ADDIS ABABA UNIVERSITY

SCHOOL OF GRADUATE STUDIES

THE EFFECTS OF SHOCKS TO ETHIOPIAN MONETARY POLICY ON PRICE AND OUTPUT: SVAR APPROACH

BY: ANTENEH GEREMEW [1]

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ADDIS ABABA

[1] Economic Modeling and Statistical Analysis Directorate, NBE

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A project submitted to the School of Graduate Studies of Addis Ababa University in Partial fulfillment of the requirement for the Degree in Masters of Art in Applied Economic Modeling and Forecasting

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This is to certify that the paper prepared by Anteneh Geremew entitled: the effects of shocks to Ethiopian monetary policy on price and output: SVAR approach, and submitted in partial fulfillment of the requirement of the Degree of Masters of Art in Applied Economic Modeling and Forecasting complies with the regulations of the University and meets the accepted standards with respect to originality and quality.

BY: ANTENEH GEREMEW

Approved by	**Signature**	**Date**
Tassew W/hanna (PhD)	………………	**……..………**

JUNE, 2014

ADDIS ABABA

DECLARATION

I, the undersigned, declare that this is my original work and has not been presented for a degree in any other university and that all sources of materials used for the project have been duly acknowledged.

Declared by

Name : Anteneh Geremew

Signature :…………………….

Date: …………………………..

Confirmed by Advisor

Name : Tassew W/hanna(PhD)

Signature : …………..……….

Date: …………..……………….

Abstract

The Effects of Shocks to Ethiopian Monetary Policy on Price and Output: SVAR Approach

Anteneh Geremew

Addis Ababa University, June 2014

The main objective of this paper was to model and investigate the effect of shocks on Ethiopian monetary policy in to output and price using SVAR methodology. Using quarterly data 1995Q3 to 2011/12Q4, SVAR model is developed. Both the domestic (GDP, CPI, M_0*, T-bill rate) and foreign variables (OPI and WCPI) were used to investigate the Ethiopian monetary policy framework. I have imposed a contemporaneous restriction based on economic theory in order to provide some economic structure to Ethiopia SVAR.*

The results of innovation accounting analyses, generated from the SVAR model suggested that a positive shock to reserve money increased output significantly with a considerable lag spans one quarter, while price respond to a positive shock to reserve money negatively for a period of one and half and after this period it was increased and sustained for long periods. A notable difference with the monetary policy variables (reserve money and T-bill rate) shock effect on output and price were obtained. I obtained that the variability of price and output due to shock to reserve money was more explained than T-bill rate shock in the short term as well as the long term horizons.

Finally, based on the findings I have drawn my recommendations. The finding indicated that in the short term and long term variability of price and output were more explained due to shock to reserve money than T-bill rate shock, therefore, the NBE should be ensure that reserve money and interest policy are consistent with each other and further studies should be needed to identified different monetary transmission mechanisms or cannels in Ethiopia.

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Acronyms

ADF:	Augmented Dickey-Fuller
AIC:	Akaike Information Criterion
FPE:	Final Prediction Error
HQ:	Hannan-Quinn Information Criterion
IMF:	International Monetary Fund
IRFs:	Impulse Response Functions
LM:	Lagrangian Multiplier
MoFED:	Minstr of Fianance and Economic Development
MTM:	Monetary Transmission Mechanism
NBE:	National Bank of Ethiopia
OMO:	Open Market Operation
SIC:	Schwanze Information Criterion
SVAR:	Structural Vector Autoregression
VAR:	Vector Autoregression
VDCs:	Variance Decompositions
VMA:	Vector Moving Autoregression

CHAPTER ONE

1 INTRODUCTION

1.1 Background of the Study

Macroeconomic stability fosters; high employment, economic growth, price stability and equilibrium in the balance of payment in one country. The central banks are one of the most powerful actors in a macroeconomic area. A central bank acts as the regulatory authority of a country's monetary policy. Monetary policy is seen as a stabilization policy instrument to one economy in the direction of achieving sustainable economic growth and price stability. The main objective of monetary policy is to focus on price stability and economic growth, the impact of this policy is always felt through the economy, especially in the short run, on monetary aggregates, interest rates and exchange rates which eventually affect the financial sectors, economic activities and price level in the economy.

Money can affect many economic variables that are important to the well-being of our economy, politicians and policymakers throughout the world care about the conduct of monetary policy, the management of money and interest rates. The organization responsible for the conduct of a nation's monetary policy is the central bank. Objective of the monetary policy varies for country to country depends in the mandate of the central banks.

The principal objective of National Bank of Ethiopia is to maintain price and exchange rate stability and support sustainable economic growth of Ethiopia. On the other hand maintaining exchange rate stability is considered as the principal policy objective of National Bank of Ethiopia so as to be competitive in international trade and to use exchange rate intervention as a policy tools for monetary policy to affect both foreign reserve position and domestic money supply (Monetary Policy Framework of Ethiopia, 2009).

The transmission mechanism of monetary policy can be analyzed via modeling the monetary policy. The monetary transmission mechanism describes how policy-induced change in nominal money stock or short-term interest rate impact, real gross domestic product (GDP) and inflation.

In current time the structural vector autoregression (SVAR) methodology has been most applicable in modeling monetary policy. SVAR is very flexible as it can accommodate various relationships among macroeconomic variables inferred from economic theories and stylized facts, which intern allows us to identify orthogonal monetary shocks. Therefore, this paper I used a structural vector autoregression (SVAR) approach to model and investigate the monetary policy shock effect on Ethiopian economy especially in the real sector of the macroeconomic variables.

Finally, the outline of this paper is as follows; chapter two describes the literature reviews and monetary policy framework of Ethiopia, chapter three methodology, chapter four result and discussions and chapter six conclusions and recommendations.

1.2 Statement of the Problem

The efficiency of the monetary policy depends on the ability of policy makers to make an accurate assessment of the timing and the effect of the policy on economic activities and prices. A methodological understanding of the dynamics of GDP, inflation and monetary instrument is important in order to undertake the appropriate monetary policy decisions.

Therefore, to solve monetary policy analytically especially using econometric model with appropriate force and right direction; policy makers need to have a clear understanding of the propagation mechanism of the monetary policy shock and the relative importance of the various channels, namely money, interest rates and exchange rates in affecting the real sectors of the economy.

Now a day Structural VAR methodology which introduced by Sim(1980), becomes an important approach in handling various economic issues and problems concerning the identification of the cotemporaneous and dynamic relationship between macroeconomic variables and the policy instruments. Even though, SVAR approach has an important role in modeling and investigating monetary policy shocks to other variables, still now the National Bank of Ethiopia has not a well defined Structural VAR model econometric model. That is why I am interested to fill this gap by developing the monetary policy model using SVAR framework.

1.3 Objective of the Study

1.3.1 Main Objective

The principal objective of this study was modeling and investigating the effects of shocks to Ethiopian monetary policy on price and output using Structural Vector Autoregression (SVAR) approach.

1.3.2 Specific Objective

Based on the main objective of the study the specific objectives were:

- To investigate output and price dynamics response to money and interest rate shock
- To investigate the nature and strength of the relationship among monetary policy, output and price
- To quantify the relative importance of monetary policy shocks in variability of output and price.

1.4 Significance of the Study

It is obvious that developing a monetary policy model has great applications in central banks in order to investigate the monetary policy shock on other macroeconomic variables. Regarding to this, this research will give different significances for National Bank of Ethiopia such as:

- ✓ To understand the dynamic effects of innovation in monetary policy on different macroeconomic variables especially on output and price.
- ✓ Introduce new technique that has not been used previously in studies of monetary policy in the National Bank of Ethiopia.

- ✓ Clarify the relative contribution of monetary policy shocks in the variability of output and price.
- ✓ It will be a base line for other researches which are related to monetary policy issues.

CHAPTER TWO

2 LITERATURE REVIEWS AND MONETARY POLICY FRAMEWORK OF ETHIOPIA

2.1 Literature Reviews

2.1.1 Theoretical Literatures

It is clear from both the theoretical literature and empirical findings that among various policy objectives, monetary policy is best suited to achieving the goal of price stability in the economy. In today's altered economic context, a low and stable price environment is being increasingly regarded as an essential condition for improving the growth and productive potential of the economy.

Monetary policy is a powerful tool in affecting the economy, therefore it is crucial to have a good understanding of the channels through which monetary policy is transmitted to the economy. Theory indicates that an increase in money supply leads eventually to an increase in aggregate demand and thus, through different channels, raises total output. Those channels include the money channel, interest rate channel, the credit channel, the exchange rate channel, and the asset price channel (Mishkin, 1995).

The money channel: - This channel effectively assumes changes in reserve money are transmitted to broad money via the money multiplier; that banks are in the business of creating inside money. But this argument also assumes a role for individuals holding components of broad money, currency in circulation, and various forms of deposits. The money view of monetary policy assumes aggregate demand moves in line with money balances used to finance transactions and affect the split of nominal GDP between real GDP and the price level. It is this idea that forms the basis for broad money representing the intermediate target in many central bankers' money-focused monetary policies (Mishkin, 1995).

The interest rate channel: **-** According to Mishkin (1995), expansionary monetary policy (increasing money supply) causes the real interest rate to fall, which means that the cost of capital is lowered. The fall in real interest rate induces businesses to increase spending on investments spending and consumers to increase their housing and durable expenditures, which are also considered investment. This increase in investment spending leads in turn to an increase in aggregate demand and a rise in output.

The credit channel: **-** This channel mainly involves with the agency problems arising from asymmetric information and costly enforcement of contracts in the financial market. The credit channel operates via two main channels, which are the bank lending channel and the balance-sheet channel. In bank lending channel, a decrease in money supply leads to a decrease in bank deposits, which further decreases the volume of money that banks have to loan out. This, in turn, decreases investment and, ultimately, aggregate demand. And also the balance-sheet channel operates through the net worth of firms, with the effects of adverse selection and moral hazard. (Mishkin, 1995).

The exchange rate channel: **-** According Mishkin (1995), an increase in money supply causes the domestic real interest rate to fall. Therefore, assets which are denominated in domestic currency are less attractive than assets denominated in foreign currency, resulting in a depreciation of domestic currency. The depreciation of the domestic currency makes domestic goods relatively cheaper than foreign goods, thereby causing net export and output to rise.

Other Asset Price Channels: - These channels operate mainly through two effects: Tobin's *q* theory of investment and wealth effects on consumption (Mishkin, 1995). According to Tobin (1969), *q* is defined as the market value of a firm divided by the replacement cost of capital. If *q* is high, the replacement cost of capital is low compared with the market value of the firm. This enables the firm to buy more plant and equipment with their now higher-value equity. Thus, investment spending increases. Conversely, if *q* is low, then the market value of the firm is also low in comparison with the replacement cost of capital and the firm will not purchase investment goods. Thus, investment decreases.

Therefore, among the cannels listed in the above, the money channel (reserve money as operating target in NBE) as a main driver and interest rate (T-bill rate) channel as a supporting role were assumed in this research with the assumption of stable money demand function in Ethiopia.

2.1.2 Empirical Literatures

To date, extensive empirical research has been conducted in the search for the presence of various channels of monetary transmission mechanism (MTM) through which monetary policy changes are propagated in an economy both in the context of developed and developing countries. In this section, I have conducted some empirical literatures which were found in journals and central bank's working paper series from websites.

Study of monetary transmission mechanism has been important for the design and effectiveness of monetary policy in one country. Many researchers in the world, attempted to estimate the effect of monetary policy on output and prices using the structural VAR approach. The purpose of the research was often to find the monetary general equilibrium model most consistent with the data. Therefore, in this section I have put all the researches from past to recent, which are important and related for my study.

Bernanke and Blinder (1992) have used different version of VAR model to decompose the set of endogenous variables in the VAR model into sub-sets of policy and non-policy variables in US. The sub-set of non policy variables includes economic variables such as output, interest rate and price and the sub-set of policy variable includes federal funds rate to capture the overall stance of monetary policy. By imposing contemporaneous identification restrictions, they analyzed the impact of monetary shocks on real activity and price. Based on US monthly data covering the period 1961:7 to 1989:12, they find that the effects of shocks to funds rate on the output are essentially zero during first two to three quarters after the shock. The effect begins to rise at about 9-months ahead and reaches the peak after two years before returning back to zero.

Morsink and Bayoumi (2001) also provided an analysis of Japan's stance. They use VAR analysis with Choleski decomposition to examine the monetary transmission mechanism in Japan and trace the influence of monetary shocks on economic activity, interest rates and prices. The estimations are based on quarterly data covering from the first quarter of 1980 to third quarter of 1998. In the basic model, real private demand representing real activity significantly decline with monetary tightening and bottoms out after 8 to 10 quarters. The price level responds positively to contractionary monetary shocks, which is known as 'price puzzle' in the empirical literature in the US implying monetary contraction producing inflation. They find interest rate rising with tightening monetary shocks.

Cheng, K.C. (2006), applied both recursive and non-recursive SVAR to monthly data in Kenya for 1997–2005 in log levels for all variables except interest rate: real GDP, CPI, broad monetary aggregate (reserve money and M3), short-term interest rate (Repo rate, interbank rate) nominal effective exchange rate (NEER), oil price, U.S. federal funds rate, and U.S. commodity prices. By using these variables and SVAR approach he found some evidence for the presence of the traditional transmission channels. A contractionary monetary policy an increase in the short-term interest rate, leads to an initial increase in the price level (the price puzzle) followed by a falling price level that is statistically significant for about two years following the shock. In response to a contractionary monetary policy, output rises initially (an-output-puzzle) but falls eventually, though the decline is not statistically significant. Shocks to the interest rate explain a much larger fraction of inflation (30%) than output (10%), consistent with the results from the impulse response analysis (IRA).

A study which is conducted in Sun Saharan Africa (SSA) finds that monetary policy is perhaps more effective in SSA than commonly believed (IMF, 2010). The study, based on a panel vector autoregression (VAR) of SSA countries in the past decade, finds that a contractionary monetary policy-defined either by (lower) reserve money growth or a (higher) central bank discount rate-decreases output growth significantly, but the impact on inflation and its statistical significance depend on the measure of the monetary policy instrument. A decline in reserve money (the operating target for many SSA countries) reduces inflation as expected, though the decline is not statistically different from zero. On the other hand, an increase in the central bank discount rate or policy rate (the operating target for a small number of SSA countries) has a statistically significant impact on inflation, but surprisingly it increases inflation (the so-called –price puzzle).

A recent study which conducted in all East Africa Countries (EAC) by Baldini, Poplawski-Ribeiro (2011), analyzed a three-variable recursive VAR. The model used annual data (1980–2005) in log levels and first difference of logs: real GDP, CPI (GDP deflator), and reserve money (discount rate) and variables are ordered as listed above. In this study monetary policy shock is indentified primarily as a shock to reserve money. According to this, he found that appositive shock to reserve money has positive and negative effects on inflation, depending on the horizon in all EAC countries except for Burundi, which shows a positive effect. No confidence bounds are shown for impulse responses. Shocks to reserve money account for (4 percent) of inflation forecast error variance in Rwanda, (5 percent) in Burundi, (13 percent) in Uganda, (15 percent) in Tanzania, and (31 percent) in Kenya.

Finally, In the context of Ethiopia, Noah Mutoti and Michael Etingo-Ego (2008) done the research in titled with "COMESA comparative study on transmission mechanism of monetary policy in member states". In this study they use structural VAR model and estimate using seasonally adjusted monthly data spanning 1992m1-2006m10 and the variables are real domestic product, domestic price, money stock(broad money), domestic interest rate(short-term Treasury bill rate) and nominal exchange rate(domestic currency/US dollar). The variable that is used to gauge the stance of monetary policy is assumed to be base money. According to this, Ethiopia's data revels that, a monetary shock has no impact on both goals but seems to cause exchange rate depreciation. Credit and M_2 shocks seem to have a prolonged effect on output but the impact dies out after 24 months. And they also conclude from the variance decomposition results that CPI in Ethiopia is driven largely by monetary aggregates, as well as by own innovations.

2.2 Monetary Policy Framework of Ethiopia

2.2.1 Ethiopia's Monetary Policy Objectives

Objective of the monetary policy varies for country to country depends in the mandate of the central banks. But they typically include one or more of the following: price stability, high employment, economic growth and welfare, and external balance.

The principal objective of the National Bank of Ethiopia is to maintain price and exchange rate stability and support sustainable economic growth of Ethiopia. Price stability is a proxy for macroeconomic stability which is vital in private sector economic decision on investment, consumption, international trade and saving. Finally, macroeconomic stability fosters employment and economic growth. Maintaining exchange rate stability on the other hand is considered as the principal policy objective of NBE so as to be competitive in the international trade and to use exchange rate intervention as policy tools for monetary policy to affect both foreign reserve position and domestic money supply.

More specifically, the objectives of Ethiopia's monetary policy[2] are to:

- Foster monetary, credit and financial conditions conducive to orderly, balanced and sustained economic growth and development.
- Preserve the purchasing power of the national currency – ensuring that the level of money supply is generally consistent with developments in the macro-economy and intervening in the foreign exchange rate market for the purpose of stabilizing the rate when conditions necessitate.

[2] National Bank of Ethiopia monetary policy framework (2009).

- Encourage the mobilization of domestic and foreign savings and their efficient allocation for productive economic activities through the implementation of a prudent market driven interest rate policy.
- Facilitate the emergence of financial and capital markets that are capable of responding to the needs of the economy through appropriate policy measures. These measures would ensure the gradual introduction of trading instruments on a short-term basis.

2.2.2 Targets, Instruments and Goals

In a decentralized market economy, the central banks does not have much direct control over inflation, employment, economic growth or external balance that might conceivably comprise the goals or objectives of monetary policy. These goals are, however, influenced by some monetary variables.

The final targets of monetary policy in Ethiopia are to maintain price and exchange rate stability and support sustainable economic growth. In achieving these objectives, the NBE sets money supply as an intermediate target. It should be noted that intermediate targets are not directly controlled by the central bank. NBE takes the broader definition of money or M2[3] as money supply. The current target is to ensure that the money supply growth is in line with nominal GDP growth rate (NBE's monetary policy framework, 2009).

[3]Broad Money (M2) is a measure of the domestic money supply that includes M1 plus Quasi-money (savings and time deposits), overnight repurchase agreements, and personal balances in money market accounts. Basically, M2 includes money that can be used for spending (M1) plus items that can be quickly converted to M1.

Consequently, the operational target is an economic variable that the central bank wants to influence, largely on a day-to-day basis, through its monetary policy instruments. They can be used to link instruments of monetary policy to intermediate targets set by the central bank and represent the first impulse in the transmission process of monetary policy. If the money demand function is stable over the long run, money supply changes are closely related to prices and income, and it should be possible therefore for policy makers to control inflation through appropriate adjustments to the money supply.

The growth of base money/reserve money is being used as operational target of the National Bank of Ethiopia. Reserve money (Base money) is defined as the sum of currency in circulation and deposits of commercial banks at NBE. The practice of targeting reserve money is based on the assumption that there will be a stable money demand function in the economy (NBE's monetary policy framework, 2009).

Finally, the National Bank of Ethiopia has been conduct open market operation (OMO) as a main instrument. NBE conduct its OMO actively through Treasury bills market to influence the variables like liquidity level and net domestic assets of the banking system and money supply in the economy and monitor whether they are in conformity with the targeted level. The NBE also uses reserve requirement as instrument to control the liquidity of banks by varying the rate according with the targeted level. The higher Reserve Requirement contracts the liquidity as well as credit expansion power of commercial banks and the opposite will increase liquidity and credit expansion power of banks.

CHAPTER THREE

3 METHODOLOGIES

3.1 Variables and Data

In this research, both domestic and foreign variables have been incorporated, which represents the National Bank of Ethiopia monetary policy. A total of seven variables have been used. Those variables were; reserve money(Mo[4]), consumer price index(CPI), output (GDP), nominal exchange rate(NEXR) and T-bill rate(Tbr)[5] are categorized as domestic and oil price index(OPI) and world commodity price index (WCPI) as foreign variables, while, I was included private sector credit[6], inflation and broad money annual data for descriptive analysis.

With regarding to the starting period of the data issue; since the financial sector has undergone reform, following the change of the government, and consequently private banks and insurances started to develop soon after the declaration of monetary and banking proclamation of 1994/95, this research has been conducted quarterly basis from 1994/95Q3 to 2012/13Q4 for econometric analysis. Along this, for descriptive analysis I employed annual data (1994/95 to 2012/13) for the variable broad money, inflation, output and private sector credit.

Finally, the variables reserve money, broad money, T-bill rate, nominal exchange rate and private advance were obtained from NBE and consumer price index and output collected from MoFED and for foreign variables the source was IMF data statistics.

[4]Since NBE has been use reserve money an operating target variable based on the assumption that there will be a stable money demand function in the economy. And reserve money(M0) = Currency Circulation + Deposit.
[5] T-bill rate refers a weighted average treasury bill rate. This variable is used as a policy interest rate because of the lack of interbank market rate in Ethiopia.
[6] Private sector credit were used to understood the financial development sector movement.

3.2 SVAR Model

Now a Structural VAR methodology which introduced by Sim(1980), becomes important in handling various economic issues and problems concerning the identification of the cotemporaneous and dynamic relationship between macroeconomic variables and the policy instruments. In line with this I was provided a brief description of the SVAR methodology here with. By assuming that the economy is described by a linear, stochastic dynamic model of SVAR can be written in a vector form as:

$$\Gamma Y_t = \Gamma_0 + A_1 Y_{t-1} + A_2 Y_{t-2} + ... + A_p Y_{t-p} + \varepsilon_t \text{..}(1)$$

Where: Y_t is a $n \times 1$ vector of endogenous variables at time t, (n is number of variables)

A_i is $n \times n$ coefficient matrix of lagged endogenous variables for $i = 1,2,...p$,

Γ is a $n \times n$ coefficient matrix of endogenous variables,

Γ_0 is a $n \times 1$ vector of fixed constants and

ε_t is a $n \times 1$ multivariate white noise error process with the following properties

$$E(\varepsilon_t) = 0$$
$$E(\varepsilon_t \varepsilon_t^{'}) = \Sigma$$

SVAR model assumes that ε_t are orthogonal, where by the structural disturbance are uncorrelated or zero and the variance-covariance matrix Σ is constant and diagonal. Matrix Γ described in model (1) is normalized across the main diagonal so that each equation in the SVAR system has a designed dependent variable.

Then the SVAR model parameters are estimated in to two stages:

First stage is to obtain the reduced form equations, premultiplying model (1) both side by Γ^{-1} we get:

$$Y_t = \Gamma^{-1}\Gamma_0 + \Gamma^{-1}A_1Y_{t-1} + \Gamma^{-1}A_2Y_{t-2} + ... + \Gamma^{-1}A_pY_{t-p} + \Gamma^{-1}\varepsilon_t \qquad (2)$$

$$Y_t = D + B_1Y_{t-1} + B_2Y_{t-2} + ... + B_pY_{t-p} + U_t \qquad (3)$$

$$Y_t = D + B(L)Y_t + U_t \qquad (4)$$

Where; $B_i = \Gamma^{-1}A_i$, $i = 1,2..., p$

$D = \Gamma^{-1}\Gamma_0$ and $U_t = \Gamma^{-1}\varepsilon_t$

Then this reduced form model can be appropriately estimated simply by OLS method.

U_t is the innovation corresponding to the reduced form and has zero mean and constant variance i.e., $U_t \sim N(0,\Omega)$ or

$$E(U_t) = 0$$

$$E(U_tU_t^{'}) = (\Gamma^{-1})(\varepsilon_t\varepsilon_t^{'})(\Gamma^{-1})^{'}$$

$$\Omega = (\Gamma^{-1})\Sigma(\Gamma^{-1})^{'}$$

The second stage is identifying the matrix Γ and Σ. This is described in identification of restriction section below.

3.3 Model Specification and Identification of Restriction

3.3.1 Model Specification

In this section, the SVAR model was established by following Enders, W. (1995) notation. Using the above described structural model equation (1) with lag operator becomes;

$$\Gamma Y_t = \Gamma_0 + A(L)Y_t + \varepsilon_t \qquad (5)$$

Where;

$$\Gamma Y_t = \begin{bmatrix} 1 & \gamma_{12} & \gamma_{13} & \gamma_{14} & \gamma_{15} & \gamma_{16} & \gamma_{17} \\ \gamma_{21} & 1 & \gamma_{23} & \gamma_{24} & \gamma_{25} & \gamma_{26} & \gamma_{27} \\ \gamma_{31} & \gamma_{32} & 1 & \gamma_{34} & \gamma_{35} & \gamma_{36} & \gamma_{37} \\ \gamma_{41} & \gamma_{42} & \gamma_{43} & 1 & \gamma_{45} & \gamma_{46} & \gamma_{47} \\ \gamma_{51} & \gamma_{52} & \gamma_{53} & \gamma_{54} & 1 & \gamma_{56} & \gamma_{57} \\ \gamma_{61} & \gamma_{62} & \gamma_{63} & \gamma_{64} & \gamma_{65} & 1 & \gamma_{67} \\ \gamma_{71} & \gamma_{72} & \gamma_{73} & \gamma_{74} & \gamma_{75} & \gamma_{76} & 1 \end{bmatrix} \begin{bmatrix} OPI_t \\ WCPI_t \\ GDP_t \\ CPI_t \\ NER_t \\ M_{0t} \\ Tbr_t \end{bmatrix}$$

$$A(L)Y_t = \begin{bmatrix} a_{11}(L) & a_{12}(L) & a_{13}(L) & a_{14}(L) & a_{15}(L) & a_{16}(L) & a_{17}(L) \\ a_{21}(L) & a_{22}(L) & a_{23}(L) & a_{24}(L) & a_{25}(L) & a_{26}(L) & a_{27}(L) \\ a_{31}(L) & a_{32}(L) & a_{33}(L) & a_{34}(L) & a_{35}(L) & a_{36}(L) & a_{37}(L) \\ a_{41}(L) & a_{42}(L) & a_{43}(L) & a_{44}(L) & a_{45}(L) & a_{46}(L) & a_{47}(L) \\ a_{51}(L) & a_{52}(L) & a_{53}(L) & a_{54}(L) & a_{55}(L) & a_{56}(L) & a_{57}(L) \\ a_{61}(L) & a_{62}(L) & a_{63}(L) & a_{64}(L) & a_{65}(L) & a_{66}(L) & a_{67}(L) \\ a_{71}(L) & a_{72}(L) & a_{73}(L) & a_{74}(L) & a_{75}(L) & a_{76}(L) & a_{77}(L) \end{bmatrix} \begin{bmatrix} OPI_t \\ WCPI_t \\ GDP_t \\ CPI_t \\ NER_t \\ M_{0t} \\ Tbr_t \end{bmatrix}$$

$$\varepsilon_t = \begin{bmatrix} \varepsilon_t^{OP_t} \\ \varepsilon_t^{WCPI_t} \\ \varepsilon_t^{GDP_t} \\ \varepsilon_t^{CPI_t} \\ \varepsilon_t^{NER_t} \\ \varepsilon_t^{M_{ot}} \\ \varepsilon_t^{Tbr_t} \end{bmatrix} \text{ and } \Gamma_0 = \begin{bmatrix} \gamma_{10} \\ \gamma_{20} \\ \gamma_{30} \\ \gamma_{40} \\ \gamma_{50} \\ \gamma_{60} \\ \gamma_{70} \end{bmatrix}$$

L=1,2,…p, (p is lag length) and the variables $OP_t, WCPI_t, GDP_t, CPI_t, M0_t, Tb_t and NXR_t$ represents; oil price, world commodity price index, real gross domestic product, domestic consumer price index, reserve money, T-bill rate and nominal exchange rate respectively at period t. And also $\varepsilon_t^{OP}, \varepsilon_t^{WCPI}, \varepsilon_t^{GDP}, \varepsilon_t^{CPI}, \varepsilon_t^{M_0}, \varepsilon_t^{Tb} and \varepsilon_t^{NER}$ represents, oil price shock, world commodity price shock, output shock, domestic price shock, broad money shock, treasury bill rate shock and nominal exchange rate shock respectively. And Γ_0 is contains fixed constants. All variables expressed in logarithms except interest rate which is in percentage term.

3.3.2 Identification of Restriction

3.3.2.1 Identification Conditions

As I have mentioned that the second stage of SVAR model parameter estimation is identification of the model, in this section I explain it in detail here. Bernanke (1986) proposed using theory to derive the identifying restrictions in the structural matrix elements. From the previous model(3) the estimation of the model gives that $U_t = \Gamma^{-1}\varepsilon_t$ then $\varepsilon_t = \Gamma U_t$,this implies whether the model is identified or over-identified or under-identified there must be count the number of known estimates and unknown parameters.

The variance covariance of Ω, which has $n \times (n+1)/2$ number of distinct known elements, while, estimates of matrix Γ has $n^2 - n$ number of unknown parameters (since diagonal elements are 1 and known). And structural shock variance covariance matrix of Σ has n unknown elements (since pure structural shock's covariance are zero). Therefore, the total number of unknowns are $n^2 - n + n = n^2$ which is greater than number of known estimate values $n \times (n+1)/2$. These forces an additional restriction needed to identify the system is $n^2 - n(n+1)/2 = n(n-1)/2$.

In general, there are three necessary conditions of the identification issue, which are:

(i) If the number of restrictions $= n \times (n+1)/2$ the model is exactly identified,

(ii) If the number of restrictions $> n \times (n+1)/2$ the model is over identified and

(iii) If the number of restrictions $< n \times (n+1)/2$ the model is under identified.

From these three options case (iii) if the model is not identified and this is not possible to estimate the model. But the two cases i.e., (i) and (ii) are possible. Case (ii) must be passed the over identification test with the null hypothesis that the over identification is valid.

3.3.2.2 Short Run (contemporaneous) Restriction

In this study, since there are seven variables in the model, normalization of the diagonal elements of Γ to be unity leaves $n \times (n-1)/2$ or 21 additional restrictions to be imposed on the system. Hence, based on economic theories, I have imposed short run restrictions on some of the elements of Γ to satisfy the necessary conditions of identification. In addition to this, I have been considered the following assumptions about the restriction on the elements of Γ matrix:

1) It is well known that the shocks to small open economies like Ethiopia have very little impact on major foreign countries. Foreign variable (OPI and WCPI) shocks can affect the domestic variables rapidly but not affected by the domestic variables.

2) Real output does not have a contemporaneous effect on domestic price. A non-policy domestic variables (CPI and GDP) do not respond contemporaneously to innovations in the policy variables (M0 and Tb), because of the fact that the non-policy variables respond slowly to change in the policy variables due to the existence of decision lags.

3) Monetary policy variables set after looking as current value of inflation, output and exchange rate. Assuming that the real sector variables (CPI and GDP) have no contemporaneous effect in identification of shocks in the monetary sector (reserve money

and T-bill rate). The policy rate (T-bill rate) assuming that may be benchmarked are being used by National Bank of Ethiopia as an additional instrument to signal changes in monetary policy stance. Since the central banks change the policy rate after choosing the reserve money path and by this assumption, T-bill rate is placed after the reserve money.

4) Unlike the structure followed for developed economy the exchange rate is considered to be a financial variable and assumed to be affected by all the variables instead of affecting them contemporaneously, in developing economy the central banks are concerned about the movements in exchange rate and take quick actions to smooth out fluctuation.

According to the above restrictions imposed, the newly obtained structural matrix Γ become as follows:

$$\Gamma U_t = \varepsilon_t \Rightarrow \begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ \gamma_{21} & 1 & 0 & 0 & 0 & 0 & 0 \\ \gamma_{31} & \gamma_{32} & 1 & 0 & 0 & 0 & 0 \\ \gamma_{41} & \gamma_{42} & 0 & 1 & 0 & 0 & 0 \\ \gamma_{51} & \gamma_{52} & \gamma_{53} & \gamma_{54} & 1 & 0 & 0 \\ \gamma_{61} & \gamma_{62} & 0 & 0 & \gamma_{65} & 1 & \gamma_{67} \\ \gamma_{71} & \gamma_{72} & 0 & \gamma_{74} & 0 & \gamma_{76} & 1 \end{bmatrix} \begin{bmatrix} u_t^{OP_t} \\ u_t^{WCPI_t} \\ u_t^{GDP_t} \\ u_t^{CPI_t} \\ u_t^{NER_t} \\ u_t^{M_{ot}} \\ u_t^{Tb_t} \end{bmatrix} = \begin{bmatrix} \varepsilon_t^{OP_t} \\ \varepsilon_t^{WCPI_t} \\ \varepsilon_t^{GDP_t} \\ \varepsilon_t^{CPI_t} \\ \varepsilon_t^{NER_t} \\ \varepsilon_t^{M_{ot}} \\ \varepsilon_t^{Tb_t} \end{bmatrix} \text{..............................} (6)$$

Because I have imposed 32 restrictions which is 32>28, the restriction is over identified. Therefore, identification test is needed in order to check the validity of the identification. Finally, I have used this final SVAR model and generate impulse response and variance decomposition results.

3.4 Stationarity Test

Before estimation of reduced VAR, time series properties of all concerned variables have been identified by Augmented Dickey-Fuller. The test has been performed in the levels and on the basis of 5% significance level using Economic Views Package (E-Views). In this package the lag length for ADF test has been decided on the basis of Schwartz's Information Criteria (SIC).

3.5 Lag Length Selection

After the co-integration relationships examined there is a lag length selection using statistical criterion in order to select the appropriate lag length (p) in a reduced VAR model. Therefore in this research five information statistical criterion such as, Akaike Information Criterion (AIC), Schwarz Information Criteria (SIC), Hannan-Quinn Information Criteria (HQ) and Final Prediction Error (FPE) were employed to identify the optimal lag length.

3.6 Co-integration Test

Checking the long run relationship among the variables at level has been conducted thorough co-integration tests. There are several approaches to test the co-integration among the variables. Johansen introduced two likelihood ratio methods in order to investigate co-integrating vectors as well as to test for a number of co integrating relation simultaneously.

In this research both trace and maximum-eigen value test have been applied. The test hypothesis and test statistics for each test can be illustrated below[7]:

Test hypothesis and test statistics of trace test:

---

[7] The notation of those trace and maximum eigne values test were taken from text book of Marno Verbeek (2004).

$H_0 : r \le r_0$ Vs

$H_1 : r_0 < r \le n$ or $H_1 : r > r_0$ and can be tested using the statistics

$$\lambda_{trace(r_0)} = -T \sum_{j=r_0+1}^{n} \log(1-\hat{\lambda}_j) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(7)$$

Test hypothesis and test statistics of maximum eigne value test:

$H_0 : r \le r_0$ Vs

$H_1 : r = r_0 + 1$ and can be tested using the statistics

$$\lambda_{\max(r_0)} = -T \log(1-\lambda_{r_0+1}) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(8)$$

where: r is number of ranks, n is number of variables and T is total number of observations.

Then, if $\left|\lambda_{trace(r_0)}\right| > |CriticalValue|$ or $\left|\lambda_{\max(r_0)}\right| > |CriticalValue|$ we will reject Ho.

3.7 Diagnostic Test

Once the final model selected, diagnostic tests are utilized to check the validity of the fitted model. In this study, VAR based diagnostic tests are reported. VAR residual serial correlation Langragian multiplier test is conducted for investigating possible serial correlation in the error term. The null hypothesis for this test is written below:

H_0 : There is no serial correlation in the error term

3.8 Stability Test

Model stability is the core issue in impulse response analysis. Therefore, the inverse characteristic roots are applied to determine the VAR/SVAR stability conditions. If the characteristic roots of the variables lie within the circle, the parameters estimated are deemed to be stable.

3.9 Impulse Response Function, Variance Decomposition

The effectiveness of monetary policy and the roles of various transmission channels in transmitting the policy shocks have been observed through impulse response functions and forecast error variance decompositions. Variance decompositions (VDCs) and impulse response functions (IRFs) derived from VARs estimation have been used to look at the relative impact of monetary policy actions (i.e., money supply or interest rate changes) on aggregate output and prices[8].

3.9.1 Impulse Response Function

The impulse response function is derived and used to examine the dynamic response of the variables to various shocks with the SVAR system (Enders 1995).. Using the lag operator L, the reduced model (4) can be written as follow:

$$B(L)Y_t = D + U_t \quad \text{...}(9)$$

This model can be reparameterized to express the endogenous variables in Y as a function of the current and future values of U, then the vector moving average (VMA) representation is given as:

$$Y_t = \mu + U_t + C_1 U_{t-1} + C_2 U_{t-2} + ... = \mu + C(L)U_t \quad \text{..}(10)$$

where, $C(L)=(I-B(L))^{-1} = \sum_{k=0}^{\infty} C_k L^k$ and $\mu=B(L)^{-1} D$

From this equation, MA model in (10) may not have ability to attributes the response of a certain variable to an economically interpreted shock, because U_t by its constraction reflects

[8] Enders (1995) mentions that IRF analysis and VDCs together known as innovation accounting is a useful tool to investigate the relationships among macroeconomic variables.

the combination of all the fundamental economic shocks and does not correspond only a particular shock. One way to solve this problem is to transform innovation U_t to recover the set of orthogonal structural innovation ε_t defined in the original SVAR model(1). Therefore, by substituting $U_t = \Gamma^{-1}\varepsilon_t$ in the MA representative of model (7) can be transformed as:

$$Y_t = \mu + C(L)\Gamma^{-1}\varepsilon_t \text{...} (11)$$
$$= \mu + \Phi(L)\varepsilon_t$$

where $\Phi(L) = k = \sum_{k=0}^{\infty}\Phi_k L^k = C(L)B^{-1} = B^{-1} + C_1 B^{-1} L + ...$

The element of matrix Φ_k matrices generates the dynamic multiplier of impulse response of Y_t to the structural shock to ε_t.

3.9.2 Variance Decomposition

Basically, the impulse response functions (IRFs) show the response of each concerned variable in the linear system to a shock from system variables. But, variance decompositions (VDCs) show the portion of the variance in the forecast error for each variable due to innovations to all variables in the system. The s period-ahead forecast error is expressed as:

$$y_{t+s} - \hat{y}_{t+s/t} = U_{t+s} + C_1 U_{t+s-1} + C_2 U_{t+s-2} + ... + C_{s-1} U_{t+1} \text{...} (12)$$

The mean square error of the s period- ahead forecast is:

$$MSE(\hat{y}_{t+s/t}) = \Omega + C_1 \Omega C_1' + C_2 \Omega C_2' + ... + C_{s-1} \Omega C_{s-1} \text{...} (13)$$

$$MSE(\hat{y}_{t+s/t}) = (\Gamma^{-1})\Sigma(\Gamma^{-1})' + C_1(\Gamma^{-1})\Sigma(\Gamma^{-1})' C_1' + C_2 C(\Gamma^{-1})\Sigma(\Gamma^{-1})'_2{}' + ... + C_{s-1}(\Gamma^{-1})\Sigma(\Gamma^{-1})' C_{s-1} \text{............} (14)$$

The above equation (11) describes the contribution of the orthogonal innovations ε_t to the MSE of the s-period-ahead forecast of variables in Y_t.

CHAPTER FOUR

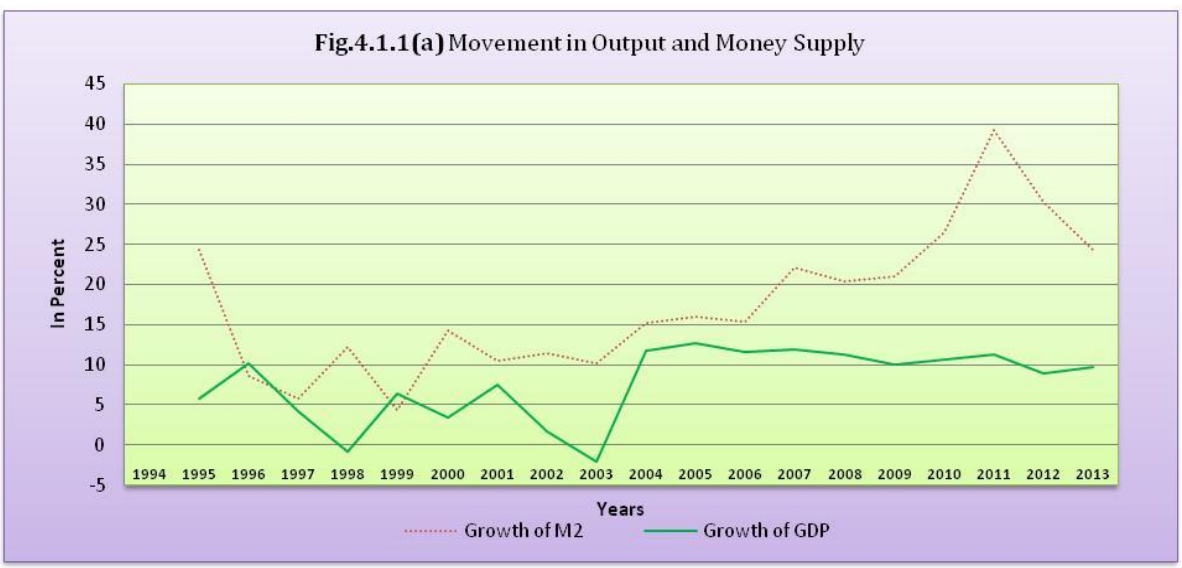
4 RESULT AND DISCUSSIONS

4.1 Descriptive Analysis

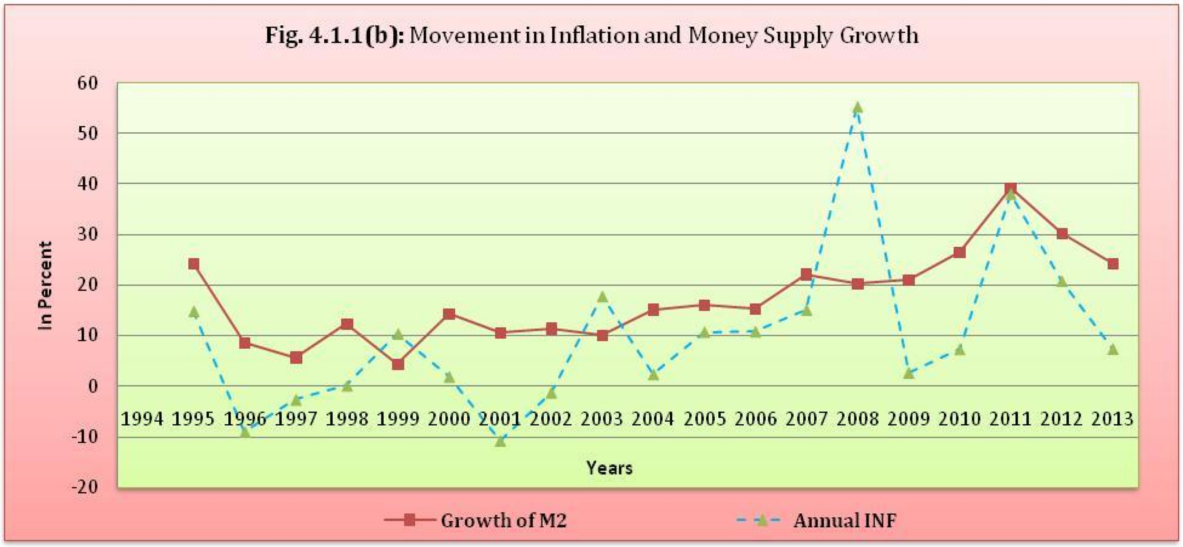
4.1.1 Movement in Inflation, Output and Money Growth

The movement of money supply (broad money) and growth of output is displayed in figure 4.1.1(a) below. Between 2003 and 2013 broad money has on average grown by 21.86 percent, while GDP has grown by 9.74 percent over the same period. This implies that the growth of money supply and output has been shown a positive relationship.

The development between inflation and broad money growth indicated in figure 4.1.1(b). It revealed that inflation has on average increased by 17.12 percent, while money supply has on average grown by 21.86 percent over the same period. The graph shows that, the growth in broad money and price has a positive common increasing trend.



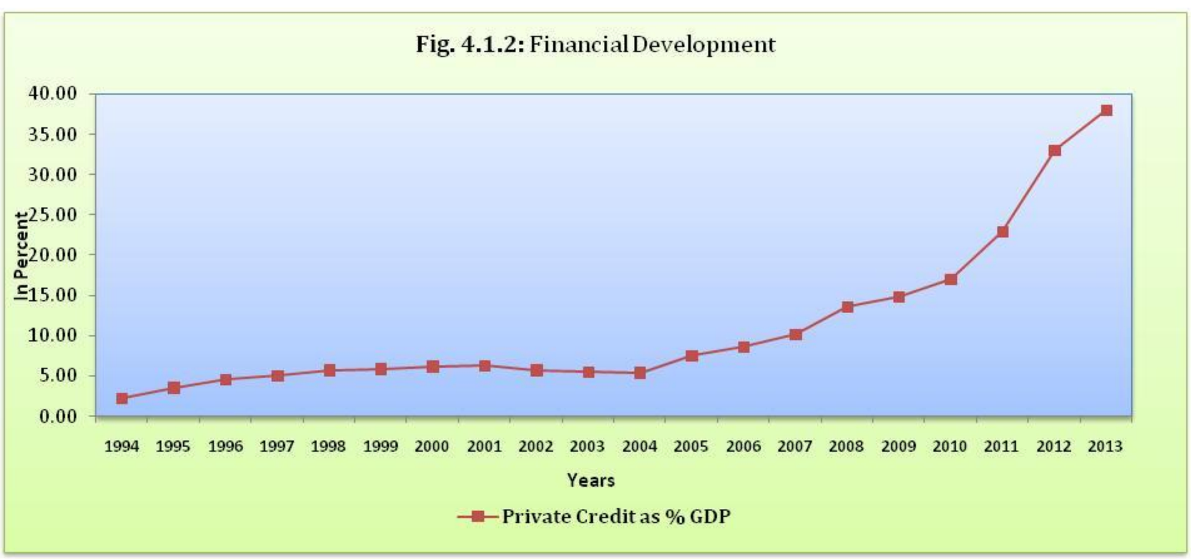
Source: National Bank of Ethiopia



Source: National Bank of Ethiopia

4.1.2 Financial Sector Development

The financial sector development has been conducted via observing the percentage change of private sector credit to GDP. As it is depicted in figure 4.1.2, private sector credit as percent of GDP has increased from 2.27% to 38.0% over the period 1994 to 2013. This implies that the financial sector development has been increasing.



Source: National Bank of Ethiopia

4.2 Econometric Analysis

4.2.1 Stationarity Test

The Augmented Dickey-Fuller (ADF) unit root test (table 4.2.1) on variables revealed that variables LOP, LWCPI and LNXR were stationary in levels with intercept and trend implying that they are I(0). But variables LCPI, LGDP, LM0 and LTbr were non stationary at level with intercept and trend. However, stationarity were achieved after first differencing implying that variables are I(1).

Table 4.1.1: Stationarity Test Result

Variables	**ADF test**	
	With intercept	**With intercept and trend**
In Level		
LOP	-0.405526	-4.978796**
LWCPI	-0.006195	-4.016017*
LCPI	2.808357	-0.374022
LGDP	4.952235	0.680371
LM0	1.007524	-2.881041
LTbr	-1.686261	-1.680457
LNXR	0.501067	-4.387125**
First Differences		
ΔLOP	-10.50608**	-10.45286**
ΔLWCPI	-10.41183**	-10.45112**
ΔLCPI	-7.185299**	-8.622011*
ΔLGDP	-0.459421	-11.91998**
ΔLM0	-8.369428**	-8.618884**
ΔLTb	-9.512957**	-9.666960**
ΔLNXR	-3.185535*	-3.390044*
MacKinnon critical values		
At 1%	-3.533204	-4.103198
At 5%	-2.906210	-3.479367
At 10%	-2.590628	-3.167404

Note: Null hypothesis have unit roots, ** significante at 1% and * significant at 5%.

4.2.2 Lag Length Selection

Since the stationarity test results confirmed that three variables were I(0) and four variables I(1), before proceed to the co-integration test, I first applied VAR test in order to determine the number of order or lag length by using lag selection criteria(table 4.2.2).

Table 4.2.2: Lag Length Selection

VAR Lag Order Selection Criteria
Endogenous variables: LOP LWCPI LCPI LGDP LM0 TBR LNEXR
Exogenous variables: C
Date: 05/29/14 Time: 17:02
Sample: 1995Q3 2012Q4
Included observations: 64

Lag	LogL	LR	FPE	AIC	SC	HQ
0	79.77406	NA	2.43e-10	-2.274189	-2.038061	-2.181167
1	440.9036	631.9767	1.42e-14	-12.02824	-10.13922*	-11.28406
2	512.0558	108.9518*	7.50e-15*	-12.72049	-9.178577	-11.32515*
3	556.6167	58.48613	9.94e-15	-12.58177	-7.386959	-10.53527
4	610.2086	58.61619	1.15e-14	-12.72527	-5.877563	-10.02761
5	675.0785	56.76109	1.20e-14	-13.22120	-4.720599	-9.872385
6	758.6881	54.86882	1.06e-14	-14.30275*	-4.149256	-10.30278

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

VAR order selection criteria (LR, FPE, and HQ) in table 1 suggested two optimal lag length, while AIC and SC were suggested lag length 6 and 1 respectively. Since the lag length of two suggested by three criteria serial and it is sufficient to eliminate residual serial correlations, optimal lag length two is selected.

4.2.3 Co-integration Test

Since the lag length selection provided that there were two lag lengths, I have used this lag length to Johansen co-integration test to check whether there is long run relationship or not at level. Bothe trace and maximum eigenvalue test were applied and those result was explore as below.

Table 4.2.3: Johansen Co-integration Test Result

Trace Test				
Null hypothesis	Alternative hypothesis	Test statistics	5% Critical value	P-value**
$H_0: r \leq 0$	$H_0: r > 0$	172.2201*	150.5585	0.0017
$H_0: r \leq 1$	$H_0: r > 1$	120.6868*	117.7082	0.0320
$H_0: r \leq 2$	$H_0: r > 2$	86.11041	88.80380	0.0770
$H_0: r \leq 3$	$H_0: r > 3$	61.39785	63.87610	0.0794
$H_0: r \leq 4$	$H_0: r > 4$	38.13069	42.91525	0.1388
$H_0: r \leq 5$	$H_0: r > 5$	22.76816	25.87211	0.1161
$H_0: r \leq 6$	$H_0: r > 6$	9.471500	12.51798	0.1533
Maximum Eigenvalue Test				
$H_0: r = 0$	$H_0: r = 0$	51.53330*	50.59985	0.0398
$H_0: r \leq 1$	$H_0: r = 1$	34.57644	44.49720	0.3901
$H_0: r \leq 2$	$H_0: r = 2$	24.71255	38.33101	0.6920
$H_0: r \leq 3$	$H_0: r = 3$	23.26717	32.11832	0.3990
$H_0: r \leq 4$	$H_0: r = 4$	15.36253	25.82321	0.6019
$H_0: r \leq 5$	$H_0: r = 5$	13.29666	19.38704	0.3047
$H_0: r \leq 6$	$H_0: r = 6$	9.471500	12.51798	0.1533

Note: Trace and Maximum eigenvalue tests indicates 2 and 1 cointegrating eqn(s) at the 0.05 level of significance. * denote rejecton of the hypothesis at the 0.05 livel, ** Mackinnon-Haug-Michelis(1999) p-val.

The Johansen co-integraion tests which are depicted in table 4.2.3 indicated that, the trace statistics strongly reject the null hypothesis of both the "none" and "at most one" cointegrating vectors in favor of at least two cointegrating vectors at the 5 percent significance level. And the maximum eigen-value test strongly rejects the null hypothesis of zero cointegraion vectors in favor of at least one cointegraing vectors. This implies that there is long run relationship between variables at level.

4.2.4 Model Diagnostic and Stability Test

As I have mentioned in section 3, the VAR residual serial correlation Langragian multiplier test is used for investigating possible serial correlation in the error term. The obtained LM statistics for residual autocorrelation after the structural VAR model in table 1(Appendix-1) shows that there is no serial correlation at tested lag order one or two, since we cannot reject the null hypothesis. This result also indicated that the lag order two selected by standard information criteria is found to be adequate.

In addition to this, for the condition of stability of the VAR / SVAR models the stability of models test result in table 2 (Appendix-1) revealed that characteristic roots of the variables lie within the circle, the parameters estimated are deemed to be stable.

4.2.5 SVAR Model Estimation

The short run restricted or contemporaneous matrix Γ defined in section 3 is estimated using the set of restrictions given equation 6. Since the SVAR model is over identified, checking the validity test is essential. The test of validity in the SVAR estimates result on table 3 (Appendix-1) indicated that the identification is valid. Then using this SVAR estimation, impulse response and variance decomposition analysis has been generated.

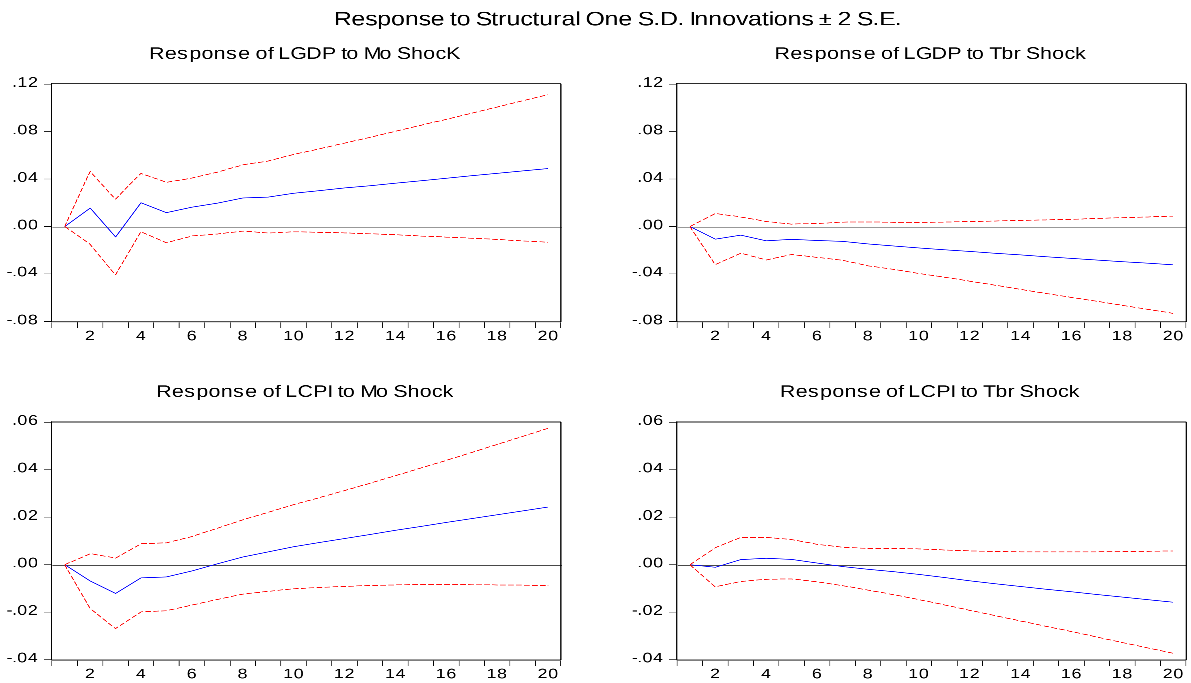
4.2.6 Impulse Response Analysis

In this section the dynamic response of variables especially for output and price to one standard deviation of various shocks is examined. The standard deviations of the corresponding orthogonal errors generated from SVAR model measures the size of each variables shocks. From SVAR estimated model result displayed in table 3(Appendix-1), the diagonal element of matrix B contains the size of the one standard deviation shocks of each variables.

4.2.6.1 Impulse Response of domestic output and price

Figure 4.2.6.1 of the first row displays the impulse of responses of output and price to one standard deviation positive shock in reserve money (expansionary monetary policy), while the second row depicts those to a positive shock in policy rate or T-bill rate (monetary tightening).

Figure 4.2.6.1: Response of LGDP to M0 and Tbr and Response of LCPI to M0and Tbr



As shown in Figure 4.2.6.1, output responds positively and significantly to a shock in reserve money (expansionary monetary policy), with a considerable lag that spans at most a one quarter. It also responds to a shock in the T-bill rate is declined and sustained over the entire period though output for two shocks is statistically significant in line with economic theory.

Figure 4.2.6.1also suggests that a positive shock to reserve money has a negative impact for one and half year, the so called price puzzle as it is observe occurred in different studies in the empirical literature, but after this period it is increased, which in line with economic theory. And also appositive shock to the T-bill rate increases a price at most one year which is also price puzzle, while beyond the one year period the price is decreased continuously which indicated that it is statistically significant. The complete set of impulse response function was displayed in (Figure 1-Appendix-1).

4.2.7 Variance Decomposition Analysis

In order to know information about dynamic relationships among jointly analyzed VAR and SVAR system variables it is important to examine variance decomposition analysis. The full variance decomposition results were depicted in table 4 (Appendix-1). However, in the below table 4.2.7.1 the variance decomposition of output and price for the 1st, 4th, 8th,16th and 20th, horizons in to the future are reported from a complete set table 4(Appendix-1) result.

Table 4.2.7.1: Variance Decomposition of Output and Price

Horizon period (Quarters)	Percent of Variation due to						
	OP	**WCPI**	**GDP**	**CPI**	**NEXR**	**Mo**	**Tbr**
Output(GDP)							
1	11.87797	5.385856	82.73618	0.00	0.00	0.00	0.00
4	15.88483	8.873342	64.48547	5.495430	0.211940	3.528356	1.520638
8	15.88550	14.37592	56.29644	3.797811	0.717661	6.164872	2.761789
16	14.18704	12.93544	48.44943	1.855748	1.296312	14.84747	6.428557
20	13.14740	11.03909	46.10713	1.652868	1.404583	18.57553	8.073396
Price(CPI)							
1	0.302689	0.00	0.00	99.69727	0.00	0.00	0.00
4	2.300742	13.54493	13.97617	65.70730	0.062374	4.168421	0.240069
8	10.85724	25.47527	19.71930	40.78051	0.164417	2.768062	0.235197
16	14.59460	26.27821	30.23588	18.88637	0.782945	6.890187	2.331814
20	14.55817	22.48251	33.63396	13.20014	0.969352	10.93341	4.222463

Table 4.2.7.1 shows that the relative importance of shocks in variability of output and price. It indicated that the variation of output in the Short term (the 1^{st}, 4^{th} and 8^{th} horizon periods) is more explained by its own effect (82.74, 64.49, and 56.27%) followed by the shocks on oil price (11.88, 15.88 and15.89%). In the longer term (the $16^{th}$and 20^{th} horizon periods), is largely affected by its own shocks (48.45and 46.11%) and reserve money shock accounts (14.85 and 18.57%).

As for price, in the short term horizon in the same table suggested that, the variation is mostly explained by its own shock (99.69 and 65.71%) and world commodity price shock (13.55 and 25.46%), while the long term horizon, much of the movement is affected by output shock (30.26 and 33.63%).

The above table 4.2.7.1 also shows that, the monetary policy variables effect on the output and price. Change in output and price are more due to shocks to reserve money in the short term as well as in the long term compare to T-bill rate shock. This finding is consistent with impulse response analysis which displayed in Figure 4.2.6.1.

CHAPTE FIVE

5 CONCLUSION AND RECOMMENDATION

5.1 Conclusion

In this research, I examined the effect of monetary policy shocks on Ethiopian economy especially in the real sector macroeconomic variables price and output using SVAR methodology for the quarterly period 1995Q3to 2011/12Q4. Both the domestic (GDP, CPI, M_0,T-bill rate) and foreign variables (OPI and WCPI) were used to investigate the Ethiopian monetary policy framework. I imposed a contemporaneous restriction based on economic theory in order to provide some economic structure to Ethiopia SVAR.

The empirical findings of impulse response function shown that an expansionary monetary policy (a positive shock to reserve money) had a positive effect on output significantly with considerable lag spans one quarter. Price responds to a positive shock to reserve money negatively for a period of one and half and after this period it was increased and sustained for long periods. A contractionary monetary policy (a positive shock to T-bill rate) was decreased output continuously and statistically significant which was in line with economic theory, while a positive shock to T-bill rate was increased a price at most one year which was so called price puzzle, while after the one year period the price is decreased continuously. The variance decomposition result show notable differences in the monetary policy shocks effect on output and price. It revealed that, the variability of price and output due to shock to reserve money was more explained than T-bill rate shock in the short term as well as the long term.

Finally, the model indicated that monetary policy shock (reserve money and T-bill rate) had an importance role in the change of Ethiopia economy especially on output and price. A model also confirmed that a money transmission mechanism policy was more effective than interest rate channel.

5.2 Recommendations

Based on the empirical findings I have drawn the following recommendations.

- As the finding indicated that in the short term and long term variability of price and output were more explained due to shock to reserve money than T-bill rate shock, therefore, the NBE should ensure that reserve money and interest policy are consistent with each other.

- Further studies should be needed to identify different monetary transmission mechanisms or channels in Ethiopia.

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APPENDIX-1

Table 1: LM test

VAR Residual Serial Correlation LM Tests

Null Hypothesis: no serial correlation at lag order h

Date: 04/26/14   Time: 16:32

Sample: 1995Q3 2012Q4

Included observations: 68

Lags	LM-Stat	Prob
1	51.77244	0.3662
2	63.08401	0.0851
3	55.98511	0.2293
4	65.08810	0.0617
5	53.53123	0.3046
6	48.75947	0.4828

Probs from chi-square with 49 df.

Table 2: Stability Test

Roots of Characteristic Polynomial

Endogenous variables: LOPI LWCPI LGDP LCPI LNEXR LM0 TBR

Exogenous variables: C

Lag specification: 1 2

Date: 04/26/14   Time: 16:59

Root	Modulus
0.991535	0.991535
0.971036 - 0.010209i	0.971089
0.971036 + 0.010209i	0.971089
0.650186 - 0.294861i	0.713922
0.650186 + 0.294861i	0.713922
0.307145 - 0.591616i	0.666594
0.307145 + 0.591616i	0.666594
-0.594837	0.594837
-0.222089 - 0.524079i	0.569194
-0.222089 + 0.524079i	0.569194
0.145909 - 0.528874i	0.548632
0.145909 + 0.528874i	0.548632
-0.184310 - 0.124996i	0.222697
-0.184310 + 0.124996i	0.222697

No root lies outside the unit circle.
VAR satisfies the stability condition.

Table 3: Structural VAR Estimates

Structural VAR Estimates
Date: 04/26/14 Time: 14:51
Sample (adjusted): 1996Q1 2012Q4
Included observations: 68 after adjustments
Estimation method: method of scoring (analytic derivatives)
Convergence achieved after 15 iterations
Structural VAR is over-identified (4 degrees of freedom)

Model: Ae = Bu where E[uu']=I
Restriction Type: short-run pattern matrix

A =

1	0	0	0	0	0	0
C(1)	1	0	0	0	0	0
C(2)	C(7)	1	0	0	0	0
C(3)	C(8)	0	1	0	0	0
C(4)	C(9)	C(12)	C(13)	1	0	0
C(5)	C(10)	0	0	C(15)	1	C(17)
C(6)	C(11)	0	C(14)	0	C(16)	1

B =

C(18)	0	0	0	0	0	0
0	C(19)	0	0	0	0	0
0	0	C(20)	0	0	0	0
0	0	0	C(21)	0	0	0
0	0	0	0	C(22)	0	0
0	0	0	0	0	C(23)	0
0	0	0	0	0	0	C(24)

	Coefficient	Std. Error	z-Statistic	Prob.
C(1)	-0.604134	0.024633	-24.52554	0.0000
C(2)	0.496981	0.166214	2.990000	0.0028
C(3)	-0.010366	0.069060	-0.150100	0.8807
C(4)	-0.002270	0.031457	-0.072156	0.9425
C(5)	-0.320895	0.297238	-1.079589	0.2803
C(6)	1.687601	0.475153	3.551697	0.0004
C(7)	-0.548671	0.260782	-2.103944	0.0354
C(8)	0.000605	0.108351	0.005585	0.9955
C(9)	0.018986	0.047877	0.396550	0.6917
C(10)	0.023545	0.463644	0.050783	0.9595
C(11)	-2.953318	0.699296	-4.223272	0.0000
C(12)	-0.036954	0.021573	-1.712990	0.0867
C(13)	0.015745	0.051922	0.303243	0.7617
C(14)	-3.798559	0.783193	-4.850093	0.0000
C(15)	-1.043151	0.910004	-1.146314	0.2517
C(16)	0.812551	0.438269	1.854002	0.0637
C(17)	0.041513	0.097849	0.424252	0.6714
C(18)	0.241915	0.020744	11.66190	0.0000
C(19)	0.049140	0.004214	11.66190	0.0000

C(20)	0.105673	0.009061	11.66190	0.0000
C(21)	0.043906	0.003765	11.66190	0.0000
C(22)	0.018798	0.001612	11.66190	0.0000
C(23)	0.142964	0.016990	8.414529	0.0000
C(24)	0.282113	0.024767	11.39054	0.0000

Log likelihood	477.5698		
LR test for over-identification:			
Chi-square(4)	2.752523	Probability	0.6001

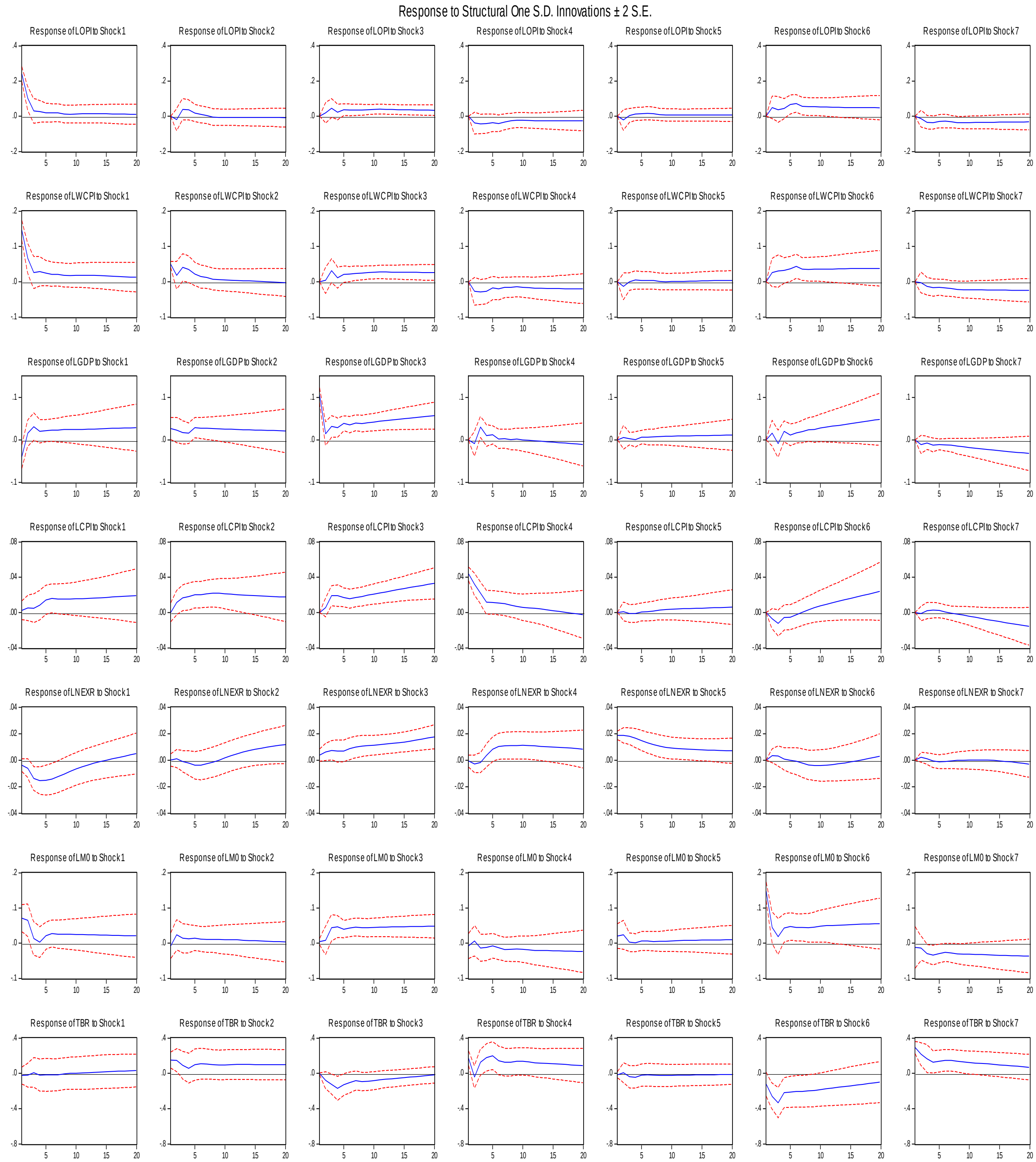
Estimated A matrix:

1.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
-0.604134	1.000000	0.000000	0.000000	0.000000	0.000000	0.000000
0.496981	-0.548671	1.000000	0.000000	0.000000	0.000000	0.000000
-0.010366	0.000605	0.000000	1.000000	0.000000	0.000000	0.000000
-0.002270	0.018986	-0.036954	0.015745	1.000000	0.000000	0.000000
-0.320895	0.023545	0.000000	0.000000	-1.043151	1.000000	0.041513
1.687601	-2.953318	0.000000	-3.798559	0.000000	0.812551	1.000000

Estimated B matrix:

0.241915	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
0.000000	0.049140	0.000000	0.000000	0.000000	0.000000	0.000000
0.000000	0.000000	0.105673	0.000000	0.000000	0.000000	0.000000
0.000000	0.000000	0.000000	0.043906	0.000000	0.000000	0.000000
0.000000	0.000000	0.000000	0.000000	0.018798	0.000000	0.000000
0.000000	0.000000	0.000000	0.000000	0.000000	0.142964	0.000000
0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.282113

Figure 1: SVAR Impulse Response Function



Note: Shock1, shock2, shock3, shock4, shock5, shock6 and shock 7 represents, LOPI, LWCPI, LGDP, LCPI, LNEXR, LM0 and Tbr respectively.

Table 4: Variance Decomposition Result

Variance Decomposition of LOPI:

Period	S.E.	Shock1	Shock2	Shock3	Shock4	Shock5	Shock6	Shock7
1	0.241915	100.0000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2	0.272352	92.76444	0.494286	0.470898	2.050466	0.622003	3.365925	0.231981
3	0.288841	83.58207	2.318074	2.998487	4.152300	0.575992	4.660968	1.712108
4	0.302014	77.26514	3.576120	3.341244	5.783784	0.685265	6.328887	3.019559
5	0.316394	70.79979	3.582647	4.444570	6.657405	0.820459	10.12777	3.567353
6	0.331455	64.85731	3.359936	5.167790	7.595640	1.000690	14.05340	3.965232
7	0.341998	61.22425	3.168088	5.930313	8.033095	1.108117	15.97931	4.556822
8	0.351389	58.13654	3.016042	6.642092	8.190022	1.116316	17.55207	5.346917
9	0.360450	55.34885	2.893361	7.388549	8.153340	1.107579	18.97854	6.129776
10	0.369198	52.87243	2.783617	8.118045	8.140257	1.097000	20.19756	6.791089
11	0.377710	50.64253	2.685430	8.871983	8.193642	1.082602	21.19228	7.331533
12	0.385959	48.63234	2.598304	9.545010	8.296187	1.067134	22.05260	7.808424
13	0.393815	46.84530	2.521424	10.12130	8.396372	1.054191	22.80982	8.251598
14	0.401380	45.22105	2.452718	10.61687	8.489515	1.044205	23.51398	8.661650
15	0.408717	43.72307	2.389549	11.05978	8.581520	1.037982	24.17553	9.032573
16	0.415831	42.33840	2.332218	11.45743	8.678336	1.035156	24.79182	9.366640
17	0.422702	41.06035	2.281968	11.81543	8.775346	1.034662	25.36123	9.671016
18	0.429323	39.88062	2.239257	12.13617	8.867200	1.035637	25.88854	9.952581
19	0.435692	38.79109	2.203606	12.42519	8.951095	1.037640	26.37642	10.21496
20	0.441816	37.78277	2.174219	12.68769	9.028072	1.040339	26.82756	10.45935

Variance Decomposition of LWCPI:

Period	S.E.	Shock1	Shock2	Shock3	Shock4	Shock5	Shock6	Shock7
1	0.154189	89.84320	10.15680	0.000000	0.000000	0.000000	0.000000	1.03E-30
2	0.173363	85.52289	9.129906	0.051035	2.444575	0.557981	2.275064	0.018549
3	0.187867	74.75221	12.41688	2.860769	4.490543	0.475271	4.484254	0.520074
4	0.198817	68.87999	14.16403	2.865778	5.874910	0.479221	6.544095	1.191979
5	0.207201	64.81130	14.10866	3.685198	6.158189	0.471159	9.103763	1.661737
6	0.216007	60.56695	13.44138	4.360377	6.566444	0.460837	12.41583	2.188187
7	0.222938	57.72320	12.90511	5.219356	6.687562	0.450226	14.20530	2.809242
8	0.229391	55.17714	12.28591	6.055625	6.780387	0.426130	15.73092	3.543891
9	0.235846	52.76074	11.67749	6.968888	6.789799	0.403219	17.13269	4.267170

10	0.242311	50.55144	11.10239	7.797287	6.843969	0.382329	18.39656	4.926026
11	0.248742	48.51870	10.56364	8.612254	6.947215	0.363439	19.48332	5.511432
12	0.255167	46.60950	10.05626	9.337778	7.101258	0.346597	20.49613	6.052478
13	0.261484	44.84519	9.587842	9.974814	7.263869	0.332722	21.43369	6.561879
14	0.267704	43.19498	9.153639	10.52960	7.431614	0.321933	22.32656	7.041675
15	0.273829	41.64071	8.751367	11.02705	7.600630	0.314409	23.17642	7.489416
16	0.279844	40.17928	8.379780	11.47188	7.771953	0.309977	23.97989	7.907247
17	0.285725	38.81074	8.038397	11.87221	7.940112	0.308135	24.73159	8.298815
18	0.291461	37.53063	7.726097	12.23151	8.101910	0.308342	25.43407	8.667438
19	0.297045	36.33497	7.441630	12.55514	8.255327	0.310235	26.08797	9.014721
20	0.302471	35.21843	7.183301	12.84715	8.401138	0.313495	26.69522	9.341266

Variance Decomposition of LGDP:

Period	S.E.	Shock1	Shock2	Shock3	Shock4	Shock5	Shock6	Shock7
1	0.116176	11.87797	5.385856	82.73618	1.71E-31	1.55E-33	8.25E-32	1.58E-30
2	0.122398	12.40227	8.464615	75.97939	0.543738	0.232270	1.622809	0.754900
3	0.135609	15.50996	8.563655	67.47685	5.567860	0.231874	1.746463	0.903342
4	0.143270	15.88483	8.873342	64.48547	5.495430	0.211940	3.528356	1.520638
5	0.154228	15.67408	11.19895	61.98770	5.360864	0.360599	3.616885	1.800921
6	0.163764	15.87879	12.78536	59.77100	4.774423	0.471352	4.203659	2.115421
7	0.174098	15.81960	13.75940	58.20693	4.250203	0.585928	4.993568	2.384368
8	0.184230	15.88550	14.37592	56.29644	3.797811	0.717661	6.164872	2.761789
9	0.194536	15.87270	14.73313	54.80821	3.414200	0.840426	7.151002	3.180328
10	0.205022	15.69241	14.81174	53.52089	3.073955	0.938532	8.314218	3.648251
11	0.215865	15.44676	14.73590	52.44401	2.773703	1.027989	9.456502	4.115130
12	0.226934	15.20355	14.52069	51.47196	2.517521	1.103391	10.59806	4.584826
13	0.238262	14.95343	14.20312	50.62650	2.299816	1.165094	11.70032	5.051724
14	0.249830	14.70050	13.81737	49.84308	2.119493	1.216106	12.78417	5.519279
15	0.261645	14.44578	13.39040	49.12358	1.971708	1.259374	13.82947	5.979679
16	0.273711	14.18704	12.93544	48.44943	1.855748	1.296312	14.84747	6.428557
17	0.286023	13.92612	12.46545	47.81710	1.768647	1.328609	15.83175	6.862315
18	0.298562	13.66552	11.98867	47.21764	1.708037	1.357055	16.78208	7.281001
19	0.311313	13.40580	11.51157	46.64897	1.670381	1.382222	17.69641	7.684647
20	0.324264	13.14740	11.03909	46.10713	1.652868	1.404583	18.57553	8.073396

Variance Decomposition of LCPI:

Period	S.E.	Shock1	Shock2	Shock3	Shock4	Shock5	Shock6	Shock7
1	0.043972	0.302689	4.57E-05	6.08E-34	99.69727	1.41E-32	7.48E-31	1.24E-30
2	0.056476	1.040150	3.999775	0.993849	92.39202	0.033436	1.501496	0.039271
3	0.066903	1.279801	9.014630	8.774887	76.40398	0.052101	4.341391	0.133214
4	0.073560	2.300742	13.54493	13.97617	65.70730	0.062374	4.168421	0.240069
5	0.080500	5.084187	17.59545	16.20172	56.89378	0.055939	3.890793	0.278129
6	0.086688	7.824258	20.62167	17.24938	50.55292	0.060888	3.445572	0.245307
7	0.092727	9.606373	23.24446	18.48229	45.33966	0.092849	3.012683	0.221687
8	0.098638	10.85724	25.47527	19.71930	40.78051	0.164417	2.768062	0.235197
9	0.104547	11.80726	27.06228	21.10208	36.75671	0.258277	2.726084	0.287314
10	0.110395	12.56163	28.00893	22.51506	33.25134	0.354453	2.912513	0.396071
11	0.116274	13.17207	28.44702	23.91466	30.18057	0.445854	3.264931	0.574884
12	0.122230	13.65276	28.48826	25.28033	27.45731	0.527560	3.766649	0.827122
13	0.128347	14.01152	28.22543	26.62294	24.99824	0.600623	4.400364	1.140881
14	0.134662	14.27626	27.73399	27.91101	22.76089	0.666973	5.148230	1.502646
15	0.141193	14.46741	27.06997	29.12258	20.72729	0.727532	5.983421	1.901794
16	0.147940	14.59460	26.27821	30.23588	18.88637	0.782945	6.890187	2.331814
17	0.154908	14.66268	25.39666	31.24217	17.22587	0.834210	7.852401	2.786001
18	0.162098	14.67574	24.45529	32.14054	15.73298	0.882089	8.856266	3.257085
19	0.169509	14.63874	23.47763	32.93599	14.39505	0.927061	9.887663	3.737866
20	0.177136	14.55817	22.48251	33.63396	13.20014	0.969352	10.93341	4.222463

Variance Decomposition of LNEXR:

Period	S.E.	Shock1	Shock2	Shock3	Shock4	Shock5	Shock6	Shock7
1	0.019574	3.657459	0.001064	3.980192	0.124731	92.23655	0.000000	3.00E-30
2	0.028883	6.294840	0.162167	6.385818	1.019242	84.24787	1.346938	0.543124
3	0.037693	17.39825	0.156654	7.646685	0.831058	72.12837	1.442641	0.396348
4	0.044798	24.27578	0.363040	7.817562	1.236750	64.94634	1.061990	0.298542
5	0.050858	27.68824	0.878981	7.905138	3.590348	58.82738	0.824374	0.285540
6	0.056247	29.08665	1.200547	8.809453	6.379602	53.56216	0.700242	0.261345
7	0.060735	29.21270	1.239805	10.17890	8.670322	49.72283	0.743947	0.231498
8	0.064509	28.53675	1.150713	11.74864	10.61429	46.77170	0.971752	0.206140
9	0.067740	27.45059	1.043600	13.29764	12.33009	44.45251	1.238577	0.186987

10	0.070620	26.13333	1.013509	14.79283	13.85900	42.55444	1.474746	0.172145
11	0.073281	24.73190	1.140249	16.26682	15.12887	40.92850	1.643392	0.160262
12	0.075824	23.32267	1.461216	17.74852	16.12376	39.46081	1.732987	0.150037
13	0.078315	21.94817	1.973970	19.22514	16.87697	38.08446	1.750632	0.140651
14	0.080810	20.63274	2.651471	20.69357	17.43022	36.74669	1.712525	0.132781
15	0.083350	19.39439	3.459287	22.16072	17.80405	35.41609	1.636502	0.128958
16	0.085970	18.24436	4.364404	23.63473	18.00612	34.07492	1.542486	0.132974
17	0.088697	17.19189	5.333998	25.11726	18.04058	32.71680	1.450224	0.149256
18	0.091553	16.24349	6.336536	26.60296	17.91477	31.34141	1.378351	0.182483
19	0.094561	15.40269	7.343071	28.08022	17.63994	29.95267	1.344091	0.237306
20	0.097737	14.66940	8.327688	29.53497	17.23038	28.55674	1.362868	0.317960

Variance Decomposition of LM0:

Period	S.E.	Shock1	Shock2	Shock3	Shock4	Shock5	Shock6	Shock7
1	0.166352	18.39013	0.195667	0.064223	0.226177	1.488289	79.10468	0.530832
2	0.187767	26.36024	1.723106	0.221926	0.298210	2.753415	67.66265	0.980450
3	0.197354	24.29394	2.064766	5.083759	0.756083	2.508495	62.14798	3.144977
4	0.210822	21.30622	2.159834	9.341912	0.990430	2.200031	58.61260	5.388978
5	0.223319	19.88613	2.341255	11.47330	1.011048	2.047061	56.68177	6.559438
6	0.235672	19.19764	2.336447	13.67974	1.218994	1.902807	54.52070	7.143674
7	0.248021	18.37938	2.289117	15.75773	1.626903	1.757680	52.48123	7.707951
8	0.259588	17.72766	2.267116	17.27327	1.933438	1.644305	50.76004	8.394177
9	0.270903	17.13877	2.227873	18.44770	2.147090	1.552242	49.42669	9.059635
10	0.282443	16.51916	2.179605	19.46753	2.365255	1.480099	48.38860	9.599748
11	0.294011	15.92568	2.129738	20.35997	2.619989	1.428013	47.49773	10.03888
12	0.305405	15.37510	2.067402	21.13247	2.882972	1.387798	46.72066	10.43360
13	0.316604	14.85645	1.992734	21.78669	3.121849	1.355136	46.07488	10.81225
14	0.327621	14.36741	1.912828	22.34469	3.329544	1.329511	45.54086	11.17516
15	0.338488	13.90370	1.831550	22.83614	3.517833	1.309612	45.08752	11.51365
16	0.349225	13.46342	1.750770	23.27664	3.696532	1.294091	44.69403	11.82452
17	0.359821	13.04888	1.671743	23.66954	3.867530	1.282105	44.34886	12.11135
18	0.370263	12.66040	1.595316	24.01768	4.029330	1.272984	44.04558	12.37870
19	0.380550	12.29562	1.522141	24.32584	4.181477	1.266278	43.77961	12.62903
20	0.390686	11.95209	1.452667	24.59942	4.324989	1.261726	43.54590	12.86321

Variance Decomposition of TBR:

Period	S.E.	Shock1	Shock2	Shock3	Shock4	Shock5	Shock6	Shock7
1	0.391692	0.420753	14.85983	0.007648	19.55410	0.177238	9.420443	55.55999
2	0.546116	0.351453	14.98922	2.075862	10.61601	0.107745	27.46635	44.39336
3	0.690818	0.234681	11.13107	4.497161	9.963985	0.372164	40.40185	33.39909
4	0.780439	0.251502	9.263217	8.272545	13.13952	0.607232	39.62708	28.83890
5	0.859516	0.252806	8.957240	9.072300	16.14412	0.557896	38.68694	26.32870
6	0.920280	0.259750	9.174155	9.208816	16.55637	0.524843	38.73887	25.53720
7	0.972504	0.258840	9.381919	8.980755	16.49158	0.514272	39.19232	25.18032
8	1.019070	0.238276	9.475376	9.002481	16.52129	0.516666	39.49751	24.74840
9	1.062832	0.219230	9.525625	9.016277	16.83799	0.522480	39.67489	24.20352
10	1.101391	0.204459	9.637211	8.989930	17.18094	0.529958	39.70592	23.75158
11	1.135674	0.193483	9.837956	8.883706	17.44719	0.533155	39.69703	23.40749
12	1.166124	0.188110	10.08119	8.755135	17.62203	0.535053	39.67479	23.14369
13	1.193431	0.189887	10.33704	8.616586	17.76797	0.536839	39.63502	22.91665
14	1.217932	0.198974	10.60093	8.479904	17.90987	0.538454	39.56534	22.70653
15	1.239962	0.214663	10.87704	8.339778	18.05167	0.539361	39.46866	22.50883
16	1.259668	0.236520	11.16705	8.197146	18.18334	0.539524	39.34898	22.32744
17	1.277281	0.265107	11.46897	8.053685	18.30118	0.538917	39.21141	22.16074
18	1.293017	0.301131	11.77849	7.912900	18.40594	0.537714	39.05901	22.00483
19	1.307084	0.344824	12.09251	7.776977	18.50062	0.536031	38.89319	21.85585
20	1.319655	0.396146	12.40960	7.647822	18.58628	0.533914	38.71461	21.71163

Factorization: Structural

Note: Shock1, shock2, shock3, shock4, shock5, shock6 and shock 7 represents, LOPI, LWCPI, LGDP, LCPI, LNEXR, LM0 and Tbr respectively.