CENTRAL BANK OF NIGERIA

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TABLE OF CONTENTS

Pages

List of Figures

LIST OF TABLES

Executive Summary

The provisions of the CBN Act 2007 show that the primary objectives of monetary policy remain the maintenance of monetary and price stability, robust currency and foreign exchange management, sound financial system; among others. The Bank started exchange rate targeting monetary policy framework in 1959 and shifted to monetary targeting since 1974. It also changed from direct to indirect monetary management in 1993. New monetary policy operational framework was introduced with interest rate corridor in December 2006, using monetary policy rate (MPR) as an anchor rate. Since 2009, it is clear that the performance of monetary policy has improved tremendously. Recently, significant modeling efforts have improved monetary policy simulation and analysis using tools such as structural time series models for short-term inflation forecasting, models for sectoral analysis, macroeconometric model of the Nigerian economy for policy analysis and dynamic stochastic general equilibrium model for forecasting. Despite this achievement, there is need to strengthen tools of policy analysis to improve on the overall macroeconomic stability required to promote sustainable economic development.

It has been suggested in the literature that standard VAR analysis of monetary policy should be conditioned on richer information sets without missing the statistical advantages of restricting the analysis to a small number of series. In this case, it is recommended that the natural solution to the problem of degree-of-freedom in VAR analysis is to augment the standard VARs with estimated factors, leading to the adoption of factor-augmented VARs (FAVARs) in assessing the effects of monetary policy on macroeconomic variables. Besides, the FAVAR approach gives high flexibility in identifying monetary policy innovations, while it also outperforms the standard VARs on the analysis of the effects of monetary policy. This model makes it possible to capture a large number of information on time series by a comparatively small number of probable factors. In employing the FAVAR framework, two sets of large data consisting of 162 monthly and 54 quarterly series of each of the 84 macroeconomic variables over the period of 2000:01 and 2013:06 were used. The data set comprises 36 fast moving and 48 slow moving variables.

The study examined the impacts of monetary policy shocks on key macroeconomic variables using large dataset available to the Central Bank of Nigeria (CBN). In a bid to increase the suite of models already built in the Bank, coupled with large data set available, we deemed it appropriate to build factor

augmented VARs (FAVARs) model. More importantly, it could be observed that few empirical works have been done using FAVAR in the African context, while there is none in Nigeria. This is considered a knowledge gap which this study intends to fill.

The study is structured as follows. Following the introduction, Section 2 provides the literature review, while section 3 focuses on the stylized facts of monetary policy in Nigeria. The methodology, covering the data description, model specification and techniques of analysis is discussed in Section 4. Section 5 discusses empirical results while section 6 presents summary, policy recommendations and conclusion.

From the empirical findings, the principal component analysis showed that the first three principal components, extracted from the full set of 83 macroeconomic variables, jointly accounted for about 45.2% of the variation in the data space. The first principal component (PC1) consisted mainly of output and price variables, while the second principal component (PC2) comprises mainly financial, output and price variables. The third principal component (PC3), on the other hand, comprised mainly money, credit and real sector variables. In addition, the correlation coefficients revealed that communications, social and personal services output, transport output, and maximum lending rate were dominant in PC1, while education CPI, urban CPI and other general bank loans were the most important variables in PC2. The PC3 was mainly accounted for by bank loans to the less preferred sectors, quasi money and total deposits of banks. The implication of this categorization suggested three main pressures, namely real output and prices; interest rates and monetary aggregates.

The response of price variables to a positive monetary policy shock indicated expected behaviour of a fall, while some showed puzzle. All items less farm produce, clothing and footwear, transport, communication and education CPI were in line with theoretical expectation. However, headline consumer price index (HCPI), alcoholic, beverage, tobacco and kola (ABCPI), food and non-alcoholic beverage consumer price index (FNCPI) and food consumer price index (FCPI) showed evidence of puzzle, albeit different degrees. This implied that all items less farm produce was more responsive to monetary policy shocks than all items CPI. In line with theoretical expectation, monetary policy shock impacts positively on money market variables such as interbank and maximum lending rates. Credit to the private sector, on the other hand, responded positively to a shock in the monetary policy rate, suggesting that credit market in Nigeria is supply-driven. The responses of the real sector variables to a positive innovation in monetary policy rate (MPR) in the Nigerian economy are mixed. A

shock to the policy rate induced [1]considerable decline in agriculture, industry, solid mineral, manufacturing, building and construction and the wholesale and retail trade sectors after two months lag, albeit at varying degrees.

A shock to the cash reserve ratio (CRR) led to a steady decline in headline inflation up to the 4th quarter. The implication of the results was that actions on the CRR lingered beyond 4 cycles of the monetary policy committee meetings. The general response of both the interbank and prime lending rates to a shock in the CRR seemed to be an increase, although, with a temporary initial decline. The exchange rates of the Naira to British Pound and the Euro appreciated in response to a shock to CRR. This suggested that headline inflation responds better to a shock in the CRR than in the MPR.

Innovations to exchange rate caused headline inflation to rise sharply and almost instantaneously attaining the highest level around the fifth quarter. Thereafter, the trend reversed, declining gradually to the steady state. This suggests strong correlation between exchange rate and domestic prices in Nigeria. The result supports the existence of exchange rate pass-through to inflation in Nigeria which implies that exchange rate policy may be a very potent policy instrument with which to address inflation concerns in Nigeria. The response of external reserves to unexpected exchange rate shocks was positive and instantaneous.

In the light of these findings, the study recommends, among others that:

i. *In order to compliment the use of MPR, emphasis should be placed on the use of CRR and exchange rate in influencing headline inflation.*

ii. *The bank should continue to monitor the behavior of the short-term interest rates in the light of their strong response to the MPR.*

iii. *The monetary authority should be cautious about the adjustment in the policy rate when the objective is to stimulate the flow of credit to the private sector as the study shows that the credit market in Nigeria is largely supply-driven.*

[1] Shocks refer to positive shocks

Chapter One

1.0 Introduction

The overarching mandate of the CBN as enshrined in the CBN Act of 2007 is to ensure a low and stable price level as well as sound financial system. In order to effectively deliver on this mandate the need for an adequate and up-to-date knowledge of the workings of the economy becomes imperative. It thus follows that any effort directed at enhancing the understanding of the structure of the Nigerian economy would assist the CBN in no small measure in achieving its monetary policy goals. Most of the time however, the economy is confronted with different types of shocks from both domestic and international economic and financial environment, with implication that the effectiveness of a particular model for policy making may be inadequate.

Recently, significant modeling efforts have improved monetary policy simulation and analysis using tools such as structural time series models for short term inflation forecasting, models for sectoral analysis, macroeconometric model of the Nigerian economy for policy analysis and dynamic stochastic general equilibrium model for forecasting. Despite this achievement, there is need to strengthen tools of policy analysis to improve on the overall macroeconomic stability required to promote sustainable economic development. Consequently, the development of a suite of analytical techniques and models should be sustained and contingent upon timely and accurate data to provide the desired guide to policy analysis and actions.

Some of the questions that these models attempted to answer were: does monetary policy affect the real sector of the economy? If so, through what channels did these effects occurred? These questions were very crucial, but debated in macroeconomics (Bernanke and Blinder 1992). Another contentious issue among economists was the methodology of estimating the effects of monetary policy. Although, there existed a compromise among economists that the long-run impact of money on prices was direct, the impact of monetary policy shocks on real variables in the short-run is still controversial (Walsh 2010). The short run relationship among the monetary and real variables is crucial for the conduct of monetary policy and requires further investigation.

VAR models have played important role in monetary policy analysis, however, one of the limitations is that they are small-scale models with a limited information set, which may not necessary reflect the total impact of monetary policy on the macroeconomic variables. Working with such limited information set has been responsible for what is recognized in the literature as "price puzzle". For instance,

it has been empirically established that a monetary policy contraction decreases prices and produces an instantaneous appreciation of the domestic currency followed by depreciation. These theoretical expositions could not be explained and justified using structural VARs. Sims (1992), for example, discovered that after a monetary tightening, prices increased contrary to expectations.

The influential works of Bernanke and Blinder (1992) and Sims (1992) provided the basis for researchers to employ recursive VARs to identify and evaluate the effects of monetary policy shocks on macroeconomic variables. Following this discovery, research works have been carried out in the area of transmission mechanism of monetary policy in both developed and developing countries focusing on how monetary policy shock affects output and prices, as well as other key macroeconomic variables (Christiano et al, 1999; and Peersman and Smets, 2003). The motivation for using these approaches lies on the possibility of producing meaningful and reasonable responses of macroeconomic variables to the shocks in monetary policy without distorting the dynamic structure of the model.

In an attempt to reconcile some of these empirical results which are in conflict with theory, studies have shown, in recent times, such puzzles could be due to insufficient information set resulting in wrong empirical results. In addition to enhance the analytical strengthen of the VAR methodology, one might wish to observe the responses of multiple indicators including, education, housing, transport, food and other components of the CPI basket. The inclusion of many variables in standard VARs is hampered by the degrees-of-freedom problems.

In the light of these developments, central banks such as that of Brazil, South Africa, Israel and China monitor a large volume of economic data and indicators to enable them make informed judgments and decisions through FAVAR approach. Accounting for such information in a data-rich technique such as the FAVAR enriches the policy analysis and forecasting toolkit of central banks. Results from such combination of forecasting technique seem to be encouraging, enhancing the robustness of the policy environment.

The task of containing inflationary pressure by monetary authority in Nigeria as well as other jurisdiction is challenged by; the need to promote fiscal prudence and consolidation; sustainable real output growth; and efficiency, safety and reliability of the payments system.

To address these policy challenges effectively, policymakers have made significant strides through the operationalization of various models that could

improve the understanding of the workings of the economy. A multiple-model approach, "suite of models" is seen as an effective approach in recent times to deal with different macroeconomic problems, for example, short term inflation forecasting model is suitable for simulating and forecasting inflation and its components. In this direction, the Research Department of the CBN has successfully built a number of models including:

- ✓ Short Term Inflation Forecasting (STIF) model (for forecasting headline inflation and its components);
- ✓ Vector Autoregression (VAR) (for forecasting economic and monetary variables);
- ✓ Sectoral models (for forecasting the short-run macroeconomic variables);
- ✓ Medium-sized macroeconometric model (for producing quarterly forecast and simulations of key macroeconomic variables); and
- ✓ Dynamic Stochastic General Equilibrium (DSGE) model (for simulations and for forecasting).

In an attempt to enrich the suite of models already built coupled with the fact that central banks globally monitor a huge volume of economic data and indicators, it is considered necessary to build additional model known as factor-augmented VARs (FAVARs). FAVARs make it possible to capture a large number of information on time series by a comparatively small number of probable factors (Stock and Watson, 2002; Bernanke and Boivin, 2003) and Bernanke, et al (2005). Limited empirical studies have been carried out using FAVAR in the African context, and in particular, there is none in Nigeria. This is considered a knowledge gap which this study intends to fill.

1.1 The Objectives of the Study

The overall objective is to examine the impact of monetary policy shocks on key macroeconomic variables using a FAVAR model. The specific objectives are to:

- build a FAVAR model for monetary policy analysis, which recognizes a wide range of variables; and
- undertake simulations and evaluate the responses of a wide range of macroeconomic variables to monetary policy shocks.

1.2 Expected Output

The output of the study is an operational FAVAR, which would provide an invaluable input to monetary policy analysis and implementation in Nigeria.
The specific outputs include:

- contributing to the Macroeconomic Outlook, which will guide the Monetary Policy Committee (MPC) in their decision-making process; and

- a working document on FAVAR model for monetary policy analysis in Nigeria, which will be published as an occasional paper.

1.3 The Structure of the Study

The rest of the study is organized as follows. Chapter 2 provides the literature review, while chapter 3 focuses on the stylized facts of monetary policy in Nigeria. The methodology, covering the data description, model specification and techniques of analysis is discussed in Chapter 4. Chapter 5 discusses empirical results, while chapter 6 presents summary, policy recommendations and conclusion.

Chapter Two

2.0 Theoretical and Empirical Literature

Generally, Vector Autoregressive (VARs) models are commonly used to identify and evaluate the impact of monetary policy actions on macroeconomic variables (see Bernanke et al 2005, Christiano et al 2000). The methodology captures structural information that measures the effects of monetary policy shocks. It is, however, associated with some criticisms including inferences about the direction and timing of the responses of economic variables due to different identifications of monetary policy innovations (Bernanke et al 2005). Other short comings of the method are; non-capturing of the anticipated changes in monetary policy, the use of relatively small information in the identification process of low dimensional VARs as well as the degrees of freedom constraint. Besides, it is believed that central banks and private sector need large information for effective analysis, which are not contained in the standard VAR analysis and the measurement of policy innovations, could be contaminated. Bernanke and Boivin (2003) suggest that standard VAR analysis of monetary policy should be conditioned on richer information sets without missing the statistical advantages of restricting the analysis to a small number of series. In this case, it is recommended that the natural solution to the problem of degree-of-freedom in VAR analysis is to augment the standard VARs with estimated factors leading to the adoption of factor-augmented VARs (FAVARS) in assessing the effects of monetary policy on macroeconomic variables. The FAVAR approach gives high flexibility in identifying monetary policy innovations.

2.1 Theoretical Literature

The factor augmented VAR (FAVAR) is an extension of the standard VAR, which allows the use of large data sets that is a challenge in the standard VAR. Generally, the standard VAR is atheoretical and its use started with the work of Sims (1980). Sims (1980) and others show in a plethora of studies that VARs provide a coherent and credible approach to data description, forecasting, structural inference, and policy analysis. Traditionally, VARs are in three forms: reduced, recursive, and structural. A *reduced form VAR reflects* each variable as a linear function of its own past values, the past values of all other variables included, and a serially uncorrelated error term. A *recursive VAR builds* the error terms in each regression equation to be uncorrelated with the error in the preceding equations. A *structural VAR,* on the other hand, uses economic theory to determine the contemporaneous links between the variables (Bernanke, 1986; Blanchard and Watson, 1986; Sims, 1986). Structural VARs require "identifying assumptions" which allow correlations to be interpreted in a causal relationship. These identifying

assumptions involve the entire VAR, so that all of the causal links in the model are spelled out, or just a single equation, so that only a specific causal link is identified.

Since Sims (1980), variants of the underlining structure of the VAR had been considered in the extant literature. Woodford (2001) and Stock and Watson (2001) are some of the examples. Woodford (2001) uses the standard Taylor (1993) rule as basis for theoretical framework underlying adoption of VAR methodology as follows:

$$i_t = 0.04 + 1.5\left(\Pi_t - 0.02\right) + 0.5\left(y_t - \bar{Y}_t\right) \quad (2.1)$$

Where i_t is federal funds rate, π_t is the inflation rate represented by GDP deflator, y_t is the actual output and $\bar{Y}_t$ is the log of potential output identified with linear trend. It is said to have described US monetary policy in the period that the policy was seen to have been unusually successful (Taylor, 1999).

Stock and Watson (2001) modify the standard "Taylor rule" by including backward-looking inflation and unemployment in the interest rate-setting behaviour in a structural VAR framework. This is used as an interest rate equation in evaluating effects of monetary policy on macroeconomic variables. Their representation of the Taylor rule is given in equation 2.2.

$$R_t = r^* + 1.5\left(\Pi_t - \Pi_t^*\right) - 1.25\left(\mu_t - \mu^*\right) + \text{lagged values of } R, \Pi_t, \mu_t + \varepsilon_t \quad (2.2)$$

r* is the desired real rate of interest, π_t and μ_t are average inflation and unemployment. π_t^* and μ^* are the target values of inflation and unemployment. ε_t is the error term. From the foregoing, equations (2.3), (2.4) and (2.5) represent Phillips curve, IS curve and a standard Taylor rule, respectively, are employed in a 3-variable VAR.

$$\pi_t = \beta\pi_{t-1} + \lambda\left(y_{t-1} - y_{t-1}^*\right) + S_t \quad (2.3)$$

$$y_t = \alpha y_{t-1} + \omega\left(R_{t-1} - \pi_{t-1}\right) + d_t \quad (2.4)$$

$$R_t = \beta\pi_{t-1} + \lambda\left(y_{t-1} - y_{t-1}^*\right) + \nu_t \quad (2.5)$$

Equation (2.3) is the Phillips curve which relates inflation (π) to the deviation of output (y_t) from potential (y^*) and a supply shock (s_t). Equation (2.4) is the IS curve which describes relationship between output and real interest rate ($R_{t-1} - \pi_{t-1}$) and a demand shock (d_t). The standard Taylor rule represented by equation (2.5) is used by monetary authority to set interest rates. The major limitation of standard VAR is the 'curse of dimensionality', leading to the development of FAVAR, as in the works of Stock and Watson (2002b) and Bernanke et al. (2005).

2.2 Empirical Literature

2.2.1 Advanced Economies

The standard VAR model became the main toolkit for analysis of monetary policy with the pioneered works of Sims (1980, 1992), Bernanke and Blinder (1992). Sims (1992) evaluated the effects of monetary policy in France, Germany, UK, Japan and United States with VAR model. He observed that contractionary monetary policy leads to lower output and money, while consumer price index increases, a phenomenon described as 'price puzzle'. He explains that the magnitude of price puzzling decreases with addition of more variables in the VAR.

Soares (2011) employed FAVAR approach of Bernanke et al (2005) to summarize information contained in a large set of macroeconomic time series with a small number of estimated factors by taking them as regressors in recursive VARs to analyze the impact of the non-systematic component of the ECB's actions. So, including factors in the VAR allowed for more coherent picture of the effects of monetary policy innovations by increasing understanding and precision of responses.

Blaes (2009) investigated the monetary policy transmission mechanism in the euro area with a view to validating the traditional hypothesis that a restrictive monetary policy dampens money growth using the FAVAR and VAR frameworks. He argued that it is not sufficient to understudy the effects of a single variable shock on broad measures of monetary aggregates given the inherent measurement errors associated with it. Contrary to economic theory, the study showed that growth in monetary aggregates was occasioned by a tight monetary policy stance in the euro area. According to the paper, this behavior of monetary aggregates was a temporary response to near zero interest rate, which negatively affected the banks' credit creating abilities. In comparing the performance of both VAR and FAVAR models, the study showed that though both model results were similar, the FAVAR model proved more superior in analysing the effects of monetary policy shocks in the euro area.

Belviso and Milani (2006) provided a structural interpretation to the FAVAR framework by identifying each of the factors as a basis for analyzing monetary policy shock in the US. Using eight structural factors, including real activity, inflation, interest rates, financial market, foreign, money, credit and expectation factors consisting of 204 monthly economic time series spanning 1959–1998, the study showed that the SFAVAR was superior to FAVAR in explaining monetary policy innovations in the US, compared with the conventional Taylor rule.

Baumeister et al. (2010) extended the FAVAR arguments to introduce time variation in the coefficient of the components to accommodate and capture more information so as to identify the time-varying effects of monetary policy shocks in the US. This approach improved the identification of monetary policy shocks as well as estimated the impact of monetary policy surprises at both the micro and macro levels in the economy. The study revealed time variation as an important feature of major macroeconomic indicators, while the different sectors of the economy, represented by over 600 macroeconomic and financial indicators, respond differently to contractionary monetary policy actions. Equally important is the discovery that such influences have persistent and meaningful effect on the relative prices in the domestic economy of the US. The result of the study could not support the existence of price puzzle as hypothesized in the literature, suggesting that the extra information captured might have led to the robust structural estimates and adequately tracks central bank reactions to monetary disturbances.

Gupta et al. (2009) examined the impact of increased defense expenditure on the growth rate of US output using a FAVAR framework, consisting of 116 quarterly variables. The result demonstrated a strong correlation between a positive shock of real defense spending and real output in the long-run. As found in most literature, the FAVAR model was found to be superior over the conventional VAR in the analysis of the effect of defense spending on US economy.

Ahmadi and Ritschl (2009) explored the role of monetary policy on the US economy during the interwar great depression using a panel of 164 times series components. To provide information on the business cycle in the US during the interwar period, five different FAVAR models of different monetary policy instruments were specified. Adopting the sign restriction approach, with a view to circumventing the price puzzle problem, the study found the impact of monetary policy on the real economy after the interwar period to be mixed. In addition, the ability of monetary policy to explain the variations in the real economy as well as measure the response of instruments to demand and shocks are also found to be weak. The study, thus, concluded that the argument in support of great

depression hypothesis is fragile although it recognized the role of monetary policy during the inter-war depression.

2.2.2 Emerging Economies

Using a combination of instruments, Leung, et al. (2009) examined the effectiveness of monetary policy in stabilizing the Chinese economy during the post-Asian crisis and currency regime shift eras using a Factor-Augmented VAR method. Findings of the study were mixed. While the interest-rate based monetary instruments, such as repo, lending and anchor rates reported moderate effectiveness in the regulation of the economy by the central bank, domestic credit and money supply, on the other hand, posted significant impact. The study further observed market-driven policies as being less effective under a more flexible exchange rate regime as well as impact mildly on industrial production and price level.

From the international perspective, Zuniga (2011) used a FAVAR model to capture how monetary policy action of the US transmited globally, especially to the emerging economies of Mexico and Brazil by employing a wide array of variables. The study observed that, owing, largely, to the heterogeneity of economies, the impact of foreign monetary policy shocks differed and as such making generalization, even for economies of the similar economic size and regional location, could be misleading. The study found macroeconomic indicators in Mexico responding more significantly to foreign monetary policy shock, compared with Brazil. Interest rate channel was identified as the dominant channel of monetary policy in both countries and that the US monetary policy actions exerted substantial influence on Brazilian economy. Also, the outcome of exchange rate responses to international monetary transmission process was inconsistent with existing literature.

In analyzing the impact of monetary policy shocks in the Peruvian economy, Lahura (2010) introduced the semi-structural model that overcame the difficulty of identifying the most appropriate indicator for monetary policy and the limited number of economic and financial data often associated with the traditional VAR. In line with arguments in literature, the study modified the conventional FAVAR model to include "semi-structural identification" using Peruvian data. The resulting semi-structural FAVAR model demonstrated some superiority in analyzing the effect of monetary policy shocks than the traditional VAR model. It was also shown that non-borrowed reserves served as more potent monetary policy tool in the purview of the central bank, compared with interest rate.

Iiboshi (2012) constructed a hybrid model that combined a dynamic stochastic general equilibrium (DSGE) with a dynamic factor model (DFM) to form a DSGE-DFM model that measured the effects of monetary policy on the Japanese macroeconomy. The approach, which identified structural shocks, including monetary policy shocks from a DSGE perspective, rested on micro foundations with rational expectations, employing 55 observable macroeconomic variables using the relatively easy and efficient Smets-Wouters (2003, 2007) type of DSGE model. The result showed large measurement errors in the macroeconomic variables, while the noise associated with inflation and real wages were moderated significantly.

2.2.3 Developing Economies

Kabundi and Ngwenya (2011) specified a FAVAR model to assess the efficacy of contractionary monetary policy on real, nominal and financial variables in the South African economy using monthly data spanning from 1985 – 2007. Though the study could not establish the existence of price puzzle common with SVAR analysis, it nevertheless found monetary policy as potential price stabilizing tool by influencing the outcomes of key macroeconomic indicators in South Africa. In addition, real and financial sector variables were observed to respond negatively to tight monetary policy stance in the economy as they were found to be significant and rightly signed.

De Carvalho and Junior (2010) studied the effect of monetary policy on the Brazilian economy using 125 monthly series in both the traditional VAR and the FAVAR framework. The study found the impact of a contractionary monetary policy as being consistent with economic theory as key economic indicators reacted negatively and decayed in a few months in line with the long-term currency neutrality. In comparing model results, the study showed that the dividing line between the traditional VAR and the FAVAR is blurred, although the information contribution of the model FAVAR was marginally higher. The study could not establish the existence of price puzzle using Brazilian data.

Du Plessis et al (2008) adopted the SVAR approach to apprise the contribution of fiscal and monetary policy to economic stabilization in South Africa. The paper constructed a structural model to capture the dynamic interactions and multi-variable effects between monetary and fiscal policy shocks on the demand side and supply shocks to overcome the problem of the size of fiscal elasticities. The study affirmed the countercyclicality of monetary policy, while evidence of pro-cyclicality was associated with fiscal policy. However, the study found the pro-cyclicality of fiscal policy having less destabilizing effect on real output in South Africa.

Munir and Qayyum (2012) employed the FAVAR methodology using 115 monthly time series variables to examine the effect of monetary policy on the Pakistani economy. The result, which was compared with the traditional VAR, showed that the FAVAR model was not only consistent with economic theory, but also more robust than the traditional VAR estimates. While the baseline VAR model shows evidence of price and liquidity puzzles, the FAVAR analysis, which identifies interest rate as the dominant channel, could not come to the same conclusion. More so, the study revealed monetary policy impulses being faster in the case of prices, compared with output even as output was affected in the short-run, while money and prices were affected in the long-run in Pakistan.

Morita (2012) explored a panel version of FAVAR allowing both common and country specific unobservable factors. He justified the use of FAVAR by the constraint of the limited number of variables employed by the standard VAR in identifying and measuring the effects of monetary policy innovations on macroeconomic variables. He explained that omitted variable bias could lead to biased inference such as the "price puzzle" (Sims 1992) that tight monetary policy shock led to rise in price level instead of decline, which makes FAVAR popular among researchers.

Figueiredo (2010) employed two data-rich techniques of principal components (PC) developed by Stock and Watson (1998) and the partial least squares (PLS) to complement the suite of models used by the Bank of Brazil for inflation forecasting. The study showed that models with large number of variables may not necessarily display better forecasting ability as fewer variables, based on granger causality results in improvements in forecast ability.

Ribon (2011) investigated the transmission of monetary policy with disaggregated components of consumer price index comprising 38 individual price groups using a FAVAR technique. The study found the impact of monetary policy transmitted strongly to interest rate and exchange rate with no evidence of price puzzle. It was further observed that relative prices responded positively to interest. Equally responding significantly to interest rate shocks were housing and energy prices, while a shock (depreciation) in the exchange rate induced a general positive price rise with traded goods, energy and housing leading others. Exchange rate was identified as the dominant channel of monetary policy in Israel.

Using a time varying parameter vector autoregressive (TVP-VAR) model with stochastic volatility combined with Bayesian econometric techniques, Mwabutwa et al (2013) explored the responses of real output and general price level to bank rate, exchange rate and credit shocks over time in Malawi. The

study showed, especially with the 1980 financial reforms, that monetary policy actions worked in tandem with economic theory as inflation, real output and exchange rate reacted significantly to monetary policy shocks with no evidence of price puzzle. The response of private credit was, however, found to be weak.

Chapter Three

3.0 Stylized Facts on Monetary Policy in Nigeria

In pursuit of the provisions of the CBN Act 2007, the primary objective of monetary policy remains the maintenance of monetary and price stability. The monetary policy of the CBN is anchored on four main pillars: inflation as a monetary phenomenon; the public expectations of future inflation; proactive and rule-based monetary policy; and the need for monetary policy to be conducted outside the control of the political authorities (autonomy or independence of monetary policy). This section highlights the instruments as well as institutions of monetary policy and presents stylized facts on the evolution of monetary policy frameworks and performance in Nigeria.

3.1 Monetary Policy Instruments

The current monetary policy framework of the CBN is monetary targeting, in which the Bank uses market-based instruments to achieve set targets. The instruments are open market operations, reserve requirements, standing facilities, discount window operations and interventions in the foreign exchange market. These instruments are used by the CBN to influence the ability of Deposit Money Banks' (DMBs) to create credit and thereby control the growth of money supply consistent with non-inflationary output growth.

3.2 Institutional Framework for Monetary Policy in Nigeria

The Monetary Policy Committee (MPC) is the overarching institutional body for monetary policy making in Nigeria. The MPC is the statutory body created by the provisions of the CBN Act 2007 to formulate and implement monetary and credit policies in Nigeria. The Committee receives input from Bank staff based on the review of domestic and international economic and financial developments. To support the tasks of the MPC, several Committees are put in place at the CBN. These include the *Monetary Policy Technical Committee*, which has the responsibility of tracking economic and financial system developments as well as preparing technical reports for the consideration of the MPC. The *Monetary Policy Implementation Committee* ensures that the decisions of the MPC are implemented accordingly.

Others are the *Fiscal Liquidity and Assessment Committee,* which facilitates an effective interaction between the Bank and the fiscal authorities; the *Liquidity Forecasting Committee*, which undertakes daily assessment and forecast of the path of liquidity; and the *Liquidity Assessment Group,* which assesses banking system liquidity on daily basis and recommends actions for intervention in domestic money and foreign exchange markets.

3.3 Monetary Policy Framework and Outcomes in Nigeria

The Central Bank of Nigeria, as the monetary authority, has deployed two monetary policy frameworks over the years. These arrangements range from exchange rate targeting framework at the inception of the CBN in 1959 to monetary targeting in 1973. Also, two monetary policy regimes were employed, namely, direct control at inception and subsequently, the introduction of the indirect monetary regime in 1993. A summary of the various monetary policy arrangements employed by the Bank since inception is provided in table 3.1 below.

Table 3.1: Summary of Monetary Policy Frameworks in Nigeria

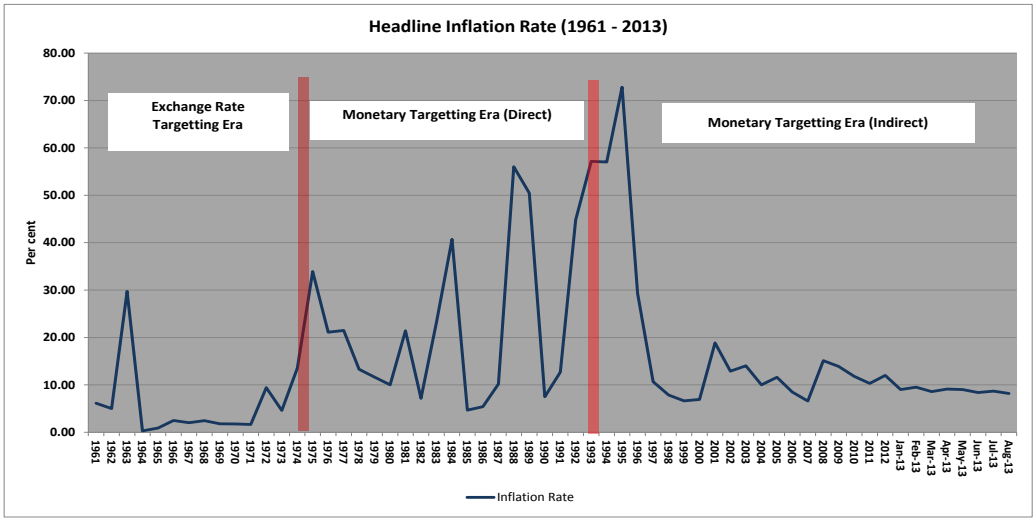
S/N	Framework	Period	Approach	Focus
1	Exchange Rate Targeting	1959 - 1973	Fixed Parity	Maintenance of BOP
2	Monetary Targeting	1973 - date	Direct Control (1959 – 1993)	Rapid and sustainable Economic growth
			Indirect Control (1993 – date)	Demand management to arrest inflationary pressures, BOP imbalances and contain influence of fiscal deficits

At the establishment of the CBN in 1959, Nigeria's monetary policy implementation framework was based on exchange rate targeting with special focus on the maintenance of favorable balance of payments and low inflation. During the period, the Nigerian pound was fixed at par to the British pound until 1967 when the British pound was devalued.

Thus, the authorities decided to peg the domestic currency to the US dollar, albeit with severe restriction on imports using strict administrative controls on foreign exchange. This was to circumvent the problems associated with the maintenance of fixed exchange rate parity with the British Pound at that time. Unfortunately, the US dollar also later suffered serious devaluation following the global financial crisis of the early 1970's and the Naira suffered major devaluations alongside, contrary to the dictates of economic fundamentals but in line with the Bretton Woods System of adjustable peg regime. Following the collapse of the Bretton woods fixed exchange rate system and in response to the risks associated with single currency pegs, the authorities decided to peg the

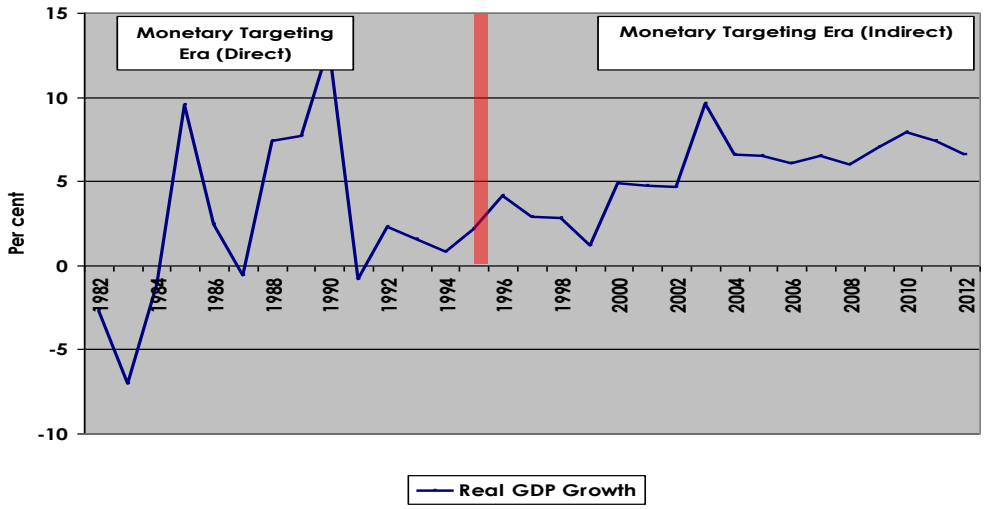
Naira to a basket of twelve (12) currencies of the country's major trading partners in 1978. During the exchange rate targeting regime, headline inflation rate averaged 5.3 per cent, with a period of low and stable prices recorded between 1964 and 1971.

Figure 3.1: Headline Inflation, 1961 – 2013



In 1974, there was a significant shift in the country's monetary policy regime from exchange rate targeting to the subsisting monetary targeting framework, a policy premised on the belief that inflation was a monetary phenomenon. This was in response to the mounting inflationary pressure resulting from increased public expenditure during the early 1970s as a result of the reconstruction works after the civil war. At the inception of the monetary targeting regime in 1974, the Bank employed the direct control approach in which differential quantitative ceilings were imposed on various sectors of the economy with agriculture, manufacturing and construction being the preferred sectors.

Figure 3.2: Real Gross Domestic Product Growth Rate, 1982 - 2012



Since the major objective of monetary policy then was to promote rapid and sustainable economic growth, these sectors were seen as growth pillars and were thus given higher credit ceilings at below market lending rates. Thus, the level and structure of interest rates were controlled by the CBN with a view to promoting the growth of the preferred sectors, curtailing inflation as well as reducing the internal debt servicing burden of the government. However, with time, the direct monetary control policy lost its effectiveness as economic agents found various means to circumvent its precepts. Thus, the extent of credit mobilization to the preferred sectors was short of expectations and the policy failed to achieve its preconceived growth and price objectives. For instance, inflation rate during 1973 – 1993 averaged 23.3 per cent, rising from 13.5 per cent 1n 1974 to about 57.2 per cent in 1993. Output growth also declined from its peak of 13.0 per cent in 1990 to 1.6 per cent in 1993.

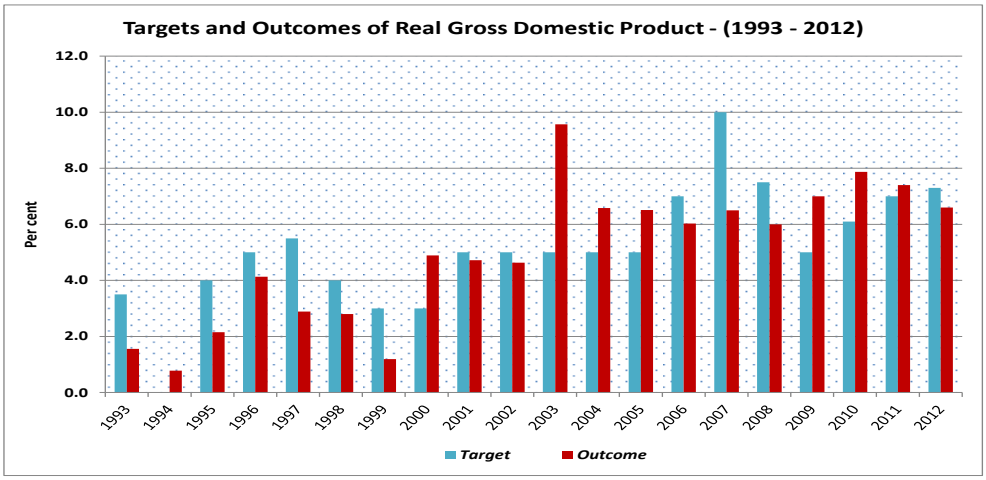
As a result of the inefficiencies associated with the direct control coupled with the move towards liberalization and deregulation in the country in the early 1990s, the direct control regime was abandoned in favour of indirect monetary control in September, 1993. Thus, the role of price signals in the economy was enhanced. At the inception of the indirect monetary control era, the Bank embarked on selective removal of all credit ceilings for banks that met some set criteria under the Basel Accord prudential guidelines. Subsequently, the use of indirect instruments to regulate growth of major monetary aggregates became prominent. Under the new arrangement, the monetary base or its components (known as operating variables) were managed, while the market was left to

determine the interest rate and credit allocations. This regime was meant to remove all the distortions associated with the direct control era.

Technically, the Bank targets monetary growth that is consistent with predetermined targets for GDP growth, inflation rate and external reserves by using market instruments to limit the credit creation ability of banks, curb excess liquidity and curtail the growth of money stock above the programmed target. The instruments used under this monetary policy arrangement include the Open Market Operations (OMO), complemented by Reserve Requirements (RR) and Discount Window Operations (DWO).

During the indirect control regime, the outcomes of monetary policy in Nigeria have been mixed and influenced by the general macroeconomic environment. While inflation rate declined steadily from its level of 57.2 per cent in 1994 to 12.0 per cent in 2012, output growth rose from 0.8 per cent in 1994 to 6.6 per cent in 2012. In terms of targets and outcomes, output performance fell below the target in the first decade after the introduction of the indirect monetary control, except in 2000 when the target was surpassed by about 1.9 percentage points (Figure 3.3). On average, target for output growth during 1993 – 2002 was 4.2 per cent while the actual growth was about 3.0 per cent. However, the period 2003 – 2012 witnessed improved output performance as the targets were surpassed. While the outcomes were below the target in 2007, 2008 and 2012, the targets were consistently surpassed in 2009, 2010 and 2011.

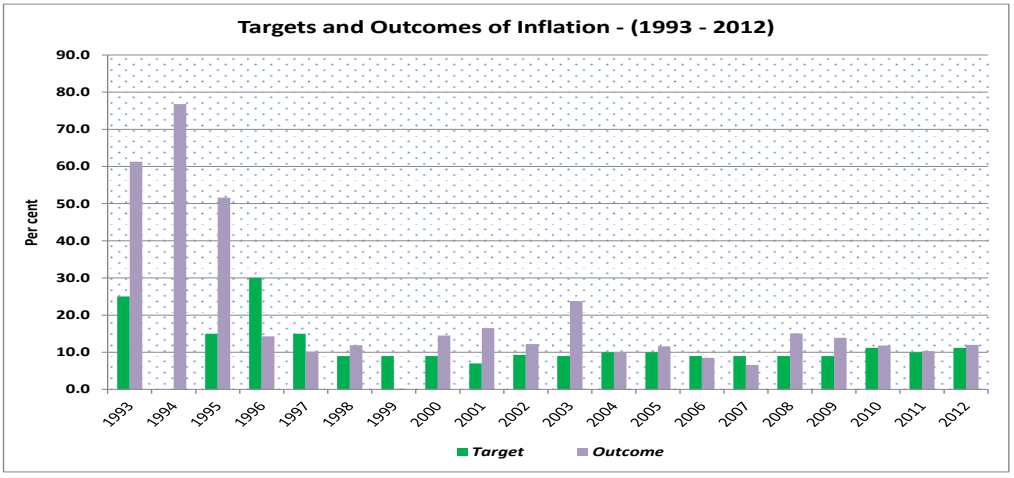
Figure 3.3: Targets and Outcomes of Real Gross Domestic Product, 1993 – 2012



As in output, inflation performance since the inception of indirect control has equally been mixed. For instance, the actual inflation rates were beyond the

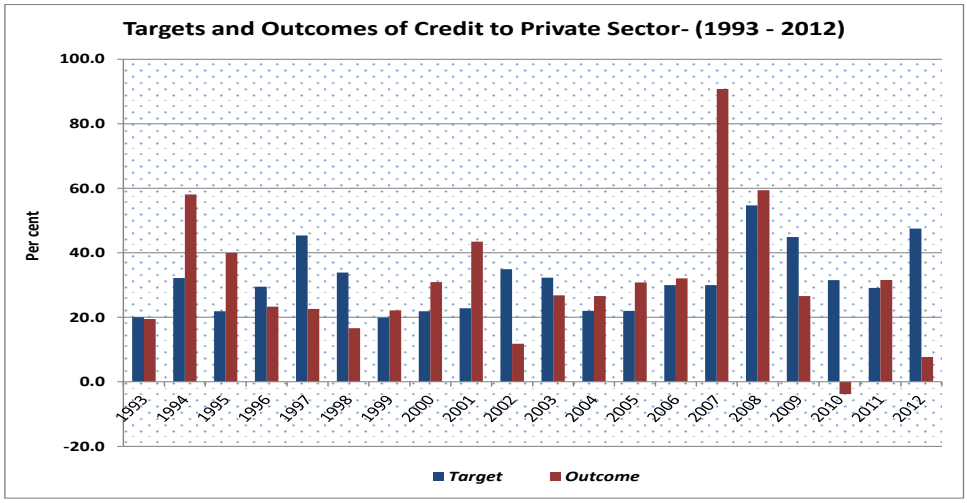
targets during 1993–1996 but below the targets in the following two years. On the average, between 2000 and 2012, the outcomes were generally above the targets, except in 2006 and 2007 when outcomes of 8.5 and 6.6 per cent were realized against the targets of 9.0 and 9.6 per cent, respectively. In 2012, the target for inflation rate was exceeded by 0.8 percentage points.

Figure 3.4: Targets and Outcomes of Inflation, 1993 – 2012



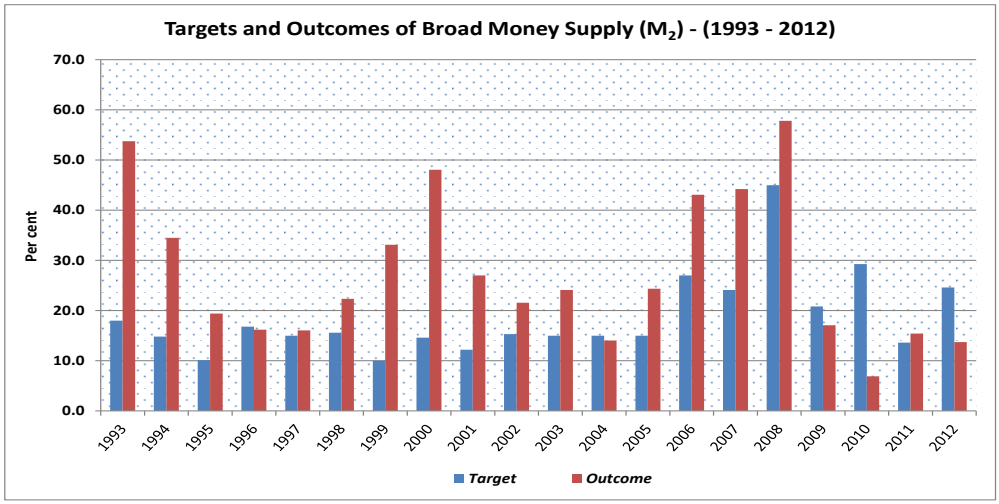
In the last two decades, the annual targets for growth in credit to the private sector were exceeded 11 times and unmet in 9 cases. On the average, the target growth was 31.3 per cent while the outcome was 30.8 per cent. While the aggregate bank credit to the private sector grew significantly between 2010 and 2011 and the target was surpassed in 2011, the performance for 2012 was largely below expectation. However, in terms of the growth in net aggregate credit to the economy, the target was surpassed by 13.7 percentage points (Table 3.2).

Figure 3.5: Targets and Outcomes of Credit to the Private Sector, 1993 – 2012



On average, growth in broad money supply (M2) since the adoption of indirect monetary control was 27.6 per cent which was above the target of 18.6 per cent. However, in 2009, 2010 and 2012 the monetary growth outcomes were satisfactorily below the targets by 3.7, 22.3 and 10.9 percentage points. Similarly, growth in narrow money supply averaged 26.5 per cent during 1993 – 2012 while the target was 19.1 per cent (Table 3.2).

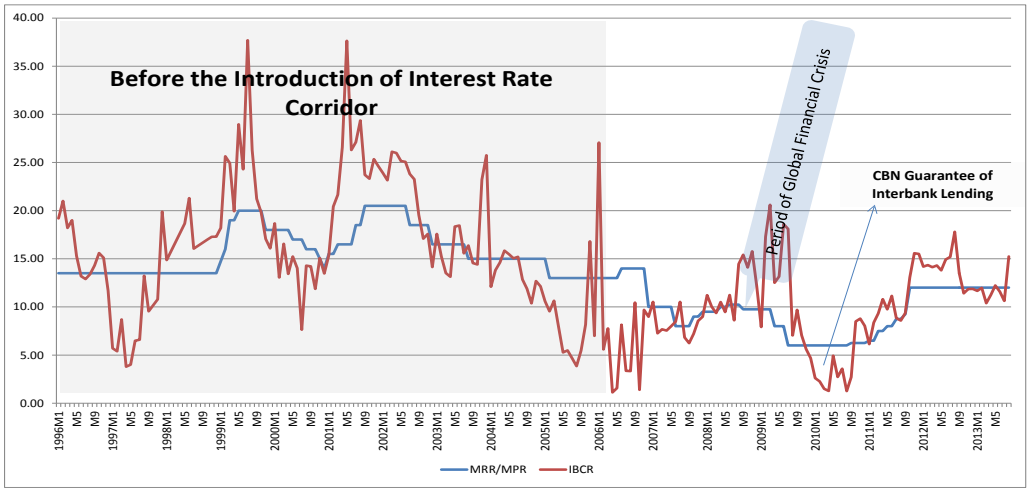
Figure 3.6: Targets and Outcomes of Broad Money Stock (M_2), 1993 – 2012



Some of the challenges of monetary policy in Nigeria include unstable Inflation, lack of well-developed financial sector, weak transmission mechanism of

monetary policy as well as a combination of liquidity surprises with the ability of the federal government to finance large budget deficits by borrowing freely from the CBN at administratively fixed interest rates prior to the regime of interest rate liberalization.

Figure 3.7: Performance of Monetary Policy Rate (MPR)



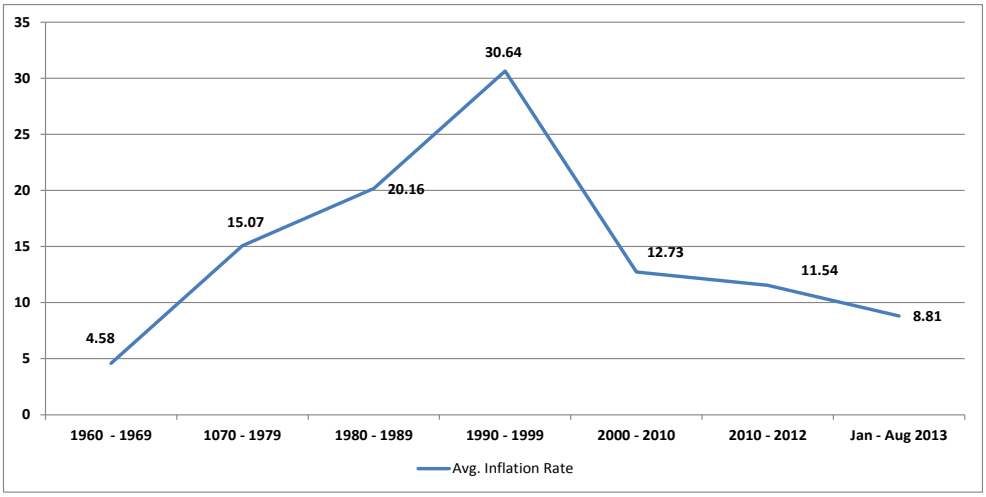
Before the introduction of the interest rate corridor, the interbank rate exhibited high volatility which has been relatively subdued under the current monetary policy framework. Pockets of volatility observed within the interest rate corridor was associated with shocks due to the global financial crisis and CBN guarantee of interbank lending.

Table 3.2: Key Policy Targets and Outcomes during 2007 - 2012 (per cent)

Year	M2		M1		Net Domestic Credit		Credit to Private Sector		Inflation		Real GDP	
	Target	Outcome	Target	Outcome	Target	Outcome	Target	Outcome	Target	Outcome	Target	Outcome
1993	18	53.76	20	56.32	17.5	64.08	20	19.47	25	61.3	3.50	1.56
1994	14.8	34.5	21.4	42.64	9.4	56.44	32.2	58.07	n.a	76.8	n.a	0.78
1995	10.1	19.41	9.4	18.9	11.3	8.03	21.9	39.97	15	51.6	4.00	2.15
1996	16.8	16.18	14.5	12.93	12	-21.77	29.5	23.3	30	14.3	5.00	4.13
1997	15	16.04	13.5	18.09	24.8	-1.4	45.4	22.6	15	10.2	5.50	2.89
1998	15.6	22.32	10.2	18.6	24.5	40.07	33.9	16.61	9	11.9	4.00	2.80
1999	10	33.12	4.1	23.39	18.3	23.32	19.9	22.18	9	0.2	3.00	1.19
2000	14.6	48.07	9.8	62.24	27.8	-25.32	21.9	30.93	9	14.5	3.00	4.89
2001	12.2	27	4.3	28.06	15.8	79.87	22.8	43.46	7	16.5	5.00	4.72
2002	15.3	21.55	12.4	15.86	57.9	56.59	34.9	11.79	9.3	12.2	5.00	4.63
2003	15	24.11	13.8	29.52	25.7	35.7	32.3	26.81	9	23.8	5.00	9.57
2004	15	14.02	10.8	8.58	22.5	11.99	22	26.61	10	10	5.00	6.58
2005	15	24.35	11.4	29.66	22.5	14.51	22	30.82	10	11.6	5.00	6.51
2006	27	43.09	n.a	32.18	-72.3	-69.13	30	32.06	9.00	8.5	7.00	6.03
2007	24.1	44.2	36.6	37.64	-29.9	276.4	30	90.8	9	6.6	10.00	6.50
2008	45	57.8	65.4	55.9	65.7	84.2	54.7	59.4	9	15.1	7.50	6.00
2009	20.8	17.07	32.2	3.3	87	59.6	44.9	26.6	9	13.9	5.00	7.00
2010	29.25	6.91	22.4	11.05	51.4	10	31.54	-3.81	11.2	11.8	6.10	7.87
2011	13.6	15.4	15.8	21.5	29.3	42.4	29.1	31.6	10	10.3	7.00	7.40
2012	24.6	13.7	34.7	4.3	52.1	1.98	47.5	7.7	11.2	12	7.30	6.60

Source: Central Bank of Nigeria

Figure 3.8: Average Inflation Rate



Having a cursory look at Table 3.2 on targets and actuals of the key monetary aggregates and the graph on inflation development, it is clear that the performance of monetary policy of recent has improved tremendously. Despite this achievement, continuous fine-tuning of the current techniques of policy analysis is required to improve on the overall macroeconomic stability.

Chapter Four

4.0 Data and Methodology

4.1 Data

For the assessment of monetary policy actions, FAVAR models require the use of high frequency data collected on a large set of macroeconomic time series, and typically categorized into fast and slow moving variables. These are premised on optimization of information to enhance the efficacy of monetary policy. Essentially, the variables are considered fast if they respond at approximate contemporaneous speed to monetary policy shocks and slow, if the response comes with inertia.

To achieve the objectives of the study, monthly and quarterly data were employed. In effect, 162 and 54 monthly and quarterly data points, respectively, on each of the 83 macroeconomic series spanning 2000 to 2013 constituted the balanced data set used in this study. The data were sourced from the CBN and NBS publications. Choice of the sample period was informed by data availability. The data set comprises 36 fast-moving and 47 slow-moving variables, drawn from the 6 variants of composite consumer price index (CPI) and 12 components of the headline CPI. Other categories in the data set were interest rates on 10 money market indicators; 12 monetary aggregates; deposit money banks' credits on 8 loan sub-categories; capital market indicator on Nigeria's stock market all-share index; real gross domestic production on 17 activity groups; industrial production indices on 4 sectors; private investment; and personal consumption and disposable income. From the fiscal sector category, data were obtained on retained revenue and expenditure of the Federal Government, while in the external sector data were obtained on 3 measures of exchange rates, external reserves, imports and exports; and crude petroleum indicators on crude petroleum production and spot price of Nigeria's reference crude – Bonny Light. There is a good depth of disaggregation of the CPI, GDP and DMB's loans.

Data gaps from 2000:1 to 2001:9 in 3 out of the 12 headline CPI components, namely communication, education and restaurant & hotels were extrapolated to maximize the sample length and also have a balanced data set. The extrapolation was done relying on the inherent movement patterns in the 3 CPI series. Following Soares (2011), macroeconomic time series in quarterly frequency are converted to a higher frequency of monthly in the cases of real GDP, private investment, personal consumption and disposable income, using the EViews "quadratic match sum" frequency conversion process suited for flow variables. Industrial production indices and DMBs' credits quarterly data are converted to

monthly series using EViews "quadratic match average" frequency conversion procedure appropriate for stocks.

Some of the real sector macroeconomic series exhibited periodic fluctuations and, therefore, were seasonally adjusted using the multiplicative decomposition of the Census X12 process in EViews. These included the 17 real GDP series, investment, personal disposable income, crude petroleum production and production indices on manufacturing and industry. Other series so adjusted include Federal Government retained revenue and expenditure, as well as imports and exports. Exponential smoothing was used to reduce the level of short-term volatility in the 2 fiscal series and imports data. Further, every series in the data set are smoothed through natural logarithm transformation with the exception of the 11 money market rates; thereafter, unit root tests to ascertain the stationary status of the 73 natural logarithm transformed series and the untransformed interest rates were performed.

Augmented Dickey-Fuller (ADF) unit root tests revealed that 8 series in the data set were stationary at level, while 76 attained stationary state after first differencing; the differencing of the data set was done on an annualized basis.

The variables were grouped into two, namely; fast and slow moving variables. While the fast variables were those that responded in a contemporaneous manner to policy shocks, the slow moving ones responded with some lags. Principal Component Analysis (PCA) procedure was applied to extract principal components from these two groups of variables. This was used to display the relative positions of the observations in the data cloud in fewer dimensions, while losing as little information as possible. The PCA helped to achieve this through standardization of all the series to have zero mean and constant variance. Since the obtained components or factors are latent, they were not susceptible to meaningful economic interpretation directly. However, as rightly argued by Marcellino et al. (2000), even if the estimated factors did not coincide with the driving forces of the economy, linear combinations of them did. This was so because the estimated factors span the same space as the true factors. The variables driving the different principal components were expected to differ, since the components were orthogonal to each other by construct.

4.2 Analytical Framework

4.2.1 Standard VAR Methodology

The standard Vector Autoregression with multi-variable time series is as follows:

$$y_t = \sum_{i=1}^{m} \lambda_i y_{t-1} + \sum_{i=1}^{m} \mu_i x_{t-1} - y + u_i \quad (4.1)$$

Where y_t represents a j vector of endogenous variable, X_t represents a k vector of exogenous variable. The λ_i and μ represent matrixes of coefficient to be estimated and μ_i is a j vector of error term known as impulse. VAR models do not distinguish dependent variable from independent variable and y_t and X_t are conventional.

4.2.2 FAVAR Methodology

The FAVAR approach enriches monetary policy analysis through the utilisation of an additional and richer information set. It gains its statistical merits by summarizing a large set of information to a small set through the use of principal components technique. To specify the FAVAR model, we consider the relationship of (F_t, Y_t) to be defined by the transition equation given as follows:

$$\begin{bmatrix} F_t \\ Y_t \end{bmatrix} = \Phi(L) \begin{bmatrix} F_{t-1} \\ Y_{t-1} \end{bmatrix} + \nu_t \quad (4.2)$$

Where Y_t represents an M ×1 vector of the observed economic indicators assumed to influence the underlying changes in the economy. According to the conventional approach in the monetary VAR literature, Y_t includes a policy indicator and observable indicators of real activity and prices. This approach is limited to the estimation of the unrestricted VAR, a structural VAR (SVAR), or some other multivariate time series models using the variable Y_t. However, it ignores relevant extra economic information that explains possible dynamics in the variables not exhaustively captured by Y_t. As an improvement over VAR, FAVAR incorporates additional information set, a vector of unobserved factors, F_t, compactly expressed as 'small' $K \times 1$ vector. The $\Phi(L)$ in equation 1 is a conformable lag polynomial of a finite order, say, d, and may contain structural restrictions as it is typical in the SVAR literature. Thus, the unobserved factors may be taken as capturing variations in unobserved potential output or "economic

activity", "price pressures", or "credit conditions" which are considered to reflect varied economic variables beyond one or two indicators.

It is noticeably difficult to estimate the unobserved factors in equation 4.1 directly. However, we can interpret the factors, in addition to the observed variables, as the common forces driving the dynamics of the economy. If we assume that we have a 'large' set of N informational (zero-mean stationary) time series, X_t, where $K+M \ll N$, which is related to the unobservable factors, F_t, and – sometimes, but not always – the observable variables, Y_t, by an observation equation:

$$X_t = \Lambda(F_t,\ Y_t) = \Lambda^f F_t + \Lambda^y Y_t + \varepsilon_t \qquad (4.3)$$

In equation 2, Λ^f and Λ^y represent factor loadings of $N \times K$ and $N \times M$ dimensions that conforms with X_t, F_t and Y_t, while ε_t represents the vector of $N \times 1$ error terms that are weakly serially and cross-sectionally correlated with mean zero. In the Stock and Watson (2002) model, the dynamic factor model is expressed without an inclusion of the observable variables, Y_t as

$$X_t = \Lambda(F_t) = \Lambda^f F_t + \varepsilon_t \qquad (4.4)$$

Thus, in the static form of the dynamic model, X_t is influenced only contemporaneously by F_t. Since we assume that $K+M \ll N$, the amount of information utilised in a FAVAR is much higher relative to a typical VAR model.

4.3 Estimation Procedure

4.3.1 Identification Schemes for the Factors

Estimation of the factors can be undertaken through either the use of a two-step method, using principal components prior to the estimation of the FAVAR; or a one-step full parametric approach, utilizing Bayesian likelihood methods and Gibbs sampling to estimate the factors and the dynamics simultaneously in a state-space representation. These approaches are uniquely different and there are no clear reasons why one is preferred to the other. Stock and Watson (1999) and Bernanke and Boivin (2003) suggest that, generally, factor methods are relevant to forecasting inflation.

In that regard, to estimate the FAVAR model in equation 4.1 and 4.2, we adopted a nonparametric two-step principal components procedure as applied in Stock and Watson (2002b), Bernanke et al. (2005) and Soares (2011). The factors of X_t, $C(F_t, Y_t)$ were first estimated, by utilizing the first $K+M$ principal components of X_t; thereafter, we estimated equation 4.1 by replacing F_t with $\widehat{F}_t$.

Following Bernanke et al. (2005), and as shown in Stock and Watson (2002b), if N is sufficiently large and the number of principal components deployed closely approximates the true number of factors, the principal components consistently recovered the space covered by both F_t and Y_t. In this way, getting $\widehat{F}_t$ implies finding the component of $\widehat{C}(F_t, Y_t)$ that was not covered by Y_t, i.e. by eliminating Y_t from the space spanned by the principal components. This was obtained in the second step by depending on a particular identification assumption that makes use of the varied behaviour of the various series included in X_t. For robustness, the matrix X_t was compartmentalized into slow-moving and fast-moving series. Slow-moving variables, such as real variables, were assumed to be predetermined in the contemporaneous period, i.e. they were unresponsive in the current period to unanticipated changes in monetary policy. The fast-moving ones, such as asset prices, on the other hand, respond in the current period to policy shocks.

In order to eliminate the direct dependence of $\widehat{C}(F_t, Y_t)$ on Y_t, $\widehat{C}^*(F_t)$ is determined as an estimate of all the common components except Y_t.

Given the assumption that the slow-moving series did not respond contemporaneously by Y_t, $\widehat{C}^*(F_t)$ was determined by extracting principal components from this set of variables. Thereafter, the estimated common components $\widehat{C}(F_t, Y_t)$ were specified to depend on the estimated slow-moving factors $\widehat{C}^*(F_t)$ and on the observed variables Y_t:

$$\widehat{C}(F_t, Y_t) = a\widehat{C}^*(F_t) + bY_t + \mu_t \qquad (4.5)$$

We now calculate $\widehat{F}_t$ as $\widehat{C}(F_t, Y_t) - \widehat{b}Y_t$, whereas the VAR in $\widehat{F}_t$ and Y_t represents estimated using equation (4.6).

$$\hat{\Psi}(L)\begin{bmatrix}\hat{F}_t \\ Y_t\end{bmatrix} = \varepsilon_t \qquad (4.6)$$

where $\hat{\Psi}(L) = \hat{\Psi}_0 - \hat{\Psi}_1 L - ... - \hat{\Psi}_d L^d$ gives a matrix of order d in the polynomial lag operator L, such that $\hat{\Psi}_j (j = 0,1, ..., d)$ defines the coefficient matrix and ε_t is the vector of structural innovations within the diagonal covariance matrix.

4.3.2 Identification of the VAR

To identify the macroeconomic shocks, we assumed a recursive structure as in Bernanke et al. (2005). This was premised on the fact that the factors entering equation (4.1) did not respond contemporaneously to monetary policy actions. In this case, we applied the Cholesky decomposition of the variance-covariance matrix of the estimated residuals. The Cholesky decomposition indicated a strict causal ordering of the series in the VAR. The variable that was placed last in the ordering responded in the current period to the other variables, but these variables were not affected contemporaneously by the variable that was ordered last. Similarly, the variable, next to the last responded in the current period to all variables, except the last, but only the last variable responds contemporaneously to it. In Bernanke et al. (2005), the FAVAR was identified by assuming that the monetary policy shock was orthogonal to the variables in the policy rule, implying that economic variables in the central bank's information set do not respond contemporaneously to the actual monetary policy shock. Thus, we follow Bernanke et al. (2005) to assume a Cholesky identification scheme in which the MPR comes last after the factors, some measure of output and prices. The innovations on the MPR, CRR and exchange rate were taken as the policy shock.

4.3.3 Forecast Error Variance Decomposition Analysis

This study conducted forecast error variance decomposition analysis to determine the proportion of the forecasting error of a variable, which was accounted for by a given time horizon. The proportion of the variance of $X_{t+k} - \hat{X}_{t+k}$ due to a particular shock such as ε_t, can be expressed as:

$$\frac{Var\left(X_{t+k} - \hat{X}_{t+k/t/\varepsilon_t}\right)}{Var\left(X_{t+k} - \hat{X}_{t+k/t}\right)} \qquad (4.7)$$

It has been described that part of the variance of the macroeconomic variables arose from their idiosyncratic components that might also be due to measurement error. However, as identified by Bernanke et al. (2005), it was unclear if the standard VAR variance decomposition gave exact measurement of the relative importance of a structural shock. The forecast error variance decomposition based on FAVAR estimation is most appropriate as the relative importance of a structural shock is evaluated only to the portion of the variable explained by the common factors. This is denoted as:

$$\frac{\Lambda_i Var\left(X_{t+k} - \hat{X}_{t+k/t/\varepsilon_t}\right)\Lambda_t^i}{\Lambda_i Var\left(X_{t+k} - \hat{X}_{t+k/t}\right)\Lambda_t^r} \tag{4.8}$$

Bernanke et al. (2005) confirmed that FAVAR approach does capture important dimensions of the business cycle movement. R^2 was reported to evaluate the goodness-of-fit properties of the estimated factors. The computed R^2 of each of the identified key variables was on the common factors: $C(F_t, Y_t)$, that is the fraction of each variable's variance which was explained by F_t, and Y_t. Having a high R^2 means that the common factors sufficiently contained the information in the variable, while a low R^2 revealed that the variable cannot be adequately explained by the common factors (Soares, 2011).

Chapter Five

5.0 Empirical Results

5.1 Principal Components Analysis

5.1.1 Monthly Data Analysis

The obtained principal components seem to capture idiosyncratic dynamics in the data set. Thus, the estimated components largely have distinct macroeconomic connotations as they could be associated with identifiable blocs of included macroeconomic variables such as prices, interest rates, credit and money. The results of the principal component analysis in Table 5.1 showed that the first three principal components, extracted from the full set of 83 macroeconomic variables, jointly accounted for about 42.4 per cent of the variation in the data space, while the first ten accounted for 78.5 per cent.

Table 5.1: Principal Component Analysis - Eigenvalues for First 10 Components

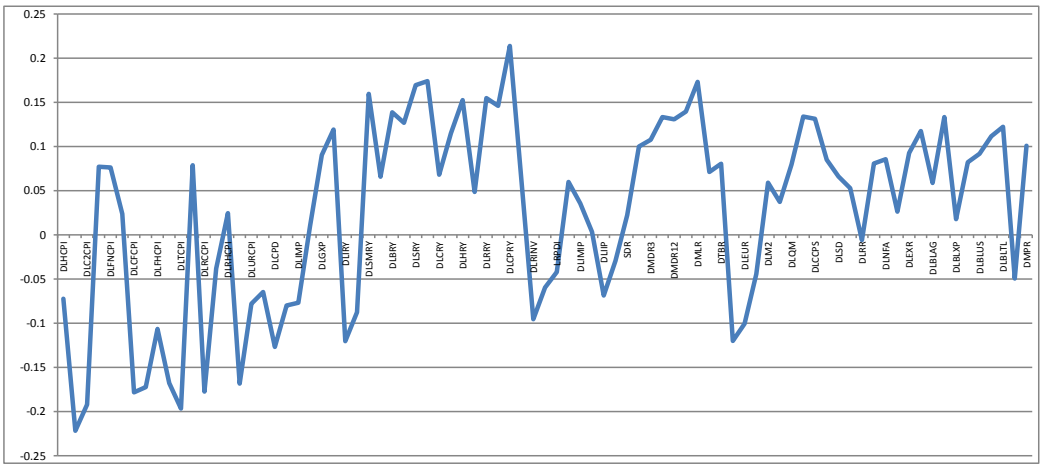
Number	Value	Difference	Proportion	Cumulative Value	Cumulative Proportion
1	13.87568	1.103897	0.1672	13.87568	0.1672
2	12.77178	4.247683	0.1539	26.64746	0.3211
3	8.524100	1.601324	0.1027	35.17156	0.4238
4	6.922776	0.611163	0.0834	42.09434	0.5072
5	6.311612	1.669962	0.0760	48.40595	0.5832
6	4.641650	1.041410	0.0559	53.04760	0.6391
7	3.600240	0.279059	0.0434	56.64784	0.6825
8	3.321182	0.498648	0.0400	59.96902	0.7225
9	2.822534	0.468542	0.0340	62.79156	0.7565
10	2.353992	0.224489	0.0284	65.14555	0.7849

Table 5.2 showed the correlation coefficient for the 10 most important variables[1] in the first three principal components extracted from the 82 variables used (excluding the policy variable). The first estimated component mainly captured the output factor of the economy, with variables such as the communication, services and personal services RGDP, transport RGDP, solid minerals RGDP, building and construction RGDP and interest rate variables recording correlation coefficients in excess of 50.0 per cent with the first principal component (PC1) (Table 5.2). The variable with the highest coefficient of correlation with PC1 was the communication, social and personal services RGDP. Thus, we concluded that

[1] For the purpose of this study, these are variables with correlation coefficients in excess of 50 per cent.

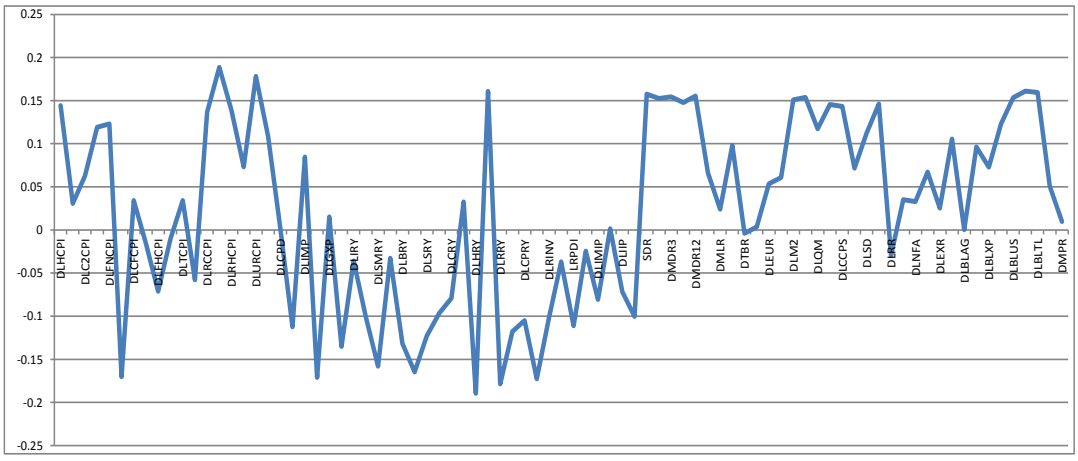
the first component represents output factor of the economy, albeit with some interest rate variables. The monthly loadings of the variables on PC1 are shown in Figure 5.1.

Figure 5.1: Monthly Variable Loadings on Principal Component 1



The second component (PC2) explained about 15.4 per cent of the total variation in the information set. It is possible to associate this component with price and credit variables in the economy. Of the first ten (10) variables with the highest correlations with PC2, two (2) of them are price variables, while three (3) are credit variables. The monthly loadings of the variables on PC2 are shown in Figure 5.2.

Figure 5.2: Monthly Variable Loadings on Principal Component 2



The third estimated component (PC3) seemed to represent the behavior of interest rates, credit and monetary aggregates, showing correlation coefficients of about 56.9, 51.4 and 51.5 per cent with maximum lending rate, total bank loan and broad money stock, respectively. The treasury bill rate and total deposit of banks had correlation coefficients of 52.7 and 54.3 per cent with the component (Table 5.2). Thus, this component could be regarded as interest rate, credit and money factor led by bank loans. The monthly loadings of the variables on PC3 are shown in figure 5.3.

Figure 5.3: Monthly Variable Loadings on Principal Component 3

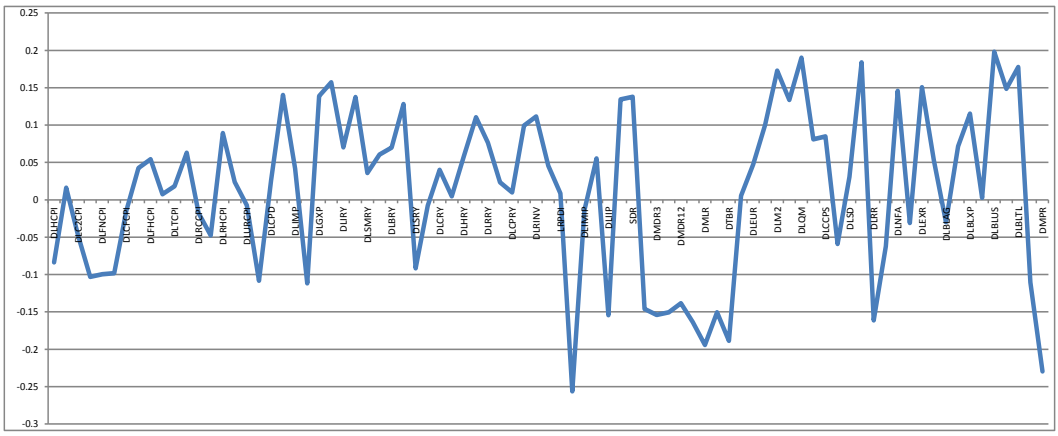


Table 5.2: Correlation between Principal Components and Key Variables - Top 10 Correlation Coefficients

Top Correlation Coefficients				
Components		**Variable**	**Correlation**	**Bloc**
Component 1	DLCPRY	Comm., Social & Pers. Services RGDP	0.7960	**Real Sector Variables**
	DLTRY	Transport RGDP	0.6493	
	DMLR	Maximum Lending Rate	0.6445	
	DLSRY	Services RGDP	0.6316	
	DLSMRY	Solid Minerals RGDP	0.5931	
	DLRRY	Real Estate & Bus. Services RGDP	0.5769	
	DLHRY	Hotel & Restaurant RGDP	0.5685	
	DLPRY	Producers of Govt. Services RGDP	0.5461	
	DPLR	Prime Lending Rate	0.5189	
	DLBRY	Building & Construction RGDP	0.5149	
Component 2	DLECPI	Education CPI	0.6744	**Money and Credit Variables; Real Variables consisting mainly of output and Price Pressure Variables**
	DLURCPI	Urban CPI	0.6371	
	DLBLOG	Bank Loan: Others – General	0.5748	
	DLFRY	Finance and Insurance RGDP	0.5739	
	DLBLTL	Bank Loan: Total	0.5695	
	SDR	Savings Deposit rate	0.5627	
	DMDR12	12 month deposit rate	0.5554	
	DMDR3	3 month deposit rate	0.5521	
	DLM11	Narrow Money Stock	0.5501	
	DLBLUS	Bank Loan: Less Preferred Sectors	0.5477	
Component 3	DLBLUS	Bank Loan: Less Preferred Sectors	0.5773	**Money and Credit Variables and Real Sector Variables**
	DLQM	Quasi Money	0.5550	
	DLTD	Total Deposits of Banks	0.5436	
	DLM2	Broad Money Stock	0.5153	
	DLBLTL	Bank Loan: Total	0.5143	
	DTBR	Treasury Bills Rate	-0.5270	
	DMLR	Maximum Lending Rate	-0.5690	
	DMPR	Monetary Policy Rate	-0.6407	
	DLIMAP	Index of Manufacturing Production	-0.7321	

5.1.2 Quarterly Data Analysis

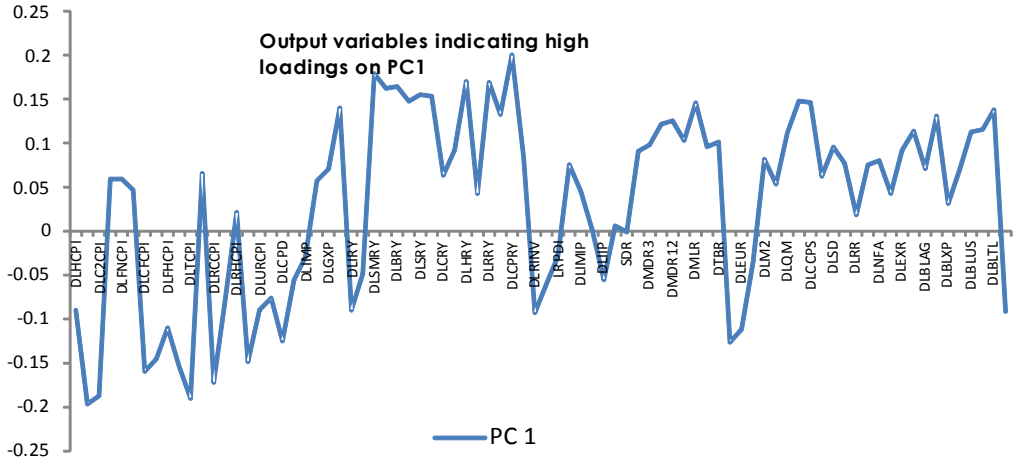
To further buttressed the results of the PCA conducted in section 5.1.1 using monthly data, quarterly data was also used. The results of the principal component analysis in Table 5.3 showed that the first three principal components, extracted from the full set of 83 macroeconomic variables, jointly accounted for about 43.4 per cent of the variation in the data space, while the first ten accounted for 80.9 per cent.

Table 5.3: Quarterly Principal Components Analysis - Eigenvalues for First 10 Components

Number	Value	Difference	Proportion	Cumulative Value	Cumulative Proportion
1	15.22833	2.538505	0.1835	15.22833	0.1835
2	12.68982	4.598631	0.1529	27.91815	0.3364
3	8.091193	0.554414	0.0975	36.00935	0.4338
4	7.536779	1.146921	0.0908	43.54613	0.5247
5	6.389858	2.133507	0.0770	49.93598	0.6016
6	4.256351	0.486776	0.0513	54.19233	0.6529
7	3.769575	0.237368	0.0454	57.96191	0.6983
8	3.532207	0.661852	0.0426	61.49412	0.7409
9	2.870355	0.122249	0.0346	64.36447	0.7755
10	2.748106	0.662962	0.0331	67.11258	0.8086

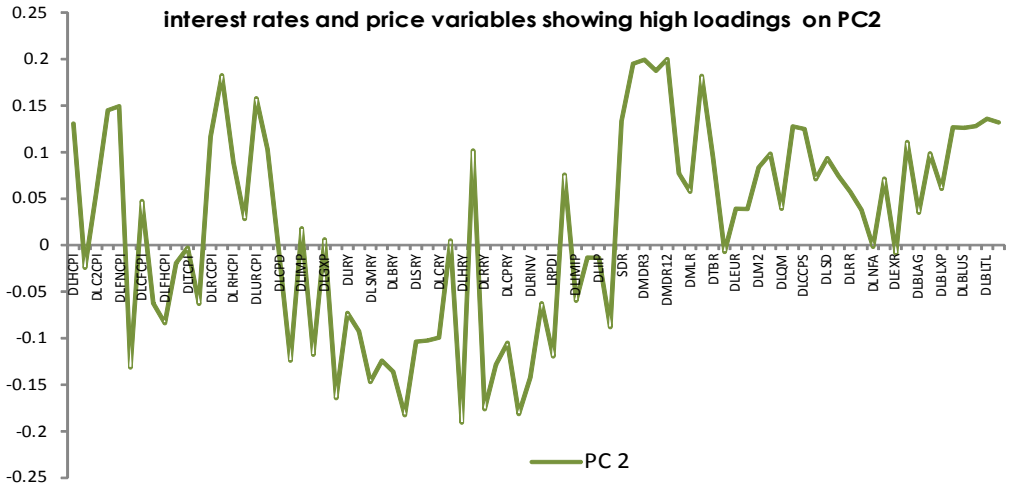
The result of the principal components analysis depicted in Table 5.4 showed that the first estimated component (PC1) mainly captured the output factor of the economy, with variables such as communication, social and personnel services RGDP, solid minerals RGDP, hotel and restaurant RGDP, real estate and business services RGDP, manufacturing RGDP and other output variables having correlation coefficients ranging between 57.0 per cent for agric. RGDP and 79.0 per cent for communication, social and personnel services RGDP. It sufficed to conclude that the first principal component represented output factor of the Nigerian economy. The quarterly loadings of the variables on PC1 are shown in Figure 5.4.

Figure 5.4: Quarterly Variable Loadings on Principal Component 1



The second principal component (PC2) was largely associated with money market interest rates with a mix of price and credit variables. Of the variables with correlations coefficients of at least 50 per cent, six (6) of them were interest rates. Among the rates, the highest was 12-month deposit rate with 68.7 per cent correlation coefficient, while the lowest was savings rate with 50.5 per cent correlation coefficient. The prices were education CPI and urban CPI. The quarterly loadings of the variables on PC2 are shown in Figure 5.5.

Figure 5.5: Quarterly Variable Loadings on Principal Component 2



As in the monthly PCA, the third principal component (PC3) represented the money and credit factors, as total deposits of banks had the highest correlation of 70.1 per cent. The broad money, quasi money, narrow money stock, credit to core private sector and credit to private sector had correlation coefficients of 67.4 per cent, 65.6 per cent, 56.6 per cent, 50.3 per cent and 49.6 per cent, respectively (Table 5.4). In effect, PC3 could be considered as money and credit factors. The quarterly loadings of the variables on PC3 are shown in Figure 5.6.

Figure 5.6: Quarterly Variable Loadings on Principal Component 3

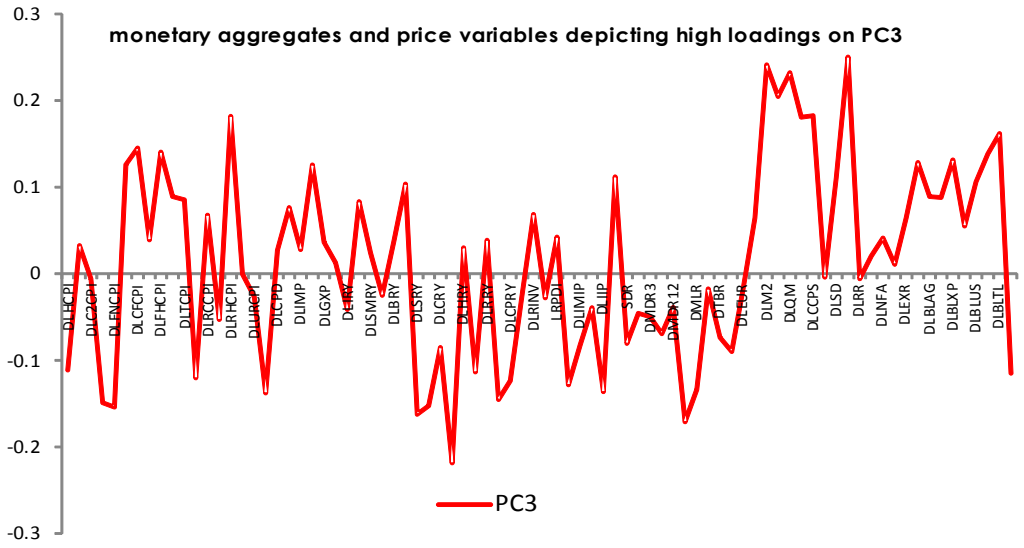


Table 5.4: Correlation between Principal Components and Key Variables - Top 10 Correlation Coefficients

Top-10 Correlation Coefficients		
Component Bloc	**Variable**	**Correlation**
	Comm. Social & Pers. Services RGDP	0.7919
	Solid Minerals RGDP	0.7045
	Hotel & Restaurant RGDP	0.6942
	Real Estate & Business Services RGDP	0.6736
PC1	Manufacturing RGDP	0.6539
	Output factor led by CSPS RGDP	
	Building & Construction RGDP	0.6888
	Wholesale & Retail Trade RGDP	0.6244
	Services RGDP	0.6213
	Transport RGDP	0.6106
	Agric. RGDP	0.5711
	12-Month Deposit Rate	0.6865
	3-Month Deposit Rate	0.6860
	1-Month Deposit Rate	0.6818
	Education	0.6533
	6-Month Deposit Rate	0.6528
	Interbank Call Rate	0.5935
PC 2	Urban CPI	0.5366
	Interest Rate Factor led by 12MDR	
	Savings Rate	0.5046
	Bank Loan: Total	0.4947
	Total Deposit of Banks	0.7012
	Broad Money Stock	0.6738
PC3	Quasi Money	0.6555
	Monetary aggregates and prices	
	Narrow Money Stock	0.5663
	Restaurant & Hotels	0.5209
	Credit to Core Private Sector	0.5029
	Credit to Private Sector	0.4964

5.2 Impulse Response Functions

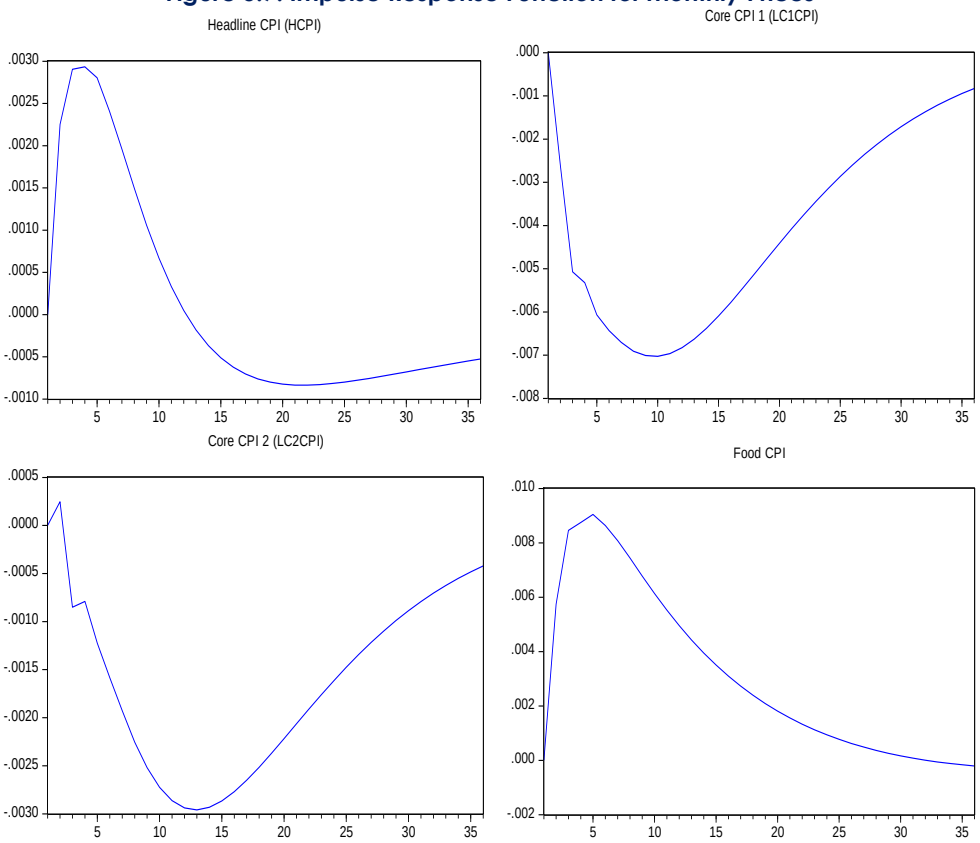
In this section, an attempt was made to evaluate the impulse response of selected macroeconomic variables to a unit shock in monetary policy rate (MPR), cash reserve ratio (CRR) and exchange rate (LUSD), over a 36-month forecast horizon. The responses of most of the variables conform to a priori expectation.

5.2.1 Estimation using Monetary Policy Rate as the Instrument (Monthly Data)

5.2.1.1 Response of CPI Components

The response of headline, core and food inflation to a standard deviation shock in monetary policy rate is shown in Figure 5.7 below. After an initial lag of about two months, headline consumer price index (HCPI) rose by 0.003 percentage point in the first five to six months before restoring back to steady state.

Figure 5.7: Impulse Response Function for Monthly Prices



The initial increase in the price level could be attributed to the 'price puzzle' found in empirical literature. The theoretical relationship between interest rate and prices was that as the interest rate rises, it increased the cost of funds to economic agents who lower their investment and eventually aggregate demand leading to a fall in prices. However, the so called price puzzle is a phenomenon where price increases in response to a tight monetary policy action. Our observations here seemed to have supported the price puzzle literature as the Headline inflation first rose before falling in response to innovations in the MPR. The initial rise in Headline inflation was mainly driven by food prices, (FCPI), rural

prices (RUCPI), and education prices (ECPI) all of which were not affected by movements in policy rates.

Like the headline inflation, the all items less farm produce (C1CPI), responded to a unit shock in the monetary policy rate only after a two-month lag, which was in line with theoretical expectations. The fall in prices lasted for about 13 months after which the trend reversed and gradually returns to steady state. The shock to C1CPI appears persistent as the trend fell to revert to steady state throughout the forecast horizon. This finding implies that core inflation responds to innovations in the monetary policy rate.

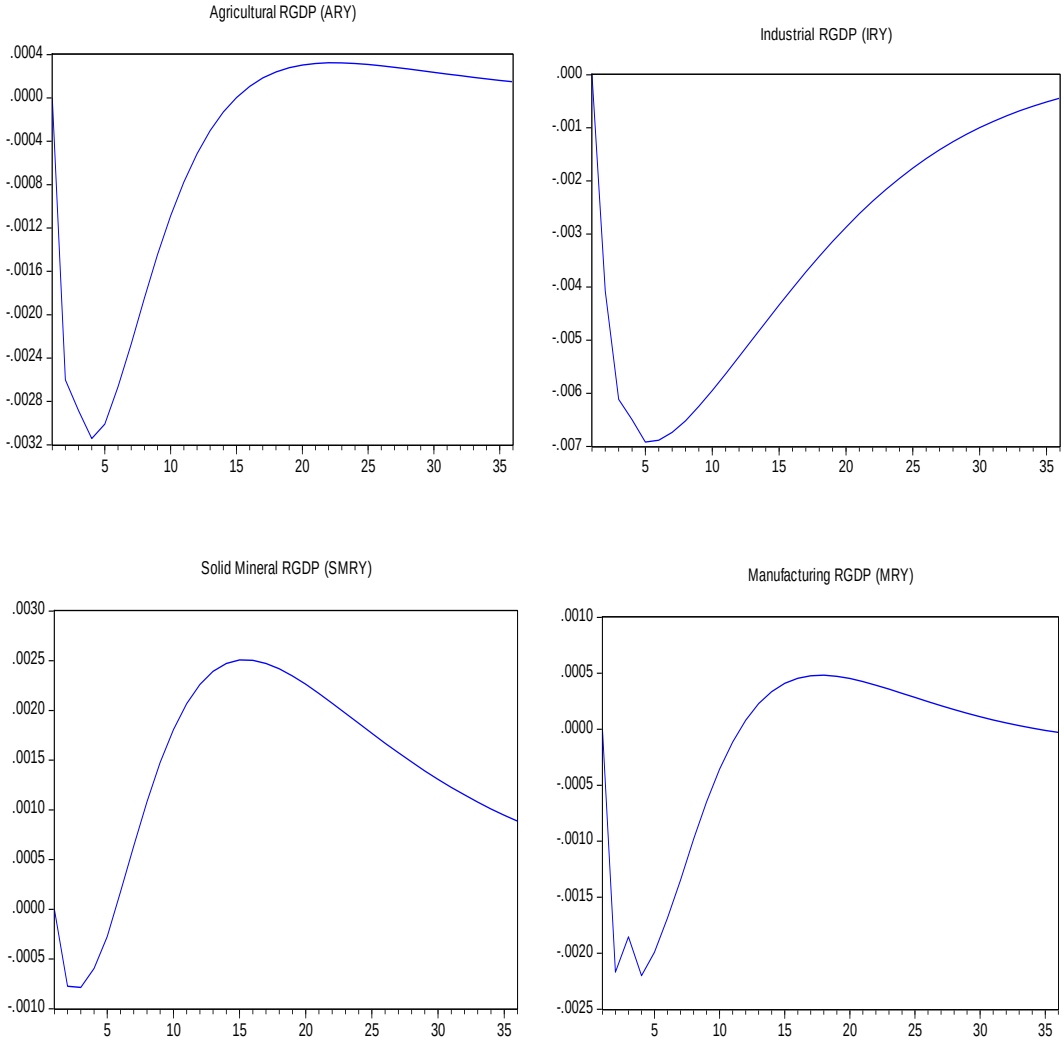
The response of the all items less farm produce and energy (C2CPI) followed the same pattern with the headline inflation. After an initial lag of about two months, C2CPI showed a slight increase that lasts for about three months before decline. The decline continued up to 14 months before reversing, though; it never reached steady state throughout the forecast horizon.

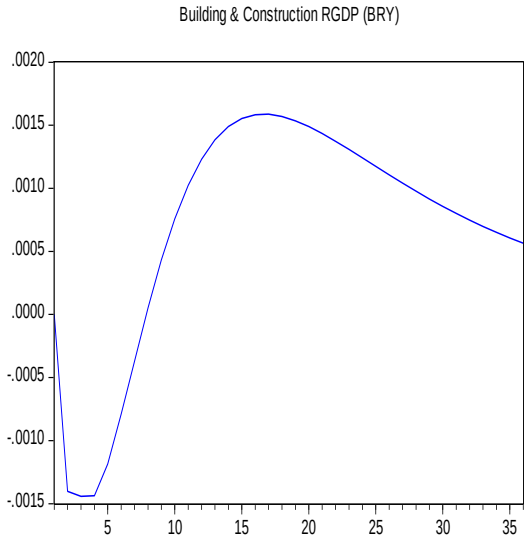
The response of food CPI to a standard deviation shock to the MPR followed the same trend with the headline inflation. There was an initial lag of about two months, followed by a rise in prices. The upward trend continued till about 9 months, peaking at 0.009 percentage deviation, gradually decelerating thereafter.

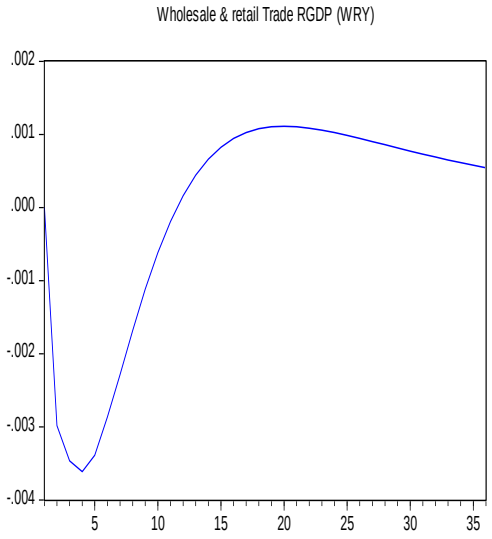
5.2.1.2 Response of Real Activities

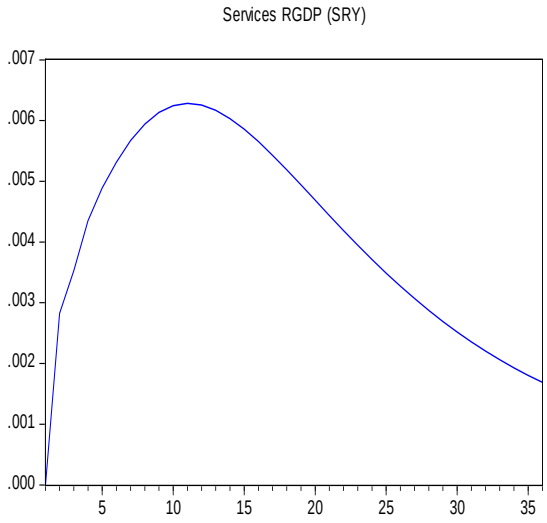
The responses of the real sector variables to a positive innovation in monetary policy rate (MPR) were mixed (see Figure 5.8). All real sector variables were consistent with theoretical expectation in terms of their responses to the policy shock, except for services RGDP. Generally, all real variables reverted to steady state during the estimation horizon except for services output.

Figure 5.8: Monthly Real Sector Components









In line with economic theory, a shock to the policy rate induced considerable decline in the activities of the agriculture, industry, solid mineral, manufacturing, building and construction and the wholesale and retail trade sectors after two months lag, albeit at varying degrees. The results showed that a standard deviation shock to monetary policy rate induced a 0.007 per cent decline in the output of the industrial sector at the 5th month, while the same shock induced a weaker response of 0.0015 per cent in the building and construction output at the 4th month. However, while equilibrium could not be attained even after 36 months horizon in the industrial sector, the shock to the building and construction sector died out after the 8th month.

Other real sector variables, namely agriculture, manufacturing and solid mineral showed an average response of 0.002 per cent during the estimation horizon. The solid mineral sector's response to a shock in the MPR exhibited the least persistence (6 months), followed by manufacturing and wholesale and retail trade. Given that the impulse response functions generated were rightly signed, it could suggest the potency of the monetary policy rate in driving the economy to the desired path.

5.2.1.3 Other Macroeconomic Variables

The response of the other macroeconomic variables to one standard deviation shock in the policy rate was with a lag and rightly signed except the exchange rate. The responses of the various variables are discussed below.

A standard deviation shock to the policy rate leads to an increase in the external reserve with a lag of about one month. The initial increase is about 0.4 unit and remains in that region, though in a fluctuating manner, up to about the 8th month before the magnitude of the impact starts to diminish. The result is theoretically consistent given that increase in the policy rate would lead to increase in the spectrum of rates within the economy thereby attracting inflow of foreign capital, particularly portfolio investment.

Exchange rate depreciated by about 0.2 percentage deviation following a standard deviation shock to the policy rate. The response appeared persistent during the forecast horizon. The result was counterintuitive, but reflected market distortions characterized by the huge government deposits in the DMBs and the access to the CBN Standing Lending Facility which tend to create liquidity surfeit unlikely to be resolved by a single instrument like the MPR. The liquidity surfeit encourages speculative activities in the foreign exchange market leading to depreciation of the naira exchange rate.

Both interbank call and the maximum lending rates showed an initial increase to a standard deviation shock in the policy rate albeit with varying magnitudes. The initial impact seemed to be highest on the interbank rate at about 0.8 unit after a lag of one month. The magnitude of the impact rose gradually, peaking at 1.2 units at the 7th month before it starts decaying. The maximum lending rate also responded to a standard deviation shock to the policy rate with a lag of one month and a magnitude of 0.5 unit. As with the interbank call rate, the response of maximum lending rate peaked at the 7th month, but at a lower level of 0.6 unit.

The response of private sector credit to a standard deviation shock to the policy rate was revealing. After a lag of one month, credit to the private sector declined

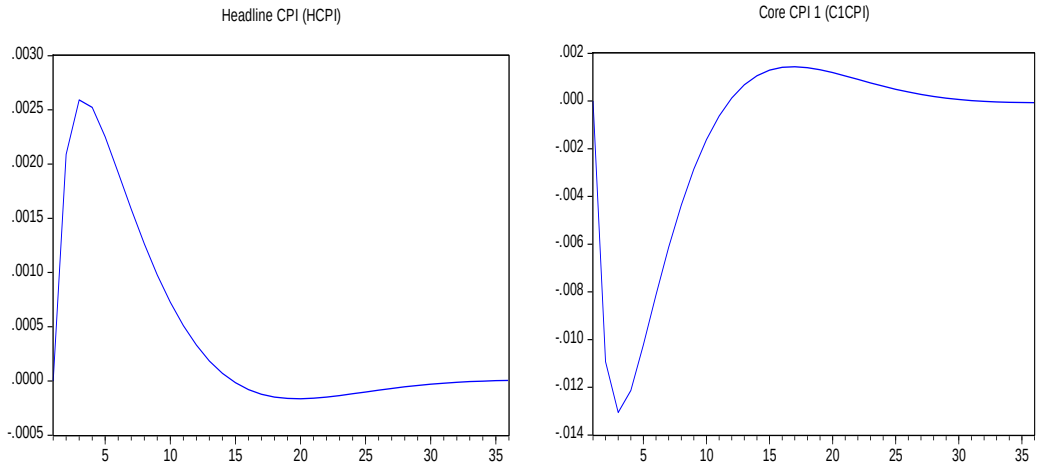
by about 0.006 unit, but commence increase at the third month which persists up to the 17th month before dying out. The initial decline was essentially a natural response of demand to higher price, but the facts that the duration of increase was more than that of the decrease and the magnitude of increase more than decline were reflection of the fact that the supply-side effect was more dominant in the credit market in Nigeria. In other words, borrowers have no alternative sources of credit implying that if rates are too low, the supply of loanable funds could dry up.

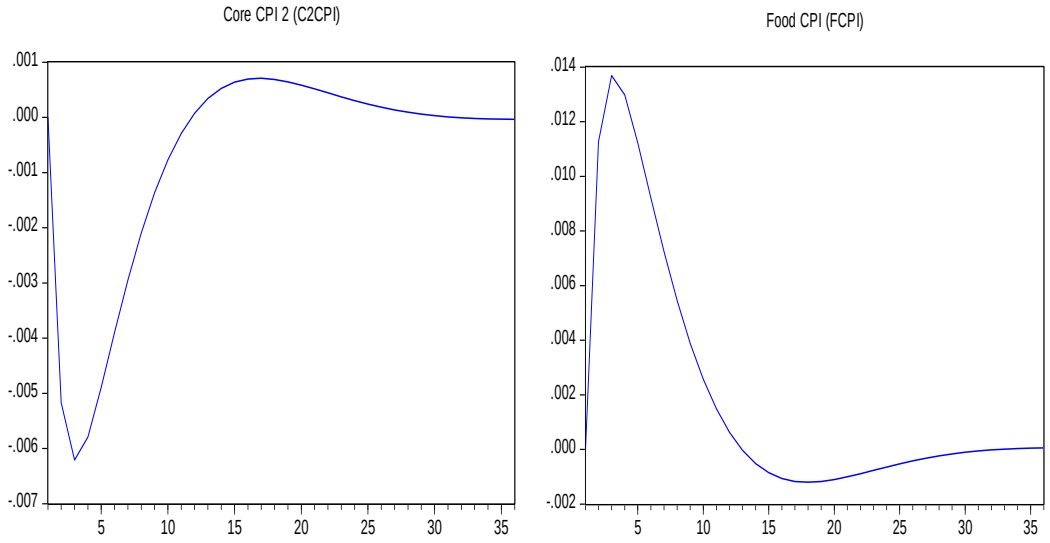
5.2.2 Estimation using Monetary Policy Rate as the Instrument (Quarterly Data)

5.2.2.1 Response of CPI Components

The impulse response functions of selected variables based on quarterly data are discussed in this section. Generally, the results followed the same pattern with the analysis obtained from the monthly data (as shown in Figure 5.9). The response of headline and food inflation to a standard deviation shock in the monetary policy rate indicated a puzzle given that both of them rose contrary to theoretical expectations. Core inflation, on the other hand, responded in accordance with a priori expectation. This implies that core inflation is more responsive to the MPR. The contrary result obtained with respect to headline inflation may not be unconnected with the large weight of food components in the CPI basket.

Figure 5.9: Impulse Response Functions for Quarterly Prices





The initial increase in prices in response to a contractionary monetary policy is a common phenomenon in most empirical studies measuring the effects of monetary policy on the economy (Bernanke and Blinder, 1992; Christiano et al., 1994; Blaes, 2009). This phenomenon is often referred to as the '*price puzzle*' in the literature because macroeconomic models either cannot explain it theoretically (eg a standard sticky-price model) or, even when capable of explaining it in principle, they do not produce a positive price response empirically (Soares, 2012).

Upon disaggregation of headline inflation into its components, we found that this strong positive response was mainly driven by the behaviour of food (FCPI) and communication (CCPI) components.

The response of core inflation to monetary tightening is in line with the theoretical expectations, because a higher short-term interest rate leads to a higher inflation. After the monetary policy shock (in this case, one standard deviation shock), there was an initial lag after which the price began to fall. The price fell sharply by 0.0017 points recorded at the 5th quarter. Similarly, the price effect showed strong persistence as the effects died down only after 25 quarters. The implication is that MPR could impact core inflation more effectively than headline and food inflation.

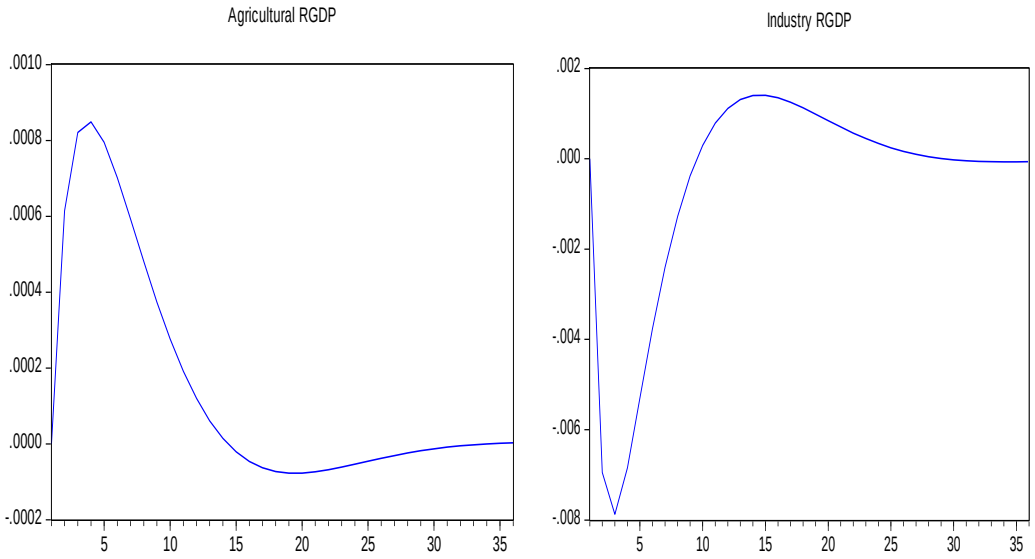
Like other components, the response of furniture and household equipment maintenance, health and transport inflation to monetary policy shock corresponded to the a priori expectations.

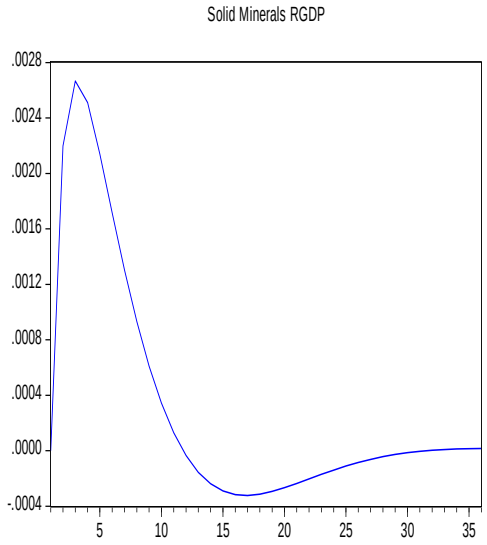
Like the food prices, communication prices exhibited some puzzling characteristics, with initial positive response to a monetary policy shock before reverting to price decline. Initially the price rose by 0.0016 percentage points after 5 quarters before falling gradually and rescinding to zero level.

5.2.2.2 Response of Real Activities

The response of real sector variables to a one standard deviation innovation in the MPR do not conform to economic theory, except industry and wholesale and retail trade. Generally, the impact of the shock is instantaneous with wholesale and retail trade, services and industry having the highest impact.

Figure 5.10: Quarterly Real Sector Components




Solid Minerals RGDP
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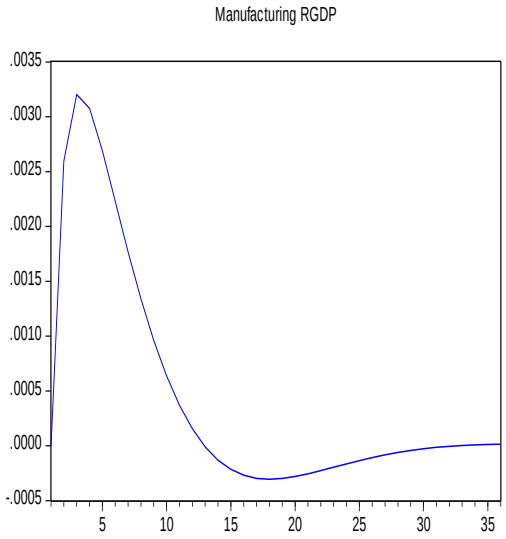
Manufacturing RGDP
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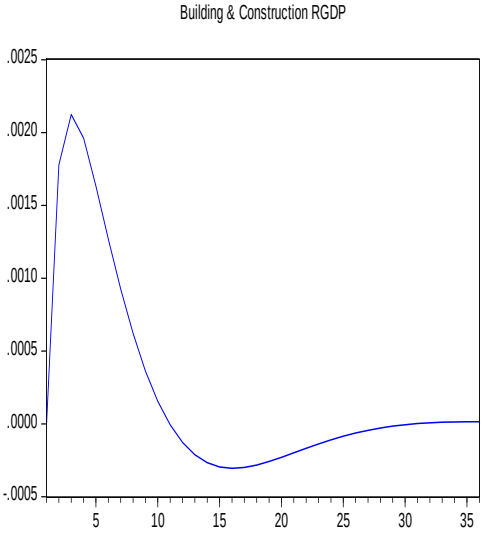
Building & Construction RGDP
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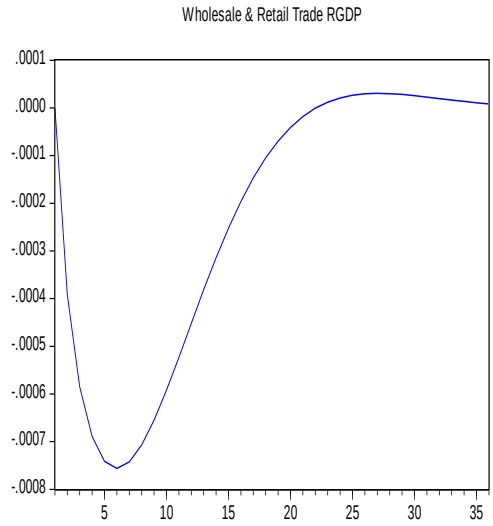
Wholesale & Retail Trade RGDP
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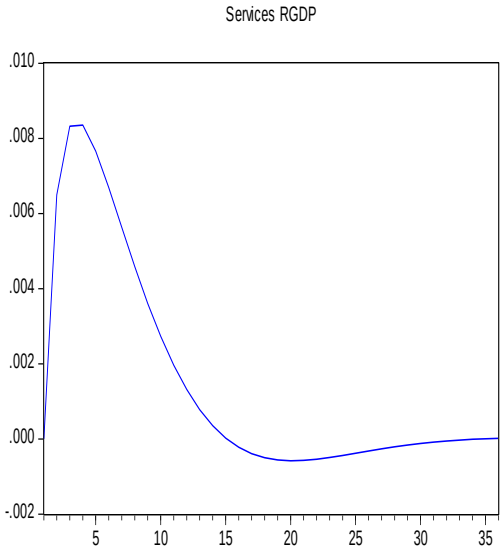


Figure 5.10 showed the impulse response function of industry and wholesale and retail trade sectors to a standard deviation shock to the MPR. A positive shock to the policy rate impacted negatively on industrial production and builds up until the tenth quarter; the highest impact of 0.008 percentage deviation was achieved at the fifth quarter. This is in line with *a priori* expectation. The response of wholesale and trade output mimic the industry pattern exhibiting a contemporaneous response in the first quarter with a magnitude of about 0.008 percentage deviation. The impact of the shock persisted until the 22nd quarter, implying that an increase in the MPR plays a significant role in stimulating real economic activities.

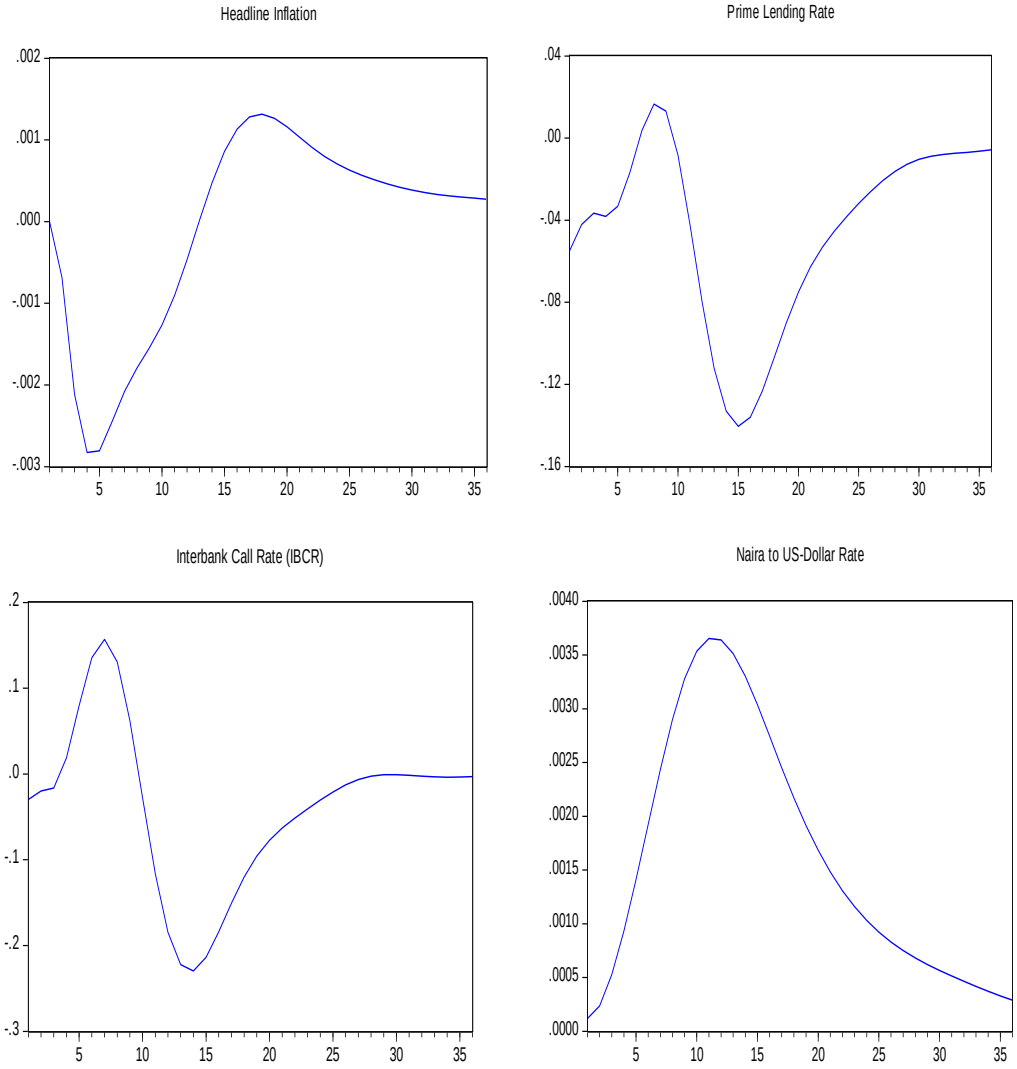
Contrary to the a priori expectation, agriculture, solid minerals, services, manufacturing and building and construction sectors show increases in response to a standard deviation shock to the MPR. This finding contradicted the results obtained using monthly data. This reveals that output sector is either insensitive to interest rate or it depends on other sources of funding outside money market.

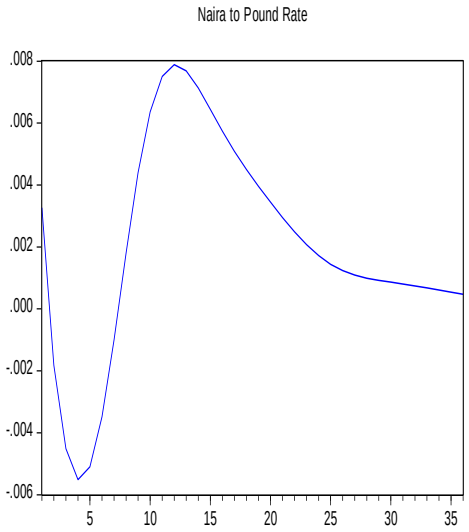
5.2.3 Estimation using Cash Reserve Ratio (CRR) as the Instrument

The impact of a standard deviation shock to the CRR did not have a contemporaneous effect on headline inflation, but declined steadily to a 0.003 percentage point up to the 4th quarter. The implication of the results is that actions on the CRR lingers beyond 4 cycles (8 months) of the monetary policy committee meetings. This finding suggests that the CRR could be more potent in influencing headline inflation than the MPR.

A standard deviation shock to the CRR initially led to a decline in both the interbank call and prime lending rates. This seemingly dampening effect is short-lived as the rates reverted almost immediately and got to the positive region by the fifth quarter. This result is counter-intuitive and may not be unconnected with the oligopolistic structure of the banking system in Nigeria and the incidence of structural liquidity.

Figure 5.11: Response of Selected Macroeconomic Variables to the CRR Shock




Naira to Pound Rate
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.006
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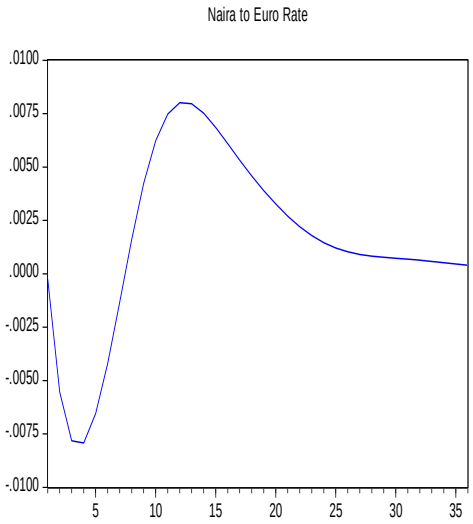
Naira to Euro Rate
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.0050
.0025
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-.0075
-.0100
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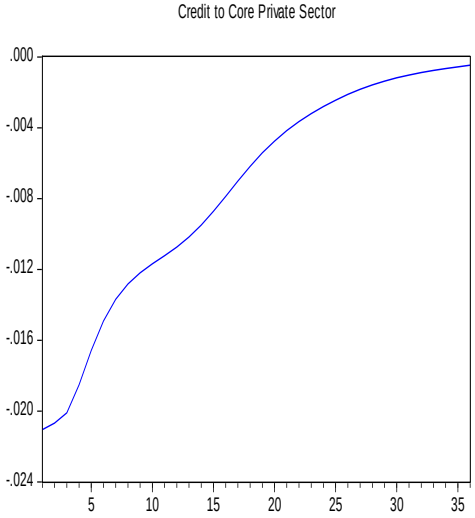
Credit to Core Private Sector
.000
-.004
-.008
-.012
-.016
-.020
-.024
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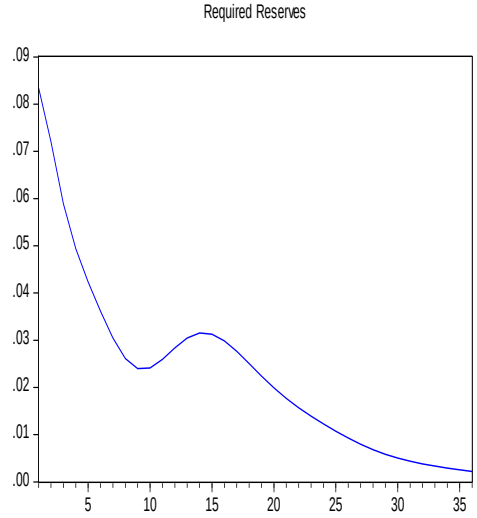
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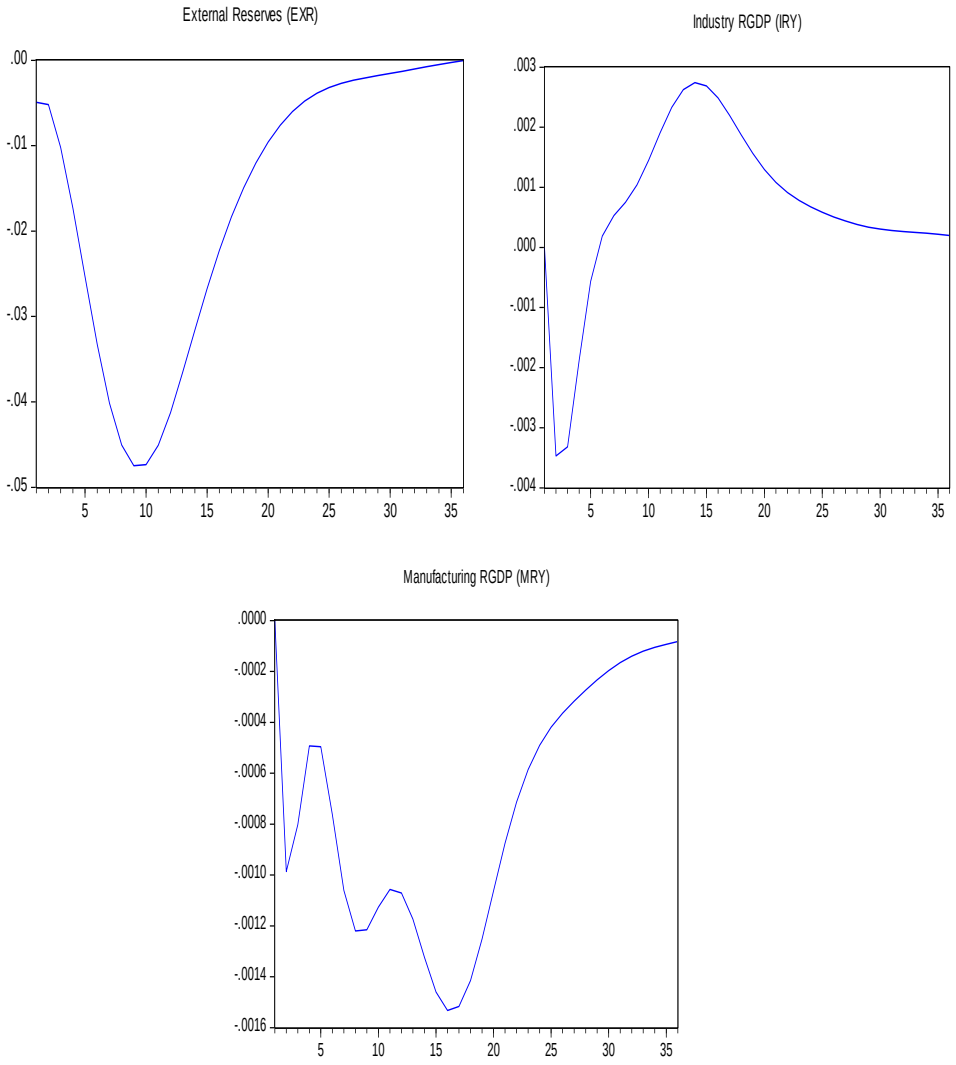


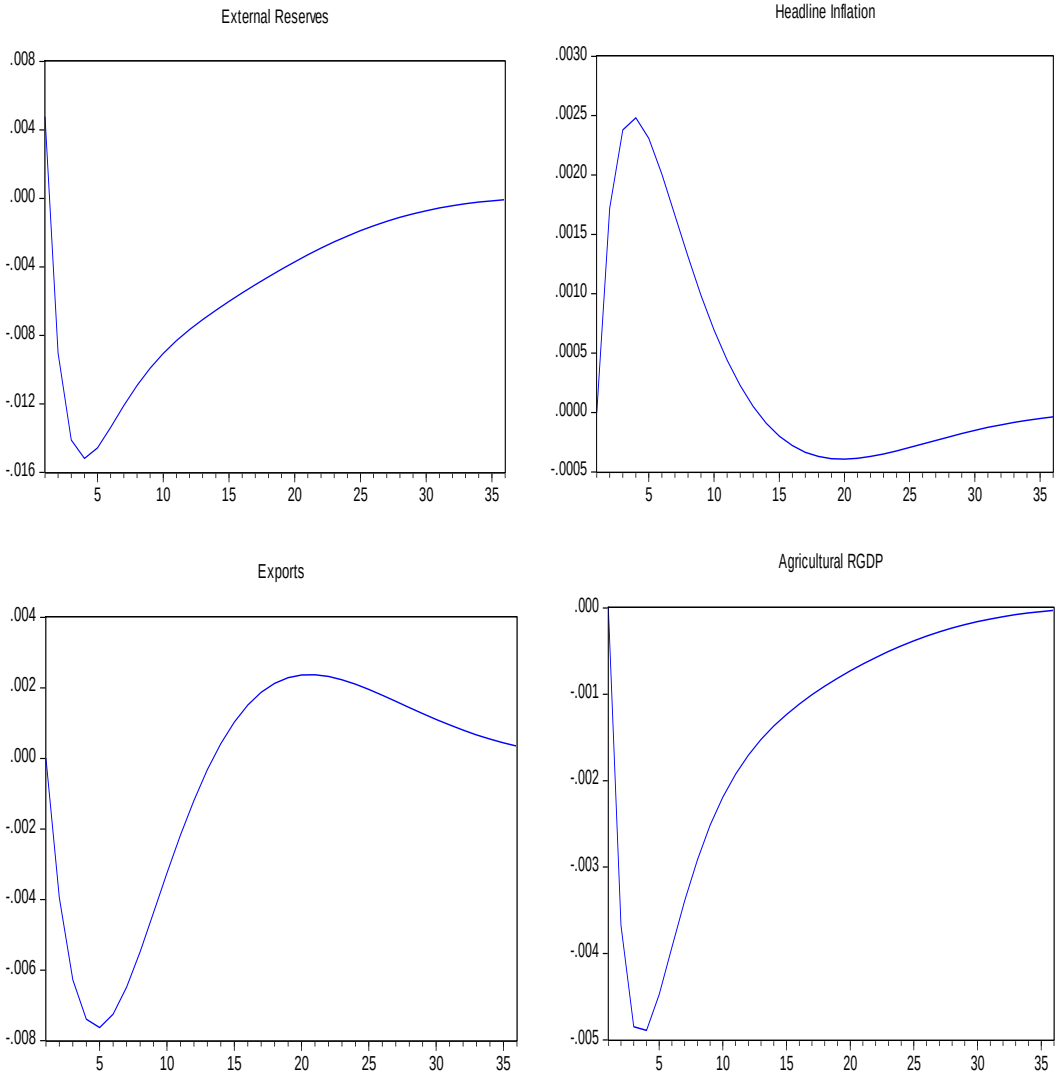
5.2.4 Estimation using Exchange Rate (LUSD) as the Instrument

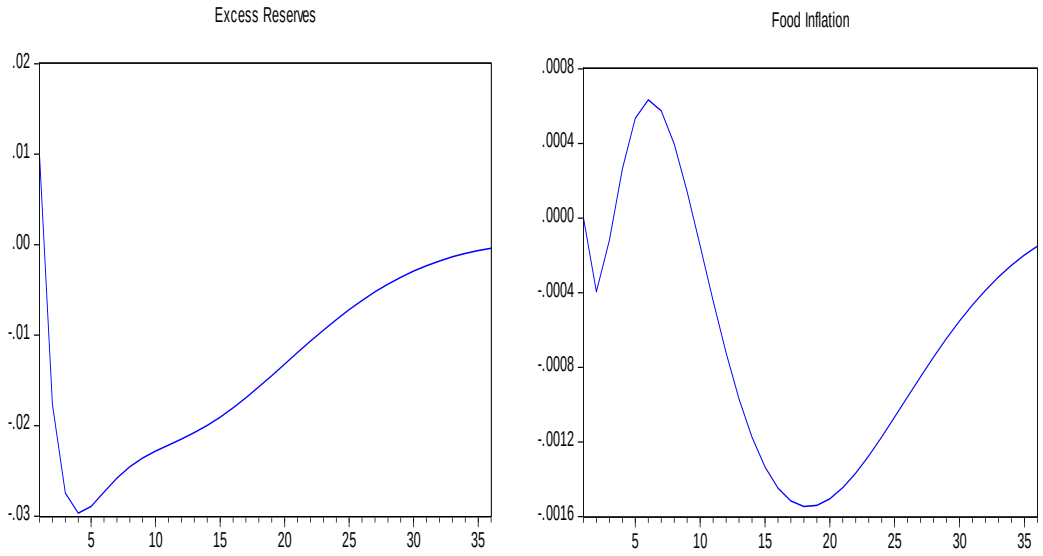
The response of external reserves to exchange rate shocks is strong and instantaneous. A one standard deviation shock to exchange rate caused external reserves to rise immediately, which is line with economic theory and drop sharply in the next quarter, reaching a trough at the 4th quarter. Thereafter, the trend reversed until it returns to steady state at the 36th quarter. Theoretically, the impact of depreciation was to increase external reserves due to improved competiveness of exports and imports resulting in increased foreign exchange earnings and reduced import bills. The finding of this study suggests that depreciation of exchange rate could lead to decline in external reserves over the medium- to long-term horizon. This finding probably reflects the peculiarities of the

Nigerian economy where the elasticities of demand for and supply of exports and imports are less than one (inelastic).

A standard deviation shock to the exchange rate caused headline inflation to rise sharply and instantaneously attaining the highest level at the 5th quarter. The effect is persistent as the rate fails to return to steady state even at the end of the forecast horizon. The strong positive response of prices to exchange rate shock suggests an exchange rate pass-through to domestic prices in Nigeria.

Figure 5.12: Response of Selected Macroeconomic Variables to Exchange Rate Shocks





The response of exports to an innovation in the exchange rate was positive, but declined in the 2nd quarter attaining its minimum level in the 5th quarter before rising gradually and reaching a steady state in the 36th quarter. This counter-intuitive response may not be unconnected to the fact that the major export of Nigeria is crude oil whose price and volume traded are determined at the international oil market.

The agricultural RGDP response to a standard deviation shock to the exchange rate was negative attaining its lowest ebb in the 3rd quarter. Since the proportion of Nigeria's agricultural products exported relative to total production was not significant, the overall output may not benefit from the depreciation. In addition, this may occur if the import demand elasticity for agricultural produce less than one as observed, depreciation may not necessarily benefit agricultural production as theory predicts. The implication of this is that exchange rate policy may not be appropriate for supporting agricultural production in Nigeria.

The initial response of DMBs excess reserves to the exchange rate shock was positive, but the trend reverses immediately to a sharp fall, reaching its minimum level at –0.03 percentage deviations in the 4th quarter. Thereafter, the curve returned gradually to the steady state.

5.3 Forecast Error Variance Decomposition Analysis

In this paper, the correlation coefficients explain the relationship between the variables and the principal components. The forecast error variance decomposition (FEVD) gave further insight into this relationship. The eigenvector,

on the other hand, explained the contribution of each variable to the individual component. Table 5.5 showed the correlation coefficients and factor loadings relating to variables contained in the different principal components, while appendix II reported the variance decomposition at horizons for 36 months with respect to the various principal components (PC1N, PC2N, and PC3N) and the policy variable MPR.

Table 5.5: Correlation and Factor Loading Coefficients Between Principal Components and Key Variables - Top 10 Coefficients

Top Correlation Coefficients					
Components		**Variable**	**Correlation**	**Eigenvectors (loadings)**	**Bloc**
Component 1	DLCPRY	Comm., Social & Pers. Services RGDP	0.7960	0.2136	**Price Variables and Real Sector Variables**
	DLTRY	Transport RGDP	0.6493	0.1738	
	DMLR	Maximum Lending Rate	0.6445	0.1731	
	DLSRY	Services RGDP	0.6316	0.1693	
	DLSMRY	Solid Minerals RGDP	0.5931	0.1595	
	DLRRY	Real Estate & Bus. Services RGDP	0.5769	0.1548	
	DLHRY	Hotel & Restaurant RGDP	0.5685	0.1523	
	DLPRY	Producers of Govt. Services RGDP	0.5461	0.1460	
	DPLR	Prime Lending Rate	0.5189	0.1393	
	DLBRY	Building & Construction RGDP	0.5149	0.1385	
Component 2	DLECPI	Education CPI	0.6744	0.1886	**Money and Credit Variables; Real Variables consisting mainly of output and Price Pressure Variables**
	DLURCPI	Urban CPI	0.6371	0.1782	
	DLBLOG	Bank Loan: Others - General	0.5748	0.1609	
	DLFRY	Finance and Insurance RGDP	0.5739	0.1606	
	DLBLTL	Bank Loan: Total	0.5695	0.1595	
	SDR	Savings Deposit rate	0.5627	0.1575	
	DMDR12	12 month deposit rate	0.5554	0.1553	
	DMDR3	3 month deposit rate	0.5521	0.1544	
	DLM11	Narrow Money Stock	0.5501	0.1538	
	DLBLUS	Bank Loan: Less Preferred Sectors	0.5477	0.1534	
Component 3	DLBLUS	Bank Loan: Less Preferred Sectors	0.5773	0.1980	**Money and Credit Variables and Real**
	DLQM	Quasi Money	0.5550	0.1903	
	DLTD	Total Deposits of Banks	0.5436	0.1839	

DLM2	Broad Money Stock	0.5153	0.1727	**Sector Variables**
DLBLTL	Bank Loan: Total	0.5143	0.1778	
DTBR	Treasury Bills Rate	-0.5270	-0.1888	
DMLR	Maximum Lending Rate	-0.5690	-0.1944	
DMPR	Monetary Policy Rate	-0.6407	-0.2298	
DLIMAP	Index of Manufacturing Production	-0.7321	-0.2562	

A cursory look at the variables that showed strong absolute correlation coefficients as well as high eigenvalues related to factor loadings in PC1N revealed mainly real sector variables (8 output categories). The results indicated that the variation in PC1N was significantly influenced by itself in the first month, despite the increased influence from other components and variable. A gradual change was observed in the 18th month, where variations in PC1N were accounted for by PC1N (output pressure), PC2N (price and interest rate pressure), PC3N (money and credit pressure) and MPR by 77.97, 5.12, 0.57 and 16.33 per cent, respectively. This influence evolved modestly over the horizon till the 36th month where the individual contribution of PC2N, PC3N and MPR increased to 7.47, 0.59 and 17.74 per cent, respectively, while PC1N has a reduced influence. It can be inferred from these results that the MPR had influence on the first component.

Table 5.6: Variance Decomposition of PC1N

Time Horizon	S.E.	PC1N	PC2N	PC3N	D(MPR)
1	0.9392	100.0000	0.0000	0.0000	0.0000
3	1.9496	91.6346	3.8754	0.8130	3.6770
6	2.8750	88.5485	3.7275	0.8476	6.8764
9	3.2980	86.2924	2.9316	0.7205	10.0556
12	3.5150	83.3164	3.1440	0.6362	12.9034
15	3.6459	80.3304	4.0725	0.5946	15.0024
18	3.7295	77.9732	5.1208	0.5707	16.3352
21	3.7820	76.3660	5.9845	0.5552	17.0943
24	3.8136	75.3663	6.5988	0.5479	17.4870
27	3.8319	74.7822	6.9996	0.5498	17.6684
30	3.8423	74.4555	7.2461	0.5604	17.7381
36	3.8514	74.1799	7.4714	0.5998	17.7488

Table 5.7 also reveals that a constellation of price and interest rate variables are closely associated with the second principal component (PC2N). The results

indicate that changes in the PC2N in the first month are accounted for by PC1N (0.006 per cent) and its own shock (99.99 per cent) only. Midway into the forecast horizon, MPR influenced the variation in PC2N by 5.66 per cent, while PC1N and PC3N impacted on the variation by 5.60 and 8.91 per cent, respectively. At the end of the forecast horizon, MPR accounted for a modest 9.41 per cent of the variation in PC2N, while PC1N, PC2N and PC3N affected the variation in the component by 5.67, 69.82 and 15.11 per cent, respectively. The relative small effect of the policy rate on the second component could be linked to the persistence of output pressures.

Table 5.7: Variance Decomposition of PC2N

Period	S.E.	PC1N	PC2N	PC3N	D(MPR)
1	0.9042	0.0069	99.9931	0.0000	0.0000
3	1.8304	6.8573	88.6778	0.2038	4.2611
6	2.5429	6.9534	86.6525	0.7821	5.6120
9	2.8002	6.2843	86.0561	2.3674	5.2922
12	2.9060	5.8530	84.6317	4.5599	4.9554
15	2.9714	5.6630	82.3732	6.8554	5.1085
18	3.0261	5.6030	79.8112	8.9264	5.6594
21	3.0755	5.5985	77.3555	10.6518	6.3942
24	3.1194	5.6129	75.2008	12.0314	7.1549
27	3.1575	5.6305	73.3989	13.1128	7.8578
30	3.1897	5.6459	71.9317	13.9530	8.4694
36	3.2381	5.6658	69.8191	15.1081	9.4070

The PC3N, which mainly consisted of money and credit variables, was more responsive to a monetary policy rate shock. The results indicated that the variations in the PC3N in the first month are accounted for by PC1N (2.35 per cent), PC2N (0.0095 per cent) and its own shock (97.64 per cent) only. At the 18th period, the MPR influenced the variation in PC3N by 46.86 per cent, while PC1N and PC2N's impacted on the variation was 1.14 and 15.82 per cent, respectively. At the 36th period, MPR accounted for a 47.60 per cent of the variation in PC3N, while PC1N, PC2N and own shock (PC3N) recorded 1.23, 15.24 and 35.94 per cent, respectively. The variation in the third component was associated mainly with policy and own shocks.

Table 5.8: Variance Decomposition of PC3N

Period	S.E.	PC1N	PC2N	PC3N	D(MPR)
1	0.7742	2.3476	0.0095	97.6429	0.0000
3	1.4046	2.8097	11.7911	60.7225	24.6766
6	2.0629	1.8687	15.8401	44.3970	37.8942
9	2.4440	1.4274	16.2623	39.4047	42.9056
12	2.6757	1.2418	16.1465	37.4582	45.1536
15	2.8250	1.1665	15.9753	36.5906	46.2676
18	2.9248	1.1444	15.8162	36.1816	46.8578
21	2.9931	1.1477	15.6757	35.9916	47.1850
24	3.0405	1.1621	15.5539	35.9126	47.3715
27	3.0739	1.1801	15.4503	35.8905	47.4790
30	3.0977	1.1983	15.3639	35.8968	47.5409
36	3.1273	1.2296	15.2355	35.9394	47.5955

The variance decomposition analysis of the monthly series, over a 36-month period, showed that shock to the MPR absorbs 78.33 per cent of its own shock in the 1st month, while components 1, 2 and 3 explained 0.07, 0.77 and 20.81, respectively. Component 1 accounted for 20.81 per cent at the 1st month, declining gradually to 20.29 and 20.23 per cent at the 3rd and the 18th month horizons. Steadily, PC1 rose to 5.86 and 6.66 per cent at the 3rd and the 18th horizon, respectively.

Table 5.9: Variance Decomposition of MPR

Period	S.E.	PC1N	PC2N	PC3N	D(MPR)
1	0.6463	0.0689	0.7763	20.8160	78.3388
3	0.6799	5.8651	0.9347	20.2957	72.9045
6	0.6850	5.9066	0.9863	20.1246	72.9825
9	0.6879	6.1874	1.1147	20.1537	72.5442
12	0.6899	6.4481	1.1912	20.1781	72.1825
15	0.6909	6.5912	1.2118	20.2073	71.9897
18	0.6915	6.6609	1.2134	20.2355	71.8902
21	0.6918	6.6950	1.2124	20.2598	71.8328
24	0.6920	6.7124	1.2120	20.2800	71.7957
27	0.6922	6.7217	1.2119	20.2968	71.7696
30	0.6923	6.7270	1.2119	20.3106	71.7505
36	0.6925	6.7319	1.2116	20.3314	71.7251

5.4 Policy Implications

- The factor loadings from the principal component analysis showed that the first component mainly captured the output factor of the economy, with variables such as the communication, services and personal services RGDP, transport RGDP, solid minerals RGDP and building and construction RGDP recording correlation coefficients in excess of 50.0 per cent with the component. The second component largely embodied prices and money market interest rates. Notably, education and urban CPI had correlation coefficient of 67.4 and 63.7 with PC2, respectively. Other variables with high loadings with PC2 included bank loans, savings deposit rate and 3-month deposit rate. The third principal component (PC3) mainly represented money and credit variables. Total deposits, broad money, quasi money, narrow money stock, restaurant and hotels price, credit to core private sector, credit to private sector and total bank loan had very high correlation coefficients with the component. The implication of this categorization is that the performance of the economy can be evaluated under three main factors namely, output, prices and credit factors.

- From the analysis, headline inflation responded contrary to one standard deviation positive shock in the MPR by rising in the first five to six months, while core inflation declined as expected. This suggests that core inflation might be more sensitive to shocks in monetary policy rate than headline inflation.

- The results also showed that credit to the private sector increases generally in response to a standard deviation shock in the MPR, implying that the credit market in Nigeria is largely supply driven.

- With regards to the external sector, it was found that a shock to the MPR led to an accretion in external reserves which implies that adjustment of the MPR could be used by the Monetary Policy Committee (MPC) to manage the external reserves in Nigeria.

- Unlike its response to the MPR, headline inflation declined following a shock to the CRR. This implies that the CRR could be more potent in influencing headline inflation than the MPR.

- A one standard deviation shock to the exchange rate caused headline inflation to rise sharply and almost instantaneously, implying that stable

exchange rate is critical to price stability objective of the Central Bank of Nigeria.

- A one standard deviation shock to the exchange rate caused external reserves to decline in the medium- to long-term period. This implies that, contrary to theoretical expectation, exchange rate depreciation could hurt the accumulation of external reserves in Nigeria.

Chapter Six

6.0 Summary, Recommendations and Conclusion

6.1 Summary

The study examined the effectiveness of monetary policy on the consumer price index, real sector variables and other economic indicators using a Factor-Augmented Vector Autoregressive (FAVAR) approach in Nigeria. Unlike the standard VAR that accommodates only a few number of variables, the FAVAR technique, popularized by Bernanke et al (2005), captures a much wider information range of variables that allow for a more robust analysis of the monetary policy transmission mechanism process. The study considered the different impulse response function of 21 variants of price groups that comprise the consumer price index, seven representative real activity indicators and five other key macroeconomic components, namely: external reserves, exchange rate, inter-bank call rate, maximum lending rate and credit to the private sector. The inclusion of other variables in the model is intended to identify the shocks transmitted into the economy.

Analysis of the factor loadings from the principal component analysis showed that the first component mainly captured the output factor of the economy, with variables such as the communication, services and personal services RGDP, transport RGDP, Solid minerals RGDP and building and construction RGDP recording correlation coefficients in excess of 50.0 per cent with the component. The second component largely embodies prices and money market interest rates. Notably, education and urban CPI have correlation coefficient of 67.4 and 63.7 with PC2, respectively. Other variables with high loadings with PC2 include bank loans; savings deposit rate and 3-month deposit rate. The third principal component (PC3) mainly represents money and credit variables. Total deposits, broad money, quasi money, narrow money stock, restaurant and hotels price, credit to core private sector, credit to private sector and total bank loan had very high correlation coefficients with the component. The implication of this categorization is that the performance of the economy can be evaluated under three main factors, namely output, prices and credit factors.

The response of headline, core and food inflation to a standard deviation shock to the MPR showed mixed results, with headline and food inflation rising, while core inflation declined. A further examination of the impulse response of the real sector activities showed that a shock in the MPR induced a decline in the activities of the agriculture, industry, solid mineral, manufacturing, building and construction and wholesale and retail trade sectors after two months, albeit at varying degrees. The response of the other macroeconomic variables to a

standard deviation shock in the policy rate was with a lag and rightly signed except the exchange rate.

A shock to the cash reserve ratio (CRR) led to a steady decline in headline inflation up to the 4th quarter. The implication of the results was that actions on the CRR lingers beyond 4 cycles of the Monetary Policy Committee meetings. The general response of both the interbank and prime lending rates to a shock in the CRR seemed to be an increase, although, with a temporary initial decline. The exchange rates of the naira to British pound and the euro appreciated in response to a shock to CRR. This suggests that headline inflation responds better to a shock in the CRR than in the MPR.

6.2 Recommendations

In the light of the findings, this study recommends that:

i. In order to compliment the use of MPR, emphasis should be placed on the use of CRR and exchange rate in influencing headline inflation.

ii. The monetary authority should place considerable premium on short-term inflation forecast as a way to enhancing forward looking policies

iii. The monetary authority should be cautious about maintaining a restrictive monetary policy stance in a period of slow down in output in order to avoid triggering recession.

iv. The monetary authority could resort to upward adjustment in the policy rate when the level of external reserve is declining.

v. The interbank market should be well developed in view of the fact that the interbank rate has the highest response to a shock in the policy rate. In addition, the bank should continue to monitor the behavior of the short-term interest rates in the light of their strong response to the MPR.

vi. Given the result that the credit market in Nigeria is largely supply-driven, the monetary authority should be cautious about the adjustment in the policy rate when the objective is to stimulate the flow of credit to the private sector.

vii. The depreciation of the exchange rate may not be the best strategy to increase external reserves as the result indicates loss of external reserve with long persistence due to depreciation.

6.3 Conclusion

In conclusion, it is noted that the FAVAR serves as a highly flexible and complementary approach to identifying monetary policy innovations through the use of a large number of information on available macroeconomic time series. While three main pressures, namely, real output; prices and interest rates; and money and credit are discernible from the factor analysis, there are varied impacts of key policy instruments (the MPR, the CRR and the exchange rate) on the macroeconomic time series. The evidence shows, for instance, that headline inflation responds better to a shock in the CRR than in the MPR. From the perspective of the price level indices, the all items less farm produce is more responsive to the MPR than all items CPI. The study which reveals that the interest rate channel is still relevant in driving the real sector of the economy, also shows strong support for the use of a policy mix that is inclusive with a view to re-balancing the low inflation objective and output expansion. The study similarly confirms the review of macroeconomic developments within two months since actions on the CRR lingers beyond 4 cycles of the Monetary Policy Committee meetings.

6.4 Areas for Further Research

This study has not been able to evaluate restrictions within the scope of the current FAVAR approach. Consequently, further research is required into the issue of identifying restrictions to clearly bring into the FAVAR methodology to make it theory consistent. Going forward, different types of shocks would be deployed to assess the evidence of price puzzle and asymmetric effects of various policy measures using sign restrictions. These issues can be implemented in a structural Factor–Augmented Vector Autoregression (SFAVAR).

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APPENDIX I

Appendix A

S/N	Acronym	Description	Ordered Transformation	Source
Consumer Price Indices (CPIs)				
1	**HCPI****,2**	All Items CPI (weight = 1000; Nov. 2009 = 100)	T8	NBS
2	**C1CPI****,2**	All Items less Farm Produce (weight = 513.10; Nov. 2009 = 100)	T8	NBS
3	**C2CPI****,2**	All Items less Farm Produce. and Energy (weight = 405.55; Nov. 2009 = 100)	T8	NBS
4	**FCPI****,2**	Food (weight = 507.06; Nov. 2009 = 100)	T8	NBS
5	**FNCPI****,2**	Food & Non Alcoholic Beverage (weight = 518.00; Nov. 2009 = 100)	T8	NBS
6	**ABCPI****,1**	Alcoholic Beverage, Tobacco and Kola (weight = 10.87; Nov. 2009 = 100)	T8	NBS
7	**CFCPI****,2**	Clothing and Footwear (weight = 76.50; Nov. 2009 = 100)	T8	NBS
8	**HWCPI****,2**	Housing Water, Electricity, Gas and Other Fuel (weight = 167.34; Nov. 2009 = 100)	T8	NBS
9	**FHCPI****,2**	Furnishings & Household Equipment Maintenance (weight = 50.30; Nov. 2009 = 100)	T8	NBS
10	**HHCPI****,2**	Health (weight = 30.04; Nov. 2009 = 100)	T8	NBS
11	**TCPI****,2**	Transport (weight = 65.08; Nov. 2009 = 100)	T8	NBS
12	**CCPI****,2**	Communication (weight = 6.80; Nov. 2009 = 100)	T2	NBS
13	**RCCPI****,2**	Recreation & Culture (weight = 6.87; Nov. 2009 = 100)	T8	NBS
14	**ECPI****,2**	Education (weight = 39.44; Nov. 2009 = 100)	T2	NBS
15	**RHCPI****,2**	Restaurant & Hotels (weight = 12.12; Nov. 2009 = 100)	T2	NBS
16	**MCPI****,2**	Miscellaneous Goods & Services (weight = 16.63; Nov. 2009 = 100)	T8	NBS
17	**URCPI****,2**	Urban CPI (weight = 1000.00; Nov. 2009 = 100)	T8	NBS
18	**RUCPI****,2**	Rural CPI (weight = 1000.00; Nov. 2009 = 100)	T8	NBS
Money Market Interest Rates				
19	**SDR***,1**	DMBs' Saving Deposit Rate (weighted average in per cent)	T0	CBN
20	**1MDR***,2**	DMBs' 1-Month Deposit Rate (weighted average in per cent)	T0	CBN
21	**3MDR***,2**	DMBs' 3-Month Deposit Rate (weighted average in per cent)	T0	CBN
22	**6MDR***,2**	DMBs' 6-Month Deposit Rate (weighted average in per cent)	T0	CBN
23	**12MDR***,2**	DMBs' 12-Month Deposit Rate (weighted average	T0	CBN

		in per cent)		
24	**PLR*,2**	DMBs' Prime Lending Rate (weighted average in per cent)	T0	CBN
25	**MLR*,2**	DMBs' Maximum Lending Rate (weighted average in per cent)	T0	CBN
26	**MPR*,1**	Monetary Policy Rate	T0	CBN
27	**IBCR*,2**	Interbank Call Rate (weighted average in per cent)	T0	CBN
28	**TBR*,2**	91-Day Treasury Bill Rate (weighted average in per cent)	T0	CBN
Capital Market Indicator				
29	**ASI*,2**	All Share Index (1984 = 100)	T8	NSE
Monetary Aggregates				
31	**M2*,2**	Broad Money Stock (In million naira)	T8	CBN
32	**M1*,2**	Narrow Money Stock (In million naira)	T8	CBN
33	**QM*,2**	Quasi Money (In million naira)	T8	CBN
34	**CPS*,2**	Credit to Private Sector (In million naira)	T8	CBN
35	**CCPS*,2**	Credit to Core Private Sector (In million naira)	T8	CBN
36	**COS*,2**	Credit to Other Sectors (In million naira)	T8	CBN
37	**SD*,2**	Saving Deposit of Banks (In million naira)	T8	CBN
38	**TD*,2**	Total Deposit of Banks (In million naira)	T8	CBN
39	**RR*,2**	Required Reserves (In million naira)	T8	CBN
40	**ER*,2**	Excess Reserves (In million naira)	T8	CBN
41	**NFA*,2**	Net Foreign Assets (In million naira)	T8	CBN
42	**NDC*,2**	Net Domestic Credit (In million naira)	T8	CBN
DMBs' Allocated Credits				
43	**BLPS*,2**	Bank Loan: Preferred Sectors (In million Naira)	T3	CBN
44	**BLAG*,2**	Bank Loan: Agriculture (In million Naira)	T3	CBN
45	**BLSM*,2**	Bank Loan: Solid Minerals (In million Naira)	T3	CBN
46	**BLXP*,2**	Bank Loan: Exports (In million Naira)	T3	CBN
47	**BLMF*,2**	Bank Loan: Manufacturing (In million Naira)	T3	CBN
48	**BLUS*,2**	Bank Loan: Less Preferred Sectors (In million Naira)	T3	CBN
49	**BLOG*,2**	Bank Loan: Others-General (In million Naira)	T3	CBN
50	**BLTL*,2**	Bank Loan: Total (In million Naira)	T3	CBN
Exchange Rates				
51	**USD*,2**	Naira to US-Dollar Rate (monthly average)	T8	CBN
52	**GBP*,2**	Naira to Pounds Rate (monthly average)	T8	CBN
53	**EUR*,2**	Naira to Euro Rate (monthly average)	T8	CBN

External Sector Indicators				
54	**EXR*,2**	E xternal Reserves (In million US Dollars)	T8	CBN
55	**EXP**,2**	Exports(FOB) (In million Naira)	T6	CBN & NBS
56	**IMP**,2**	Imports (CIF) (In million Naira)	T7	CBN & NBS
Fiscal Sector Indicators				
57	**GRV**,1**	Govt Revenue (In million Naira)	T5	OAGF
58	**GXP**,2**	Govt Expenditure (In million Naira)	T5	OAGF
Crude Petroleum Indicators				
59	**CPD**,1**	Crude Petroleum Production (In million barrels per day)	T6	NNPC
60	**COP**,2**	Crude Oil Price - Bonny Light (In US Dollar)	T8	Reuters
Production Indices				
61	**IMAP**,2**	Index of Manufacturing Production (1990 = 100)	T4	CBN
62	**IMIP**,2**	Index of Mining Production (1990 = 100)	T3	CBN
63	**IEP**,2**	Index of Electricity Production (1990 = 100)	T3	CBN
64	**IIP**,2**	Index of Industrial Production (1990 = 100)	T4	CBN
Real Gross Domestic Production				
65	**ARY**,2**	Agric RGDP (1990 constant basic prices; in million Naira)	T4	NBS
66	**IRY**,2**	Industry RGDP (1990 constant basic prices; in million Naira)	T4	NBS
67	**CGRY**,1**	Crude Petroleum & Natural Gas RGDP (1990 constant basic prices; in million Naira)	T4	NBS
68	**SMRY**,2**	Solid Minerals RGDP (1990 constant basic prices; in million Naira)	T4	NBS
69	**MRY**,2**	Manufacturing RGDP (1990 constant basic prices; in million Naira)	T4	NBS
70	**BRY**,2**	Building & Construction RGDP (1990 constant basic prices; in million Naira)	T4	NBS

71	**WRY**^{**,2}	Wholesale & Retail Trade RGDP (1990 constant basic prices; in million Naira)	T4	NBS
72	**SRY**^{**,2}	Services RGDP (1990 constant basic prices; in million Naira)	T4	NBS
73	**TRY**^{**,2}	Transport RGDP (1990 constant basic prices; in million Naira)	T4	NBS
74	**CRY**^{**,2}	Communication RGDP (1990 constant basic prices; in million Naira)	T4	NBS
75	**URY**^{**,2}	Utilities RGDP (1990 constant basic prices; in million Naira)	T4	NBS
76	**HRY**^{**,2}	Hotel & Restaurant RGDP (1990 constant basic prices; in million Naira)	T4	NBS
77	**FRY**^{**,2}	Finance & Insurance RGDP (1990 constant basic prices; in million Naira)	T4	NBS
78	**RRY**^{**,2}	Real Estate & Business Services RGDP (1990 constant basic prices; in million Naira)	T4	NBS
79	**PRY**^{**,2}	Producers of Govt. Services RGDP (1990 constant basic prices; in million Naira)	T4	NBS
80	**CPRY**^{**,2}	Comm., Social & Pers. Services RGDP (1990 constant basic prices; in million Naira)	T4	NBS
81	**RY**^{**,2}	Total RGDP (1990 constant basic prices; in million Naira)	T4	NBS
Real Private Investment				
82	**RINV**^{**,2}	Real Private Investment (In million Naira)	T4	NBS
Personal Consumption and Disposable Income				
83	**RPC**^{**,1}	Real Personal Consumption Expenditure (In million Naira)	T4	NBS
84	**RPDI**^{**,1}	Real Personal Disposable Income (In million Naira)	T4	NBS

Notes on Appendix A

*Series is categorized as fast

**Series is categorized as slow

T0 - Series is used without any transformation

T1 - Data gaps between 2000:1 and 2001:9 in series are extrapolated; resulting series is not transformed.

T2 - Data gaps between 2000: 1 and 2001: 8 in series are extrapolated; resulting series is natural logarithm transformed.

T3 - Series in quarters is converted to monthly frequency; monthly series is natural logarithm transformed.

T4 - Series in quarters is converted to monthly frequency; monthly series is seasonally adjusted; seasonally adjusted monthly series is natural logarithm transformed.

T5 - Series in quarters is converted to monthly frequency; monthly series is seasonally adjusted; seasonally adjusted monthly series is taken through exponential smoothing; lastly, resulting series is natural logarithm transformed.

T6 - Series is seasonally adjusted; seasonally adjusted series is natural logarithm transformed.

T7 - Series is seasonally adjusted; seasonally adjusted series is taken through exponential smoothing; lastly, series is natural logarithm transformed.

T8 - Series is only natural logarithm transformed.

[1]ADF unit root test include intercept only reveals that series is stationary at level.

[2]ADF unit root test include intercept only reveals that series is stationary at first difference; differencing is annualized.

APPENDIX B

Figure 1: Variants of Composite CPI

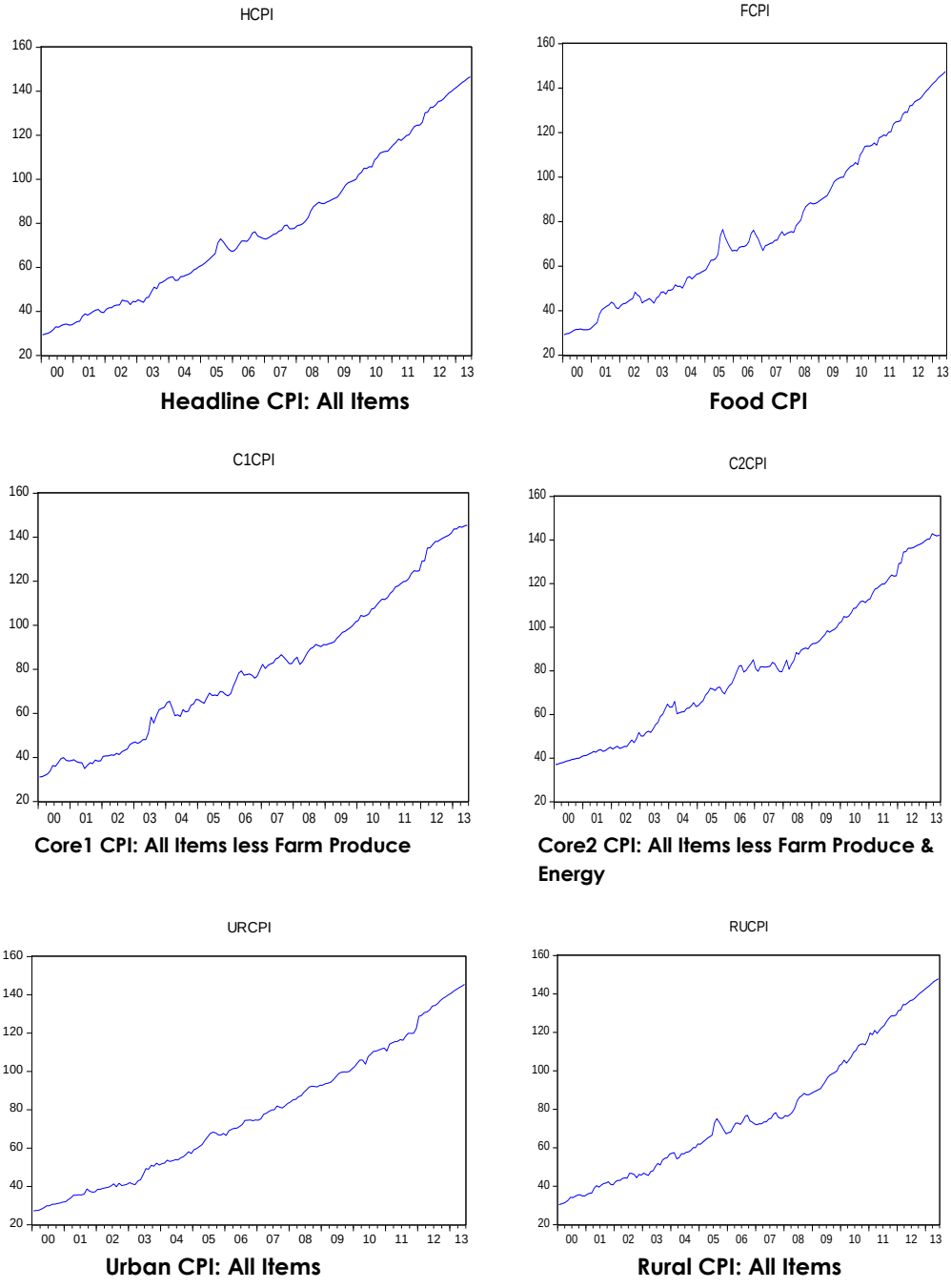
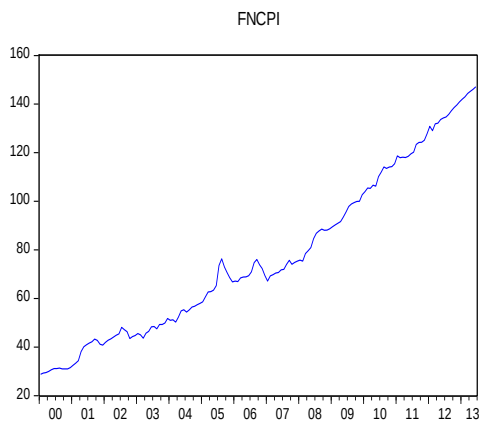
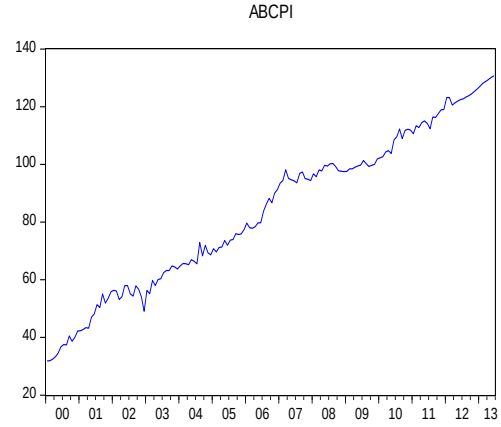


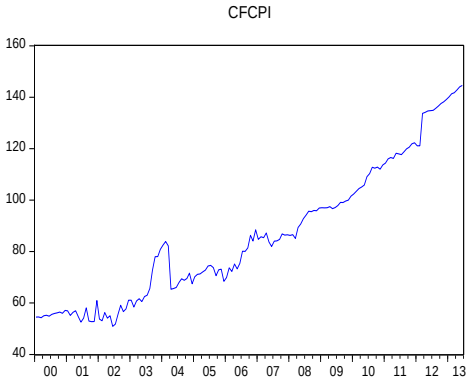
Figure 2: Components of Headline CPI



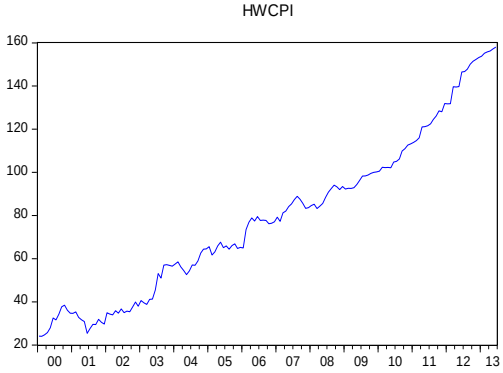
Food & Non-Alcoholic Beverage CPI



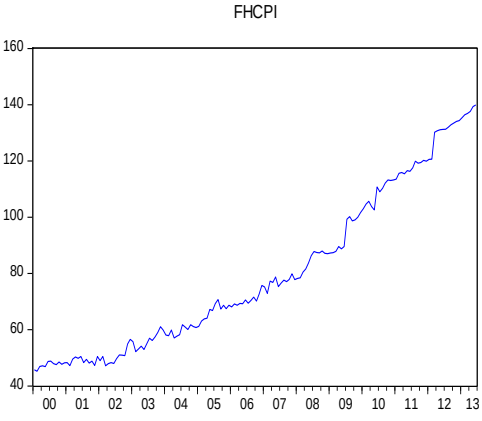
Alcoholic Beverage, Tobacco and Kola CPI



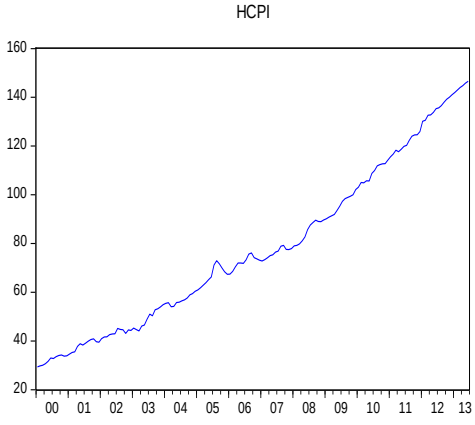
Clothing and Footwear CPI



Housing, Water, Elect., Gas and Other Fuel CPI



Furnishings & Household Equip. Maint. CPI



Health CPI

Figure 2: Components of Headline CPI (Continued)

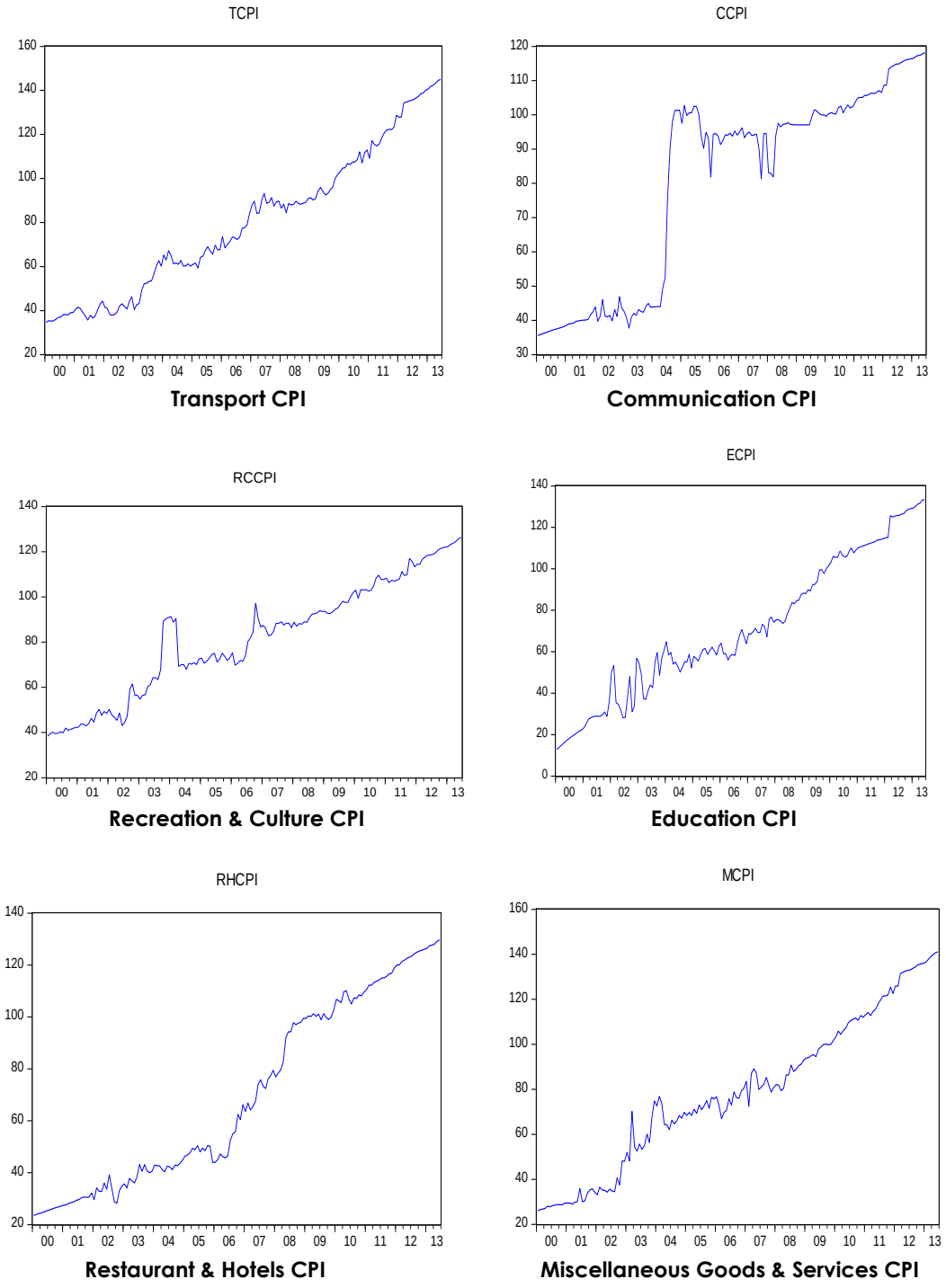


Figure 3: Money Market Interest Rates

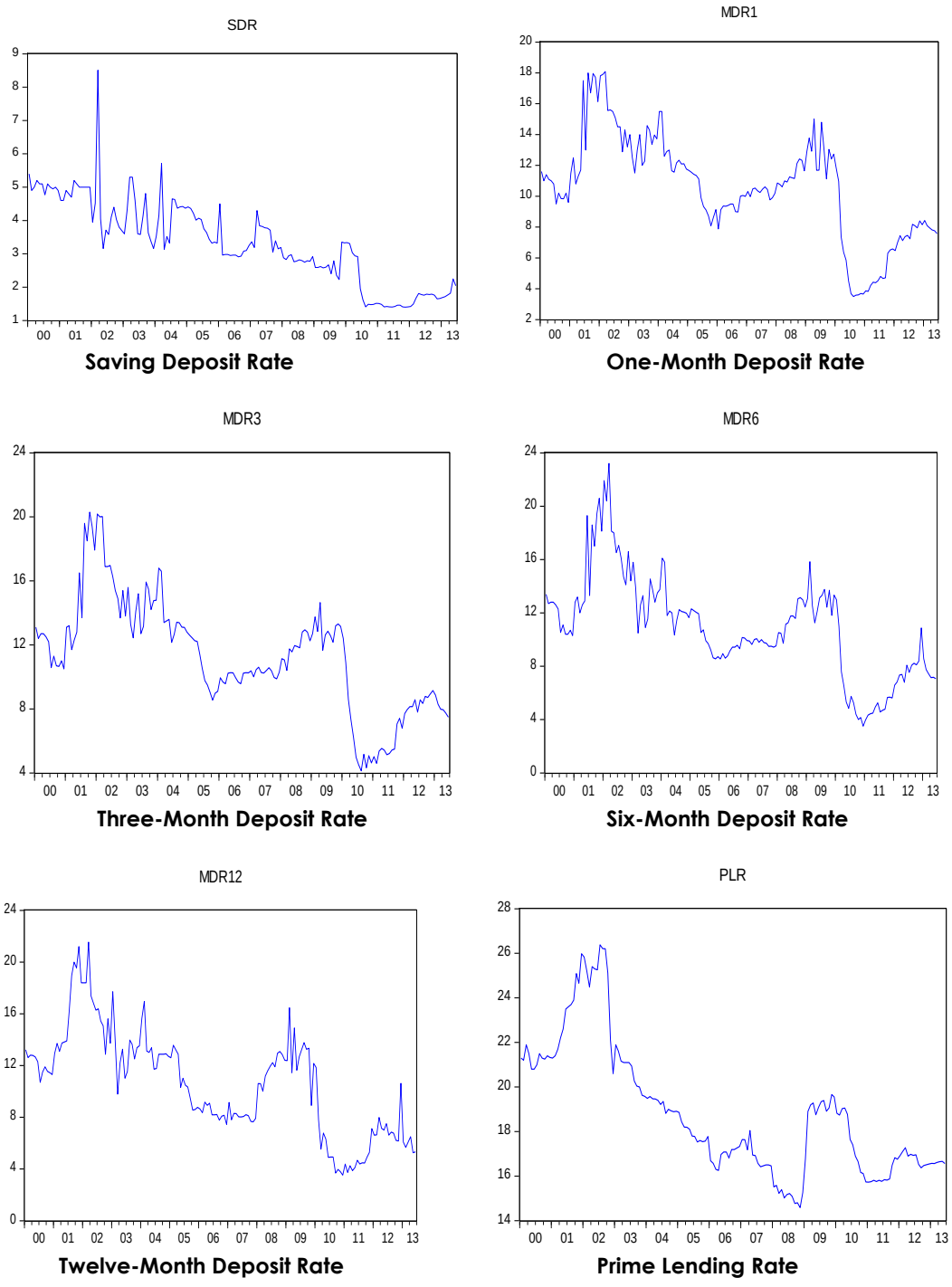


Figure 3: Money Market Interest Rates (Continued)

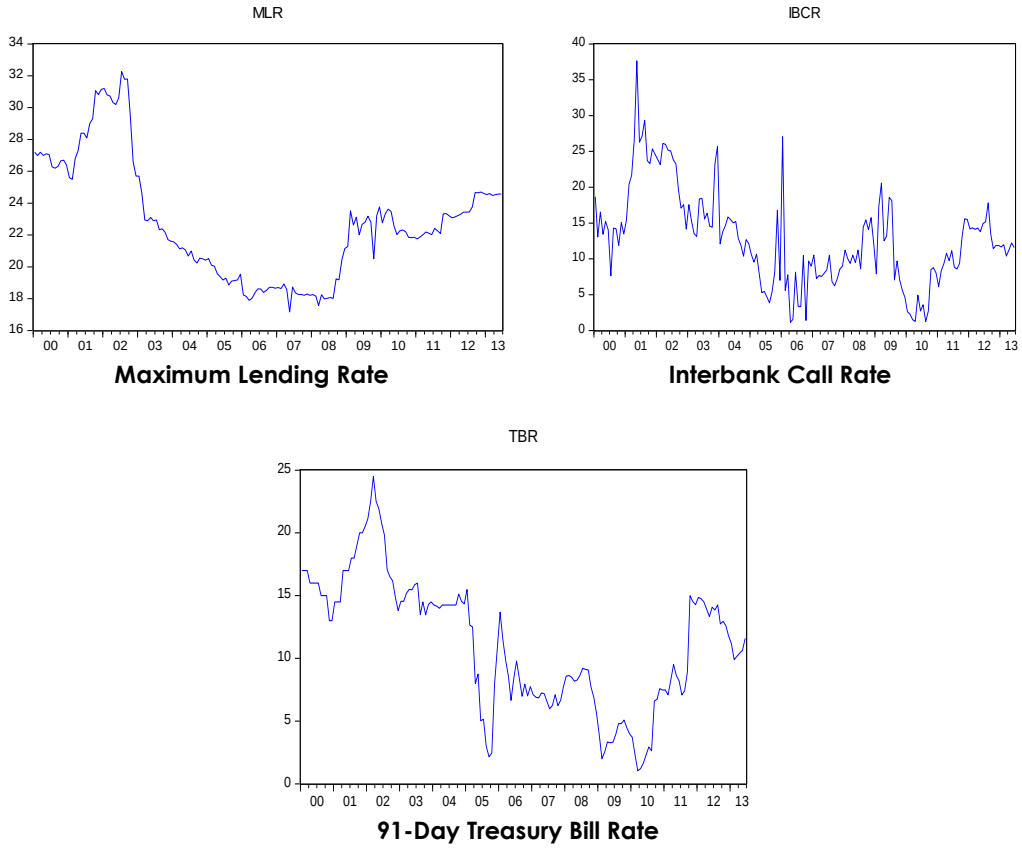


Figure 4: Monetary Policy Rate

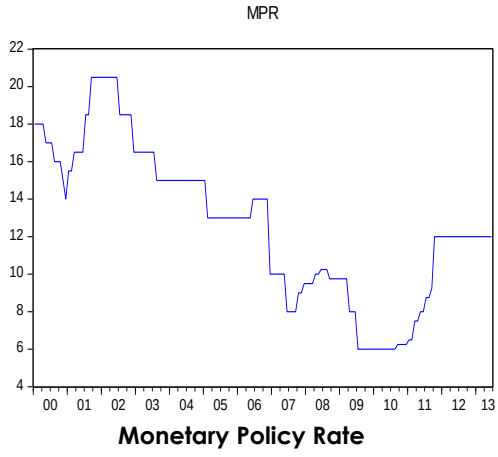


Figure 5: Capital Market Indicator

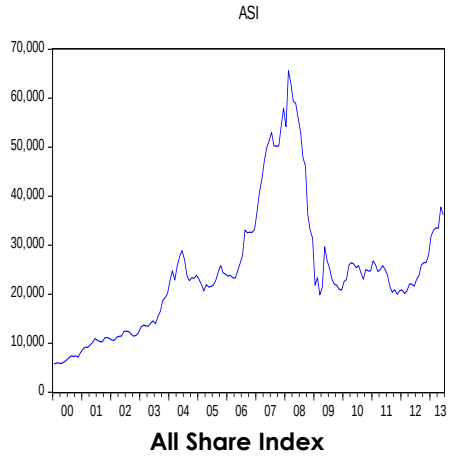


Figure 6: Monetary Aggregates

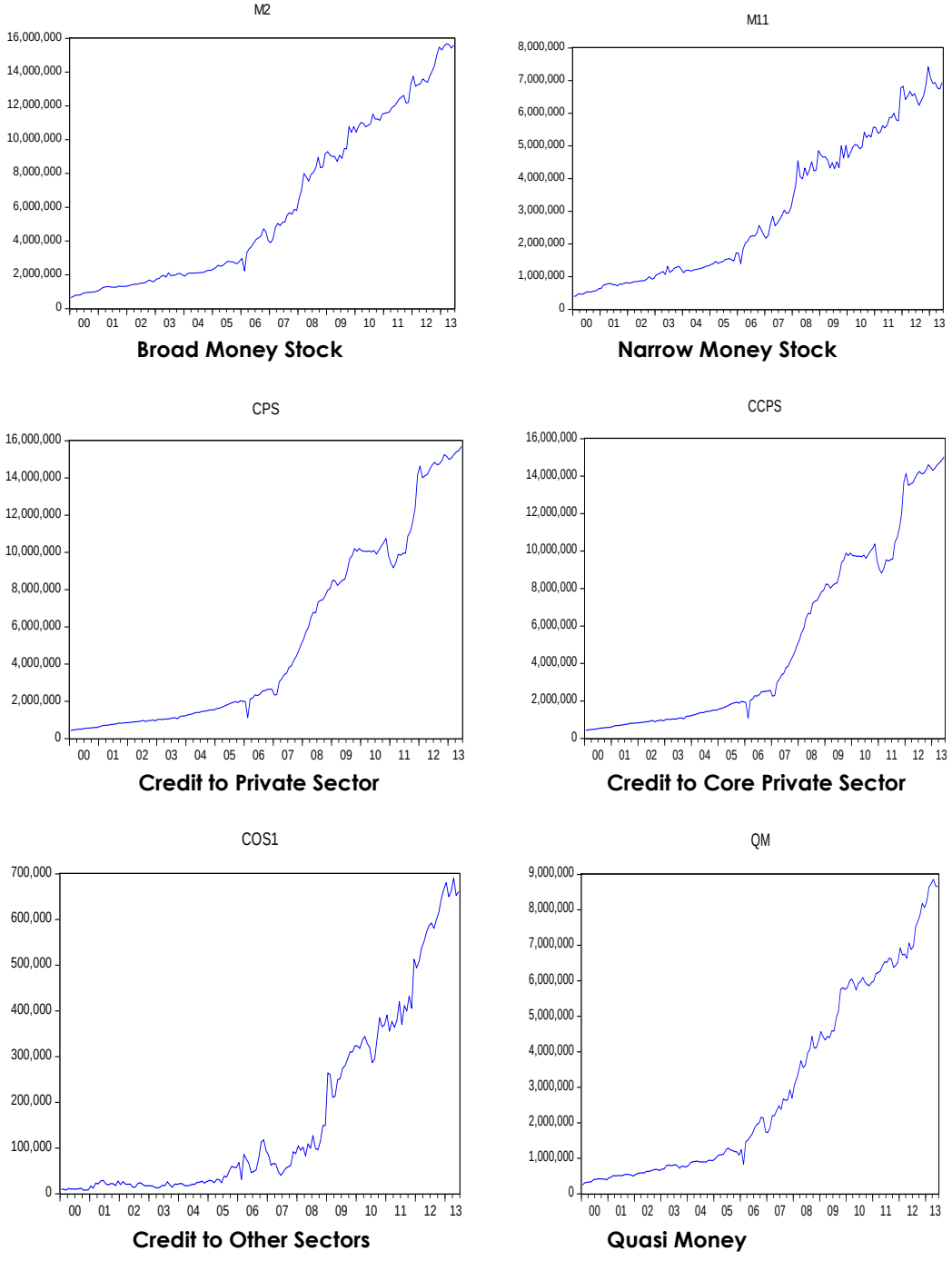
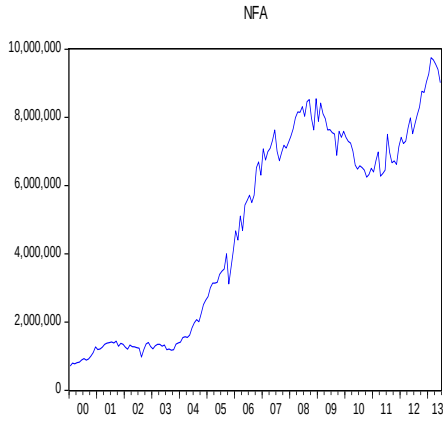
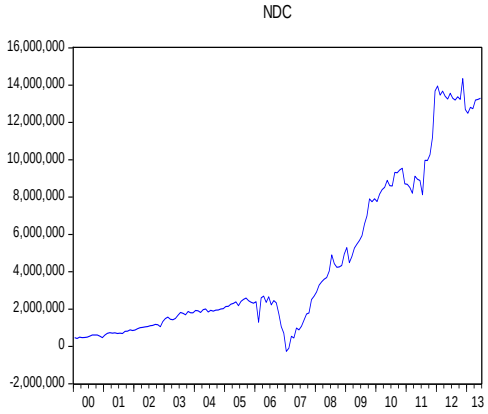


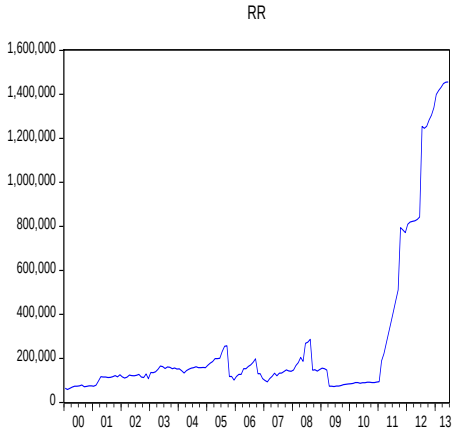
Figure 6: Monetary Aggregates (Continued)



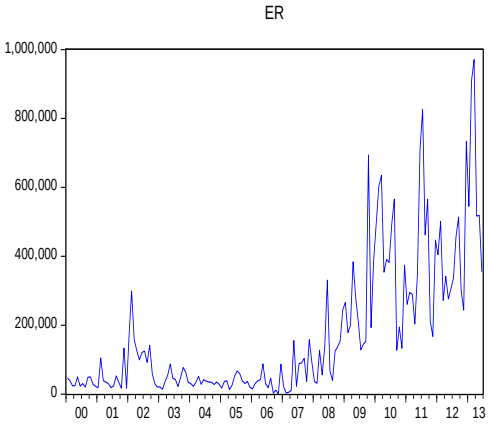
Net Foreign Assets



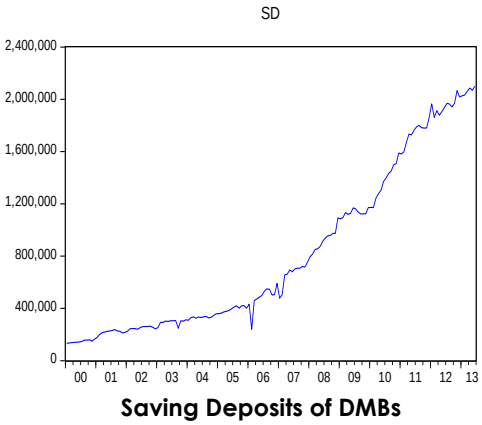
Net Domestic Credit



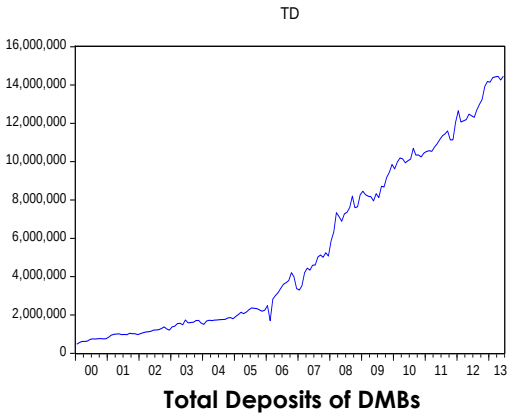
Required Reserves



Excess Reserves

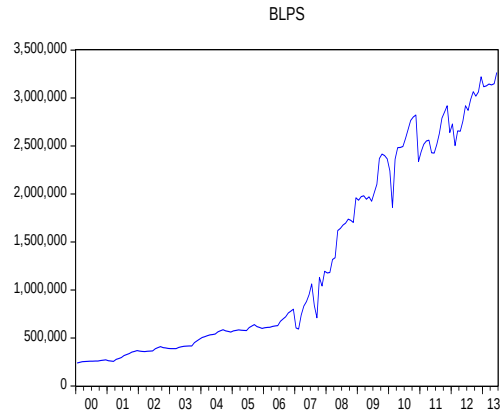


Saving Deposits of DMBs

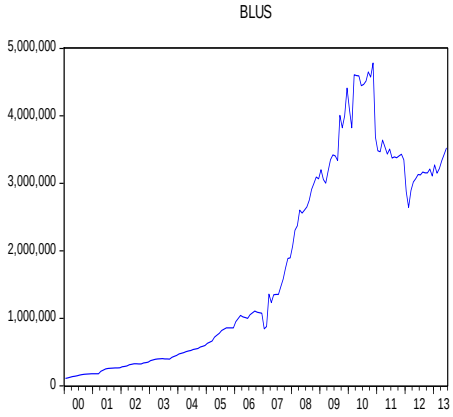


Total Deposits of DMBs

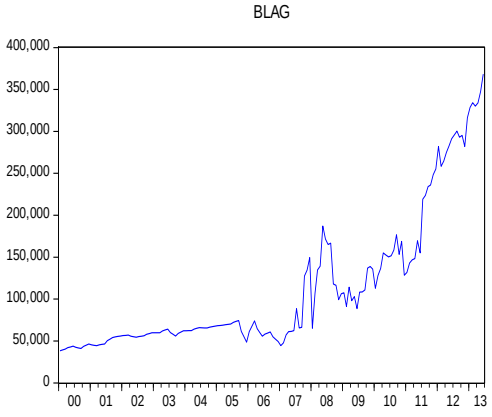
Figure 7: DMBs' Allocated Credits



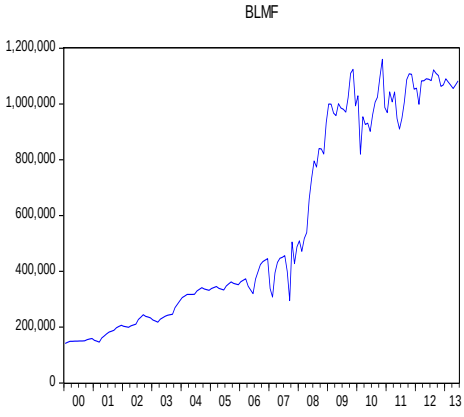
Bank Loan to Preferred Sectors



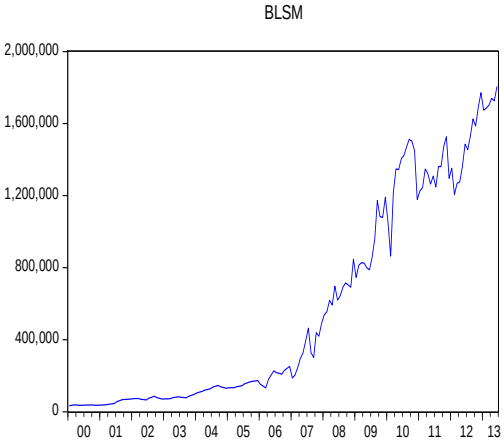
Bank Loan to less Preferred Sectors



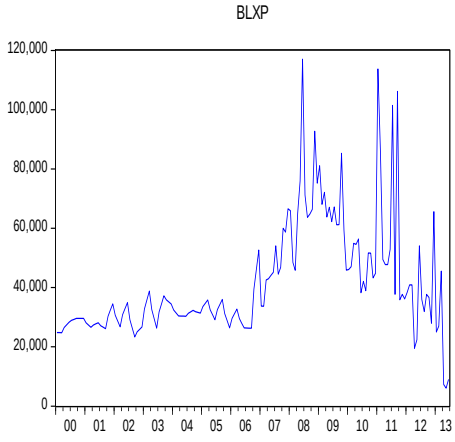
Bank Loan: Agriculture



Bank Loan: Manufacturing

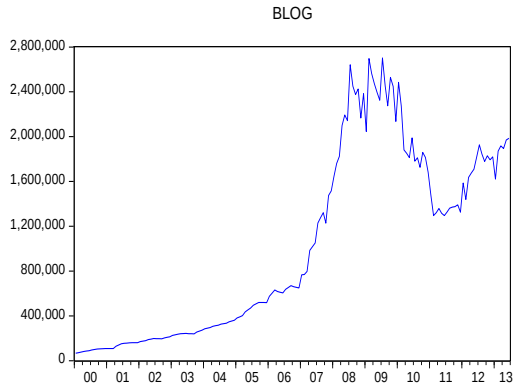


Bank Loan: Solid Mineral

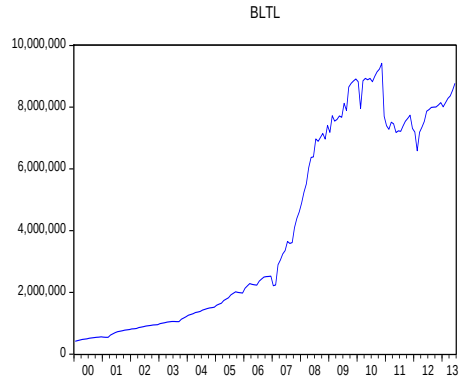


Bank Loan: Exports

Figure 7: DMBs' Allocated Credits (Continued)

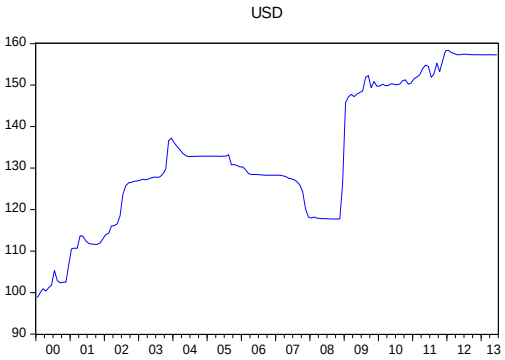


Bank Loan: Others-General

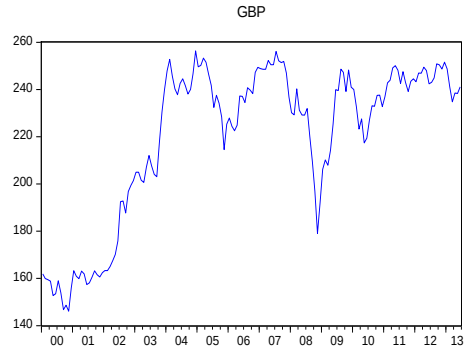


Bank Loan: Total

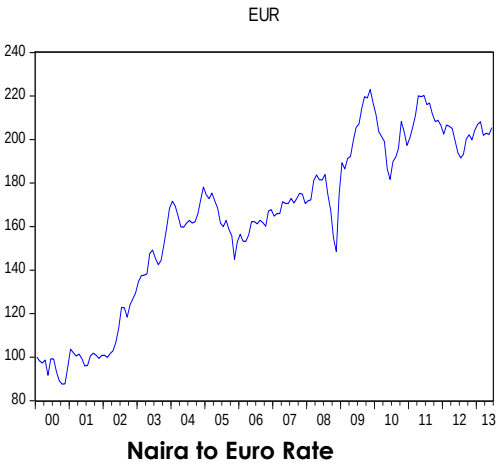
Figure 8: Exchange Rates and External Reserves



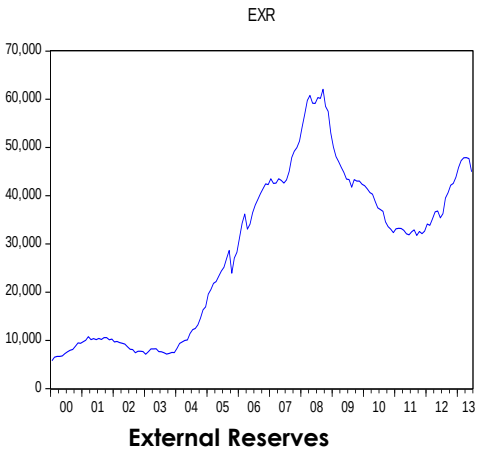
Naira to US Dollar Rate



Naira to Great Britain Pound Rate

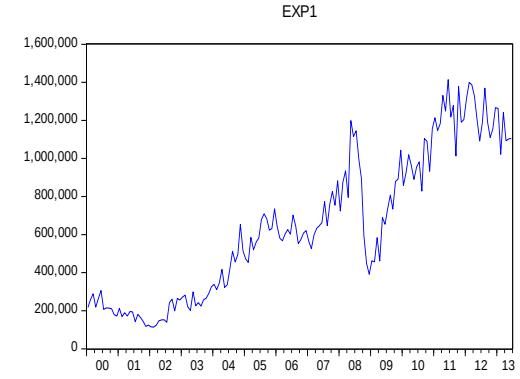


Naira to Euro Rate

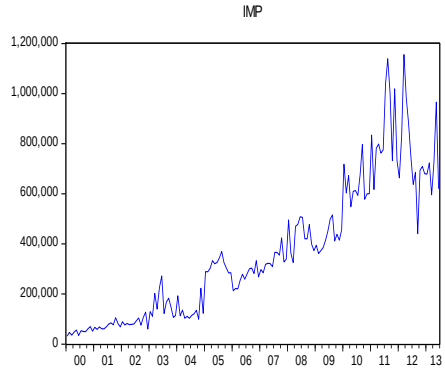


External Reserves

Figure 9: External Trade Indicators

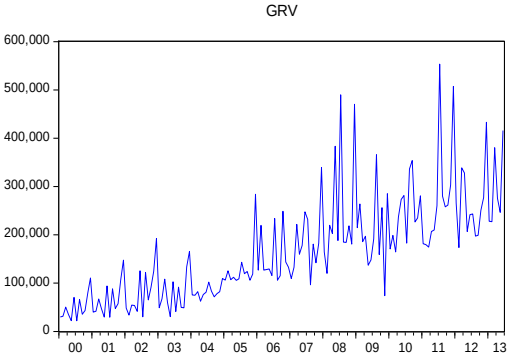


Exports

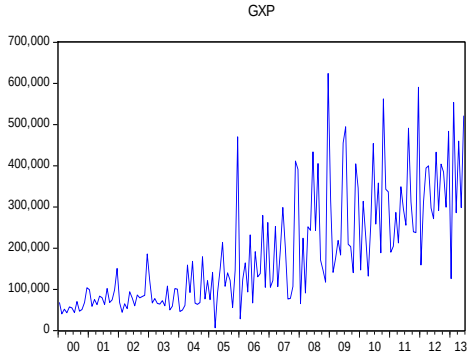


Imports

Figure 10: Fiscal Sector Indicators

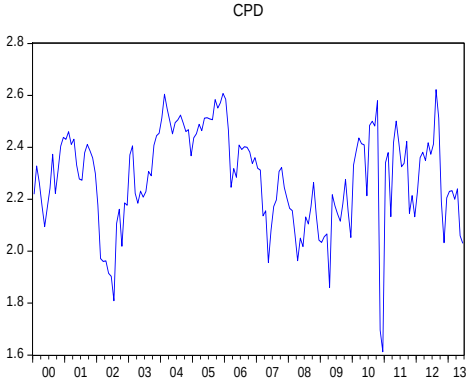


Retained Revenue of Federal Government

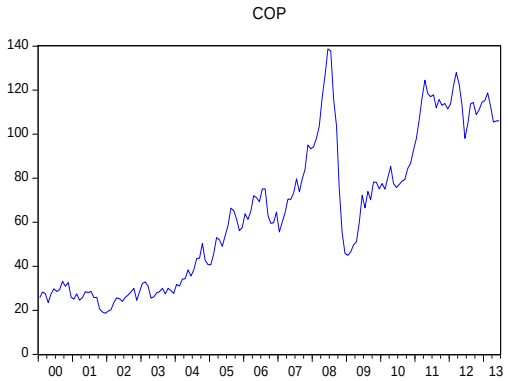


Total Expenditure of Federal Government

Figure 11: Crude Petroleum Indicators



Crude Petroleum Production



Crude Petroleum Price

Figure 12: Production Indices

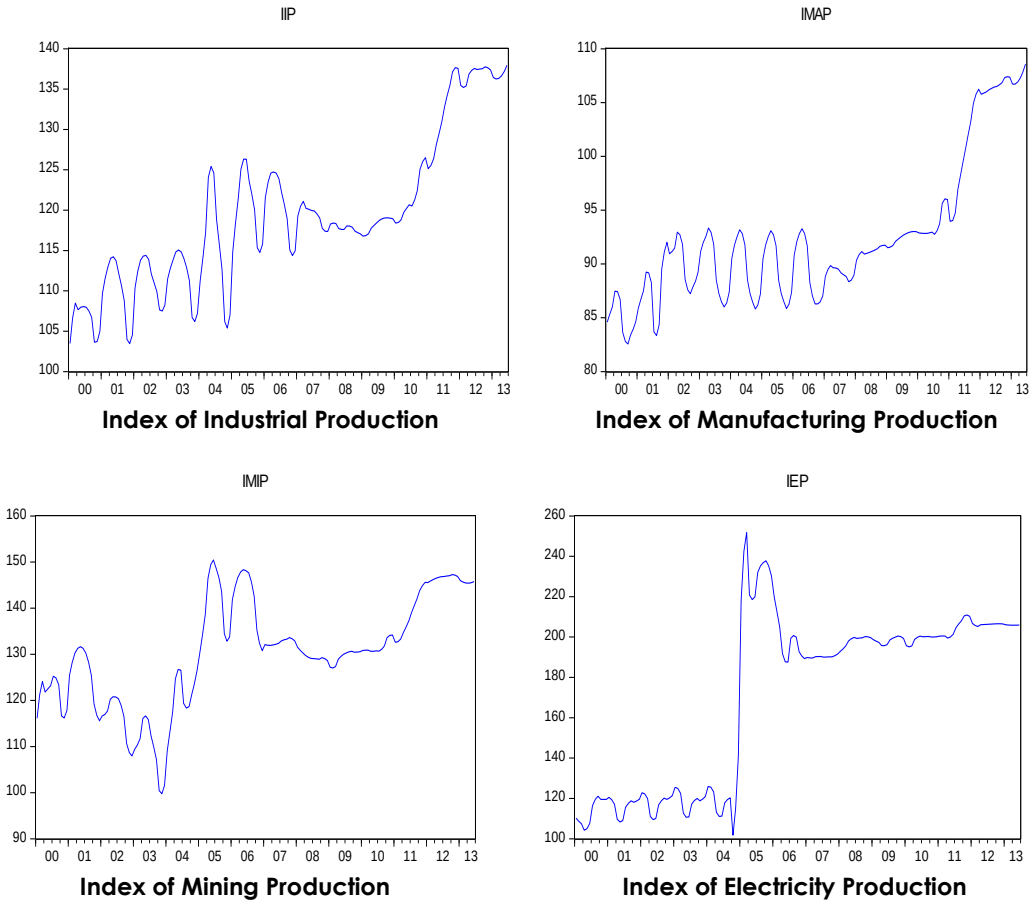


Figure 13: Real Gross Domestic Production

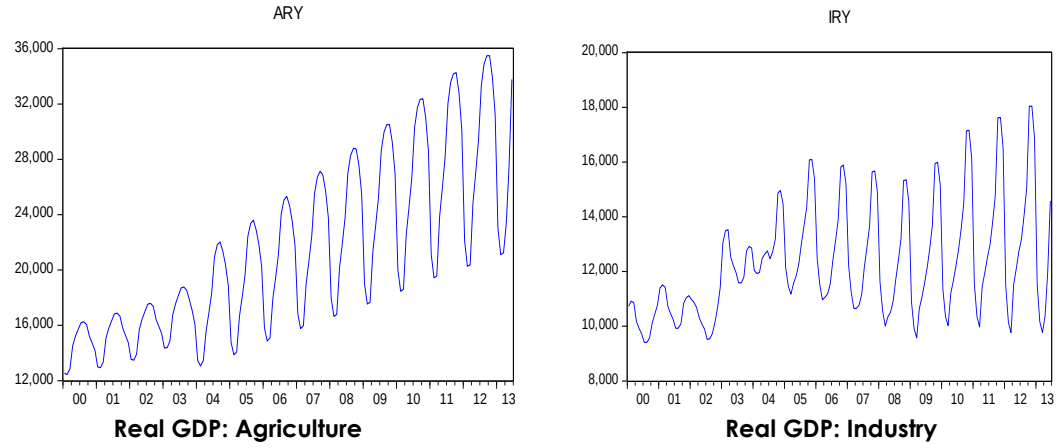
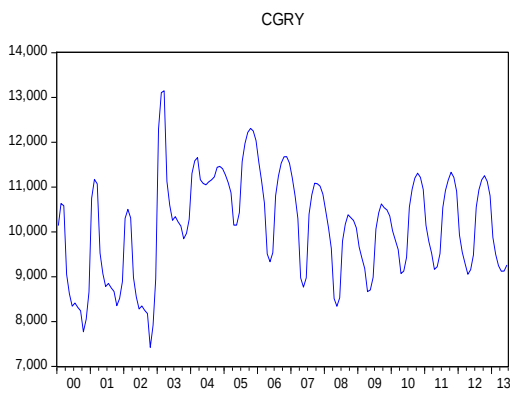
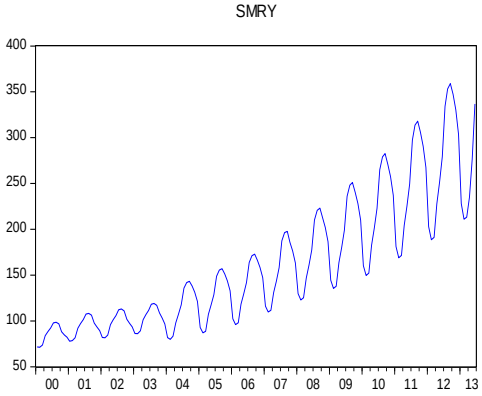


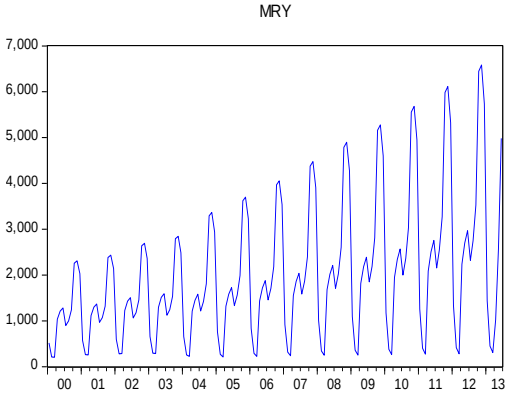
Figure 13: Real Gross Domestic Production (Continued)



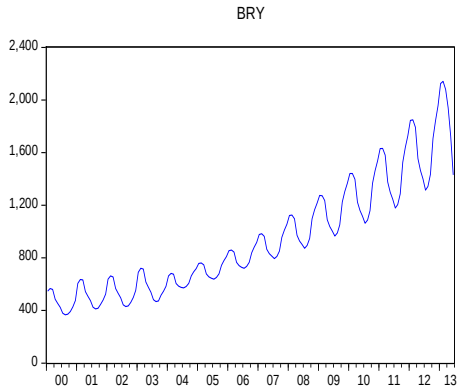
Real GDP: Crude Petroleum & Natural Gas



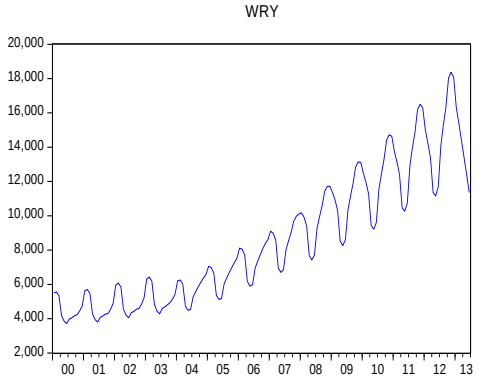
Real GDP: Solid Minerals



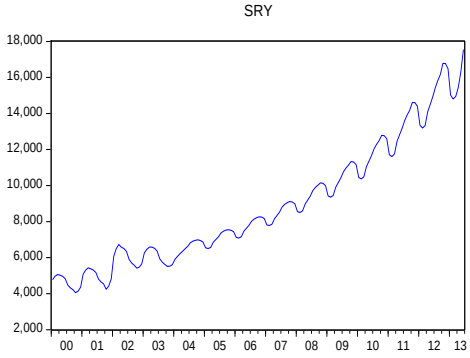
Real GDP: Manufacturing



Real GDP: Building & Construction



Real GDP: Wholesale & Retail Trade



Real GDP: Services

Figure 13: Real Gross Domestic Production (Continued)

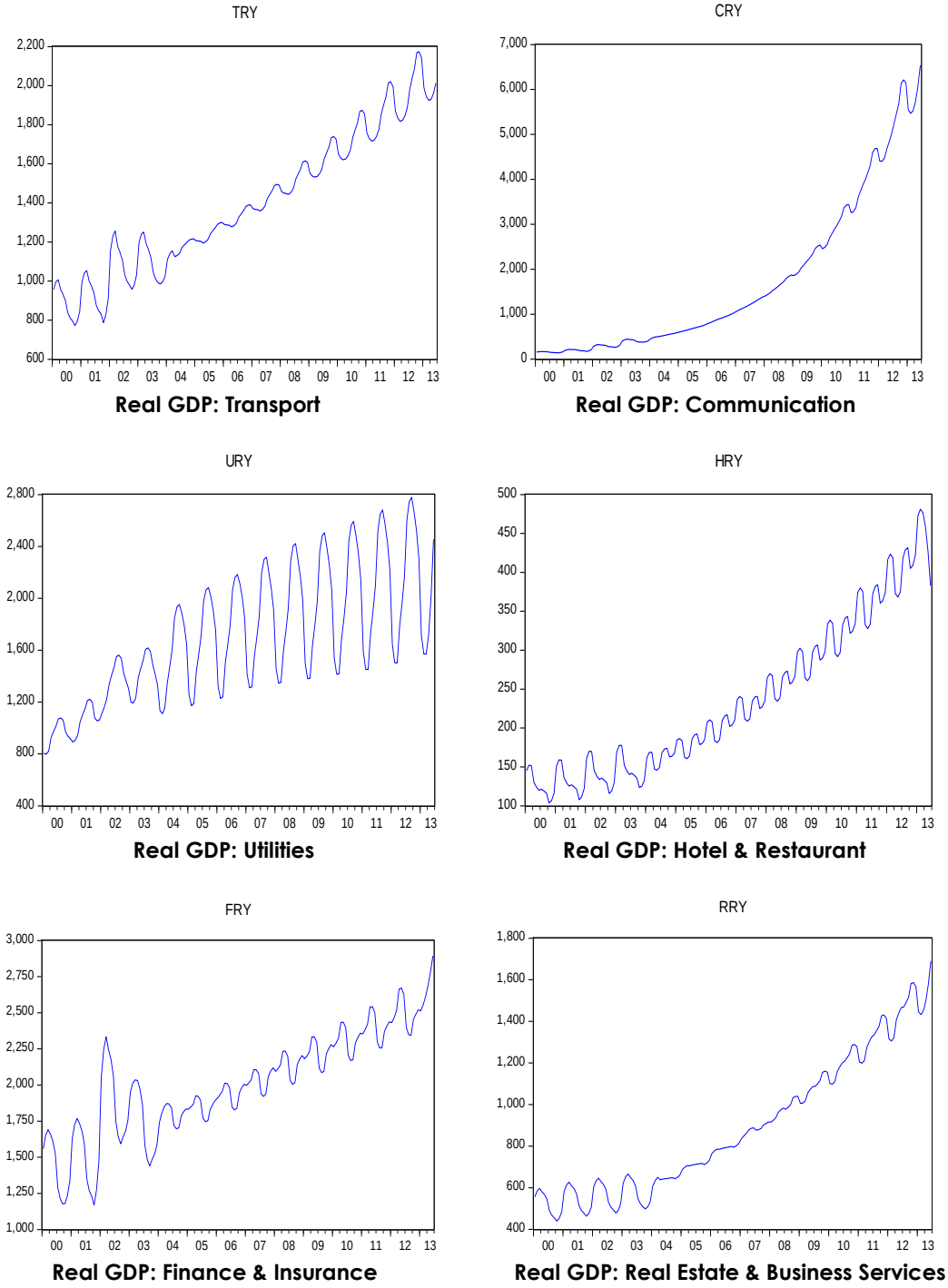
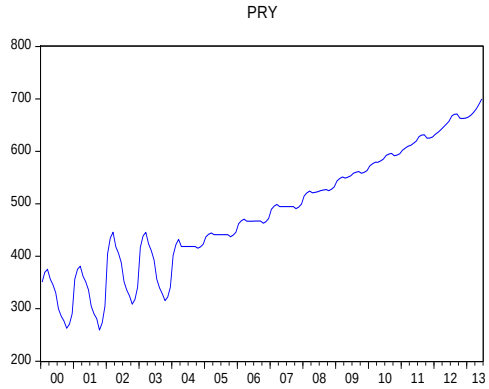
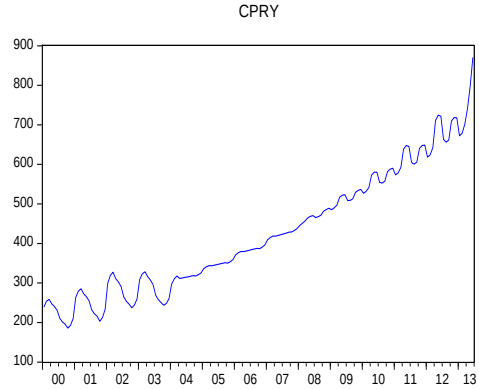


Figure 13: Real Gross Domestic Production (Continued)

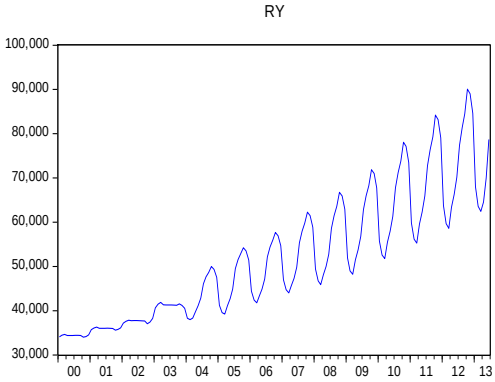


Real GDP: Producers of Govt. Services

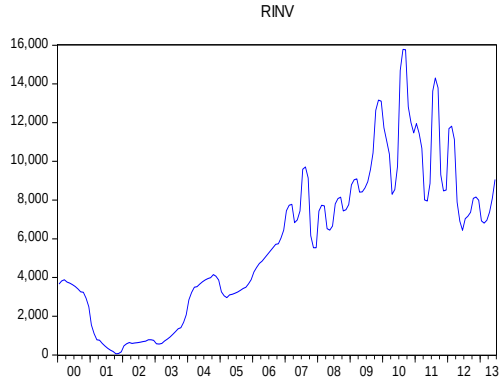


Real GDP: Comm. Social & Personal Services

Figure 14: Private Investment

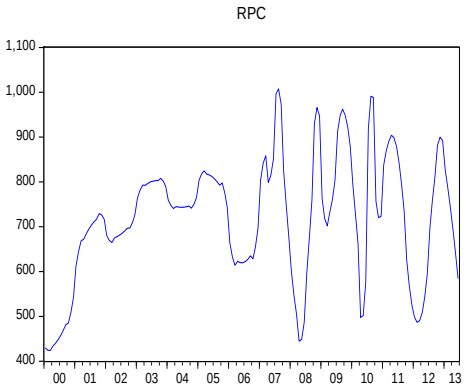


Real GDP: Total

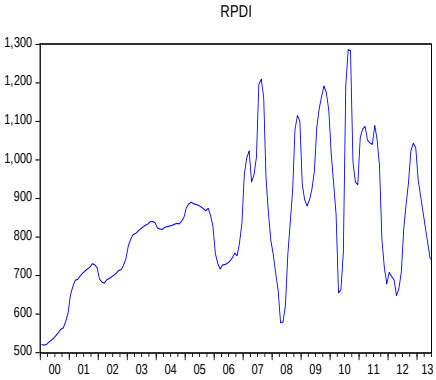


Real Private Investment

Figure 15: Personal Consumption and Disposable Income



Real Personal Consumption



Real Personal Disposable Income

CENTRAL BANK OF NIGERIA

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