation move in tandem with changes in the aggregate demand, food inflation seems to be the most responsive to changes in the aggregate demand. This could be explained by the relatively high proportion of food in the consumer basket.

Fig. 14
Food Inflation Rate vs Credit to the Private Sector and Aggregate Demand, 1981 - 2005

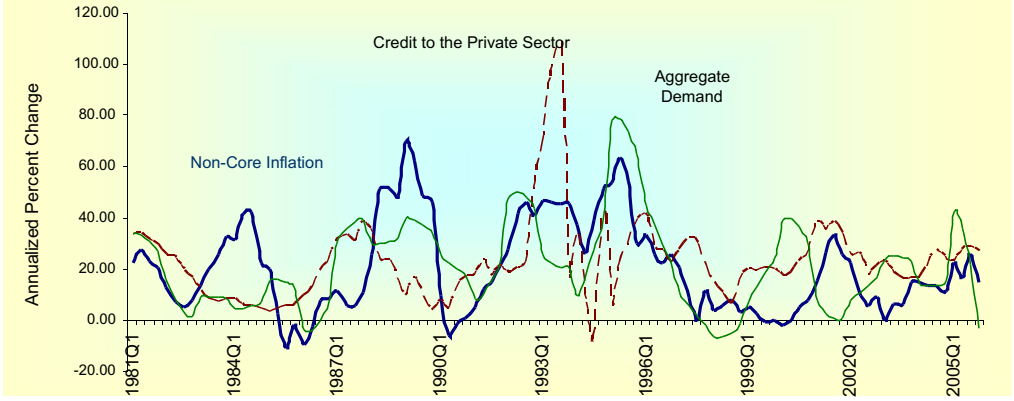
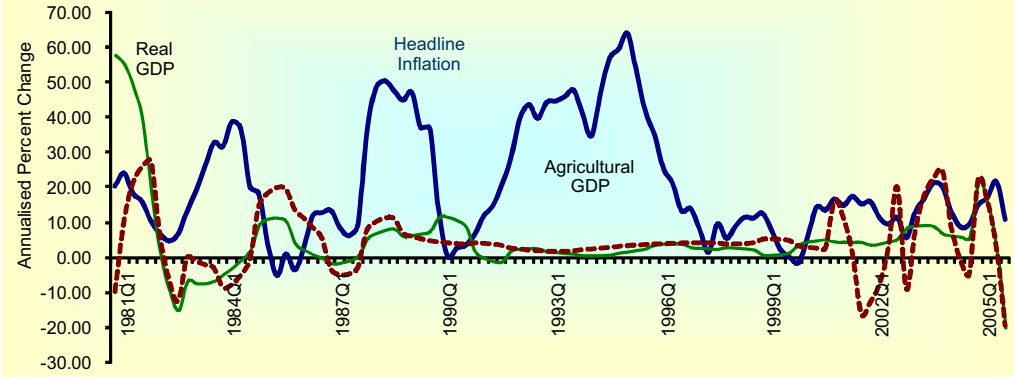


Fig. 15
Headline Inflation vs Overall and Agricultural GDP, 1981 - 2005



Figures 15-17 depict the trend in output growth (overall and agricultural GDP[3]) vis-à-vis the various variants of inflation rate. As expected, the charts indicate that there appears to be an inverse relationship between the inflation rate and output growth.

[3] Agricultural GDP comprises crops, livestock and fishing, excluding forestry.

Fig. 16
Core Inflation vs Overall and Agricultural GDP, 1981 - 2005

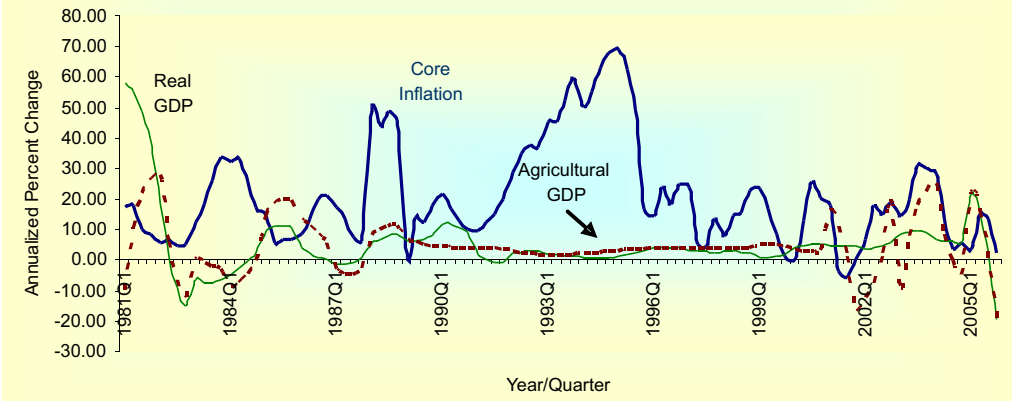
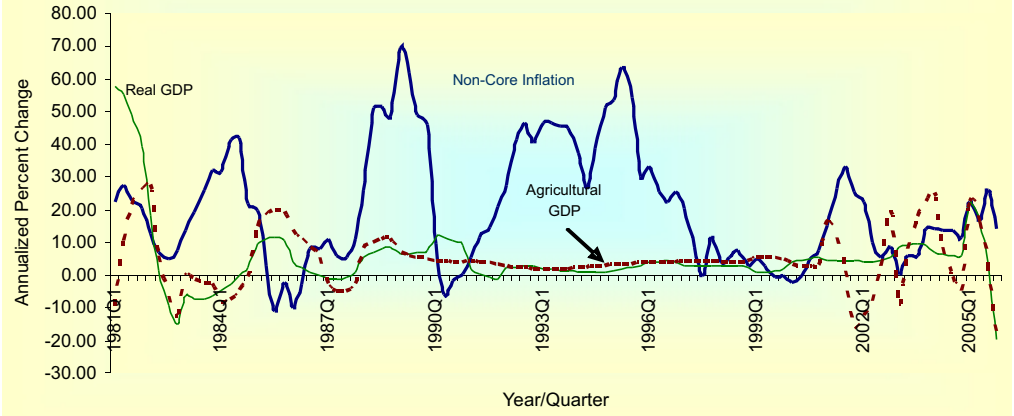


Fig. 17
Non-Core Inflation vs Overall and Agricultural GDP, 1981 - 2005



Overtime, the response of inflation to changes in output, as depicted in the charts takes about one quarter. Basically, the charts show that while headline and core inflation respond more to changes in real output, non-core inflation varies most prominently with Agricultural GDP. Beginning from 1999, however, the pattern of relationship between output growth and inflation becomes less discernible.

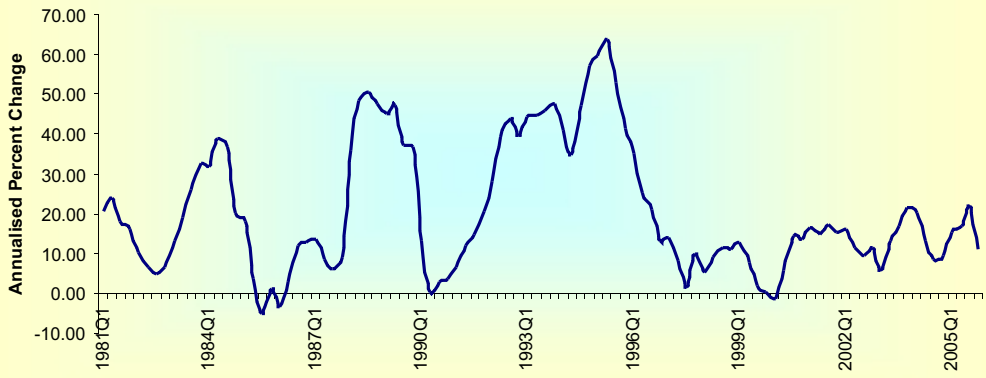
III.4 Trends in Inflation and Policy Response

Episodes of high inflation did not occur until the early 1970's, when inflation rose sharply from a very low level. Prior to that time, headline inflation was relatively stable, averaging 3.5 per cent between 1960 and 1970. Post independence industrial policy, increase in government expenditure to finance the civil war, low levels of

production during the war, post-war reconstruction, and the Adebo/Udoji wage increases following the oil boom, were some of the factors that induced high inflation at that time. However, in the last twenty five years (1981-2005), episodes of high inflation have become more frequent. For instance, during the collapse in the oil market in the early 1980's, headline inflation rose from the moderate levels of 16 per cent in 1980 to peak at 38 per cent by mid-1984. Similarly, non-core inflation rose substantially during that period reaching 42.2 per cent by mid-1984. Core inflation also rose rapidly during that time with a spike in 1983. The sharp increase in headline and core inflation were attributable to the persistent output gap and the austerity measures introduced in 1983 to stem the imminent collapse of the economy, factors such as import restriction and foreign exchange constraints led to severe shortages in supply of goods and services. The increase in the non-core component was adduced to non-monetary factors, Dutch-disease syndrome as well as rigid control on the marketing of agricultural commodities.

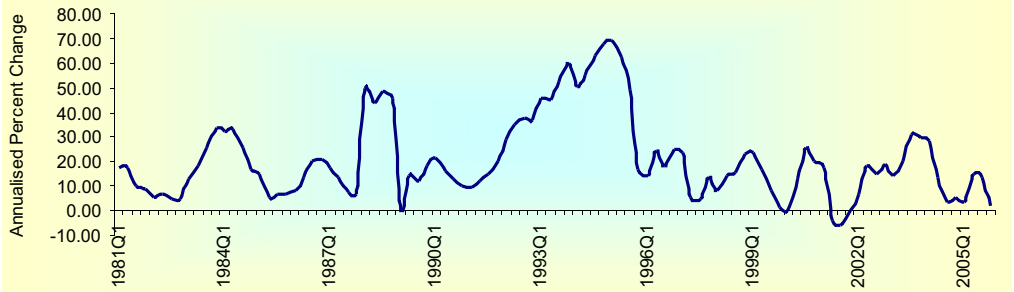
Even though inflation decelerated from 1985, it was becoming increasingly obvious that monetary tightening and the fiscal measures adopted were inadequate given the magnitude of the problem confronting the Nigerian economy. Thus, by 1986, Nigeria adopted the Structural Adjustment Programme (SAP), which saw a more liberalized economic environment. However, the balance of payments crises that precipitated the adjustment programme persisted. For the first time in a long while, there was a fuel price adjustment in 1988, and a significant depreciation of the exchange rate. Monetary policy became accommodating as government strived to give SAP a humane face following the onset of adjustment fatigue and resistance to the programme. Even though government expenditure was kept rather stable, the financial markets were clearly affected and both long and short-term interest rates rose sharply. Consequently, inflation began to rise and by 1988, headline inflation peaked at 61 per cent on an annualized basis, while core inflation showed a similar trend reaching 50 per cent.

Fig. 18
Headline Inflation Rate (1981 - 2005)



Following this development, the confidence that there would be an improvement in the rising inflation situation did not materialize.

Fig. 19
Core Inflation Rate (1981 - 2005)



In a bid to intervene and reverse the ugly trend, the monetary authority began the withdrawal of public sector funds from the commercial banks, with a view to tightening liquidity in the system. Nevertheless, fiscal expansion largely financed by ways and means advances culminated in an all-time peak in non-core inflation of 69.9 per cent in 1989. Persistent inflation inertia continued to increase the rate of growth in the price level. This was largely attributed to the frequent increases in administered prices on petroleum products, monetization of the Gulf war windfall, and deteriorating political environment with series of industrial actions in the early 1990's. Growth in money supply and fiscal deficit accelerated rapidly. In addition, the management of the agricultural output boom was also poor. This situation was compounded by nominal adjustment of the exchange rate, following the March 1992 devaluation. The result was high inflation in all its components.

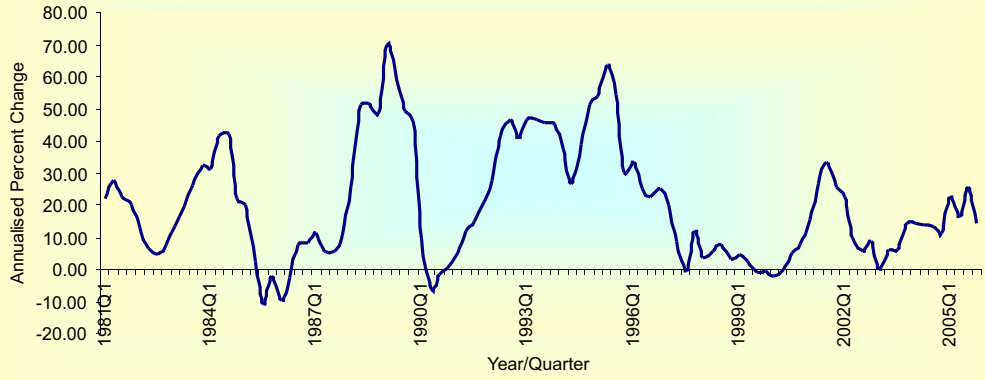
By 1993, it was clear that the macroeconomic policies pursued were no longer sustainable and needed drastic change. In response to the ensuing macroeconomic instability, government reverted to a guided de-regulation in 1994. Interest rate again was administratively fixed. The exchange rate regime was changed and the autonomous foreign exchange market (AFEM) was introduced in 1995, while fiscal measures were introduced to curtail deficits. However, because these measures were taken at a time when there were excess money supply, scarce foreign exchange, severe shortages in commodity supply, as well as continual labour and political unrest following the annulment of the June 1993 elections, there was a remarkable rise in the rate of inflation.

Analysis of the non-core inflation in the early 1990s revealed that the adverse conditions of that period caused a huge increase in its level, as it recorded a high of 63.6 per cent in late 1994. Headline inflation rose rapidly by 1995 to reach an all time high of 72.8 per cent, though it decelerated gradually to single digit in 1997. In the

same vein, core inflation, which began a gradual ascent in early 1990, peaked at about 69 per cent in mid-1995 before slowing down in 1997. The deceleration in inflation rate during this period could be attributed to the favourable fiscal balance between 1995 and 1997 coupled with non-accommodating monetary policy stance during that period. The administratively fixed exchange rate regime, tight monetary policy, increased credit to the private sector, and low interest rates, were factors that aided in stabilizing domestic prices. Thus, inflation remained at single digit until 1999.

The low inflation rate regime did not last for too long, with the resurgence of spikes in headline and core-inflation between 1999 and 2000. Policy reversals and inconsistency, the general election of 1999, wage increase, and banking sector distress were mainly responsible for the downturn and by 2001, headline inflation rate had risen to 18.9 per cent. In recent times, particularly, with the second term of the Obasanjo administration in 2003, macroeconomic stability was restored, following the gains of a comprehensive and consistent economic reform programme. Monetary policy has become more proactive, while the fiscal authorities have supported the implementation of monetary policy through frequent consultations. Inflation has, however, remained at moderate levels. The persistence of structural rigidities, the general election of 2003 and the continued effect of fuel price hike are some of the factors that have been adduced for the inability to reduce inflation to single digit.

Fig. 20
Food Inflation Rate (1981 - 2005)



However, the government has mounted an elaborate food programme that would promote food crop production and export as well as pay more attention to the development of the small and medium scale enterprises to promote wealth creation and increase output. The exchange rate has also been relatively stable, with significant real appreciation. With these developments, inflation inertia has been curtailed and high inflation may be a thing of the past, if sustained.

Overall, the following stylized facts emerge from the preceding discussions:

- Monetary expansion, which reflects either demand for credit by the domestic economy or government fiscal expansion is a major determinant of inflation.

- There is a co-movement between aggregate demand and inflation but with a lag.

- Increase in real output, particularly food output has a dampening effect on inflation.

- High inflation seems to be associated with the long-run depreciation of the exchange rate. However, there appears to be inconsistency in the evolution of exchange rate and inflation between 1986 and 1996.

III.5 Decomposition of CPI

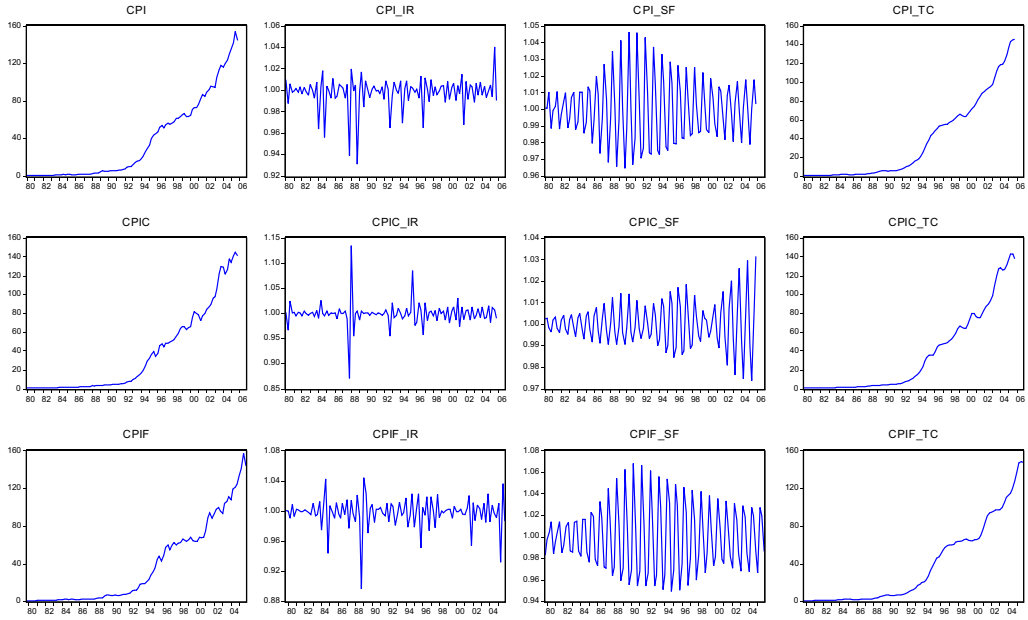
Time series observed at quarterly and monthly frequencies often exhibit cyclical movements that recur every month or quarter. Typically, a time series is made up of a time trend (TC), seasonal factors (SF), irregular variation (IR), and cyclical patterns. In order to understand these movements, a decomposition of the CPI series into its component parts is necessary. This is done for headline, core and non-core CPI series in Figure 21 using the Census X12 seasonal adjustment programme.

The plot of the actual headline, core and non-core series are quite similar in pattern, showing significant upward trending. This is confirmed from the de-trended series (CPI_TC, CPIC_TC, and CPIF_TC) plot. Indeed, the trend was very gradual in the early eighties, but by 1988, it became sharper and steeper. However, the trend was more pronounced for core CPI than the other components.

The prominence of trend in core CPI may be indicative that economic policies determine its evolution. The period of sharp increases in the trend resulted from sustained fiscal expansion, frequent hike in the prices of petroleum products, devaluation of the exchange rate of the Naira, among other factors, suggesting that stabilization policies may have been haphazardly implemented. With respect to seasonal behaviour, the CPI shows unstable and sizeable patterns, but was more prominent around the 3rd and 4th quarters and within the late 1980s and 1990s. It is also typically more pronounced for headline and food CPI, thus confirming the dominance of food in the composite CPI basket. Intuitively, the marked seasonality of food CPI to a great extent results from agricultural production, which is known to show seasonal patterns with peaks during the harvest period in the 3rd and 4th quarters. There were no obvious seasonal patterns in the core CPI except that it peaked from 2000, after being relatively stable in the early 1980s.

The irregular components for all the series were important over the sample period and featured prominent spikes, peaks and troughs. Since these are mainly unplanned random factors, the spikes seem to capture very well the periods of civil/labour, political, and religious unrests. However, there is a striking feature in 1988 and 1989, with sharp troughs, particularly for headline and food CPI.

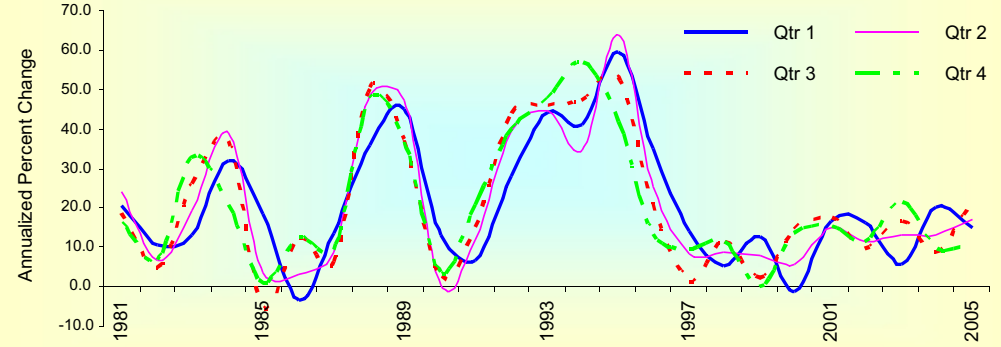
Fig. 21 Decomposition of Quarterly Changes of Inflation[1]



Figures 21a-21c below depict the quarterly disaggregated variants of the CPI for the period 1981 to 2005. Visual inspection of the plots of quarterly headline inflation rate over the study period revealed that headline inflation rate peaked more frequently in the fourth quarter relative to other quarters, while the most troughs are experienced in the first and third quarters. However, adopting the standard deviation as a measure of volatility further showed that it is more volatile in the first quarter at 19.55, with the least volatility in the second quarters at 16.00.

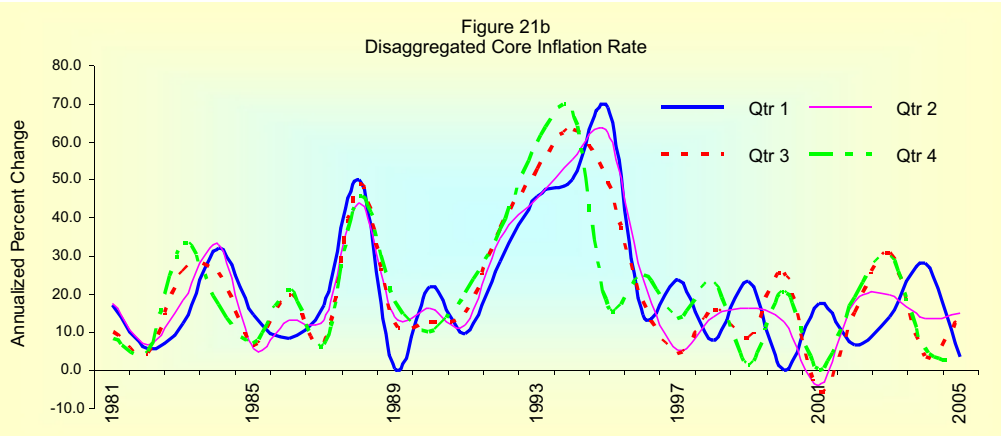
[1] CPI, CPIC, and CPIF are headline, core, and food inflation, respectively.

Figure 21a
Disaggregated Headline Inflation Rate

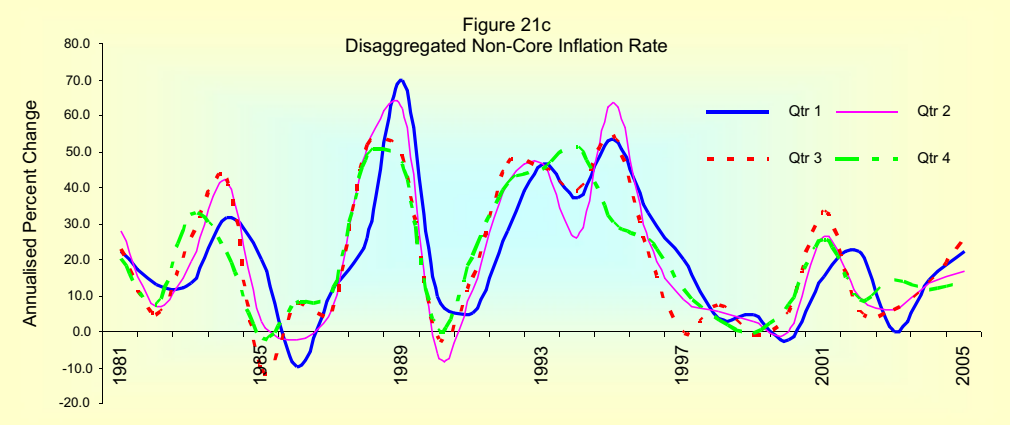


Although core inflation rate often peaks during the first quarter over the years, its standard deviation reveals that it was more volatile at 18.07 in the third quarter, while the least volatile quarter is the first quarter with a standard deviation of 15.62.

Figure 21b
Disaggregated Core Inflation Rate



Visual examination of the quarterly disaggregated non-core (food) inflation suggests that it peaks frequently during the third quarter, with frequent troughs in the first and third quarters of the year. It is, however, more volatile in the second and fourth quarters at 20.15 and 17.45, with least volatility in the first quarter of the years.



Overall, it is interestingly observed that non-core (food) inflation is the most volatile at 18.28, while headline inflation at 16.29 exhibited the least volatility over the study period.

Table 2: Volatility of Headline, Core and NonCore (Food) Inflation*

Inflation	Q1	Q2	Q3	Q4	Overall
Headline	19.55	16.00	17.45	16.24	16.29
Core	15.62	17.26	18.08	17.32	16.80
Non-Core	16.05	20.15	17.14	17.45	18.28

* *Standard deviation was used as a measure of volatility*

IV. Modeling Inflation Dynamics

Three major modeling approaches are adopted for studying the inflation dynamics, namely; trend, autoregressive integrated moving average (ARIMA), and structural econometric models. Under the structural models, we have the mark-up, monetarist and Phillips Curve models.

IV.1 Trend Models

The rationale for constructing a time trend model for inflation or any variable of interest follows a visual inspection of the plot of that variable. The presence of a time trend would suggest that, all things being equal, inflation varies with time. Thus, inflation is modeled against time with an *a priori* expectation that time and inflation

would move in the same direction. In other words, inflation is expected to increase with time, all other things being equal. This relationship can be written mathematically as follows:

$$y_t = \alpha_1 + \alpha_2 trend + \varepsilon_t \text{ - - - - - - - - - - - - - - - (3)}$$

Where, trend, α_1, α_2 is the time, are parameters, while ε is an error term, assumed white noise.

IV.2 Autoregressive Integrated Moving Average (ARIMA) Models

Simple autoregressive integrated moving average (ARIMA) models are basically, generalizations of the simple autoregressive, AR (p), model for modeling the serial correlation in the disturbance to include: first-order or higher-order terms of the AR (p); the integration order term, corresponding to the number of time the series is designed to be differenced; and a moving average, MA (q), term to improve the current forecast.

The notation AR(p) refers to the autoregressive model of order p. The AR(p) model is written as

$$X_t = c + \sum_{i=1}^{p} \varphi i X_{t-i} + \varepsilon_t \text{ - - - - - - - - - - (4)}$$

where, $\varphi_1 \ldots\ldots\ldots \varphi_p$ are the parameters of the model, c is a constant and ε_t is an error term. The constant term is omitted by many authors for simplicity. An autoregressive model is essentially an infinite impulse response filter with some additional interpretation placed on it. Some constraints are necessary on the values of the parameters of this model in order that the model remains stationary. For example, processes in the AR(1) model with $|\varphi_1| > 1$ are not stationary. The notation MA(q), on the other hand, refers to the moving average model of order q.

$$X_t = \varepsilon_t + \sum_{i=1}^{q} \theta_i \varepsilon_{t-i} \text{ - - - - - - - - - - - - - - (5)}$$

where $\theta_1, \ldots, \theta_q$ are the parameters of the model and $\varepsilon_t, \varepsilon_{t-1}, \ldots$ are again, the error terms. The moving average model is essentially a finite impulse response filter with some additional interpretation placed on it.

Finally, the combined ARMA(p, q) model is given by:

$$(1 - \sum_{i=1}^{p} \varphi_i L^i) X_t = (1 + \sum_{i=1}^{q} \theta_i L^i) \varepsilon_t \text{ - - - - - - - - - (6)}$$

Where the series is differenced to achieve stationarity, the process becomes an ARIMA (p,d,q) process. Thus, p is the order of the AR component, d is the number of times the series is differenced, and q is the order of the MA process.

In order to fit an ARIMA to the series, an examination of the autocorrelation properties, using the correlogram view of the individual series is important. This aids the determination of the best fit for the model. This procedure is called identification (not to be confused with the same term used in the simultaneous equations literature) and provides guidance in selecting an ARIMA specification. The nature of the autocorrelation function from the correlogram is a valid indicator of the nature of the structure of the ARIMA. Thus, if the autocorrelation function decays smoothly at a geometric rate, and the partial autocorrelations were zero after one lag, then a first-order autoregressive model is appropriate. Alternatively, if the autocorrelations were zero after one lag and the partial autocorrelations declined geometrically, a first-order moving average process would seem appropriate. If both AR and MA are present, an ARMA model becomes appropriate. On the other hand, if the autocorrelations appear to have a seasonal pattern, this would suggest the presence of a seasonal ARMA (SARMA or SARIMA) structure.

ARIMA models in general can, after choosing p and q, be fitted by least squares regression to find the values of the parameters which minimise the error term. The goal of ARIMA estimation is to obtain a parsimonious representation of the process generating inflation and to be able to adequately forecast its future values based on such information. It is generally considered good practice to find the smallest values of p and q which provide an acceptable fit to the data.

IV.3 Structural Models of Inflation

There are three basic classes of structural models deriving from the major causes of inflation. The first views inflation as a cost-push phenomenon in the context of a long-term constant mark-up over costs. The second treats inflation primarily as a monetary phenomenon and attempts to link changes in prices directly to changes in monetary aggregates or to both developments in the monetary and traded goods sector. The third class views inflation as arising from real factors, in particular imbalances between aggregate demand and aggregate supply.

IV.3.1 Mark-up Models

In this type of model, the price level is determined by costs and a given mark-up of the following form:

$$P_t = \mu_t (W_t)^{\gamma w} (E_t P_t^*)^{\gamma e} \text{ - - - - - - - - - - - - - } (7)$$

Where P is the domestic price level, μ is the mark-up over costs, W are wages, E is the nominal exchange rate and P* is the level of foreign prices.

The long-run specification, usually, assumes that the mark-up is constant or fluctuating randomly around a given long-run value. In the short or medium run, there could be persistent fluctuations in the mark-up depending on how quickly price setters adjust to changes in wages and foreign prices. In such a situation, it is important to allow for more complex dynamics, particularly to capture inertia, and contemporary changes in wages and foreign prices to capture immediate adjustment, possibly an error correction term meant to preserve the long-run equilibrium. There are major constraints to adopting this model for Nigeria. Prominent among them is the lack of information on costs, wages, and productivity.

IV.3.2 Monetarist Models

For monetary targeting economies, it is of primary interest to develop a model that could be used to derive inflation forecasts as an input into its formulation. Such models are based on the paradigm that inflation is always and everywhere a monetary phenomenon. We shall consider two of such models. The first is based on the money market disequilibria, while the second extends this thinking to cover the traded goods market.

IV.3.2.1 *Money Gap*

The monetarists approach reflects the standard assumption that inflation could possibly originate from disequilibria in the money market. In other words, changes in the aggregate price level are a way in which the economy responds to monetary disequilibria. These types of models are consistent with the "active-money" paradigm where money is viewed as an active part of the transmission mechanism in that excess money causes inflation. A situation of monetary disequilibria exists if the quantity of money in the economy is above (below) what the public desires to hold. Should this occur, monetary models predict that the price level will rise (fall) to re-establish the equilibrium between demand and supply for money. An excess supply of money can translate to inflationary pressure just as an excess demand for goods does.

Monetary disequilibria can be measured using the money gap. Hence, according to the monetary models, a positive money gap is associated with rising inflationary pressures. In other words, monetary aggregates contain useful information concerning future inflation. The money gap is typically derived in two ways. First, it is derived as the difference between actual money supply and the estimated long-run money demand. Thus,

$$\text{Money gap} = m^s - m^d \text{----------} \quad (8)$$

The second method uses the difference between the actual money supply and the potential money supply as a money gap. Thus,

$$\text{Money gap} = m^s - m^p \text{----------} \quad (9)$$

IV. 3.2.2 ***Open Economy Model***

An extension of the monetarist framework in small open economies, considers disequilibria, not only in the money market but also in the traded goods market. In other words, inflation process in an open economy is determined by developments in the two markets.

Generally, the framework begins with the assumption that the price level, P_t, is a weighted average of tradable prices, P_t^T, and non-tradable prices,: P_t^N

$$P_t = qP_t^N + (1- q)P_t^T \qquad (10)$$

and q is the weight on non-tradable prices in the price index. The price of tradable goods is determined in the world market, with their price in the domestic economy being a function of the foreign currency price, P_t^f, and the exchange rate, E_t (with an increase representing a depreciation). The price of non-tradables is determined in the domestic money market:

$$LogP_t^N = a\left(LogM_t - LogM_t^d\right) \qquad (11)$$

Where M_t is the outstanding stock of money, M_t^d is the demand for real money balances, and is a scale factor representing the relationship between economy wide demand and demand for non-tradable goods. The demand for real money balances is assumed to be determined by the level of real income, Y_t, and the opportunity cost of holding money vis-à-vis other assets (real or financial), i_t. Consequently, the price of non-tradables can be rewritten as:

$$LogP_t^N = a\left(LogM_t - a_1 LogY_t + a_2 i_t\right) \qquad (12)$$

An increase in the outstanding money stock is expected to result in higher prices, while an increase in real income is expected to expand the demand for money for transactions and, in turn, lead to a decline in prices. An increase in the opportunity cost of holding money, by reducing the demand for money balances, will result in an increase in prices or by increasing aggregate demand would generate inflationary pressures. So, with lower case letters representing logs, prices, p_t, can be written as:

$$p_t = a\,q(m_t - a_1 y_t + a_2 i_t) + (1- q)(e_t + p_t^f) \qquad (13)$$

Equation (13) thus posits that the price level or inflation is determined by the stock of money, real income (or output), interest rate, exchange rate and foreign price level.

IV. 3.3 Phillips Curve Model

The Phillips curve, originally estimated as a relationship between the percentage change of money wages and the level of unemployment have, in recent times, been modified to include excess demand expressed in terms of an output gap and expected inflation rather than an unemployment gap and is given by:

$$\pi_t = \pi_t^e - \theta(y_t - y_t^*) \text{----------(14)}$$

Where π_t *and* π_t^e *are actual and expected inflation,* y_t and y_t^* are, respectively, actual and desired output, and θ captures the impact of output on inflation. The difference between y_t and y_t^* *is termed the "output gap", and in practice is a measure of the deviation of output from capacity or trend output.*

The output gap is measured as a percentage of the level of the GDP. It may be negative (equivalent to a deflationary gap) or positive, implying that the economy was operating unsustainably fast- that is, was overheating (in an inflationary gap). The inflation rate tends to fall when actual output is above potential and tends to rise when actual output is below potential. However, where agricultural output is a dominant component of the GDP, an inverse relationship is expected. The gap is useful in assessing the effects of monetary policy because it assumes that any increase in aggregate demand in the economy will generate extra output if actual GDP is below potential and will generate inflation, if actual output exceeds potential.

The appropriateness of the Phillips curve in determining prices in Nigeria would depend on whether demand or supply shocks dominate in the economy. If demand shocks dominate, then the estimation could be confined to an index other than consumer prices, for instance, manufactured prices. On the other hand, an output gap related to agricultural sector could be used with the expectation that agricultural output above potential will, other things being equal, result in a decline in inflationary pressures (the converse is true for the case of industrial production above potential, Callen and Chang, 1999).

IV.4 Estimation Technique/Specification

For the trend and ARIMA models, the ordinary least squares (OLS) estimation technique would be used to derive the model parameters. This method enhances an understanding of the evolution of inflation through time in the case of trend model during the estimation period (1981Q1 2005Q4), and the relationship between inflation and its past realizations as well as the process underlying the data in the case of an ARIMA model. Quarterly data were used to account for the evolution and developments in all the macroeconomic variables utilized. From the results, ex-ante

and ex-post values of inflation are then derived. The Theil Inequality would then be used to assess the significance of the forecast.

In the monetarist model, the money gap would be estimated using a simple dynamic framework which incorporates past inflation and lag values for money gap. Money gap is defined as in equation (9).

The open economy model is estimated using an error correction modeling framework. Specifically, the Engel-Granger (1987) two-step modeling approach is adopted for this study. In the first step, the time series properties of the variables that determine inflation are examined. This reveals whether or not the variables are generated from a stationary process. It is an important step as it serves as a guide towards an appropriate formulation of the model. The augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests are used for this purpose.

In the second step, an examination of the linear combination of these non-stationary variables for stationarity is carried out. This is, via the residuals, extracted from the static or long-run relationship between inflation and its determinants. Residuals stationarity would imply that there is cointegration, in which case there exists a long-run equilibrium relationship among the variables. Cointegration then means that there exists a dynamic adjustment process explaining how departure from the long-run equilibrium is corrected.

The error correction mechanism (ecm) can then be thought of as a short-run counterpart to the long-run equilibrium relationship. In this framework, the residuals, if stationary, are a valid error correction mechanism with the coefficient of the ecm representing the deviation from the long-run equilibrium. The functional form of the model, which initially is presented in a general form, incorporating many lag terms, is reduced to a specific or parsimonious structure by empirical testing and elimination. A search for parsimony in this dynamic model typically follows the general-to-specific framework, using various information criteria (Akaike, Schwarz, log likelihood, etc.).

Diagnostic tests are performed on the results with a view to validating the model. First, the omitted variable tests are performed to investigate the appropriateness or otherwise of dropping a particular variable or a set of variables. The second set of tests deals with the residuals from the regression. They include normality, serial correlation, and heteroskedasticity tests. The third test is the stability test. This is intended to investigate whether or not there are structural breaks and whether or not the model parameters are stable over time. If there are signs of breaks or instability, these are corrected using the appropriate technique. For instance, dummies could be included in the model.

V. Empirical Model Specifications for Nigeria

Except for interest rates and trend variables, lower-case letters are used to indicate that logarithmic transformation have been carried out on the variables.

V.1 Trend Model

Drawing from the findings of the decomposed CPI (see Figure 21), which suggest significant trend, we do a trend regression of the form:

$$cpih_t = a_0 + a_1 trend + \varepsilon_t \text{ ---------} \quad (15)$$

$$cpic_t = b_0 + b_1 trend + \mu_t \text{ --------} \quad (16)$$

$$cpif_t = c_0 + c_1 trend + \omega_t \text{ --------} \quad (17)$$

where cpih, cpic, cpif, are the headline, core and non-core (food) inflation, respectively, trend is the time trend.

The rationale for constructing a time trend model follows from the visual inspection of the charts resulting from the decomposition of the different series (Figure 21), which strongly suggests that all the variants of inflation are trended. This implies that inflation varies with time. Thus, we model inflation against time with an *a priori* expectation that time and inflation would move in the same direction. In other words, inflation is expected to increase with time, all other things being equal.

V.2 ARIMA Model

The specification for the ARIMA models derives from the identified series as earlier discussed. Thus, headline inflation is estimated as an ARIMA (2, 1, 2), but with fourth quarter seasonal terms. This was supported by evidence from the decomposed series in Figure 21, and was similar to the one generated by taking out the 4^{th} quarter component (deseasonalising) of the series. In the case of core inflation, the best fit was ARIMA (1,1,1). This series is found to contain no seasonal components. Lastly, the non-core inflation closely approximates an MA (3). The lag order selection is guided by the Akaike and Schwarz information criteria. After fitting a candidate ARIMA specification, verification is carried out to ensure that there are no remaining autocorrelations that the model had not accounted for.

Thus, the ARIMA model for headline, core, and food inflation in Nigeria is given as:

$$\Delta cpih_t = a_0 + a_1 \Delta cpih_{t-1} + a_2 \Delta cpih_{t-2} + \varepsilon_t + \alpha_1 \varepsilon_{t-1} + \alpha_2 \varepsilon_{t-2} \text{ - - - - - - - (18)}$$

$$\Delta cpic_t = a_0 + a_1 \Delta cpic_{t-1} + \varepsilon_t + \alpha_1 \varepsilon_{t-1} \text{ - - - - - - - - - - - - - - - - - - - (19)}$$

$$\Delta cpifa = {}_0 + \varepsilon_t + \alpha_1 \varepsilon_{t-1} + \alpha_2 \varepsilon_{t-2} + \alpha_3 \varepsilon_{t-3} \text{ - - - - - - - - - - - - - - - - - (20)}$$

V.3 Monetarist Model

V.3.1 Monetary Gap Model

The money gap models for headline, core and food inflation are given by:

$$\mathrm{D}cpih_t = a_o + a_1(L)\mathrm{D}cpih_{t-1} + a_3(L)m2gap + e_t \text{ ----------(21)}$$

$$\mathrm{D}cpic_t = a_o + a_1(L)\mathrm{D}cpic_{t-1} + a_3(L)m2gap + a_4(L)plr + u_t \text{ - - - - - - - - - (22)}$$

$$\mathrm{D}cpif_t = a_o + a_1(L)\mathrm{D}cpif_{t-1} + a_3(L)m2gap + w_t \text{ - - - - - - - - - - - - - - - (23)}$$

In the case of core inflation, which is mainly demand driven, other demand factors are added. In this model, the money market interest rate is included.

V.3.2 Open Economy Model

The long-run estimable determinants of headline are expressed as follows:

$$cpih_t = a_o + a_1 ier + a_2 m2_t - a_3 rgdp_t + a_4 gex + a_5 fpr + a_6 plr_t + e_t \text{ - - - - - - - - - (24)}$$

The core long-run model used two different monetary variables, namely, base money and money supply. Thus we have;

$$cpic_t = a_o + a_1 ier + a_2 bm_t - a_3 rgdp_t + a_4 gex + a_5 fpr + a_6 i_t + n_t \text{ - - - - - - - - - (25}a\text{)}$$

$$cpic_t = a_o + a_1 ier + a_2 m2_t - a_3 rgdp_t + a_4 gex + a_5 fpr + a_6 tbr_t + y_t \text{ - - - - - - - - (25}b\text{)}$$

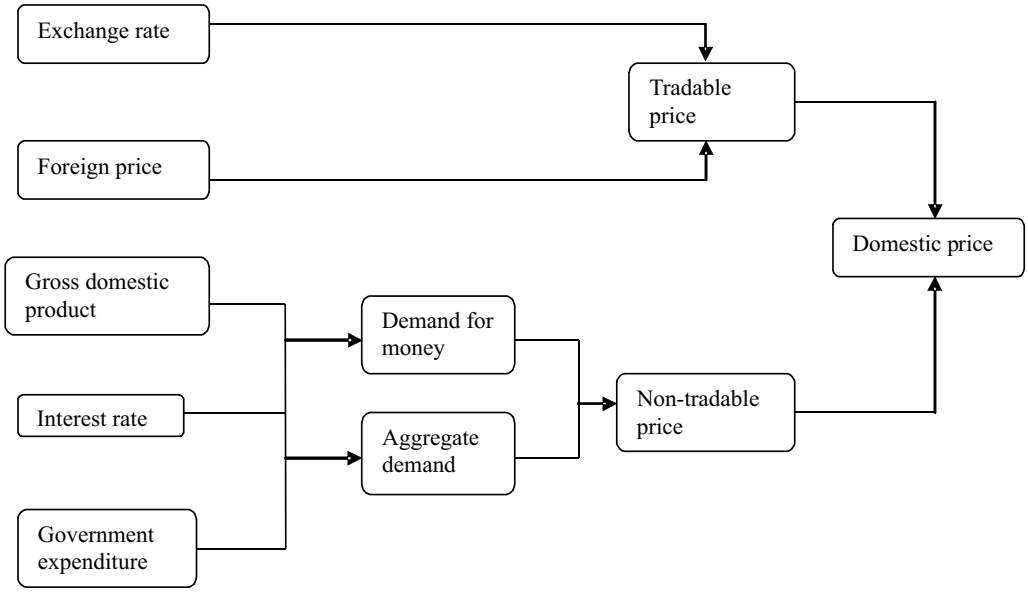
In the case of food inflation, we have;

$$cpif_t = a_o + a_1 ier + a_2 m2_t - a_3 gdpf_t + a_4 gex + a_5 fpr + a_6 plr_t + w_t \text{ - - - - - - - - - (26)}$$

In equation (26), the output of the agricultural sector, excluding forestry, is used instead of real GDP. These models are estimated and their long-run properties assessed.

We can use a flow chart to draw out the main linkages in the model. The model is set out in the context of an open economy, with the effects of domestic and foreign variables playing a crucial role in price determination. Exchange rate and foreign prices are the major foreign variables, while the domestic money and goods market as well as government operation are important signaling variables. The foreign variables impact on prices through the tradable goods sector, while domestic variables affect prices via the non-tradable goods sector, which adjust to changes in money and aggregate demand.

Figure 22: Flow Chart Representation of the Monetarist Price Determination



V.4 Phillips Curve Model for Nigeria

In this section, we make the assumption that price movements in Nigeria are determined by an expectation-augmented Phillips curve, using the output gap/unemployment. The output gap is derived using the Hodrick-Prescott (HP) filter to detrend the log of real GDP.

The mathematical representation of the model for headline, core and food inflation are given below.

$$\Delta lcpih_t = \alpha_0 + \alpha_1(L)\Delta lcpih_t + \alpha_2(L)\Delta gap_t + \varepsilon_t \text{ - - - - - (27)}$$

$$\Delta lcpic_t = \alpha_0 + \alpha_1(L)\Delta lcpic_t + \alpha_2(L)\Delta gap_t + \upsilon_t \text{ - - - - - (28)}$$

$$\Delta lcpif_t = \alpha_0 + \alpha_1(L)\Delta lcpif_t + \alpha_2(L)\Delta gap_t + \omega_t \text{ - - - - - (29)}$$

In these models, a backward looking inflation expectation is assumed and, hence, the lag values of inflation are used as proxies in the absence of any measure of expectation. Both the change in CPI and output gap have been found to be generated by a stationary process.

We also estimate the Phillips curve, using the output gap, disaggregated into agricultural and industrial output gaps, reflecting their sectoral contributions to output. Consequently, we derive agricultural and industrial output gaps by the same method (Hodrick-Prescott filter). *A priori*, an increase in agricultural output above its trend would have a dampening effect on inflation, other things being equal, while an increase in industrial output above its potential, results in an increase in inflationary pressure (Callen and Chang, 1999).

VI. Analysis and Major Findings

This section presents the results of the analysis and the major findings for all the models. All tests are conducted at the 5 and 10 per cent levels of significance.

VI.1 Results from the Time Trend Models

The result presented in Table 3 shows that, in conformity with *a priori* expectation, except for food inflation, trend has a significant positive influence on inflation. In the two cases, there is a significant positive relationship between inflation and the time trend, with coefficients of 0.038 for headline and 0.048 for core inflation. This indicates that, all things being equal, time would induce a change of 0.038 and 0.048 per cent increase in headline and core inflation, respectively. The result for food inflation is not entirely surprising for it is well-known that food production is subject to the vagaries of weather, natural disaster, and other domestic crises. This is why the food inflation series was observed to have significant seasonal components and strong irregular patterns.

The one quarter lag of inflation is highly significant in all the models. Indeed, there is

a one-to-one correspondence between inflation in any current period and the previous quarter. Thus, inflation in the previous period is carried into the next period, suggesting the propagation of inflation (that is persistence in the inflation variable).

The coefficient of determination (R^2) for the three equations is quite high, indicating that the variation in inflation can be adequately explained by linear trend and inflation inertia. The overall regression is also highly significant, confirming the goodness of fit for the model. The significant Durbin-Watson (DW) statistic also shows that serial correlation is absent in the models. Based on the findings from the decomposed non-core CPI series, seasonal dummies for the third and fourth quarters are introduced to determine their influence on core and non-core CPI/inflation. The seasonal dummy for the third quarter is found insignificant and is consequently dropped from the model.

Table 3: Results from the Trend Models

	CPIH	CPIC	CPIF
Constant	-0.6867	-0.9622	-0.2597
	(0.3104)	(0.2470)	(0.7920)
Trend	0.0383	0.0488	0.0523
	(0.0598)	(0.0415)	(0.0778)
Seasonal Dummy			-2.9976
			(0.0003)
Inertia	1.0014	0.9927	0.9902
	(0.0000)	(0.0000)	(0.0000)
R squared	0.9967	0.9950	0.9934
Adjusted R squared	0.9966	0.9949	0.9932
F-statistic	15243.13	9994.56	5034.103
Prob (F-statistic)	0.0000	0.0000	0.0000
Durbin-Watson	1.7324	1.7047	2.2158

Figures in parentheses are the probabilities for rejecting the null hypothesis;
Inertia means one-period Lag of Inflation

Table 4: Further Diagnostic Tests for the Time Trend Models

Model	Serial Correlation	ARCH LM	White Heteroskedasticity	Chow Breakpoint
CPIH	0.1371	0.0000	0.0000	0.2962
CPIC	0.0113	0.0560	0.0000	0.1168
CPIF	0.0719	0.0000	0.0000	0.0434

Notes:
1. Reported values are the probability values of the F-statistic of each test.
2. Serial Correlaton was performed using the Breusch-Godfrey LM test, while the Engle LM test was used for the Autoregresstive Conditional Heteroskedasticity (ARCH).

Further diagnostic tests on the trend equations for the various measures of inflation show that absence of serial correlation is not rejected in the case of headline and non-core inflation, but is rejected for the core inflation. The tests for the absence of heteroskedasticity, both ARCH and White, are rejected for all the measures of inflation, while the Chow breakpoint test for testing the stability of the model equations suggests rejection of the null hypothesis for the non-core (food) inflation

Following the estimation of the equation, forecasts are made as shown in the table below.

Table 5: Forecasts of the Consumer Price Index (CPI) from the Trend Models

	Actual	Forecasts			
	2006 Q1	2006 Q1	2006 Q2	2006 Q3	2006 Q4
Headline	151.3	148.2	151.8	155.5	159.1
Core	156.1	144.0	147.2	150.4	153.6
Food	147.6	149.5	154.7	159.9	165.4

VI.2 Results from the Autoregressive Integrated Moving Average (ARIMA) Models

The estimated models for headline (ARIMA (2,1,2), core (ARIMA (1,1,1)), and non-core (MA(3)) inflation are shown in Table 6. The results show that the information content of the models is significant. The explanatory AR/MA terms were also significant at the 5 per cent level in all the three models.

Table 6: Result from the ARIMA Models

Dependent Variable	CPIH	CPIC	CPIF
AR(1)	-0.3587	0.9852	
	(0.0002)	(0.0000)	
AR(2)	-0.4521		
	(0.0000)		
MA(1)	-1.9391	-0.8686	0.2324
	(0.0000)	(0.0000)	(0.0120)
MA(2)	0.9409		-0.0725
	(0.0000)		(0.4427)
MA(3)			0.4156
			(0.0000)
Akaike info Criterion	-2.5481	-2.4345	-2.1073
Schwarz Criterion	-2.4425	-2.3830	-2.0305
Durbin-Watson	2.1956	1.9116	1.6502

Figures in parentheses are the probabilities for rejecting the null hypothesis

Table 7: Further Diagnostic Tests for the ARIMA Models

Model	Serial Correlation	ARCH LM	White Heteroskedasticity	Chow Breakpoint
CPIH	0.0358	0.6121	-	-
CPIC	0.9130	0.7685	-	0.0419
CPIF	0.0001	0.9368	-	0.7051

Notes:
1. Reported values are the probability values of the F-statistic of each test.
2. Serial Correlaton was performed using the Breusch-Godfrey LM test, while the Engle LM test was used for the Autoregresstive Conditional Heteroskedasticity (ARCH).

Absence of serial correlation is rejected for the headline and non-core inflation, while stability is rejected for core inflation. All remaining diagnostic tests indicate non-rejection of the null hypotheses. Overall, the results from the ARIMA model are quite significant and the forecasts generated from these models are shown below:

Table 8: Forecast of the Consumer Price Index (CPI) from the ARIMA Models

	Actual	Forecasts			
	2006 Q1	2006 Q1	2006 Q2	2006 Q3	2006 Q4
Headline	151.3	140.3	144.89	144.56	141.71
Core	156.1	144.4	147.6	150.78	153.98
Food	147.6	143.69	148.73	142.52	146.24

VI.3 Results from the Monetarist Models

VI.3.1 Money Gap Model

The results for the money gap models are shown in Table 9. The findings for each type of inflation are presented below.

VI.3.1.1 Headline Inflation

Results from the ordinary least squares (OLS) estimate of the money gap model for headline inflation show that inflation inertia is highly significant at the first lag, such that past headline inflation induces a 0.27 per cent rise in current inflation. The one-quarter lag money gap is appropriately signed and shows an increase in inflation rate by 0.30 per cent following a one per cent widening of the gap. By the second lag, the effect diminishes and is opposite in direction. However, the sum of the lags is

positive, indicating that the total effect of money gap on prices is still positive and significant. The result shows that money gap and inflation inertia are the key determinants of headline inflation during the period covered by the study.

The results from the diagnostic tests on the model can also be gleaned from the residual plot in Figure 23. The tests for normality reject the null hypothesis, while the test for heteroskedasticity and serial correlation are not significant. There is also absence of ARCH effects. The model is also found to be somewhat unstable from the stability tests, as some points on the residual plot are outside the two standard error band.

VI.3.1.2 Core Inflation

In the case of core inflation, inflation inertia is not significant, while the money gap and interest rate are significant at the first lag. However, the coefficient of the money gap variable is very low at 0.17 per cent. Despite this low response of inflation to changes in the money gap, the model diagnostics are good as the model is devoid of serial correlation, heteroskedasticity and ARCH effects. The residuals are, however, not normally distributed. Indeed, the recursive graph shows instability in the parameters. The money gap and interest rate appear to be the key variables driving core inflation during the period.

VI.3.1.3 Food Inflation

Results for food inflation are mixed. Food inflation inertia is significant and persists into the second quarter. Money gap is also highly significant as a one per cent widening of the gap induces a 0.33 per cent change in the price level. Thus, inflation inertia and money gap are the key explanatory variables for non-core (food) inflation. Diagnostic tests performed show significant serial correlation, heteroscedasticity and non-normality, although ARCH effects appear to be absent. The recursive plot shows that the model parameters may not be stable over a long time horizon.

Table 9: Results from the Money Gap Model

Explanatory Variables	Headline Inflation	Core Inflation	Food Inflation
Constant	0.0351	-0.0025	0.0528
	(0.0000)	(0.9060)	(0.0000)
CPI (-**1)**	0.2794		0.1959
	(0.0064)		(0.0406)
CPI (-2)			-0.3159
			(0.0010)
MGAP (-1)	0.3181	0.1711	0.3309
	(0.0051)	(0.0259)	(0.0001)
MGAP (-2)	-0.2237		
	(0.0402)		
PLR (-1)		0.0029	
		(0.0087)	
R^2	0.1924	0.0921	0.2372
Adj. R^2	0.1678	0.0740	0.2137
D - W	1.8623	1.8388	1.8269

Figures in parentheses are the probabilities for rejecting the null hypothesis

A pure money gap model as established for headline and food inflation neglects the obvious transmission channel from changes in monetary aggregates to prices, which the core inflation model captured by the inclusion of interest rate. The low coefficient of money gap when interest rate is used explains the slow responsiveness of changes in core inflation to changes in monetary aggregate. Overall, however, the explanatory powers of the various equations are quite low. The low adjusted R-square may suggest the omission of important explanatory variables from the model.

Figure 23: Graph of Actual, Fitted and Residual Plot for the Money Gap Models

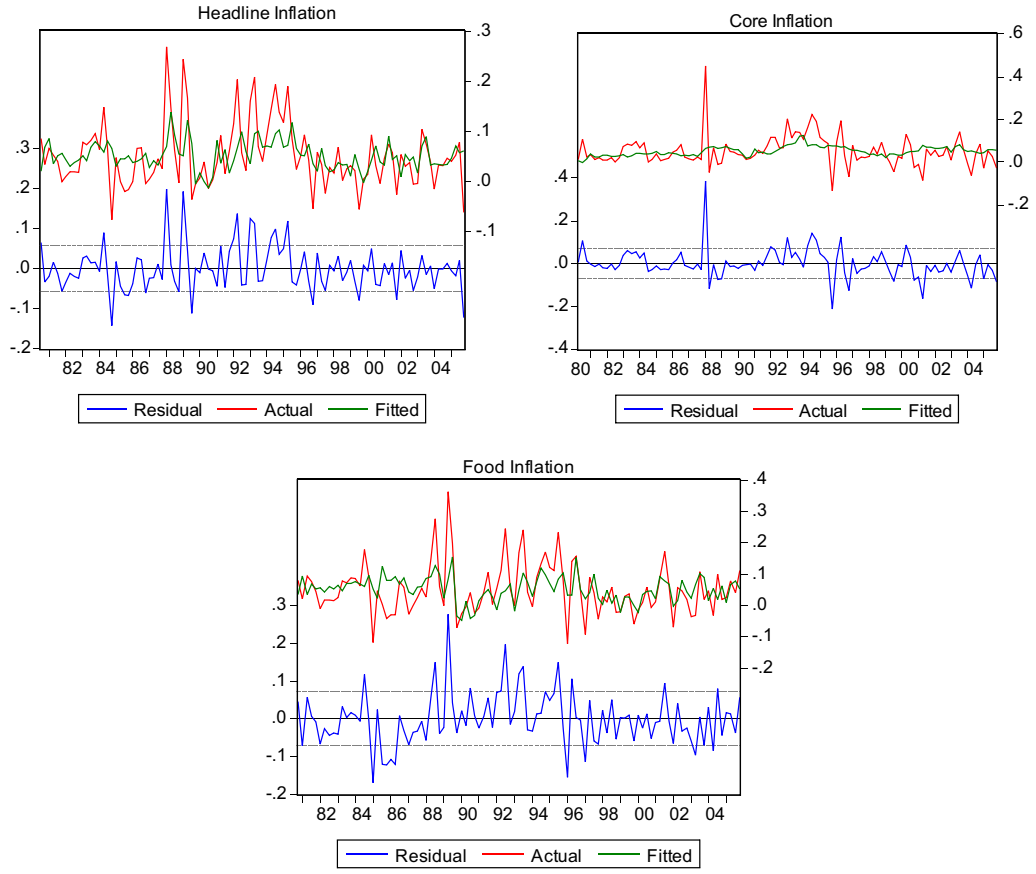


Table 10: Further Diagnostic Tests for the Money Gap Models

Model	Serial Correlation	ARCH LM	White Heteroskedasticity
Model_cpih	0.1618	0.8349	0.4306
Model_cpic_l	0.7590	0.7007	0.1650
Model_cpif	0.0443	0.6991	0.0141

Notes:

1. Reported values are the probability values of the F-statistic of each test.
2. Serial Correlation was performed using the Breusch-Godfrey LM test, while the Engle LM test was used for the Autoregressive Conditional Heteroskedasticity (ARCH).

Figure 24: Histogram Normality Test for Residuals of the Money Gap Models

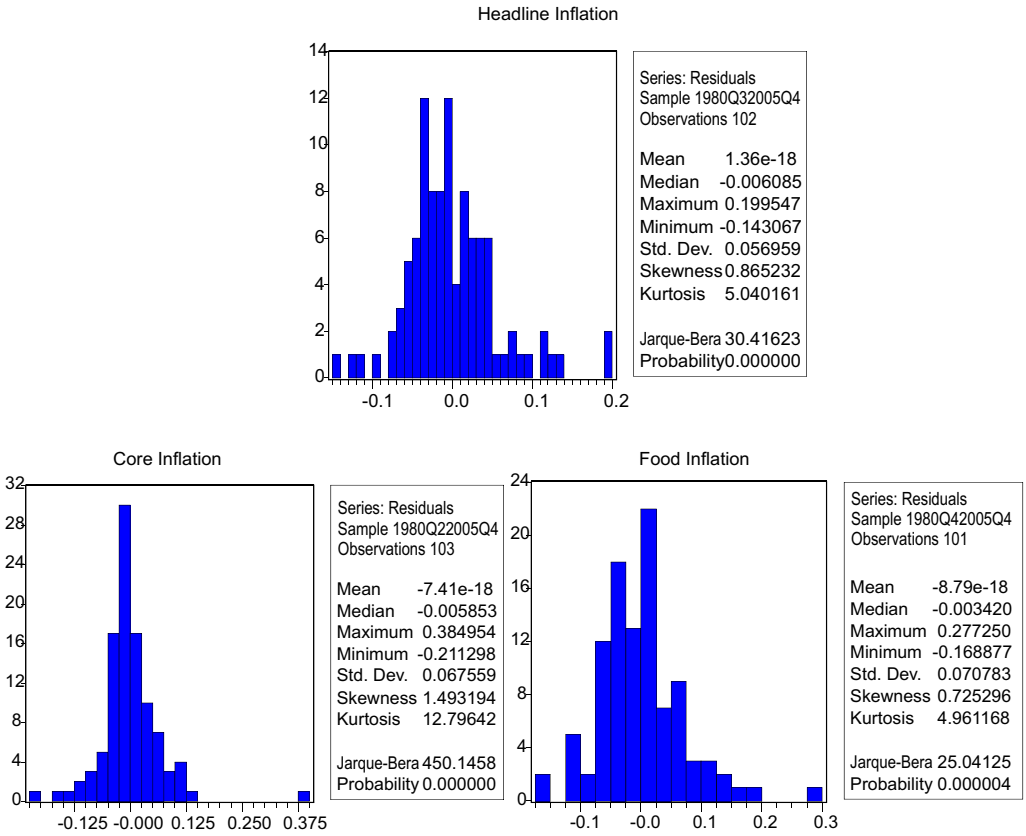
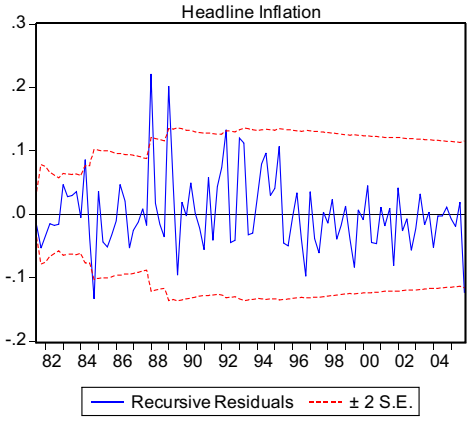
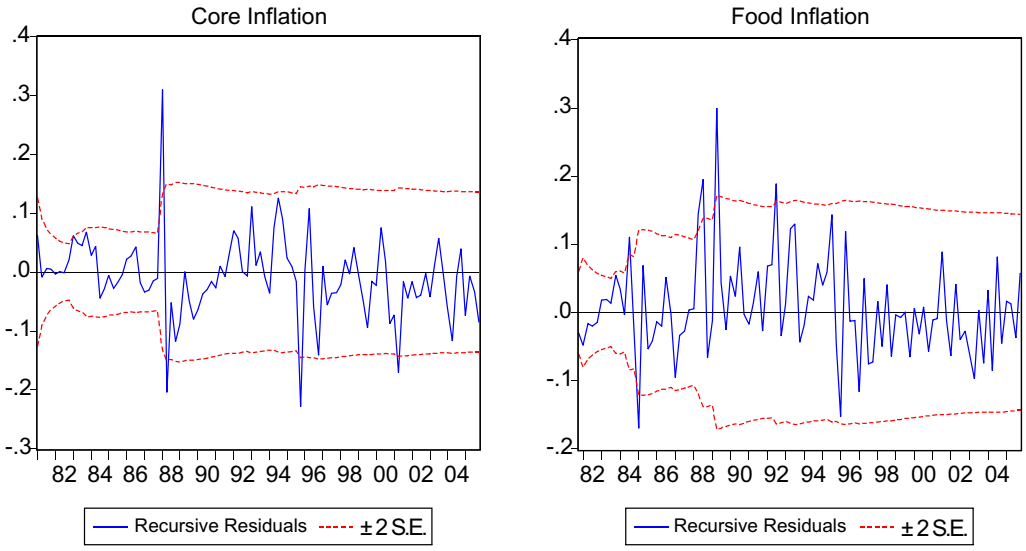


Figure 25: Recursive Residual test of Stability of the Money Gap Models





The Consumer Price Index forecast using the Money Gap Model is shown below.

Table 11: Forecast of the CPI from the Money Gap Models

	Actual	Forecasts			
	2006 Q1	2006 Q1	2006 Q2	2006 Q3	2006 Q4
Headline	151.3	144.01	150.95	155.84	168.38
Core	156.1	147.52	154.73	160.98	170.97
Food	147.6	142.56	155.15	164.76	175.59

VI.3.2 Open Economy Model

Results from the long-run models are presented in Table 12 below.

VI.3.2.1 Headline Inflation

All the variables in the model are significant and appropriately signed. The model shows that a one per cent depreciation in the exchange rate induces a 0.30 per cent increase in inflation, while money supply induces a 0.32 per cent increase in inflation for a one per cent rise in its level. The long-run impact of government expenditure and interest rate on inflation is comparatively minimal. However, the influence of imported inflation is high. Result shows that in the long-run, a one per cent increase in foreign prices exerts a 2.0 per cent rise in inflation. The sign of the interest rate

variable is worrisome as it suggests that an increase in lending rate leads to a decline in the inflation rate in the long-run, contrary to economic theory and conventional wisdom, and the fact that producers tend to raise the price of their products to accommodate higher interest rate costs, particularly if they borrowed to finance production.

VI.3.2.2 Core Inflation

In the case of core inflation, the results for the model using money supply or base money are very similar. However, the base money model is encompassing, implying that it is a more plausible determinant of inflation in the long-run. Other variables in the two models meet *a priori* expectations in terms of sign and size of the coefficients. For instance, the model with base money shows that a one per cent depreciation in the exchange rate induces a pass through of 0.22 per cent to inflation, while a one per cent rise in government expenditure, base money, and foreign prices will induce a corresponding 0.19, 0.32, 2.69 per cent rise, respectively, in inflation. An increase in real output and interest rate, on the other hand, leads to a 0.42 and 0.03 decline in inflation, respectively. Though the exchange rate pass through to inflation is low, the result lends credence to the Nigerian culture of import-dependence which is reflected in the high demand for foreign goods and services as well as higher costs of imported inputs.

VI.3.2.3 Food Inflation

The long-run determinants of food inflation are all highly significant. Exchange rate depreciation, money supply, government expenditure, foreign prices, interest rate, and food GDP, all exert a considerable influence on food inflation in the long-run. Specifically, a one per cent increase in food output reduces inflation by almost one per cent (0.95 per cent). This confirms the significance of food in the long-run price developments in Nigeria.

Table 12: Long Run Models for Inflation

Explanatory Variable	Headline Inflation	Core Inflation		Food Inflation
		I	II	
Constant	-10.5092	-12.1792	-9.9178	-3.9645
	(0.0000)	(0.0000)	(0.0000)	(0.0310)
IER	0.3203	0.2223	0.3179	0.3395
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
M2	0.3243		0.4203	0.2759
	(0.0007)		(0.0000)	(0.0018)
RGDP	-0.4486	-0.4180	-0.5171	
	(0.0286)	(0.0198)	(0.0089)	
GDPF				-0.9557
				(0.0002)
GEX	0.1156	0.1955	0.1262	0.1580
	(0.1734)	(0.0003)	(0.1218)	(0.0610)
FPR	2.1568	2.6924	1.8290	2.5573
	(0.0007)	(0.0000)	(0.0025)	(0.0000)
PLR	-0.0170	-0.0317	-0.0244	-0.0141
	(0.0001)	(0.0000)	(0.0000)	(0.0024)
BM		0.3166		
		(0.0000)		
R^2 Adj	0.9917	0.9941	0.9929	0.9909
D - W	0.2979	0.6948	0.4685	0.4624

Figures in parentheses are the probabilities for rejecting the null hypothesis

Despite this result, a cursory look at the diagnostics shows very high coefficient of determination but very low Durbin-Watson statistic indicative of possible spurious regression in the face of trending or non stationary variables. Indeed, the high coefficient of determination may wrongly indicate the presence of a long-run equilibrium relationship when this may not be so. Thus, there is a justification to look at the inherent properties or characteristics of the data. Thus, we test for stationarity or otherwise of the variables used in the regression using the conventional unit root tests. The unit root tests on these variables are given below in Table 13.

Unit Root Test

The results from the unit root tests of the variables in the model for headline, core, and food inflation are presented below:

Table 13: Unit Root Test for the Variables Used In the Models

Levels							First Differences						
variable	ADF Test Statistic	Order of Integration	Included in test equation	Phillips Perron	Order of Integration	Included in test equation	variable	ADF Test Statistic	Order of Integration	Included in test equation	Phillips Perron	Order of Integration	Included in test equation
cpih	-2.0553	I(1)	T&C	-1.2603	I(1)	T&C	?cpih	-3.3785	I(0)	T&C	-7.0137	I(0)	T&C
cpic	-0.8269	I(1)	T&C	-1.2378	I(1)	T&C	?cpic	-8.5302	I(0)	T&C	-8.6462	I(0)	T&C
cpif	-2.3119	I(1)	T&C	-1.5385	I(1)	T&C	?cpif	-4.1776	I(0)	T&C	-7.9005	I(0)	T&C
bm	-1.7587	I(1)	T&C	-1.8193	I(1)	T&C	?bm	-11.2331	I(0)	T&C	-11.1688	I(0)	T&C
ier	-0.9752	I(1)	T&C	-0.9752	I(1)	T&C	?ier	-9.5552	I(0)	T&C	-9.5456	I(0)	T&C
plr	-2.2530	I(1)	C	-2.2068	I(1)	C	?plr	-9.2804	I(0)	C	-9.5238	I(0)	C
m2	-2.0831	I(1)	T&C	-2.1409	I(1)	T&C	?m2	-8.8925	I(0)	T&C	-8.9297	I(0)	T&C
rgdp	-4.7206	I(0)	T&C	-6.1778	I(0)	T&C							
gdpf	-5.1742	I(0)	T&C	-3.7810	I(0)	T&C							
fpr	-1.6082	I(1)	T&C	-3.7437	I(0)	T&C	?fpr	-4.0077	I(0)	C			
gex	-1.9434	I(1)	T&C	-2.6209	I(1)	T&C	?gex	-6.8581	I(0)	T&C	-7.0014	I(0)	T&C

Note: C = Intercept ; T&C = Trend and Intercept; N = None

As can be seen from the table above, all the variables except rgdp and gdpf are integrated of order one (I(1)) in their levels, but integrated of order zero (I(0)) in their first differences. For the variable, fpr, the results from the ADF and PP tests in level form tend to contradict each other. We, however, categorize the variable as I(1) based on the ADF result, for it is better to err on the side of caution. Thus, the first condition under the Engel and Granger approach is satisfied. The existence of a long-run equilibrium relationship, which is a test of stationarity in the residuals of the long-run regression are examined and the result is shown below.

Table 14: Unit Root Test of the Residual[1]

Variable	Calculated *t*	Critical *t*			Order of
		1%	5%	10%	Integration
ecm_cpih	-2.9336	-2.5658	-1.9393	-1.6156	I(0)
ecm_cpic	-3.7269	-2.5658	-1.9393	-1.6156	I(0)
ecm_cpif	-3.4736	-2.5658	-1.9393	-1.6156	I(0)

[5] *Note: The Augmented Dickey-Fuller (ADF) test was performed on the residuals without trend and intercept. The critical values reported above were derived from Mackinnon (1991), Critical Values for Cointegration, in R.F Engle and C. W. J. Granger (Eds), Long Run Economic Relationships: Readings in Cointegration Advanced Texts in Econometrics, Oxford University Press.*

The residuals of all the cointegrating regressions are found to be level stationary, that is, I(0). This confirms that the variables in the long-run models are cointegrated. Given that cointegration was developed to make the concept of long-run equilibrium operational, the dynamics of inflation is then specified in an error correction model. Consequently, a dynamic over-parameterized error correction model is estimated for each of the different inflation measures. A maximum lag of four is chosen for both the dependent and explanatory variables. This is consistent with Hendry and Mizon (1984) and with models based on quarterly data. The specification and results for the parsimonious short-run models are discussed below.

Short-Run Dynamic Error Correction Model

The short-run dynamic specification of these long-run relationships can be written for headline, core, and food inflation, respectively as:

$$D cpih_t = a_o + a_1(L)D cpih_t + a_2(L)D ier + a_3(L)Dm2_t - a_4(L)rgdp_t + a_5 ecm_{t-1}^{cpih} + e_t \text{ - - - - - - - - - - (30)}$$

$$D cpic_t = a_o + a_1(L)D cpic_t + a_2(L)D ier_t - a_3(L)rgdp_t + a_4(L)plr_t + a_5 ecm_{t-1}^{cpic} + n_t \text{ - - - - - - - - - - - (31)}$$

$$D cpif_t = a_o + a_1(L)D cpif_t + a_2(L)D ier + a_3(L)Dm2_t + a_4 ecm_{t-1}^{cpif} + w_t \text{ - - - - - - - - - - - - - - - - (32)}$$

In all cases, is the first difference operator, L is the lag operator, and ecm is the residuals from the estimated long-run models. In the short-run models, variables that are not significant are systematically eliminated using an admixture of criteria (parameter significance, information criteria, etc.).

Headline Inflation

The result shows significant presence of inflation inertia, particularly in the third and fourth quarters. However, the effect is stronger in the third than in the fourth quarter. The contemporaneous effect of exchange rate and money on inflation rate is also weak. Nevertheless, money supply, lagged one period, is highly significant in explaining changes in the price level. This confirms the long held view that money supply affects the price level with a lag. The third lag value of real GDP is also highly significant. The error correction mechanism shows that 16.0 per cent of any disequilibrium in the inflation process is corrected within a quarter. In this case, the full adjustment is slow and takes a little over six quarters.

The graph of the residuals for the short-run models is shown in Figure 26. A sharp spike is observed in 1988 for headline inflation. This seems to coincide with the period of the first fuel price hike and the volatility in the exchange rate resulting from the introduction of the Dutch Auction System (DAS). Overall, the fitted values mimic the actual realization of the inflation process.

Several diagnostic tests are performed on the model (Table 15). First, the omitted variable test (for the omission of government expenditure and foreign prices) is not significant and, therefore, not rejected. Normality (Figure 27), serial correlation, and heteroskedasticity test statistic (Table 16) are also not significant. Absence of serial correlation is rejected for the model, model _cpih_I, at the one per cent level. The stability test shows that the model is stable within the two standard error band. However, because of the spike observed in 1988, a dummy variable is introduced for that year to improve on the model.

The introduction of the dummy in 1988 indeed improves the significance of the results but does not really change the size and sign of the parameters of the model. However, the model exhibited more stability, evident from the recursive residuals graph, where the model derived therefrom fitted perfectly within the two standard error band. The conclusions that emerged from the analysis of the cointegrating regression equation and the short-run dynamic error correction model are as follows: in the long-run factors such as the exchange rate, money supply, real GDP, foreign prices and prime lending rates determine the headline inflation, while in the short-run, the key determinants of headline inflation are inflation inertia, exchange rate, money supply and real GDP complemented by policy shocks, like the adjustments in the pump price of petroleum products.

Core Inflation

The result for core inflation shows rapid inflation inertia, in the first quarter. The contemporaneous exchange rate is not significant; however, a low pass through is observed in the third quarter. Money supply and base money are no longer significant in explaining changes in the price level, so are government expenditure and foreign prices. The results also show a decline in the effect of interest rate. The error correction variable is significant and appropriately signed. Thus, 19.0 per cent of any disequilibrium in the model is corrected within a quarter. This adjustment is slow and takes approximately over 5 quarters for the disequilibrium to be fully corrected.

Even though the residual graph shows that the model has a good fit, it also indicates the same spike in 1988 as in the model for headline inflation (Figure 28). The diagnostics also show that the test for the omission of government expenditure and foreign price is not rejected. The test for normality rejects the null hypothesis while the tests for the absence of serial correlation and heteroskedasticity are not rejected.

To test for structural break, a Chow test performed on the model was significant and a dummy was introduced for 1988. The result indicates that the model, apart from becoming more stable and significant, also shows some improvements in the size of the parameters. For instance, the coefficient of the error correction variable is larger and reveals a much faster adjustment of 20 per cent within the quarter. The non-

normality improves with the introduction of the dummy variable, even though it is still significant and thus, rejects the null hypothesis. The recursive residuals plot to test for stability also shows that the model is more stable, although slight evidence of instability remains around 1988 and between 1992 and 1996. Thus, in the short-run, inflation inertia, exchange rate, real GDP and prime lending rate appear to be the most significant determinants of core inflation, while in the long-run exchange rate, monetary aggregates, real GDP, government expenditure, foreign prices and prime lending rate play more dominant roles in affecting movements in core inflation.

Food Inflation

Government expenditure, foreign price, agricultural output, and interest rate are not significant in explaining food inflation in the short-run. However, there is, considerable inflation inertia in the first, third and fourth lags. The one-period lag of exchange rate and money supply are the only significant variables in explaining movements in the food inflation in the short-run. The error correction variable is highly significant and properly signed. The coefficient of the ecm indicates that 21.0 per cent of any disequilibrium in the model is corrected within a quarter and it takes approximately five quarters for such a disequilibrium to be fully corrected.

The residual graph shows no significant event all through the sample period. The fitted values of inflation mimic the actual. The model is well behaved as it passes all the diagnostic tests at the five per cent level. Specifically, serial correlation and heteroskedasticity are absent. The Jarque-Bera test for normality does not reject the null hypothesis and there are no ARCH effects.

The Chow stability test shows no break-point, while the recursive residuals test for stability indicates that the model is stable as all the points fall within the two standard error band, although there are a couple of instances where the plots are close to the two standard error band.

Table 15: Short Run Models for Inflation

Explanatory Variable	Headline Inflation		Core Inflation		Food Inflation
	I	II	I	II	
Constant	-0.0139	-0.0153	0.0459	0.0451	-0.0243
	(0.1217)	(0.0831)	(0.0000)	(0.0000)	(0.0257)
CPI					
-1			0.2144	0.1814	0.0613
			(0.0302)	(0.0665)	(0.0356)
-3	0.2093	0.2011			0.2125
	(0.0000)	(0.0000)			(0.0000)
-4	0.1084	0.1021			0.1063
	(0.0054)	(0.0079)			(0.0015)
IER				0.0849	0.1177
				(0.0685)	(0.0068)
-1	0.0764	0.0744			
	(0.0265)	(0.0280)			
-3			-0.0694	-0.0675	
			(0.0755)	(0.0800)	
M2					
-1	0.2663	0.2511			0.3159
	(0.0141)	(0.0187)			(0.0219)
RGDP					
-3	-0.4047	-0.4142			
	(0.0368)	(0.0299)			
-4			-0.3329	-0.3109	
			(0.0648)	(0.0809)	
PLR			-0.0064	-0.0063	
			(0.0402)	(0.0395)	
-3			-0.0048	-0.0053	
			(0.0939)	(0.0617)	
-4			0.0068	0.0056	
			(0.0485)	(0.1003)	
ECM (-1)	-0.1614	-0.1453	-0.1905	-0.2039	-0.2117
	(0.0001)	(0.0003)	(0.0007)	(0.0003)	(0.0000)
DUM88		0.0595		0.0646	
		(0.0460)		(0.0655)	
R^2 Adj	0.3993	0.3804	0.1795	0.2015	0.3998
D - W	1.4409	1.4685	2.0433	1.9136	1.4947

Figures in parentheses are the probabilities for rejecting the null hypothesis

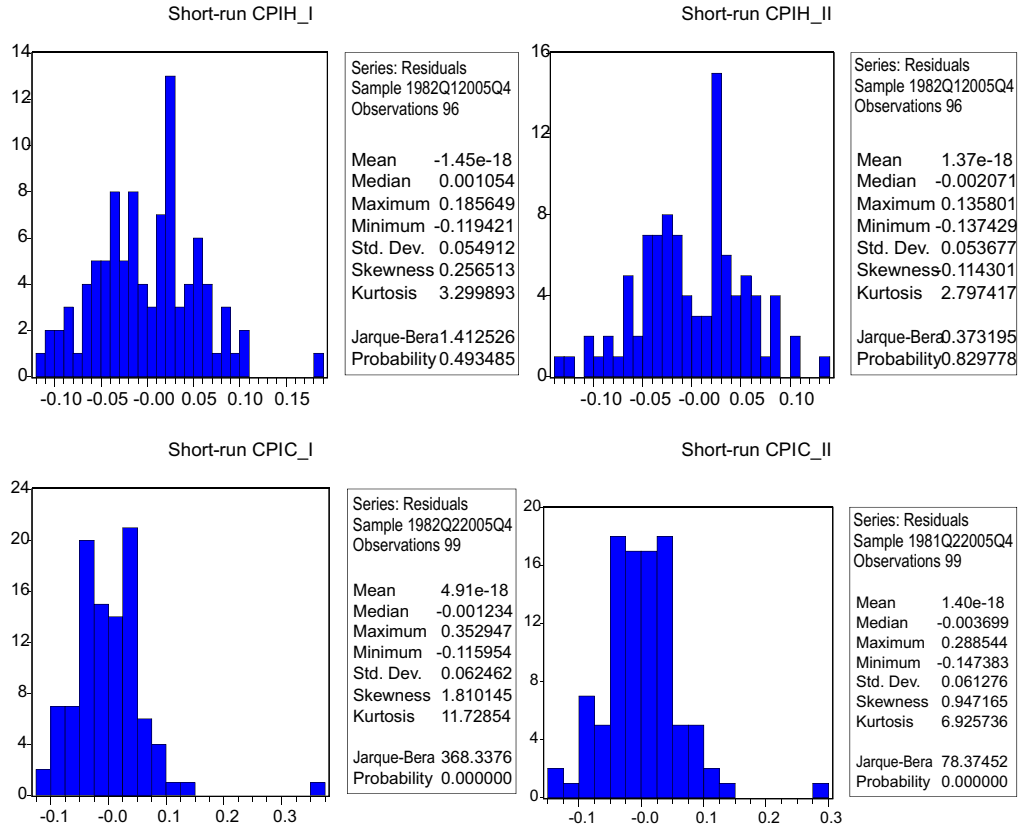
Figure 26: Actual Fitted and Residual Charts for the Short Run Models

Table 16: Further Diagnostic Tests for the Short Run Models

Model	Omitted Variable	Serial Correlation	ARCH	Chow Breakpoint	White Heteroskedasticity
Model_cpih_I	0.6891	0.0105	0.1572	0.2245	0.1783
Model_cpih_II	0.7485	0.0674	0.8677	-	0.0034
Model_cpic_I	0.9858	0.2451	0.6300	0.0115	0.9939
Model_cpic_II	0.9919	0.2236	0.1091	-	0.0000
Model_cpif	0.9013	0.1051	0.7243	0.5052	0.5149

Notes:
1. Reported values are the probability values of the F-statistic of each test.
2. Omitted variables tests were conducted for GEX and FPR in the CPIH and CPIC models, while in the CPIF model GDPF was included.
3. Serial Correlation was performed using the Breusch-Godfrey LM test, while the Engle LM test was used for the Autoregressive Conditional Heteroskedasticity (ARCH).

Figure 27: Histogram Normality Test for Residuals of the Short Run Models



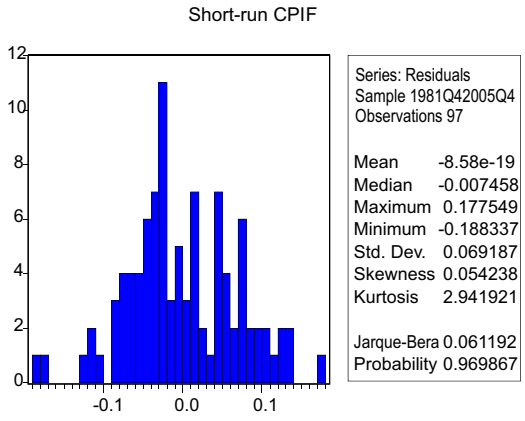
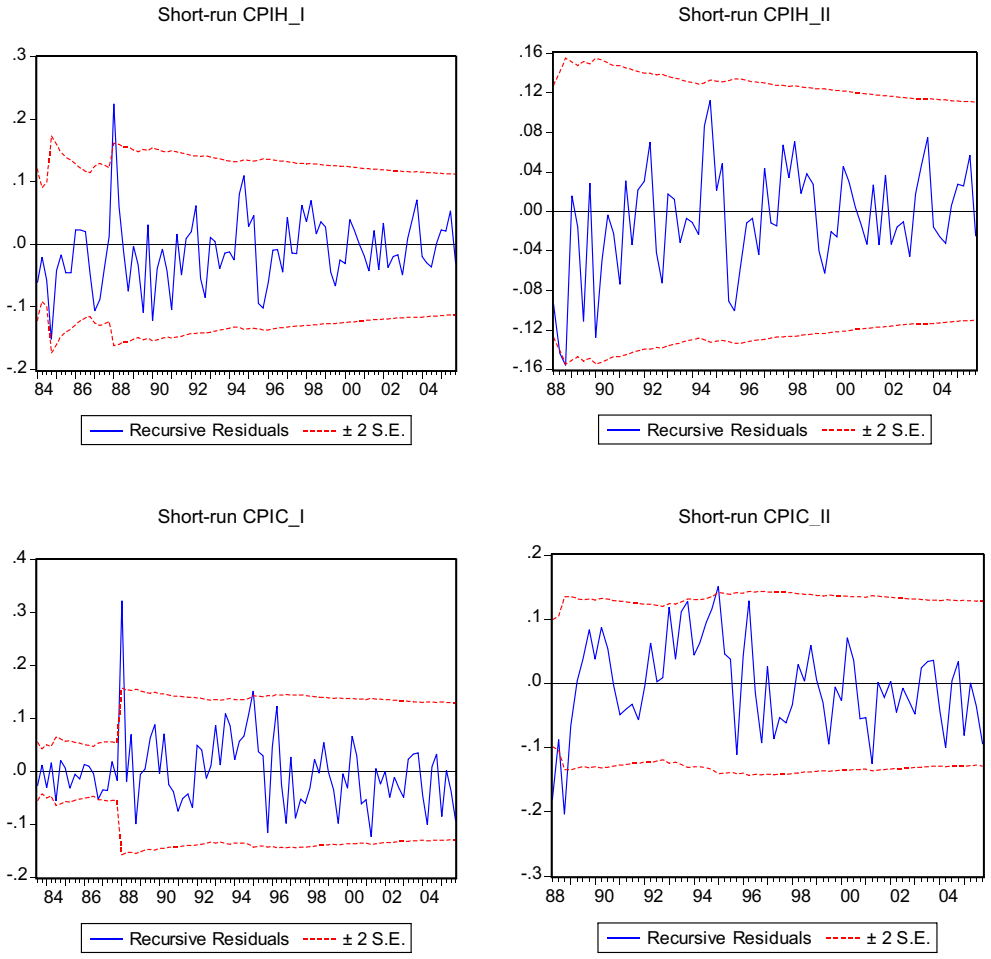
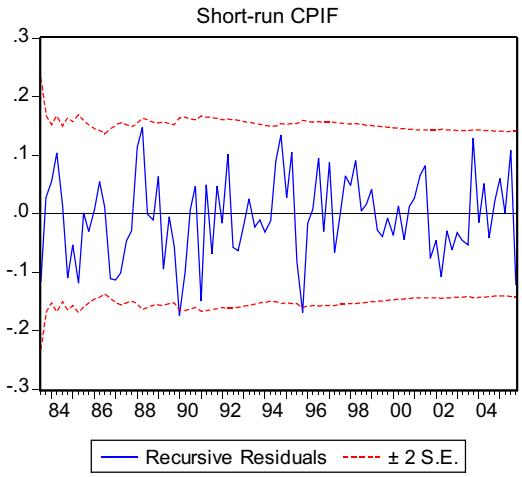


Figure 28: Recursive Residual test of Stability of the Short-Run Models





The forecast values for CPI, using the error correction model are presented below. It can be seen that the predictive ability of the model appear quite good.

Table 17: Forecast of the CPI from the Error Correction Models

	Actual	Forecasts			
	2006 Q1	2006 Q1	2006 Q2	2006 Q3	2006 Q4
Headline	151.3				
• **Without Dummy**		147.12	152.49	154.96	152.55
• **With Dummy**		147.33	153.58	157.81	154.34
Core	156.1				
• **Without Dummy**		144.30	143.97	147.65	157.96
• **With Dummy**		145.14	144.25	146.76	155.24
Non-core	147.6	145.21	149.50	151.68	150.72

VI.4 Results from the Phillips Curve Model

Estimates of the Phillips curve models are presented in Table 18. The result for headline inflation shows that past inflation is significant in explaining current inflation, almost on a one to one basis, while the three and four period lags of output gap are also significant in explaining changes in the price level. The combined effect of a one per cent widening of the output gap is a 0.10 per cent decline in inflation. However, when both the agricultural and industrial gaps are used, the result shows that inflation reduces by 0.17 per cent, for a one per cent widening of the agricultural output gap but increase by 0.20 per cent for a unit change in industrial output gap.

Table 18: Results from the Phillips Curve Models

Explanatory Variable	Headline Inflation		Core Inflation		Food Inflation	
	I	II	I	II	I	II
Constant	0.0464	0.0423	0.0630	0.0574	0.0494	0.0478
	(0.0003)	(0.0006)	(0.0000)	(0.0000)	(0.0015)	(0.0030)
CPI						
(-1)	1.3321	1.3178	0.9964	0.9980	1.2202	1.2193
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
(-2)	-0.3362	-0.3206			-0.2235	-0.2219
	(0.0007)	(0.0012)			(0.0250)	(0.0266)
GAP						
(-1)					-0.1092	
					(0.3870)	
(-3)	-0.3734		-0.4496			
	(0.0510)		(0.0447)			
(-4)	0.2600		0.3406			
	(0.1121)		(0.0813)			
GAP_AGRIC						
(-1)		-0.1701		-0.2461		
		(0.1076)		(0.0509)		
(-2)						-0.1666
						(0.2538)
GAP_IND						
(-4)		0.2085		0.2400		0.2111
		(0.0346)		(0.0381)		(0.1168)
R^2 Adj	0.9988	0.9988	0.9984	0.9985	0.9979	0.9978
D - W	1.8973	1.8787	1.7601	1.8061	1.8826	1.8810

Figures in parentheses are the probabilities for rejecting the nu ll hypothesis

In the case of core inflation, inflation inertia remains within the one to one margin, while a reduction in inflation of 0.10 per cent results from a one per cent increase in the output gap. With respect to agriculture and industry output gaps, there are 0.25 and 0.24 per cent decline and increase in inflation, respectively.

The result for food inflation is, however, not significant for output gap as well as for both agricultural and industrial gaps, even though the signs are appropriate.

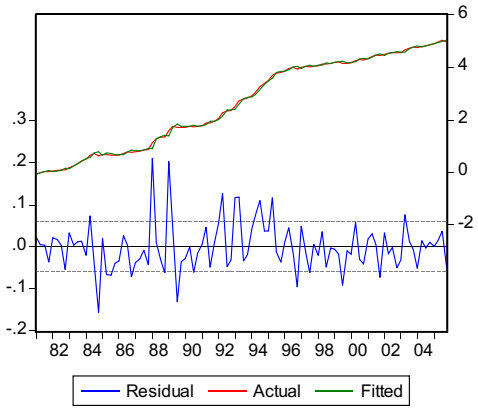
The results for headline and core inflation still confirm the significance of output gap in explaining inflation in Nigeria. The result also confirms *a priori* expectation that an increase in industrial output puts pressure on prices, while the opposite effect occurs when agricultural output gap increased. Figure 29 shows that the estimated model tracks the actual realization of the series very well.

The output gap models are validated using the standard diagnostic tests. For instance, the residual plot shows that the fit is good despite the extreme periods of 1988 and 1995, particularly for headline and core inflation, where the spikes are considerably high. This suggests that there could be structural breaks.

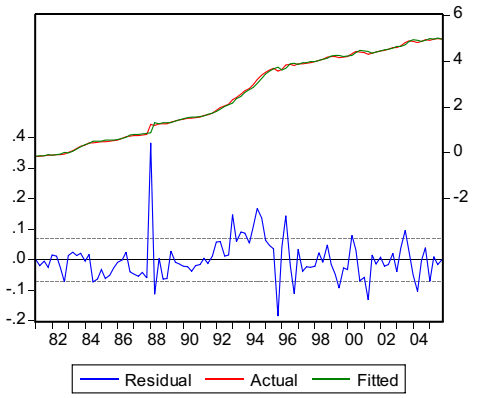
Figure 29: Actual, Fitted and Residual Charts for the Phillips Curve Models

Output Gap

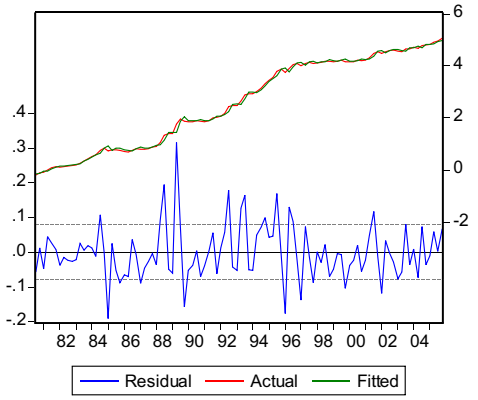
CPIH



CPIC

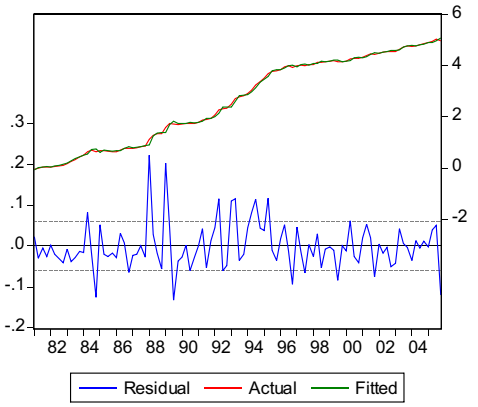


CPIF

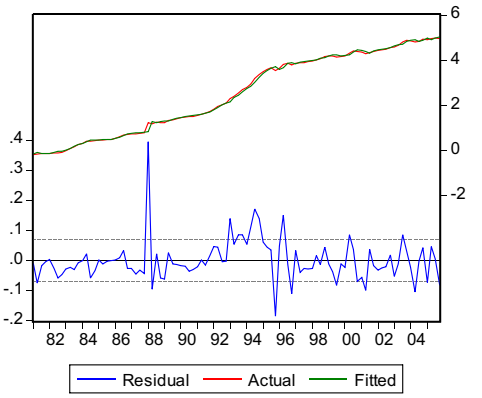


Agriculture/Industry Gap

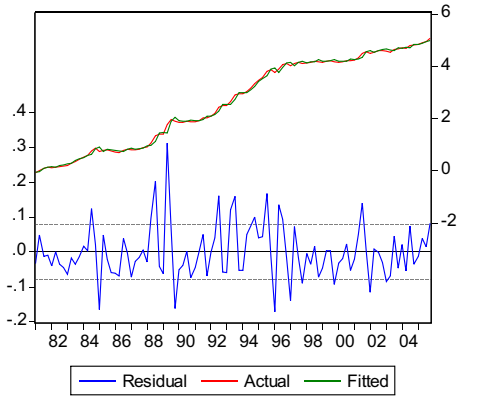
CPIH



CPIC



CPIF



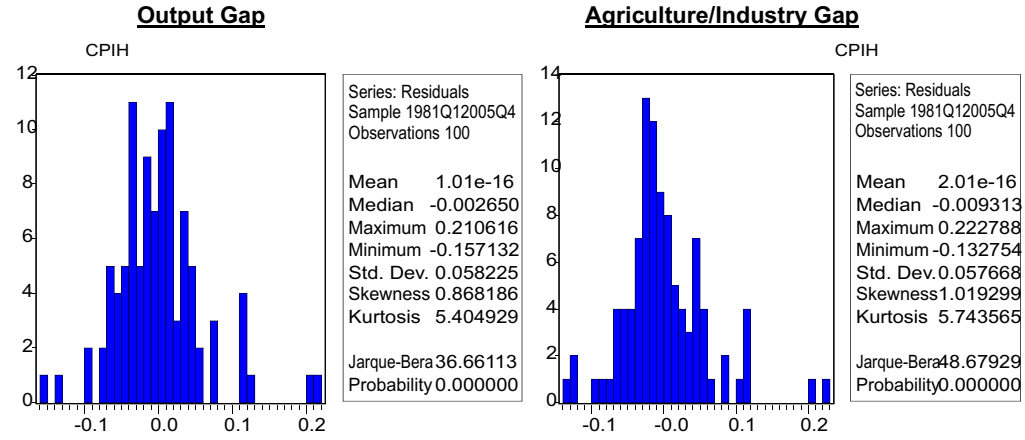
The diagnostic tests results are presented in Table 19, below. The Chow tests for the period 1988 in the different models are not significant. In other words, there is no structural break in the model between the period before 1988 and after. The test for serial correlation is significant for food inflation in the agric/industry gap model thus rejecting the null hypothesis of no serial correlation. Also, there are evidences of the presence of heteroskedasticity in all the models except for output gap models for headline and core inflation. The Jarque-Bera test rejects the null hypotheses of normality for all the models.

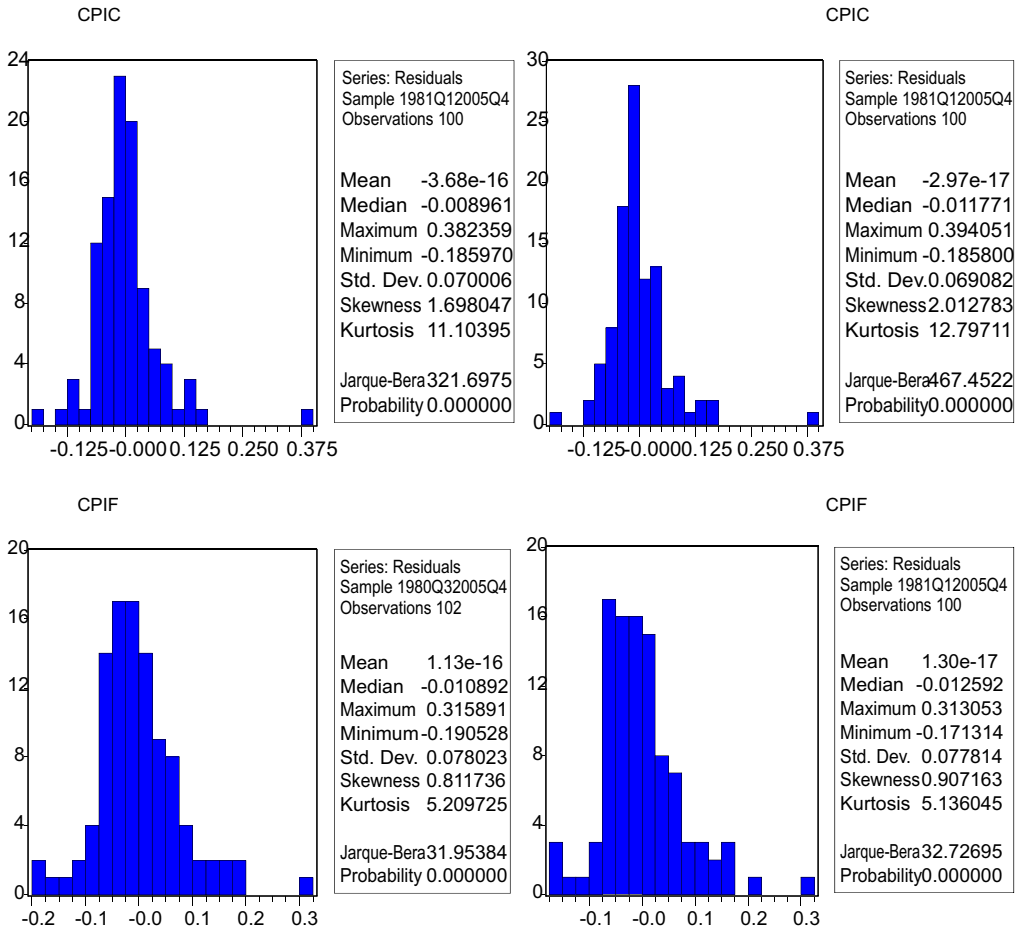
Table 19: Diagnostic Tests for the Phillips Curve Models

Model	Serial Correlation	ARCH	Chow Breakpoint	White Heteroskedasticity
Output Gap				
cpih	0.2107	0.3344	0.4151	0.0000
cpic	0.2860	0.4374	0.5523	0.0000
cpif	0.2268	0.0000	0.4573	0.0000
Agric/Industry Gap				
cpih	0.6083	0.0513	0.6069	0.0000
cpic	0.2239	0.0510	0.4873	0.0000
cpif	0.0000	0.0353	0.4476	0.0000

Notes:
1. Reported values are the probability values of the F-statistic of each test.
2. Serial Correlation was performed using the Breusch_Godfrey LM test, while the Engle LM test was used for the Autoregressive Conditional Heteroskedasticity (ARCH).

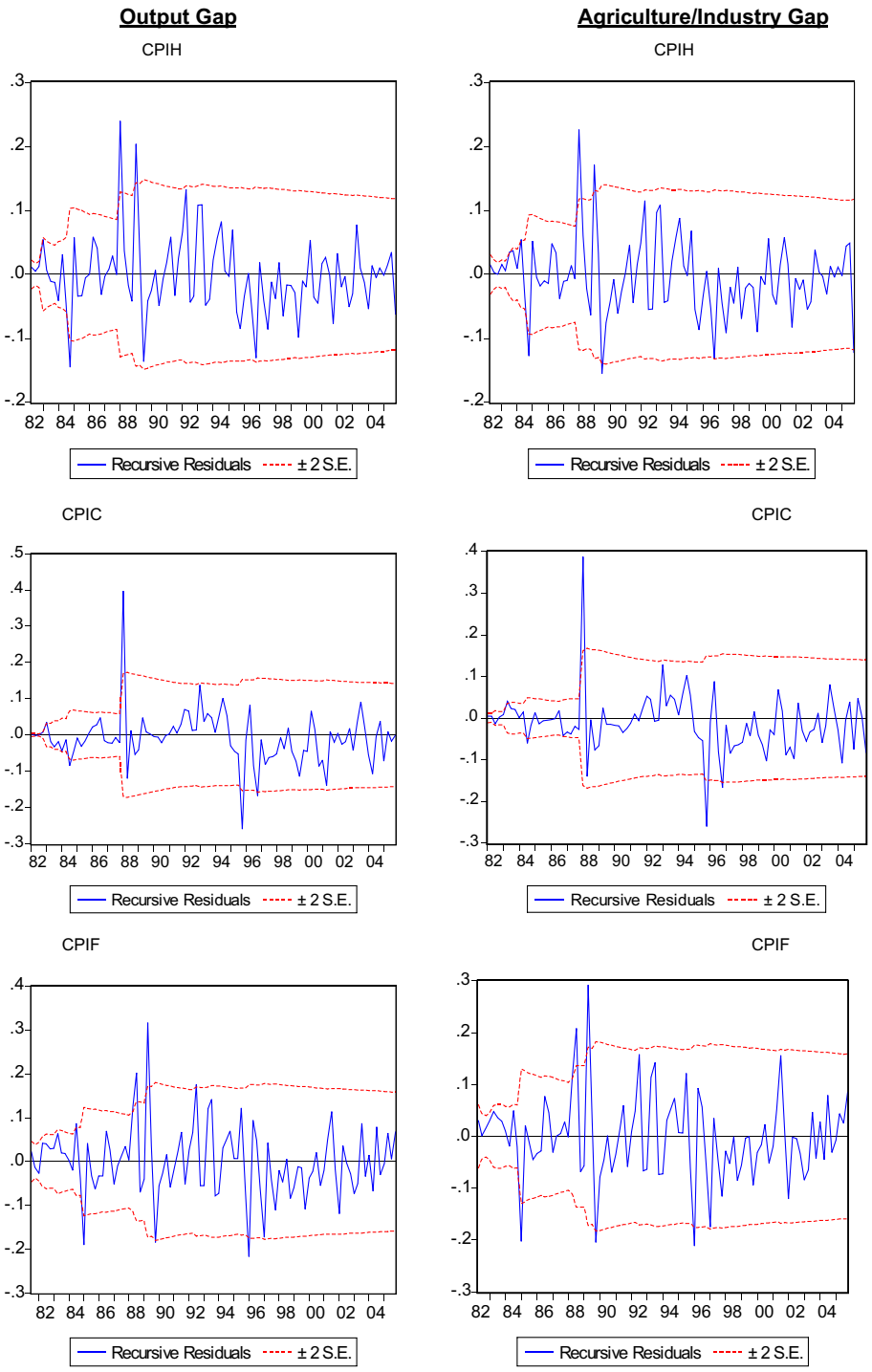
Figure 30: Histogram Normality Test for Residuals of the Phillips Curve Models





The graphs of the recursive residual estimates below show that the models are relatively unstable for all the measures of inflation, as the recursive residual plots cross the two standard error band several times.

Figure 31: Recursive Residual Test of Stability of the Phillips Curve Models



The forecast generated from the output gap models are presented below

Table 20: Forecast of the CPI from the Output Gap Models

	Actual	Forecasts			
	2006 Q1	2006 Q1	2006 Q2	2006 Q3	2006 Q4
Headline	151.3	145.76	155.15	176.78	169.02
Core	156.1	148.97	162.92	188.47	170.69
Food	147.6	149.79	153.74	159.61	168.06

Table 21: Forecast of the CPI from the Agriculture/Industry Output Gap Models

	Actual	Forecasts			
	2006 Q1	2006 Q1	2006 Q2	2006 Q3	2006 Q4
Headline	151.3	157.69	170.88	179.93	179.18
Core	156.1	163.89	176.71	184.77	183.12
Food	147.6	152.74	178.30	178.3	175.59

A cursory look at the forecast shows that the CPI peaks by the third quarter, before declining in the fourth quarter.

VI.5 In-Sample Performance of Inflation Forecast

In this section, we present the point and interval in-sample forecasts for headline, core, and food inflation, derived from the trend, ARIMA, Money Gap, ECM, and Output Gap models (Table 22). A combined (average) forecast from all the models (table 23) is also computed following the "thick model" approach with a view to minimizing the mean square forecast error.

Table 22: Forecasts of Headline, Core and Food Inflation[1]

Trend Model

	Point Forecast (%) In-Sample Forecasts for 2005				Point Forecast (%) 2006
	Q1	Q2	Q3	Q4	Q1
Headline	10.94	10.80	10.65	10.51	9.78
	(16.30)	(18.60)	(24.30)	(11.60)	(12.00)
Core	9.99	9.83	9.69	9.55	7.30
	(3.60)	(16.20)	(14.60)	(2.40)	(16.30)
Food	15.40	15.26	15.13	15.00	10.66
	(25.00)	(18.00)	(29.50)	(15.50)	(9.30)

	Interval Forecast (%) In-Sample Forecasts for 2005				Interval Forecast (%) 2006
	Q1	Q2	Q3	Q4	Q1
Headline	8.44 - 13.44	8.30 - 13.30	8.15 - 13.15	8.01 - 13.01	7.28 - 12.28
	(16.30)	(18.60)	(24.30)	(11.60)	(12.00)
Core	7.49 - 12.49	7.33 - 12.33	7.19 - 12.19	7.05 - 12.05	4.80 - 9.80
	(3.60)	(16.20)	(14.60)	(2.40)	(16.30)
Food	12.90 - 17.90	12.76 - 17.76	12.63 - 17.63	12.50 - 17.50	8.16 - 13.16
	(25.00)	(18.00)	(29.50)	(15.50)	(9.30)

ARIMA Model

	Point Forecast (%) In-Sample Forecasts for 2005				Point Forecast (%) 2006
	Q1	Q2	Q3	Q4	Q1
Headline	7.33	18.42	20.30	31.87	3.93
	(16.30)	(18.60)	(24.30)	(11.60)	(12.00)
Core	4.60	2.25	16.38	14.58	7.60
	(3.60)	(16.20)	(14.60)	(2.40)	(16.30)
Food	10.52	14.06	24.80	16.43	6.36
	(25.00)	(18.00)	(29.50)	(15.50)	(9.30)

	Interval Forecast (%) In-Sample Forecasts for 2005				Interval Forecast (%) 2006
	Q1	Q2	Q3	Q4	Q1
Headline	4.83 - 9.83	15.92 - 20.92	17.80 - 22.80	29.37 - 34.37	1.43 - 6.43
	(16.30)	(18.60)	(24.30)	(11.60)	(12.00)
Core	2.10 - 7.10	-0.25 - 4.75	13.88 - 18.88	12.08 - 17.08	5.10 - 10.10
	(3.60)	(16.20)	(14.60)	(2.40)	(16.30)
Food	8.02 - 13.02	11.56 - 16.56	22.30 - 27.30	13.93 - 18.93	3.86 - 8.86
	(25.00)	(18.00)	(29.50)	(15.50)	(9.30)

[1] *Values in parenthesis are actual inflation for the stated periods. Th e bias and variance proportions of the various forecasts are generally low. In the same vein, the Theil inequality statistic suggests acceptable fit for the forecast s.*

Table 22 contd…

Error Correction Model

	Point Forecast (%) In-Sample Forecasts for 2005				Point Forecast (%) 2006
	Q1	Q2	Q3	Q4	Q1
Headline	(16.30)	(18.60)	(24.30)	(11.60)	(12.00)
No Dummy	10.32	12.18	13.53	15.46	8.98
With Dummy	10.28	12.06	13.55	15.41	9.13
Core	(3.60)	(16.20)	(14.60)	(2.40)	(16.30)
No Dummy	7.90	5.04	19.93	16.51	7.53
With Dummy	7.91	5.20	19.32	16.71	8.15
Food	16.38	22.00	25.50	24.86	7.48
	(25.00)	(18.00)	(29.50)	(15.50)	(9.30)

	Interval Forecast (%) In-Sample Forecasts for 2005				Interval Forecast (%) 2006
	Q1	Q2	Q3	Q4	Q1
Headline	(16.30)	(18.60)	(24.30)	(11.60)	(12.00)
No Dummy	7.82 – 12.82	9.68 - 14.68	11.03 - 16.03	12.96 - 17.96	6.48 - 11.48
With Dummy	7.78 – 12.78	9.56 - 14.56	11.05 - 16.05	12.91 - 17.91	6.63 - 11.63
Core	(3.60)	(16.20)	(14.60)	(2.40)	(16.30)
No Dummy	5.40 – 10.40	2.54 - 7.54	17.43 - 22.43	14.01 - 19.01	5.03 - 10.03
With Dummy	5.41 – 10.41	2.70 - 7.70	16.82 - 21.82	14.21 - 19.21	5.65 - 10.65
Food	13.88 - 18.88	19.50 - 24.50	23.00 - 28.00	22.36 - 27.36	4.98 - 9.98
	(25.00)	(18.00)	(29.50)	(15.50)	(9.30)

Money Gap Model

	Point Forecast (%) In-Sample Forecasts for 2005				Point Forecast (%) 2006
	Q1	Q2	Q3	Q4	Q1
Headline	11.26	20.55	21.62	27.68	6.67
	(16.30)	(18.60)	(24.30)	(11.60)	(12.00)
Core	5.24	4.06	17.55	16.27	9.93
	(3.60)	(16.20)	(14.60)	(2.40)	(16.30)
Food	10.76	30.65	16.32	39.20	5.52
	(25.00)	(18.00)	(29.50)	(15.50)	(9.30)

	Interval Forecast (%) In-Sample Forecasts for 2005				Interval Forecast (%) 2006
	Q1	Q2	Q3	Q4	Q1
Headline	8.76 – 13.76	18.05 - 23.05	19.12 - 24.12	25.18 - 30.18	4.17 - 9.17
	(16.30)	(18.60)	(24.30)	(11.60)	(12.00)
Core	2.74 – 7.74	1.56 - 6.56	15.05 - 20.05	13.77 - 18.77	7.43 - 12.43
	(3.60)	(16.20)	(14.60)	(2.40)	(16.30)
Food	8.26 – 13.26	28.15 - 33.15	13.82 - 18.82	36.70 - 41.70	3.02 - 8.02
	(25.00)	(18.00)	(29.50)	(15.50)	(9.30)

Table 22 contd…

Output Gap Model

	Point Forecast (%) In-Sample Forecasts for 2005				Point Forecast (%) 2006
	Q1	Q2	Q3	Q4	Q1
Headline	10.32	18.45	19.31	18.86	7.97
	(16.30)	(18.60)	(24.30)	(11.60)	(12.00)
Core	6.00	3.70	16.15	6.57	11.01
	(3.60)	(16.20)	(14.60)	(2.40)	(16.30)
Food	11.55	25.86	15.16	32.43	10.87
	(25.00)	(18.00)	(29.50)	(15.50)	(9.30)

	Interval Forecast (%) In-Sample Forecasts for 2005				Interval Forecast (%) 2006
	Q1	Q2	Q3	Q4	Q1
Headline	7.82 - 12.82	15.95 – 20.95	16.81 - 21.81	16.36 - 21.36	5.47 - 10.47
	(16.30)	(18.60)	(24.30)	(11.60)	(12.00)
Core	3.50 - 8.50	1.20 - 6.20	13.65 - 18.65	4.07 - 9.07	8.51 - 13.51
	(3.60)	(16.20)	(14.60)	(2.40)	(16.30)
Food	9.05 - 14.05	23.36 – 28.36	12.66 - 17.66	29.93 - 34.93	8.37 - 13.37
	(25.00)	(18.00)	(29.50)	(15.50)	(9.30)

Agriculture and Industry Gap Model

	Point Forecast (%) In-Sample Forecasts for 2005				Point Forecast (%) 2006
	Q1	Q2	Q3	Q4	Q1
Headline	12.45	15.44	17.67	27.23	16.81
	(16.30)	(18.60)	(24.30)	(11.60)	(12.00)
Core	8.89	-0.11	13.73	15.83	22.12
	(3.60)	(16.20)	(14.60)	(2.40)	(16.30)
Food	12.98	30.02	14.42	30.18	13.21
	(25.00)	(18.00)	(29.50)	(15.50)	(9.30)

	Interval Forecast (%) In-Sample Forecasts for 2005				Interval Forecast (%) 2006
	Q1	Q2	Q3	Q4	Q1
Headline	9.95 - 14.95	12.94 – 17.94	15.17 - 20.17	24.73 - 29.73	14.31 - 19.31
	(16.30)	(18.60)	(24.30)	(11.60)	(12.00)
Core	6.39 - 11.39	-2.61 - 2.39	11.23 - 16.23	13.33 - 18.33	19.62 - 24.62
	(3.60)	(16.20)	(14.60)	(2.40)	(16.30)
Food	10.48 - 15.48	27.52 – 32.52	11.92 - 16.92	27.68 - 32.68	10.71 - 15.71
	(25.00)	(18.00)	(29.50)	(15.50)	(9.30)

The headline inflation in-sample forecast from the trend model indicates that the actual for both end period 2005 and first quarter 2006 of 11.6 and 12.0 per cent are within the estimated bands of 8.0-13.3 and 7.2-12.2 per cent, respectively. The result from the error correction model also shows close predictions for headline inflation as the forecasted bands for the fourth quarter 2005 and first quarter 2006 are 12.9-17.9 and 6.5-11.5 per cent, respectively, compared with actual of 11.6 and 12.0 per cent. The second quarter 2005 interval forecast from the ARIMA model contains the actual while the forecast for the third quarter is close to the actual for the period. The result from the money gap and Philips curve models is close only in predicting the 2006Q1 headline inflation.

The forecast of core inflation is generally weak in respect of 2005Q4, for all the models. This is not surprising as the actual core inflation of 2.4 in 2005 is a far cry from the actual of the last five years beginning from 2000. The quality of the data could have influenced the forecast result as the actual for 2006Q1 seems to be closer to the band, with an average maximum departure of not more than ±5.0 per cent as against the average of over ±10 per cent for 2005Q4.

The in-sample forecast for food inflation follows the pattern in core inflation as the forecast from the ecm, money gap and output gap models are not within the band for 2005Q4. Only the trend and ARIMA models predicted values for 2005Q4 are within the band. However, for 2006, the actual food inflation of 9.3 per cent is within the predicted band for all the models.

The results of the in-sample forecast are indicative of the fact that the different models could be useful for forecasting inflation in Nigeria. However, it is important to note that a model is at best a thinking tool. Judgment based on a proper understanding of current developments in the economy, which history cannot track is essential in obtaining realistic estimates.

In order to minimize errors associated with using a particular model the study adopts the method in Razzak (2002), which involves averaging the estimates (combined forecast) of all the different encompassing models. The use of the average of diverse models mitigates the adverse effect of uncertainties. Such model diversification spreads the risk of errors and provides greater robustness for policy. Consequently, policies that rely on more than one model are more robust and minimize the size of policy bias. When backed by strong empirical support for deriving the estimable equation and diagnostic tests, this is the best option. The results of this method in this exercise are discussed below.

Table 23: Average In-Sample Forecast from all Models

Forecast for Headline, Core and Food Inflation /1

	Point Forecast (%) In-Sample Forecasts for 2005				Point Forecast (%) 2006
	Q1	Q2	Q3	Q4	Q1
Headline /3	10.03	16.06	17.09	20.87	7.50
	(16.30)	(18.60)	(24.30)	(11.60)	(12.00)
Core /4	6.75	5.01	15.82	12.73	8.80
	(3.60)	(16.20)	(14.60)	(2.40)	(16.30)
Food	12.92	21.57	19.38	25.58	8.18
	(25.00)	(18.00)	(29.50)	(15.50)	(9.30)

	Interval Forecast (%) In-Sample Forecasts for 2005				Interval Forecast (%) 2006
	Q1	Q2	Q3	Q4	Q1
Headline /3	7.53 - 12.53	13.56 - 18.56	14.59 - 19.59	18.37 - 23.37	5.00 - 10.00
	(16.30)	(18.60)	(24.30)	(11.60)	(12.00)
Core /4	4.25 - 9.25	2.51 - 7.51	13.32 - 18.32	10.23 - 15.23	6.30 - 11.30
	(3.60)	(16.20)	(14.60)	(2.40)	(16.30)
Food	10.42 – 15.42	19.07 - 24.07	16.88 - 21.88	23.08 - 28.08	5.68 - 10.68
	(25.00)	(18.00)	(29.50)	(15.50)	(9.30)

/1 Point and Interval Forecasts are averages of forecasts from 5 models namely:
Trend, ARIMA, Error Correction (with dummy), Money Gap and Out put Gap Models.

Forecast for Headline, Core and Food Inflation /2

	Point Forecast (%) In-Sample Forecasts for 2005				Point Forecast (%) 2006
	Q1	Q2	Q3	Q4	Q1
Headline /3	10.45	15.45	16.76	22.54	9.26
	(16.30)	(18.60)	(24.30)	(11.60)	(12.00)
Core /4	7.32	4.25	15.33	14.59	11.02
	(3.60)	(16.20)	(14.60)	(2.40)	(16.30)
Food	13.21	22.40	19.23	25.13	8.65
	(25.00)	(18.00)	(29.50)	(15.50)	(9.30)

	Interval Forecast (%) In-Sample Forecasts for 2005				Interval Forecast (%) 2006
	Q1	Q2	Q3	Q4	Q1
Headline /3	7.95 - 12.95	12.95 - 17.95	14.26 - 19.26	20.04 - 25.04	6.76 - 11.76
	(16.30)	(18.60)	(24.30)	(11.60)	(12.00)
Core /4	4.82 - 9.82	1.75 - 6.75	12.83 - 17.83	12.09 - 17.09	8.52 - 13.52
	(3.60)	(16.20)	(14.60)	(2.40)	(16.30)
Food	10.71 - 15.71	19.90 - 24.90	16.73 - 21.73	22.63 - 27.63	6.15 - 11.15
	(25.00)	(18.00)	(29.50)	(15.50)	(9.30)

/2 Point and Interval Forecasts are averages of forecasts from 5 models namely:
Trend, ARIMA, Error Co rrection, Money Gap and Agriculture/Industry Gap Models.

VI.6 3-Quarter Ahead Inflation Forecasts

The average forecasts derived by combining the forecasts from the different models to generate the 3-quarter ahead forecasts for headline, core, and food inflation in 2006 is presented in table 24.

Headline, core and non-core inflation were projected to be 9.5, 13.8 and 11.8 per cent at the end of 2006, respectively. Furthermore, both headline and food inflation tends to decline by the third quarter before increasing towards the end of the year. This is consistent with observed trends of inflation in Nigeria, where good harvest dampens inflationary pressure and the end of year festive period raises food prices. The forecasts for core inflation show significant decline in inflation in the second quarter before an increase in the third and fourth quarters. This is also consistent with past trends. However, there are no discernible explanations for this observation.

Table 24: Average Point and Interval Inflation Forecast

	Point Forecast (%) 1/			
	2006			
	Q1	Q2	Q3	Q4
Headline /3	7.50	6.31	2.73	9.54
Core /4	8.80	6.95	9.76	13.87
Food	8.18	8.21	-1.08	11.87

	Interval Forecast (%) 1/			
	2006			
	Q1	Q2	Q3	Q4
Headline /3	5.00 - 10.00	3.81 - 8.81	0.23 - 5.23	7.04 - 12.04
Core /4	6.30 - 11.30	4.45 - 9.45	7.26 - 12.26	11.37 - 16.37
Food	5.68 - 10.68	5.71 - 10.71	-3.58 - 1.42	9.37 - 14.37

	Point Forecast (%) 2/			
	2006			
	Q1	Q2	Q3	Q4
Headline /3	9.26	8.52	3.14	10.95
Core /4	11.02	8.90	9.25	15.63
Food	8.65	10.51	1.29	12.91

	Interval Forecast (%) 2/			
	2006			
	Q1	Q2	Q3	Q4
Headline /3	6.76 – 11.76	6.02 - 11.02	0.64 - 5.64	8.45 - 13.45
Core /4	8.52 – 13.52	6.40 - 11.40	6.75 - 11.75	13.13 - 18.13
Food	6.15 – 11.15	8.01 - 13.01	-1.21 - 3.79	10.41 - 15.41

/1 Point and Interval Forecasts are averages of forecasts from 5 models namely: Trend, ARIMA, Error Correction (with dummy), Money Gap and Output Gap Models.

2/ Point and Interval Forecasts are averages of forecasts from 5 models namely: Trend, ARIMA, Error Correction, Money Gap and Agriculture/Industry Gap models.

VII. Summary, Conclusion and Recommendations

VII.1 Summary and Conclusion

The aim of this paper is to examine the dynamics of inflation in Nigeria and to develop suitable models, based on sound theoretical foundations that can be used to forecast its future path. The value of such models lies in providing a simple framework that analyzes and quantifies the short to long-term effect of macroeconomic variables that are major determinants of inflation. These variables and the forecasts ultimately generated are of interest for monetary policy formulation and implementation. Consequently, the outcome of the model is crucial in setting monetary policy targets and also for determining the optimal monetary policy that is consistent with such targets.

The models are empirical and highly disaggregated in nature and rest on several stylized facts about the behaviour of inflation in particular and the Nigerian economy in general, over the past 25 years. The estimated equations cover both the long-run steady state relationships and the short-run dynamics, incorporating error correction mechanisms, to ensure that departure from the long-run path is only transient and that a return to equilibrium is assured after a shock. The disaggregated nature of the models embodies the fact that inflation, for a country like Nigeria, has both non-core components, and core components which are driven by demand shocks.

The composition of the CPI basket is found to be skewed towards food as it constitutes 63.76 per cent, while the core component is 40.95 per cent. Thus, factors affecting food production are critical determinants of inflation in Nigeria. A decomposition of the CPI according to trend, seasonal factors, and irregular variations shows a strong trend for all types of inflation and a strong seasonal component for food inflation.

It is pertinent at this point to note that monetary policy in Nigeria is conducted in an environment characterized by uncertainty and frequent changes in economic policy. Also, the development of an adequate model for inflation is complicated by inconsistent policies and variations in environmental conditions either of a climatic nature or crises. This suggests that the use of multiple models is better for forecasting inflation.

In order to explain the dynamics of inflation and forecast its future path, the study explores several models, based on whether or not inflation arises from monetary or real variables, and also to mimic the observed time series nature of inflation. Further, due to the fact that no model, however complex, captures all the major structural characteristics affecting the underlying inflationary process, the "thick model" approach is adopted to pool all models to generate inflation forecasts with a view to

minimizing the mean square forecast error. From the results, the following can be deduced:

- Trend has a significant positive relationship with core and headline inflation, while food inflation shows significant seasonal variations. The significant seasonal component exhibited by food inflation confirms that it responds mostly to the predictable conditions of weather, which influences farm produce.

- Inflation inertia is prevalent and persistent. Thus, there is a backward looking behaviour by economic agents in setting future prices. This often has a snow balling effect, as it tends to induce undue pressure. For instance, when producers expect inflation, they raise their prices and inflation tends to rise and producers keep raising their prices, as evidenced from the lag effect.

- Analysis of the short-run error correction model reveals that a one per cent change in the money stock induces about 0.25 per cent and 0.32 per cent change in the rate of headline and food inflation, respectively, after a quarter. Consequently, a one per cent decline in the rate of headline and food inflation may require the growth in money stock to decelerate by 4.0 per cent and 3.2 per cent, respectively, over a quarter. The analysis shows that money does not affect core inflation in the short-run. In the long-run, however, changes in the stock of money affect core inflation significantly. A one per cent change in the money supply would, after one year, change core inflation by 0.42 per cent indicating that monetary aggregates affect core inflation, significantly, only in the long-run. The effect of money on headline inflation increases in the long-run, peaking at 0.32 per cent after one year, while food inflation is less responsive to the money stock in the long-run than in the short-run.

- The money gap model indicates that it would take between one and two quarters for the money gap to impact significantly on inflation. Headline and food inflation rates respond significantly to changes in the money gap with coefficients of 0.32 and 0.33, respectively. However, contrary to the result in the error correction model, the coefficient of core inflation at 0.17 is significant. Thus, a one per cent decline in the rate of headline, core and food inflation, respectively, would require a reduction in the money gap by about 3.2, 5.9, and 3.0 per cent.

- Other key variables to consider when designing policies aimed at controlling inflation are: the exchange rate and the level of output. From the analysis of the various models, a one per cent depreciation of the exchange rate would take about three months to induce, on the average, about 0.07 per cent increase in the rate of inflation. This indicates that a one per cent decline in inflation would

require about 13.0 per cent exchange rate appreciation in three months. In the long-run, however, the exchange rate affects inflation more significantly with a one per cent depreciation inducing about 0.32 per cent increase in the rate of inflation. The long-run pass through is, therefore, higher than the short-run pass through.

- The level of output in the economy, as indicated in the analysis affects both the headline and the core inflation rates, significantly. Food inflation responds less significantly to changes in the output level. Further analysis of the short-run model and the output gap model reveal that changes in real output and the output gap have a somewhat similar impact on the inflation rate. A one per cent increase in the level of output and the output gap would cause headline inflation to fall by about 0.41 per cent and 0.37 per cent, respectively. In the same vein, it would induce about 0.31 per cent and 0.44 per cent decline, respectively, in core inflation. These impacts would take a lag of about nine months. Thus, it would require about 2.4 per cent increase in output and 3.2 per cent narrowing of the output gap to lower headline inflation by one per cent over a period of nine months. The analysis further reveals that output gap influences core inflation more than headline inflation, while changes in real output explain headline inflation better than core inflation. Although food inflation does not respond significantly to changes in total output, it, however, responds significantly to changes in agricultural output in the long-run.

Overall, policy issues that can be drawn from the results include the following:

- It is evident that monetary policy affects the price level with a lag. Indeed, it takes on the average two quarters for key monetary variables, e.g. changes in the money stock, interest rate and exchange rate to impact on domestic prices. Monetary policy should, therefore, be designed in line with the expected magnitude of these changes. While headline and food inflation can be tracked by changes in the money stock in the short-run, policies targeted at core inflation, in the short-run may necessarily have to consider other monetary aggregates or the money gap as a policy variable. This is because monetary aggregates such as money supply and base money are not significant in the short-run in explaining core inflation. This raises the concern of whether the use of these monetary aggregates as intermediate monetary targets for core inflation should be continued. Consequently, the call to target core inflation may be misplaced as monetary factors indeed have significant effect on headline and food inflation.

- The Phillips curve model performs well in explaining and forecasting inflation and is best in its disaggregated form. However, this result is robust only in explaining the behaviour of headline and core inflation. It is not significant in

explaining food inflation, even in its disaggregated form. Thus, in the design of policies for the deceleration of overall rate of inflation and core inflation rate, real variables need to be closely considered.

- The evolution of exchange rate is not very important in explaining inflation. This is evident by the low degree of pass through that is recorded for all types of inflation. Thus, rapid disinflation may be less responsive to exchange rate stabilization policy in the short-run.

- The in-sample forecasts are satisfactory and indicate that the average of the encompassing models can be used to track inflation today and in the future.

VII.2 Concluding Remarks

- There is the need to take cognizance of the lag effect in the design of monetary policy in order to ensure that policy targets are effectively monitored. In particular, monetary policy needs to be more forward looking to achieve price stability.

- Developments in monetary aggregates still provide important information about future inflation, however, the type of aggregates used need to be re-examined. Even when the Bank finally adopts inflation targeting, information about future inflationary development can still be gleaned from them.

- Headline inflation, which is well understood by the public, affects households instantly and should continue to be used as a measure of inflation. The use of underlying inflation, which core inflation represents, may not be adequate except its definition takes care of other variable components of the CPI basket, such as energy[7].

- In order to offset biases, reduce forecast error variances, and minimise policy errors, the average of all forecasts derived from the different well-specified models are preferable for deriving inflation forecast.

- The quality of data is important for modeling. There is need to continuously improve on the quality of data generated, particularly now that the country is in the process of adopting inflation targeting framework for the conduct of monetary policy.

[7] *This was not done in this study considering the short time period for which data on core less food and energy were available.*

VIII. Direction for Future Work

The need for a robust inflation forecasting model cannot be over-emphasized. However, what has been documented in this study is a good starting point from where an improved model can be developed. Some of the challenges of this study are, therefore, pointers to the direction for future work. These are listed below.

- Re-identify the ARIMA model to explore the possibility of deriving improved forecast.

- Estimate a VAR to be able to capture impulse responses, though it may not yield values that would guide the setting of specific targets.

- Estimate a p-star (p^*) model for inflation

- Acquire appropriate software that would aid the solving and automation of models.

- Automate the model to ease the implementation of dynamic simulations, which would generate the response of the variables in the model to changes in monetary policy and a range of shocks.

In conclusion, the study notes that no central bank the world over uses a single model to forecast/project inflation in the conduct of monetary policy. Indeed, the norm is to use the outcomes of a suite of models and then complement these with expert judgment and expert forecasts. This approach generally tends to perform better and tends to be more reliable and intuitively appealing than what is obtainable from a single model; hence, this approach is recommended for the Central Bank of Nigeria.

Bibliography

Adamson, Y. K. (2000). "Structural Disequilibrium and Inflation in Nigeria: A Theoretical and Empirical Analysis". Center for Economic Research on Africa. New Jersey 07043: Montclair State University, Upper Montclair.

Agénor, P. (2000). "Monetary Policy under Flexible Exchange Rates: An Introduction to Inflation Targeting". Washington DC 20433: The World Bank, November.

Agénor, P. and Hoffmaister, A. W. (1997). "Money, Wages and Inflation in Middle-Income Developing Countries". *IMF Working Paper: WP/97/174.*

Alesina, A. and Summers, L. H. (1993). "Central Bank Independence and Macroeconomic Performance: Some Comparative Evidence". *Journal of Money, Credit and Banking*, Volume 25, Number 2, May.

Amato, J. D. and Gerlach, S. (2001). "Modeling the Transmission Mechanism of Monetary Policy in Emerging Market Countries Using Prior Information". *Bank for International Settlements (BIS) Paper* Number 8, November.

Aron, J. and Muellbauer, J. (2000). "Inflation and Output Forecasting for South Africa: Monetary Transmission Implications". Centre for the Study of African Economies, *CSAE Working Paper Series,* 2000-23, December.

Aron, J., Muellbauer, J. N. and Pretorius, C. (2004). "A Framework for Forecasting the Components of the Consumer Price Index: Application to South Africa". Centre for the Study of African Economies, *CSAE Working Paper Series,* 2004-07, March.

Aron, J., Muellbauer, J. N. J. and Smit, B. W. (2004). "A Structural Model of the Inflation Process in South Africa". Centre for the Study of African Economies, *CSAE Working Paper Series* 2004-08, March.

Asogu, J.O. (1991). "An Econometric Analysis of the Nature and Causes of Inflation in Nigeria". *Central Bank of Nigeria Economic and Financial Review*, Volume 29, Number 3.

Atta-Mensah, J., and Bawumia, M. (2003). "A Simple Vector Error Correction Forecasting Model for Ghana". *Bank of Ghana Working Paper:* WP/BOG-2003/01, February.

Bailliu, J., Garcés, D., Kruger, M. and Messmacher, M. (2002). "Explaining and

Forecasting Inflation in Emerging Markets: the Case of Mexico". The Bank of Canada and the Banco de Mexico, October.

Batini, N. (2004). "Achieving and Maintaining Price Stability in Nigeria". *IMF Working Paper*: WP/04/97, Research Department, June.

Baumgartner, J., Ramaswamy, R. and Zettergren, G. (1997). "Monetary Policy and Leading Indicators of Inflation in Sweden". *IMF Working Paper:* WP/97/34, European I Department, April.

Beechey, M. et al (2000). "A Small Model of the Australian Macroeconomy". *Reserve Bank of Australia Research Discussion Paper,* 2000-05, Economic Research Department, June.

Bjornland, H. C., Brubakk, L. and Jore, A. S. (2006). "Forecasting Inflation with an Uncertain Output Gap". *Norges Bank Working* Paper, ANO 2006/2, Economics Department, March.

Callen, T. and Chang, D. (1999). "Modeling and Forecasting Inflation in India". *IMF Working Paper*: WP/99/119, Asia and Pacific Department, September.

Colander, D. C. (1995). Macroeconomics. Second Edition. United States of America: Richard D. Irwin, Inc.

Colander, D. C. (2001). Economics. Fourth Edition. New York: Irwin/McGraw-Hill.

Cottarelli, C., Griffiths, M. and Moghadam, R. (1998). "The Non-monetary Determinants of Inflation: a Panel Data Study". *IMF Working Paper,* WP/98/23, European Department, March.

Cukierman, A., Webb, S. B. and Neyapti, B. (1992). "Measuring the Independence of Central Banks and its Effect on Policy Outcomes". *The World Bank Economic Review*, Volume 6, Number 3.

De Brouwer, G. and Ericsson, N. R. (1995). "Modeling Inflation in Australia". Reserve Bank of Australia *Research Discussion Paper 9510,* Economic Analysis and Economic Research Departments, November.

Debelle, G. and Fischer, S. (1994). "How Independent Should a Central Bank Be?". Fuhrer, J. C. (Eds.). In Goals, Guidelines, and Constraints Facing Monetary Policymakers, *Proceedings of a Conference* held at North Falmouth, Massachusetts, Conference Series No. 38 (Boston, Massachusetts: Federal Reserve Bank of Boston), June.

Dickman, A. (2001). "Inflation Targeting in Australia: Policy Framework, Implementation and Experience". Paper presented at t*he 14th Pacific Basin Central Bank Conference.*

Dornbusch, R., Fisher, S. and Kearney, C. (1996). Macroeconomic. Sydney: The McGraw-Hill Companies, Inc.

Dufour, J. D., Khalaf, L. and Kichian, M. (2005). "Inflation Dynamics and the New Keynesian Phillips Curve: an Identification Robust Econometric Analysis". Université de Montréal, Département de Sciences Économiques, 2005-17, August.

Duravell, D. and Ndung'u, N. S. (1999). "A Dynamic Model of Inflation for Kenya, 1974-1996". *IMF Working Paper,* WP/99/97, Research Department, July.

Engle, R. F. and Granger, C. W. J. (1987). "Cointegration and Error Correction: Representation, Estimation and Testing". *Econometrica*, Volume 55, Number 2, pp. 251 76, March.

Essien, E. A. (2002). "Identifying the Trend of Core Inflation in Nigeria". *Central Bank of Nigeria Economic and Financial Review*, Volume 40, Number 2, June.

Essien, E. A. (2005). "Exchange Rate Pass-Through to Inflation in Nigeria". *West African Journal of Monetary and Economic Integration* (First Half), Volume 5, Number 1, Accra: West African Monetary Institute.

Fakiyesi, O.M. (1996). "Further Empirical Analysis of Inflation in Nigeria". *Central Bank of Nigeria Economic and Financial Review*, Volume 34, Number 1, March.

Fisher, I. (1930). The Theory of Interest. New York: Macmillan.

Fisher, J. D. M. (2000). "Forecasting Inflation with a Lot of Data". The Federal Reserve Bank of Chicago, *Chicago Fed Letter*, Number 151, March.

Folorunso, B. A. and Abiola, A. G. (2000). "The long-Run Determinants of Inflation in Nigeria (1970-1998)". *Nigerian Journal of Economic and Social Studies*, Volume 42, Number 1, Ibadan: Nigerian Economic Society.

Fuhrer, J. C. (1995). "The Phillips Curve is Alive and Well". *New England Review*, March April.

Gokal, V. and Hanif, S. (2004)."Relationship between Inflation and Economic Growth". *Reserve Bank of Fiji Working Paper,* Number 4, Economics Department, December.

Goodfriend, M. (2000). "*Maintaining Low Inflation: Rationale and Reality*". (www.imf.org/external/pubs/ft/seminar/2000/targets/strach2.pdf).

Gordon, J.P. (2002). Macroeconomics. Addison Wesley, ISBN 0201770369

Grilli, V., Masciandaro, D. and Tabellini, G. (1991). "Political and Monetary Institutions and Public Financial Policies in the Industrial Countries". *Economic Policy*, Number 13, pp. 341-92.

Gujarati, D. N. (1995). Basic Econometrics, Third Edition. Economic Series. Singapore: McGraw-Hill International Editions.

Hamilton, A. (2001). "Exploding Inflation". *Zeal Intelligence*.

Hornok, C. and Jabak, Z. M. (2002). "Forecasting Inflation: a Case Study of the Czech, Hungarian, Polish, Slovakian and Slovenian Central banks". *NBH Background Studies:* 2002/2, July.

Jhingan, M. L. (2002). Monetary Economics, 5th Revised and Enlarged, Edition; Delhi: Vrinda Publications (P) Ltd.

Khan, M. S. and Schimmelpfennig, A. (2006). "Inflation in Pakistan: Money or Wheat?". *IMF Working Paper, WP/06/60,* Middle East and Central Asia Department, March.

Kuijs, L. (1998). "Determinants of Inflation, Exchange Rate and Output in Nigeria". *IMF Working Paper,* WP/98/160, African Department, November.

Leigh, D. (2005). "Estimating the Implicit Inflation Target: an Application to U. S. Monetary Policy". *IMF Working Paper,* WP/05/77, European Department, April.

Lim, C. H. and Papi, L. (1997). "An Econometric Analysis of the Determinants of Inflation in Turkey", *IMF Working Paper,* WP/97170, European I Department, December.

Longworth, D. (2000). "The Canadian Monetary Transmission Mechanism and Inflation Projections". (www.imf.org/external/pubs/ft/seminar/2000/targets/strach1.pdf).

Masha, I. (2000). "New Perspective on Inflation in Nigeria". *Central Bank of Nigeria Economic and Financial Review*, Volume 38, Number 2, June.

Melberg, H. O. (1992). "Inflation: an Overview of Theories and Solutions". (www.geocities.com/hmelberg/papers/921201.htm).

Mohanty, M. S. and Klau, M. (2001). "*What Determines Inflation in Emerging Market Economies*?". (www.bis.org/publ/bispap08a.pdf.).

Moser, G. (1995). "Money Demand in Nigeria: 1970 1994". Appendix II in Nigeria: Experience with Structural Adjustment, *IMF Occasional Paper* Number 148, by Gary Moser, Scott Rogers and Reinhold van Til (Washington: International Monetary Fund), pp. 55 - 62.

Ndaferankhande, M. D., and Ndhlovu, T. M. (2005). "Inflationary experiences in Malawi: An Investigation of the Underlying Determinants (1980.1 2002.4)".A text of paper presented at the African Economic Research Consortium (AERC), Nairobi, Kenya, February.

Nnanna, O. J. (2002). "Monetary Policy and Exchange Rate Stability in Nigeria". *Central Bank of Nigeria Economic and Financial Review.* Volume 40, Number 3, pp. 1- 4, September.

Odusola, A. F and Akinlo, A. E. (2001). "Output, Inflation, and Exchange Rate in Developing Countries: An Application to Nigeria". *The Developing Economies*, June.

Ojo, M. O. (2000). "The Role of the Autonomy of the Central Bank of Nigeria (CBN) In Promoting Macroeconomic Stability". *Central Bank of Nigeria Economic and Financial Review*, Volume 38, Number 1, March.

Olofin, S. (2001). An Introduction to Macroeconomics. Malthouse Social Science Series, Lagos: Malthouse Press Limited.

Palley, T. I. (2004). From Keynesianism to Neoliberalism: Shifting Paradigms in Economics, in The Intellectual Foundations of Neoliberalism Foreign Policy in Focus (FPIF), May.

Phillips, A. W. (1958). "The Relation between Unemployment and Rate of Change in Money Wage Rates in the United Kingdom". *Economica* 25, November.

Piana, V (2001). Inflation Economics. Web Institute.

Pollard, P. S. (1993). "Central Bank Independence and Economic Performance". *Federal Reserve Bank of St. Louis Economic Review*, July-August.

Posen, A. (1993). "Why Central Bank Independence does not Cause Low Inflation: There is no Institutional Fix for Politics". in R. O'Brien (ed.), *Finance and the International Economy*, volume 7, Oxford: OUP.

Razzak, W. A. (2002). "Monetary Policy and Forecasting Inflation with and without the Output Gap" Reserve Bank of New Zealand, Discussion Paper Series (DP2002/03), March.

Ross, K. (1998). "Post Stabilization Inflation Dynamics in Slovenia". *IMF Working Paper*, WP/98/27, European I Department, March.

Rudd, J. and Whelan, K. (2005). "Modeling Inflation Dynamics: A Critical Review of Recent Research". *Central Bank & Financial Services Authority of Ireland Research Technical Paper*: 7/RT/05, Economic Analysis and Research Department, November.

Stock, J. H and Watson, M. W. (1999). "Forecasting Inflation", National Bureau of Economic Research *NBER Working Paper Series,* Working Paper 7023, March.

Stock J. H. and Watson, M. W. (2000). "Diffusion and Indexes". Princeton University working papers.

Sun, T. (2004). "Forecasting Thailand's Core Inflation". *IMF Working Paper,* WP/04/90, Asia and Pacific Department, May.

Svensson, L. E. O. (1996). Inflation Forecasting Targeting: Implementing and Monitoring Inflation Targets. Institute for International Economic Studies, Stockholm University.

Thomas, P. (2006). "*Does the US have a Handle on Inflation*?", Street Insight.

Ubide, A. (1997). "Determinants of Inflation in Mozambique". *IMF Working Paper,* WP/97/145, African Department, October.

Vegh, C. (1992). "Stopping High Inflation: an Analytical Overview". *IMF Staff Paper* 39.

Williams, O. and Adedeji, O. S. (2004). "Inflation Dynamics in the Dominican Republic". *IMF Working Paper*, WP/04/29, Western Hemisphere

Department: Washington, D. C., February.

Woglom, G. (2005). "Forecasting South African Inflation". In Richard S. Volpert '56 (eds.) Professor of Economics, Amherst College.

Appendix: Glossary and Data

Glossary

All variables are expressed in natural logs except for prime lending rate and the *GAP* and *M2GAP* variables.

CPIH Headline consumer price index for Nigeria. It is the composite price index comprising both urban and rural price indexes

CPIC Core component (all items less farm produce) of the composite consumer price index

CPIF Non-core component (food) of the composite consumer price index

M2 Broad money supply or money stock

BM Base money

PLR Prime lending rate

IER Index of exchange rate

FPR Foreign price

GEX Government expenditure

RGDP Gross domestic product at 1990 constant basic prices

GDPF Agriculture component (less contribution of forestry) of RGDP

GAP Output gap measured as the difference between actual output and potential output

M2GAP Money gap measured as the difference between actual money stock and potential money stock

DUM88 Dummy variable used to capture irregular event of 1988 in the decomposed CPI series.

Definitions

CPI
It is the composite consumer price index of the rural and urban price indexes. It can be decomposed as core and non-core consumer price indexes.

Headline Inflation
It is the annualized (year-on-year) inflation rate computed using the CPI. It is computed for each quarter as the growth rate over the corresponding quarter of the preceding year.

Core Inflation
Its computation is based on the core component (all items less farm produce and energy) of the composite CPI. In this paper, however, core inflation is derived from core CPI defined as "all items less farm produce". The quarterly series is derived as the growth rate of the present quarter over the corresponding quarter of the preceding year.

Non-core Inflation
Its computation is based on the food component of the composite CPI. The quarterly series is derived from the food CPI as the growth rate of the present quarter over the corresponding quarter of the preceding year.

Real GDP
It is the gross domestic product at constant basic prices. In this paper, it is defined as the value of productions that took place in the Nigerian economy within a quarter at 1990 basic prices.

GDP Food
It is the gross domestic product of agriculture (crop production, livestock and fishing only) at 1990 basic prices.

Interest Rate
Prime lending rate is used as a proxy for the money market interest rates. The prime lending rate is the interest rate which banks charge on loans and advances to high net-worth and credit worthy customers.

Nominal Exchange Rate
It is the quarterly average price of the US dollar in terms of the naira.

Foreign Consumer Price
The consumer price index (2000 = 100) of the United States of America (USA) is used as a proxy for the foreign consumer price.

Potential Output
Potential (natural) output is the optimal level of production that an economy can attain without overheating the system.

Output Gap
It is the difference between the economy's actual output and its potential output. The gap is positive when actual output exceeds the economy's potential and vice versa.

Potential Money Stock
It is the optimal level of money stock that can support the existing labour, capital, and technology without putting sustained upward pressure on inflation.

Money Gap
It is a measure of the difference between actual money stock and potential money stock. Alternatively, it is given by the difference between money supply and money demand.

Lag
A lag is the amount of time it takes for a variable to respond to changes in its explanatory variables (factors).

AR Model
The auto-regressive (AR) model is that which uses the lagged values of the dependent variable (as independent variables) to forecast its current values.

MA Model
The moving average (MA) model is that which uses the lagged values of the forecast error to improve the forecast of the dependent variable.

ARMA Model
The auto-regressive moving average (ARMA) model uses both the lagged values of the dependent variable and the forecast error to improve the forecast of a stationary dependent variable. It is the combination of both the AR and MA terms in a model.

ARIMA Model
The auto-regressive integrated moving average (ARIMA) model is derived when the time series variable in the ARMA model is differenced to attain stationarity.

Stationary Series
A time series variable, X_t, is stationary if the underlying stochastic process that generated that series is invariant with respect to time.

Unit Root
The presence of a unit root in a time series indicates that the series is not stationary. This can be determined by using the Augmented Dickey-Fuller (ADF) test of unit root. If there is a unit root, i.e., when the series is not stationary at level, the series can be made stationary by differencing.

Order of Integration
The order of integration denoted by I(d) (d = 0, 1, 2, …) is the number of times a time series variable is differenced before it becomes stationary. At current period, when d = 0, the series is said to be I(0) and stationary at level. At a one lag period, when d = 1, the series is said to be I(1) and stationary at first difference; and when d = 2, it becomes I(2) and stationary at second difference.

Cointegration
This occurs when two or more time series variables, which themselves may be non-stationary, drift together at roughly the same time. This implies that a linear combination of the variable is stationary.

Dummy Variable
It is a qualitative variable used in capturing nominal scale data. A dummy variable takes the value one for some observation to indicate the presence of an effect or membership in a group and zero for the remaining observations. Alternative names of dummy variables are indicator variables, binary variables, categorical variables, qualitative variables and dichotomous variables.

Short-Run
The short-run is a period too brief to change the quantity of all input (independent) variables; at least one is fixed while the other input variables can be varied. In the model: $\mathbf{Y_t = \alpha + \beta_0 X_t + \beta_1 X_{t-1} + \beta_2 X_{t-2} + \ldots + \beta_k X_t + \upsilon_t}$, the short-run is before k periods, whereby at least one independent variable is fixed while the others can be varied.

Long-Run
The long-run is a period long enough to vary the quantity of all input (independent) variables. In the model: $\mathbf{Y_t = \alpha + \beta_0 X_t + \beta_1 X_{t-1} + \beta_2 X_{t-2} + \ldots + \beta_k X_{t-k} + \upsilon_t}$, the long-run is after k periods, whereby all independent variables X_{t-i} (i = 0, 1, …. , k) can be varied.

Dynamic
An econometric model is dynamic if it includes one or more lagged (past) values of the dependent variable among its explanatory variables. In other words, an autoregressive model is a dynamic econometric model.

Static
An econometric model is static if it does not include lagged (past) values of the dependent variable among its explanatory variables.

ECM

Error correction mechanism is the residual of a long-run model used in tying the short-run behaviour of the dependent variable to its long-run value. It is the speed of adjustment (on quarterly basis) that returns the system to equilibrium in the short-run after a distortion.

Data

The various data series used for the estimation and forecasting of the models were those officially available as at end-2005. Data coverage, on quarterly basis, spanned 1981Q1 to 2005Q4. Quarterly series on gross domestic product (RGDP and GDPF) and government expenditure (GEX) were derived through a process of disaggregation of the annual data series.

CENTRAL BANK OF NIGERIA