Empirical Characterization of the Dynamic Effects of Fiscal Policy Shock on Key Macroeconomic variables in Ethiopia

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ABSTRACT

Empirical Characterization of the Dynamic Effects of Fiscal Policy Shocks on Key Macroeconomic variables in Ethiopia

Daniel Abebe Asfaw
Addis Ababa University, 2012

The Ethiopian economy has recorded an impressive growth performance for nearly a decade. The government has had a substantial and persistent size in the economy over these years. The dynamic effect of fiscal policy on macroeconomic variables is, however, far from being obvious. The objectives of this study are, therefore, to empirically characterize the dynamic effects of net government spending, net tax revenue as well as disaggregated government spending components on key macroeconomic variables in Ethiopia using quarterly data over the period 1998/99:1-2010/11:4. A five variable and six variables SVAR models are constructed and the Blanchard and Perotti (2002) approach is employed to identify structural innovations. Impulse responses and variance decompositions are then estimated, respectively, to trace out the dynamic effects and unveil the relative importance of shocks in explaining the endogenous variables in the models. To substantiate the result, the recursive identification approach based on Cholesky decomposition is also used. Government expenditure shocks are expansionary and have inflationary impact at least in the short term. Tax shocks, on the other hand, have positive effect on output through increasing expenditures and have little impact on inflation. In view of the narrow tax base, there is a need to enhance the capacity to collect and administer tax. In normal times capital spending are more expansionary. Current spending can be used to stimulate the economy at the expense of lower output in the long run.

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List of Acronyms and Abbreviations

ADB – Asian Development Bank

ADF - Augmented Dickey-Fuller Test

ADLI – Agriculture Development Led Industrialization

AfDB- African Development Bank

AFRODAD – African Forum and Network on Debt and Development

AIC – Akaike Information Criteria

CPI - Consumer Price Index

EDRI - Ethiopian Development Research Institute

EEA: Ethiopian Economic Association

ESAF - Enhanced Structural Adjustment Facility

GDP - Gross Domestic Product

GLS – Generalized Least Square

GTP - Growth and Transformation Plan

IMF - International Monetary Fund

IRF – Impulse Response Function

KPSS - Kwiatkowski, Phillips, Schmidt, and Shin

MoFED - Ministry of Finance and Economic Development

NBE – National Bank of Ethiopia

NP - Ng and Perron

OECD – Organization for Economic Cooperation and Development

PASDEP – Plan for Accelerated and Sustainable Development to End Poverty

PRSP - Poverty Reduction Strategy Paper

PP - Phillips-Perron

RGDP - Real Gross Domestic Product

SAPs - Structural Adjustment Programs

SDPRP - Sustainable Development and Poverty Reduction Program

SVAR - Structural Vector Autoregression

VAR – Vector Autoregression

VAT - Value Added Tax

VD – Variance Decomposition

WB - World Bank

CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

Fiscal Policy is defined as the deliberate manipulation of government income and expenditure to achieve economic and social objectives and sustain growth (Cristina and Mihaela, 2009). The main objectives of this policy include allocation of resources, demand management, redistribution of income and economic growth (Tanzi, 2008).

Perspective on fiscal policy as a device for macroeconomic management has moved back and forth since the time of Keynes. Active use of the tools may have reached its peak in the 1960s and 1970s (Alan, 2005). It came under serious criticisms in early 1980s when it fail to rescue countries from the oil price shock and eventually led to high deficit and huge debt crisis (Beetsma, 2009). Such Keynesianism has suddenly come back into favour as a solution to the recent global economic crisis (Weeks, 2009).

Discussions on the effectiveness of fiscal policy may be divided into two strands (Geoffery et al, 2006): the first strand on *automatic stabilizers* and the second on *discretionary policy.* The automatic stabilizers refer to the government's budget component that automatically responds to the business cycle. Government transfers such as unemployment benefits rises (in advanced countries), and tax revenues on labor, consumption and capital falls when economic activity slows down and the reverse happens as the economic activity improves. Beetsma (2009) classifies the discretionary policy into two structural components-endogenous and exogenous. The endogenous structural component of fiscal policy relates to the systematic response of fiscal policy to economic activity or to other macroeconomic variables. For example, the government may systematically reduce tax rates whenever activity falls below potential and raise them whenever activity rises above potential. The other structural component of discretionary fiscal policy is the exogenous component that includes the increase in public spending to finance war or a politically motivated transfer to the population usually prior to election.

Although there is wide consensus regarding the impact of monetary policy changes, relatively little is known about the effects of fiscal policy shocks on macroeconomic variables (Beetsma, 2009; Perotti, 2007). There are two major schools of thought in the contemporary literature on the effect of fiscal policy. The neo-classical theory claims that expansionary fiscal policy crowds out private sector output, reduce real wage and causes deflation. The lower private sector output and deflation occur mainly due to the rise in interest rate following a higher public debt. Real wage reduces as a result of increase in labor supply to finance expected increase in future taxes that is caused by the higher public debt. The New Keynesian School, on the other hand, argues that the increase in public spending increases aggregate demand and hence output through the multiplier effect. This effect is based on the assumption that prices are sticky and there is excess capacity (Beetsma, 2009).

Studies on the macroeconomic effects of fiscal policies are concentrated mainly to the US economy. For countries in Europe and for emerging economies, there are only few researches in the area while it is extremely scanty for developing countries especially in Sub-Saharan Africa including Ethiopia (Perotti, 2007). The major constraint in undertaking empirical studies on macroeconomic effects of fiscal policy in low income countries is unavailability of high frequency data (Perotti, 2007). However, quarterly data on fiscal variables is available in Ethiopia. Moreover, there is a recently constructed quarterly Gross Domestic Product (GDP) data at Ethiopian Development Research Institute (EDRI). This study employs these data and empirically characterizes dynamic effects of fiscal policy shock on macroeconomic variables.

1.2 Statement of the Problem

Ethiopia has achieved sustained economic growth nearly for a decade in spite of the fact that the country has non-oil exporting and non-mineral economy. Double digit growth in Real Domestic Product (RGDP) has been recorded consecutively since 2003/04.[1] Such an impressive growth is coincided with the termination of the International monetary Fund (IMF) and the World Bank (WB) Programs (such as Structural Adjustment Programs (SAPs), Enhanced Structural Adjustment Facility (ESAF) and Poverty Reduction and Growth Facility) in 2004/05. These programs entail advice to the government to follow strict fiscal and monetary policy. The government, however, embarked on less stringent fiscal and monetary policies and argue that such growth is the result of its rejection of the 'neo-liberal' policies.

The government has been expanding its investment in economic (particularly road) and social infrastructures such as education and health facilities in its endeavour to build human capital that are meant to relax the structural rigidities in the economy. The increased spending is in line with the government's fiscal policy objective of "maintaining sustainable fiscal deficit while at the same time increasing its expenditure on pro-poor sector" as indicated in the Plan for Accelerated and Sustained Development to End Poverty (PASDEP) and in the Growth and Transformation Plan (GTP). Accordingly, on average, government spending has been increasing by 21.5%

[1] The growth rate in 2008/09 is reported as single digit according to some sources. For instance, Ethiopian Economic Association reports 8.8% growth because of the global economic slowdown. However, the 2011/12 report from NBE reports 10% growth in 2008/09.

annually over the years 2002/03-2010/11. This increase is accounted for by increase in both current and capital spending. Moreover, the proportion of the two expenditure components to the total government spending has reversed. For instance, the proportion of current expenditure in total government spending was more than 68% in 2002/03. This has turned to around 48% in 2006/07 and 43% in 2010/11. This seems to follow the argument that larger current expenditures impede growth by reducing the resources available for capital expenditures as the latter has a potential to increase the growth potential of an economy (Weeks, 2010). On the revenue side, the government has implemented tax reforms since 2001. The annual average growth rate in tax revenue and total revenue including grant over the period 2002/03-20010/11 has been 25.7% and 23.8% respectively. The fiscal deficit excluding grant, on the other hand, has been above 5% (negative) of GDP over the period 2002/03-2010/11. The financing of government deficit over this period has been an important source of debate in determining the effects of fiscal policy. Since capital markets barely exist in Ethiopia, the government relied on external sources and printing high powered money (currency and deposit at the National Bank). External sources have not been expanding equally with the government's commitment to finance large-scale capital projects and infrastructural improvements (AfDB/OECD, 2007). As a result, domestic sources have been an increasingly significant source of deficit financing in Ethiopia causing inflation, as argued by different researchers at individual and institutional level. Alemayehu and Kibrom (2008) argue high level of financing capital expenditure from Central Bank treasury as a cause for the recent inflationary pressure in Ethiopia. They claim that most of the capital projects result in inflation given that these projects take time to be implemented as well as to bear fruit and they are financed through money creation in a country where the elasticity of food supply is low. Domestic borrowing from commercial banks is also argued to have crowding out effect through lowering the amount of fund available for private investment.

Despite these arguments there is no study in Ethiopia that explicitly characterizes the dynamic effect of fiscal policy change on macroeconomic variables using empirical data. The empirical literature on the effectiveness of fiscal policy is grouped into two: those that employ VAR methodology and those using structural macroeconometric models. The latter usually impose *apriori* theoretical assumptions rather than document the effect of fiscal policy. In Ethiopia, empirical evidences on the effects of fiscal policy on macroeconomic variables are modelled using theoretically imposed structural models (For instance, Teshome (2006) and Daniel (2011)). Therefore, this study fills the gap by characterizing macroeconomic effects of fiscal policy shock over the period 1998/99:1-2010/11:4 by employing Structural Vector Autoregression (SVAR) model where identification of exogenous fiscal policy shock is achieved by applying the Blanchard and Perotti (2002) approach and the recursive approach based on Cholesky Decomposition.

1.3 Objectives of the study

The general objective of this study is to empirically characterize the dynamic effects of fiscal policy shocks on macroeconomic variables such as RGDP, inflation and interest rate by employing SVAR model for which quarterly data is used over the period 1998/99:1-2010/11:4. The specific objectives include:

- to analyse the dynamic effects of a shock in government spending on macroeconomic variables;
- to analyse the dynamic effects of net tax revenue shock on macroeconomic variables;

- to evaluate the relative effects of current and capital expenditures on the macroeconomic variables and
- to forward policy implications.

1.4 Significance of the Study

Perotti (2007) states that understanding the effects of fiscal policy shocks is basic in formulating optimal behaviour of fiscal policy over business cycle and in evaluating its long runs effects. Tracing the response of macroeconomic variables to fiscal shocks is essential for both a positive and a normative assessment of the trade-offs between short-run and long-run objectives of fiscal policy. Therefore, the study will have an immense value to policy makers in these regards. It will also be source to further studies.

1.5 Data and Methodology

Quarterly data over the period 1998/99:1-2010/11:4 on real net government expenditure, real net tax revenue, RGDP, Consumer Price Index (CPI) and nominal interest rate are included in the baseline model. Data on CPI, used as a proxy for inflation, and average of all commercial banks nominal deposit interest rate are obtained from National Bank of Ethiopia (NBE) while the data on fiscal variables are obtained from Ministry of Finance and Economic Development (MoFED). Quarterly data on RGDP constructed at EDRI is employed. Five variables and six variables SVAR models are constructed to analyze the dynamic effect of fiscal policy shock on macroeconomic variables. While the former considers total net government spending, the latter disaggregates this into net real current expenditure and capital expenditure. Identification of the SVAR models are achieved through the Blanchard and Perotti (2002) approach that is based on institutional information about the tax system to identify automatic response of fiscal variables to economic activity thereby infer fiscal shocks. Accordingly, exogenous elasticities are constructed for output and price elasticity of net tax revenue. Once the model is fully identified, impulse responses are estimated to trace out the effect of different shocks. To substantiate the result, the impulse responses are also estimated using recursive identification based on Cholesky decomposition.

1.6 Scope and Limitation of the Study

This study primarily characterizes the macroeconomic effects of four discretionary fiscal policy measures in Ethiopia: change in net government spending, change in net tax revenue, change in government recurrent expenditure, and change in government capital expenditure. The macroeconomic variables the responses of which are under investigation include RGDP, inflation and interest rate. The study characterizes effects of fiscal policy based on quarterly data on these variables over the period 1998/99:1-2010/11:4. It does not examine the effects on GDP components such as consumption, investment and Trade balance as well as other external variables such as, real effective exchange rate and terms of trade.

1.7 Organization of the paper

This study has six chapters. The first chapter is an introductory part of the study. In the second chapter, theoretical issues and empirical studies are reviewed. The third chapter, in a descriptive way, discusses fiscal policy and developments in macroeconomic variables in Ethiopia over the period 2002/03-2010/11. In the fourth chapter, the model specification and methodological framework of the study are presented. The fifth chapter is devoted to the discussion of the results from the empirical analysis. Chapter six concludes and identifies the policy implication of the study.

CHAPTER TWO

LITERATURE REVIEW

2.1 Theoretical Literature Review

This chapter presents the recent literature in the area of fiscal policy and its possible implications in an economy. The chapter begins by a review of theoretical literature in which basic concepts are first explained followed by the different theoretical frameworks used to describe effects of fiscal policy. The literature on alternative deficit financing and their consequences on inflation are also explicitly discussed before presenting the empirical literature review. The empirical literature section reviews the major works at the international level and shows how far has been done in Ethiopia to the best of the researcher's knowledge.

2.1.1 Definitions and concepts

Fiscal Policy is defined as the deliberate manipulation of government income and expenditure to achieve economic and social objectives and sustain growth (Cristina and Mihaela, 2009). The main objectives of this policy include allocation of resources, stabilization of the economy, redistribution of income and economic growth (Tanzi, 2008). The two main instruments of fiscal policy are government spending and taxation. The change in one or the composition of these instruments has the ability to affect the economy. Tanzi (2008) point that the level, structure and composition of government spending are important and can be used as separate instruments. For tax, in addition to the level and structure, tax expenditure and tax incentives can be used as separate instruments. He categorizes countries based on their reliance in using these different tax instruments. Accordingly, Scandinavian countries rely more on levels and structures; Anglo-Saxon countries on tax expenditures and Asian and many developing countries rely on tax incentives.

Fiscal policy can work through both aggregate demand and aggregate supply channels. Changes in total tax and public expenditure affect the level of aggregate demand in the economy. Structure of tax and public expenditure, on the other hand, affect the incentive to save and invest, take risk, and export and import goods and services (Jha, 2007).

To stabilize the business cycle, fiscal policy also works in two general ways. These are though automatic stabilizers and discretionary policy. Automatic stabilizers are built in fiscal mechanisms that automatically reduce expansions and contractions in the business cycle (Cristina and Michaela, 2009). Progressive tax structure and transfer schemes interacted with aggregate production and income enable automatic stabilizers to enact countercyclical policy. However, automatic stabilizers are found to be pro-cyclical in developing countries due to imperfections in international credit market and the political economy in these countries (Ilzetski, 2008). Discretionary policy, on the other hand, is a policy action initiated by the government. Policy lag in discretionary policy made it difficult to use it as an easy solution to macroeconomic instability. These lags are of three forms; the time between changes in fiscal policy is needed and the change is recognized by the government; the time between it is recognized and enacted; the time between the policy changes is enacted and it is felt in the economy. Cristina and Michaela (2009) stated that the change in fiscal policy may not be felt until six to twelve months after the policy is implemented.

Discretionary policy can be classified into endogenous and exogenous structural components. The endogenous structural component of fiscal policy relates to the systematic response of fiscal policy to economic activity or to other macroeconomic variables. For example, the government may systematically reduce tax rates whenever activity falls below potential and raise them whenever activity rises above potential. The other structural component of discretionary fiscal policy is the exogenous component that includes the increase in public spending to finance war or a politically motivated transfer to the population usually prior to election (Beetsma, 2009).

2.1.2 The Equilibrium Vs The Market Failure Views

There are two general views of the economy in macroeconomics from which the effect of fiscal policy can be analyzed. These are the equilibrium view and the market failures view. The first view sees the economy quickly returning to full capacity whenever disturbances displace it from full employment. The implication of this view is that changes in any policy, fiscal or monetary, have little potential for stabilizing or affecting economic activity. It can rather aggravate, rather than diminish, business-cycle fluctuations. The second view sees critical market failures causing the economy to adjust with more difficulty to disturbances. Due to the market failures, changes in fiscal and monetary policy have greater potential for stabilizing aggregate demand and economic activity. The extent to which the economy reacts to fiscal policy depends on how far is the economy from its full employment level.

The first view is originated from classical economics that gives excessive role to the market leading to the conclusion that policies are always harmful or insignificant to the economy. In the classical economics literature, as a consequence, government expenditures and tax revenues were only considered as a way to redirect resources from private sector to public sector but no role to affect aggregate level of spending and employment in the economy. This view dominated the economics literature until the Keynesian revolution in the 1930s. The revolution focused on market failures and the subsequent role of fiscal policy to stabilize and affect economic activity through stimulating aggregate demand. The simple Keynesian model assumes price rigidity and excess capacity implying that a fiscal expansion leads to a multiplier effect on aggregate demand and output. This model, however, neglects important inter-temporal aspects of fiscal policy changes (see Beetsma, 2009). These aspects include the way fiscal expansions are financed, whether the change is temporary or permanent, the behaviour of consumers and institutional constraints.

Two major frameworks came out of the general views discussed above that addresses the inter-temporal aspects; the neo-classical and the New Keynesian (Beetsma, 2009; Perotti, 2007; Shaheen and Turner, 2009). These frameworks explain the consequences of fiscal policy shocks in inter-temporal models with micro-foundations. Moreover, both have different variants depending on specific assumptions employed.

2.1.3 The Neoclassical Framework

In Neoclassical models, a shock to government spending generates negative wealth effect on the infinitely lived representative household (higher government spending means higher taxation in present discounted terms), as the household feels poorer, labor supply increases and consumption and real wage falls. Baxter and King (1993) showed how discretionary fiscal policy affects the macro economy in a neo-classical framework assuming lump-sum tax to finance higher government spending Assuming that leisure and consumption are normal goods, labor supply increases as households feel poorer. Given the labor demand constant, marginal labor productivity and real wages decline. As a result, consumption decreases while output rises. If the shock persists, marginal productivity of capital rise and hence private investment would increase. Ultimately, a new steady state is reached where real wages have returned to their initial level and private consumption has been lower than before. If, on the other hand, the tax is distortionary, the outcome would be different due to the intra-temporal and inter-temporal substitution effect in labor supply. The result depends on the manner in which the tax rate is designed. For instance, Burnside et al (2000) show the effect of increase in government expenditure financed by changes in tax rates in a hump shaped manner. The hump shaped government purchases produces hump shaped pattern in output, consumption and employment. In the new steady state, private consumption, investment and output have fallen. In general, the neo-classical models have trouble in producing increase in private consumption unlike what the empirical analysis usually suggests. As Beetsma (2009) states the main obstacle lies in the rightward shift of the labor supply curve for a given labor demand which yields lower wage.

2.1.4 New Keynesian Framework

The New Keynesian models argue that an increase in government spending increases demand and thus economic activity, i.e, output through crowding in or multiplier effect. It, moreover, produces increases in private consumption by introducing nominal rigidities, increasing returns, countercyclical mark-ups and non-Ricardian consumers. Introducing nominal rigidities into a monopolistic competition implies that price is greater that marginal cost. Given the increase in labor supply due to the standard wealth effect (the rise in tax) discussed in the neo-classical literature, the increased demand for goods will be met by firms since prices are sticky and it is greater than the marginal cost in monopolistic competition. To produce the additional output, firms need to employ more labor units which in turn raise the real wage.

Devereux et al (1996) and Ravn et al (2006) found another mechanisms in which the labor demand curve also shift and positive consumption response might result. In particular, Devereux et al (1996) introduced increasing returns where government spending may increase the equilibrium number of firms in intermediate goods characterized by increasing returns to specialization. The increase in productivity in these firms enables them to demand more labor. Consequently, the labor demand shifts outward thereby increasing the real wage. Ravn et al (2006) introduced "deep habits" instead of increasing returns. "Deep habits" refer to habit formation for a variety of goods in which the individuals group their demand for good into a price elastic and price inelastic components. An increase in demand via higher government spending increases the weight of the elastic component and induces producers to lower their price mark-up. The counter-cyclical reduction in the wage along with the increase in labor supply (the standard wealth effect) leads to a rise in labor demand, higher real wage and higher consumption. Optimizing consumers, however, can spread the consumption across time and private consumption may not increase substantially. Gali et al (2007) introduced non-Ricardian, "rule-of-thumb" consumers, an additional imperfection that ensures increased private consumption (Beetsma, 2009). These are consumers who consume their entire disposable income. If these consumers are large (as in developing countries), the positive current private consumption in general increases as this effect more than offsets the negative wealth effect.

2.1.5 Non-Keynesian Effects

Non-Keynesian effects of fiscal policy are also considered in the literature. These effects refer to the situation where fiscal consolidation (reduction in government spending and/or increase in tax) causes a rise in output. This negative multiplier effect occurs as a result of reduction or elimination of cost of fiscal consolidation due to favourable expectational effects driving intertemporal saving choices. These expectations directly influences the two non-mutually exclusive channels namely, consumption and investment channels (Carvalho, 2009).

Private consumption can increase after fiscal consolidation because of three effects: Pure expectational effects, wealth effects and substitution effects. The pure expectational effect implies that households expect lower tax burden in the future when taxes are higher and/or spendings are lower today. The lower tax burden allows a reduction in precautionary saving and leads to higher value of the present discounted disposable income thereby increasing private consumption (Feldstien, 1982). The wealth effect, on the other hand, increases private consumption through lower interest rate that increases the market value of the asset held by households and increases the opportunity cost of private saving. However, along with these two effects there is a direct negative effect of fiscal consolidation due to lower disposable income. Thus, the relative strength between the direct effect of fiscal consolidation (that depends on how disposable income is affected) and the expectational and wealth effects (that is dependent more on permanent income) determines the ultimate effect on private consumption. The financial market plays a crucial role in allowing households to be able to consume based on their permanent income. The third effect relates to the substitution of public consumption by private consumption which is largely a function of private willingness and ability to provide social services like education, health and so on.

Private investment is the more pronounced channel that could result in expansionary fiscal consolidation in the literature. Interest rate reduction and the labor market effect are the two ways through which higher investment and hence output results. [see (Alesina, et al. 1998); (Ardagna, 2007)]

2.1.6 Keynesian/Structural Framework

This framework explains the effects of fiscal policy in developing countries. It emphasizes the positive role of active fiscal policy as resources are underutilized in these economies. Public expenditure in these countries crowds in private spending either by directly complimenting it or indirectly through increasing aggregate demand. Weeks (2009) summarizes the role of fiscal policy in these economies in particular in Sub-Saharan Africa into three: short run, medium run and long-run. In the short run, increase in public expenditures can compensate for the fall in domestic private spending or export demand and prevents losses in output due to insufficient aggregate demand. In the medium-term, this short-run policy can be used systematically and purposefully as a countercyclical instrument to reduce fluctuation and maintain output close to full potential. In the long-term, public investment increases the growth rate by increasing capacity and lowering costs.

To sum up, both standard Neo-classical and New Keynesian as well as Structural models predict positive response of output to the rise in government spending while the non-Keynesian effect acknowledges the possibility of negative multiplier. Furthermore, neo-classical models typically predict negative response in private consumption while New Keynesian models yields the opposite result for a positive shock in government spending. The effect on private investment is more ambiguous. In neo-classical models, private investment responds positively if the shock in government spending is persistent and taxes are non-distortionary. In the New

Keynesian models, investment increases if the accelerator effect dominates the higher interest rate effect. The Non-Keynesian effect implies positive response of private consumption and private investment to fiscal consolidation.

2.1.7 Fiscal deficits and Inflation

The above sub-sections presented a brief review of the literature on the effects of fiscal policy on output and its components. An important area especially in expansionary fiscal policy is the issue of financing deficit. Inflation and interest rate are the two major macroeconomic variables through which fiscal deficit affect the economy. There are several sources of financing. These include central bank financing, commercial bank financing, domestic sale of government bonds to cover the deficit and foreign financing. Each of these has different macroeconomic consequences. Central bank financing raises the monetary base and the money supply, thereby blurring the distinction between monetary and fiscal policies. Foreign financing will raise the cost of servicing external debt whereas domestic bond issues will raise interest rates. More importantly, the implication of deficit financing in the economy depends on whether the economy is operating at full potential or below full potential.

The literature in monetary school provides explanation on the implication of deficit financing in economies where there is full employment of resources. According to Monetarists, the only cause of inflation is money expansion[2] and deficits contribute to money expansion and hence inflation regardless of whether the deficit is money-financed or bond-financed. While money-financed deficit expands money directly, the latter has different channels in which it results in inflation. According to Sargent and Wallas (1981) bond-financed deficit will put upward pressure on interest rates and

[2] The origin of this argument is the classical quantity theory of money.

non-government bonds. The Central Bank will be obliged to monetize the deficit either now or in later periods especially when the time paths of government spending and taxes are exogenous making the bond-financed deficits non-sustainable. Such monetization causes inflation through the increased money supply at least in the long run. Miller (1983) provides alternative channel whereby deficits result inflationary pressure even if Central Banks does not monetize deficits. The higher interest rate caused by bond-financed expenditure crowd out private investment, and hence reduce the rate of growth of real output.

If the economy is operating below its potential, however, neither form of financing will be inflationary, though they could crowd out private investment (Weeks, 2010). Bond-financed deficits will not cause inflation as the total money supply remains constant. However, since the additional bonds must be issued at higher interest rate (assuming that the public held their desired level of government bond), they crowd out private investment. Moreover, the higher interest rate increases the cost of servicing the domestic public debt. Weeks (2009) argues that borrowing from Central Bank is an effective means of expanding aggregate demand for African countries as they are operating below full potential. These deficits are not necessarily inflationary and they do not crowd out private investment. However, there is a limit that these deficits could be monetized without inflationary impact on the economy. i.e., government expenditures by money creation should not exceed the goods and services produced by these expenditures valued at stable prices. Although it is an effective means to finance, Weeks (2010) points that monetization can still have minor and transitory effect on inflation.

2.2 Empirical Literature Review

The empirical analysis on the effects of fiscal policy on economic activity can be grouped into three. The first group analyzes the impact of large fiscal contraction through budget reduction on the macroeconomy. Although the cyclically adjusted primary deficit that is used to measure fiscal contraction gives important information about current policy, this group implicitly imposes same impact of increase in government spending and tax reduction. The second group focuses on the stabilizing role of fiscal policy. The third group, in which this study is also categorized, analyses the impact of discretionary fiscal policy on the macroeoconomy. This group has got more attention recently due to the argument that fiscal variables move for many reasons apart from output stabilization and hence, there are many exogenous shocks in economies (Blanchard and Perotti, 2002).

The empirical literature on discretionary fiscal policy is further classified based on the model/methodology they employ. Accordingly, there are two major strands of studies: those that employ the VAR methodology and those that base their analysis on the structural macro-econometric model. The studies by Blanchard and Perotti (2002), Mountford and Uhlig (2002), Fatas and Mihov (2001) and Ramey and Shapiro (1997) are the major ones under the former category and the studies by Geoffery et al, (2006), Roeger W. and Veld J. (2002), Barrell and te Vede (2002) and Barrell et al, (2004) falls under the second.

Identification of exogenous and unexpected fiscal shock is the major problem in the empirical literature. Under the VAR methodology, this problem is addressed by four different approaches. These are the Structural VAR approach proposed by Blanchard and Perotti (2002); the recursive approach by Fatas and Mihov (2001), the sign restriction structural VAR approach by Mountford and Uhlig (2002 and 2008), and the event identification employed by Romer and Romer (1989), Ramey and Shapiro (1997) and Burnside et al. (2003).

Blanchard and Perotti (2002) use institutional information on the transfer and tax systems and the timing of tax collection to construct the automatic response of fiscal policy to economic activity thereby infer fiscal policy shock. In other words, elasticities are obtained based on information that measures the automatic response of fiscal policy to output and using these, the exogenous shocks in fiscal policy are estimated. The estimates are then used to trace the dynamic response of macroeconomic variables to fiscal policy shocks. Blanchard and Perotti (2002) use quarterly data from 1947:1-1997:4 that contributes to the identification of exogenous shocks as the decision and implementation lags in fiscal policy make it very rare to respond to output fluctuation within a quarter. Consistent with the theory, their result shows that positive innovation in public spending and taxes had respectively a positive and a negative effect on output. Private consumption also consistently responds positively to government spending shock as the Keynesian theory predicts but difficult to reconcile with the neoclassical theory except under counterfactual assumption about the tax overtime. On the other hand, investment negatively responds to increases in both tax as well as expenditure. The multipliers they found were small, often close to one due to the opposite effects on components of output. Carvalho (2009) considers the strong negative response of private investment to government spending as the non-Keynesian effect caused by higher real interest rate.

Fatas and Mihov (2001) applied the recursive approach of Sims (1980) for the first time to the analysis of exogenous fiscal policy shock. The recursive approach implies causal ordering of the variables. In this group of empirical literature government spending and possibly its components are ordered first followed by the remaining variables in the VAR which would either be left unrestricted or ordered thereafter according to some theoretical justifications. Their result shows that government spending has strong and persistent positive effect on output through increasing consumption and employment. Investment also increases with some lag. Net tax revenue, on the other hand, affects output negatively. This approach, however, does not allow the identification of pure shock in tax.

Mountford and Uhlig (2002) use sign restriction to identify government spending and tax shocks while controlling for other shocks in the economy. Their result suggests that deficit financed government spending crowds out private investment and does not affect (reduce) private consumption significantly. A deficit spending cut, on the other hand, stimulates the economy but they found deficit financed tax cut to be the best to stimulate the economy in the US.

Unlike the above mentioned approaches that are based on structural innovations, Ramey and Shapiro (1997) used narrative approach to identify exogenous fiscal policy shock. The narrative method identifies truly exogenous events in a reduced VAR set up. For instance, Ramey and Shapiro (1997) and Burnside et al. (2003) identify “war dates” to fiscal spending; Romer and Romer (1989) use the Reagan fiscal expansion in the US to estimate the fiscal policy effects on macroeconomic variables. While the standard VAR approach mentioned above mostly produces higher consumption and real wage following increase in government spending, the sign identification yields the opposite in the US. Ramey (2009) argue that the shocks in both cases miss the timing of the news and incorporate anticipation effects. His result suggests that government spending has lower impact overall as it reduces consumption.

Disaggregated fiscal policy shocks are also studied to articulate the issue. Heppke-Folk et al (2006) investigated the macroeconomic effect of exogenous fiscal shock in Germany. They disaggregated spending and revenue into different components to see their effect independently. Accordingly, government consumption was found to have almost no effect on output while direct expenditure as a whole increases output and private consumption on impact with low statistical significance and private investment also falls. Government investment expenditure, on the other hand, increases output significantly for twelve quarters ahead. Similarly, government net revenue on aggregate does not affect output significantly. But lower direct tax increases output while indirect tax has little effect. However, the positive effects in the short run turn into a negative effect in the long-run.

Below are reviews of some empirical works that employ SVAR model to study macroeconomic effects of fiscal policy shock outside the US. Ravnik and Zilic (2010) estimated impulse responses from SVAR model identified by the Blanchard and Perotti approach to characterize the effect of fiscal policy shock in Croatia. Unlike the quarterly data that is employed in studies analyzing fiscal policy shock, they employ monthly data. They include five variables in the baseline SVAR model. Output responds negatively following a shock in government expenditure. While revenue shocks permanently increase revenue, expenditure shocks are short lived as shocks in expenditures are usually independent of other expenditures. Revenue shock increases inflation in the short term and decreases interest rate in the short term before stabilization occurs after one year. Spending shocks, on the other hand, decrease inflation in the short term and increases it in the medium term. The effect of changes in expenditure on interest rate was found opposite to the effect on inflation. i.e., interest rate increases in the short term and decreases in the medium term. The negative effect of government spending might be because of inappropriate proxy to represent output as they use industrial production.

Mancellari (2011) studied the dynamic effects of change in spending and net revenue on macroeconomic variables in Albania. He used SVAR model and the Blanchard and Perotti identification approach. He estimated multipliers from the model. Accordingly, he found that reduction in tax has the highest impact on output reaching a multiplier of 1.65 after five quarters. Between the two spending components, capital spending has higher role in stimulating the economy than current spending. While interest rate is not responsive for change in any of the spending components, it decreases following a tax cut. Prices; slightly increase following positive shock in current spending, do not respond for a change in capital spending and fall with respect to a cut in taxes.

Shaheen and Turner (2009) characterize the dynamic effect of fiscal policy shock in Pakistan for the period 1973:1-2008:4 by employing a five variable SVAR model and using Blanchard and Perotti (2002) and the Recursive approaches to identify exogenous fiscal shocks. They found that government expenditure increases output in the short run and decreases it in the medium term. Interest rate and inflation increases following government spending shock. Revenue shocks also increase output, inflation and interest rate. While output decreases in the long run as in the case of government spending shock, interest rate increases at a higher level in the medium and long term. They concluded that in Pakistan increases in government spending and tax can be used to expand output in the short run at the expense of higher output and inflation.

SVAR models are rarely used to study fiscal policy in Africa. The only study to the best of the researcher's knowledge is the one by Abderrahim et al (2010) for Algeria. They studied macroeconomic effects of fiscal shocks in a five variables SVAR mode. They found that positive structural shock in government spending have positive effect on output in the short term with very small multiplier which turns into negative effect in the medium term and in the long run through crowding out private investment thereby increasing the average interest rate in the economy. Prices increase persistently following this shock. Public revenue shocks, on the other hand, result in positive impact on government spending in the short term through which the effect on output is channelled i.e, output responds in similar pattern as in the case of government spending shock. The effect on prices and interest rate is persistent and negative in the medium and long term. They used, however, annual data that makes identification of truly exogenous shock rather less reliable.

Mostly the empirical literature on fiscal policy for developing countries consists of studies that employ structural macro-econometric models. Geoferry et al, (2006) analysed the macroeconomic effects of fiscal policy using structural macro-econometric model for four Asian countries-Bangladesh, People's Republic of China, Indonesia and Philippines. They study effectiveness of discretionary policy and automatic stabilizers using the macro-econometric models developed for each country at Asian Development Bank (ADB) that employs quarterly time series data. The study finds a consistent result that productive spending (targeted on investment) has larger multiplier than untargeted expenditures. It also confirms the traditional Keynesian argument that spending multipliers are higher than tax multipliers which declines to very low levels except for Philippines. The fiscal expansion causes demand-pull inflation only in People's Republic of China. The inflation is caused by the overinvestment resulting from government investment. Automatic stabilizers, on the other hand, are found to have varying significance across countries. In general, fiscal spending has an expansionary impact in all the countries investigated with inflationary impact on People's Republic of China and it is not stabilizing for Indonesia and Bangladesh.

Most of the studies on fiscal policy in Africa are analyzed in a growth framework. Their focus is mainly on making fiscal policy work for the poor. However, their short run macroeconomic impact is less studied. Roy and Weeks (2004) explain that even if macroeconomic instability usually harm the poor, policies that aim at securing stability does not necessarily benefit the poor.

In Ethiopia the impact of fiscal policy is studied in a growth framework focusing on poverty. Daniel (2011) studied the impact of fiscal policy shock in Ethiopia using static computable general equilibrium model. His main emphasis was on poverty impacts of fiscal policy shocks. He found that changes in government consumption positively affect private consumption and the real GDP while rise in sales tax lowers them. But his model was static and does not consider public investment shock that constitutes the significant portion of fiscal policy in the country. The inflationary pressure of government spending cannot be addressed in static computable general equilibrium mode. This study fills the gap by employing SVAR model that captures the dynamic effects of fiscal policy shock on key macroeconomic variables in the country.

CHAPTER THREE

FISCAL POLICY AND MACROECONOMIC DEVELOPMENTS IN ETHIOPIA

3.1 Trend in Economic Growth and Fiscal Policy in Ethiopia from 2001/02 to 2010/11

Since October 1992, Ethiopia had been adopting a series of economic reform measures under the Structural Adjustment Program directed and funded by the IMF and WB. These measures were meant to foster economic growth by correcting distortions resulted from the previous regime's centrally planned economic system. The macroeconomic policy prescriptions dictate conservative fiscal and monetary policy so as to reduce the fiscal deficit and let the market to play its primacy role in resource allocation. During this period the country also adopted the Agriculture Development Led Industrialization (ADLI) strategy. As a result of the fiscal reform measures and non-inflationary sources of financing the budgetary deficit, government savings increased and budget deficits were reduced (Haile, 2003). In the period between 1991/92-2000/01, annual growth rate in GDP averaged to 4.5%. However, the growth in this period was not trickling down to the poor and the prospect of addressing the structural bottlenecks of the country seemed gloomy.

At the turn of the new millennium, the government embarked on a new policy direction by developing an Interim Poverty Reduction Strategy Paper (PRSP) as a way to join the Highly Indebted Poor Countries Initiative of the WB (AFRODAD, 2005). The country launched three consecutive PRSPs namely Sustainable Development and Poverty Reduction Program (SDPRP) in 2002, Plan for Accelerated and Sustainable Development to End Poverty (PASDEP) in 2005/06 and Growth and Transformation Plan (GTP) in 2009/10. In these plans, the government adopted less strict fiscal and monetary policies. The objective of fiscal policy stated in these papers indicates the commitment of the government to increase its spending in pro-poor sectors while maintaining the fiscal deficit at sustainable level.

Table 3.1 Trend in Economic growth between 2001/02-2010/11

Year	Real GDP (in millions of Birr)	Growth in RGDP
2001/02	68012	1.6
2002/03	66587	-2.1
2003/04	74397	11.7
2004/05	83804	12.6
2005/06	93474	11.5
2006/07	104499	11.8
2007/08	116190	11.2
2008/09	127844	10
2009/10	141187	10.4
2010/11	157464	11.4

Source: NBE Report 2010/11

Clearly notable during this period is that the country's economy shifted to a higher growth trajectory and more diversified sources. As shown in table 3.1, Real GDP has been growing at double digit since 2003/04 averaged 11.3% between 2002/03-2010/11. In the past growth had been volatile due to weather induced fluctuation in the agricultural sector as well as associated terms of trade. Apart from the growth in agricultural sector, the sustained growth since 2003/04 is complemented by strong performance in construction, manufacturing, trade and tourism, banking and insurance and real estate sectors and sub sectors (Getachew, 2009).

The government in Ethiopia claims such an impressive performance as a result of its rejection of the neo-liberal policies and the subsequent active role played in the economy. Annual growth rate in total government expenditure over the period 2002/03-2010-11 averaged 21.5%. This increase was accompanied by increase in both recurrent and capital expenditures. During the same period, the rate of increase in recurrent and capital expenditures was 16.9% and 27.5%, respectively, reversing the proportion of the two expenditures to the total government expenditure.

Table 3.2 Trend in Government Expenditures between 2001/02-2010/11 (the levels are in millions of Birr)

Year	Total Government expenditure (TGE)	Growth in TGE	Growth in Recurrent Expenditure (RE)	Growth in Capital Expenditure (KE)	Contribution of RE to TGE	Contribution of KE to TGE
2001/02	16684.0				63.3%	36.8%
2002/03	19849.4	19.0	28.2	3.0	68.2%	31.8%
2003/04	20236.7	2.0	-11.6	31.0	59.1%	40.9%
2004/05	24781.5	22.5	12.31	37.1	54.2%	45.8%
2005/06	29375.7	18.5	14.1	23.8	52.2%	47.8%
2006/07	35563.0	21.1	11.9	31.0	48.3%	51.7%
2007/08	46915.0	31.9	32.8	31.1	48.6%	51.4%
2008/09	57774.3	23.2	19.2	26.9	47.0%	53.0%
2009/10	71154.9	23.2	17.1	28.5	44.8%	55.3%
2010/11	93943.1	32.0	27.7	35.5	43.3%	56.7%

Source: MoFED and own computation using data from MoFED

As can be seen in table 3.2, contribution of capital expenditures to the total government spending increased from 31.8% in 2002/03 to 56.7% in 2010/11 due to expanding investment in economic and social infrastructure.

In line with sharp growth in expenditures, the government took several tax reform measures since 2001 and has been exerting increased effort to improve the tax administration (Getachew, 2009).

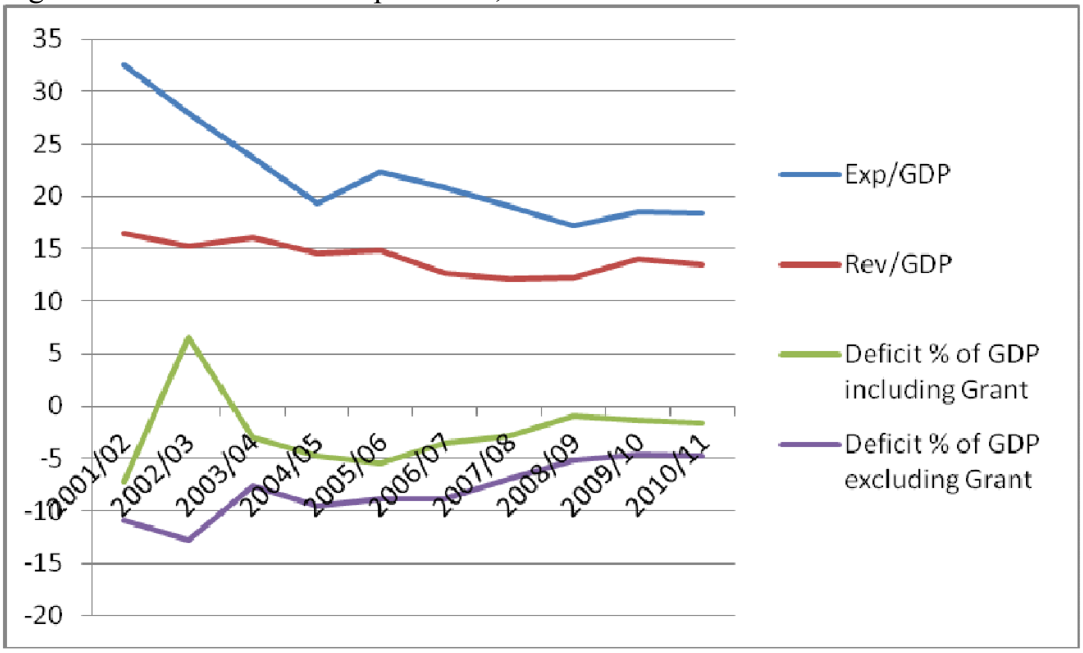
Table 3.3 Trend in Government Revenue between 2001/02-2010/11 (the levels are in millions of Birr)

Year	Total Revenue excluding Grant	Growth in Total Revenue excluding Grant	Total Revenue including Grant	Growth in Total Revenue including Grant	Growth in Tax Revenue (TR)	Growth in Non Tax Revenue (NTR)	Contribution of TR to Total Revenue excluding grant	Contribution of NTR to Total Revenue excluding grant
2001/02	10409.0		12832.0				76.2%	23.8%
2002/03	11150.0	7.1	15703.0	22.4	4.0	17.0	73.9%	26.1%
2003/04	13916.8	24.8	17918.5	14.1	32.3	3.6	78.4%	21.6%
2004/05	15582.2	12.0	20147.1	12.4	13.7	5.8	79.6%	20.4%
2005/06	19529.8	25.3	23261.5	15.5	14.2	68.7	72.5%	27.5%
2006/07	21796.4	11.6	29379.8	26.3	22.6	-17.3	79.6%	20.4%
2007/08	29793.1	36.7	39703.9	35.1	37.2	34.9	79.9%	20.1%
2008/09	40173.7	34.8	54627.4	37.6	21.8	86.5	72.2%	27.8%
2009/10	53861.3	34.1	66237.4	21.3	49.4	-5.6	80.4%	19.6%
2010/11	69119.9	28.3	85611.2	29.3	36.2	-3.9	85.3%	14.7%

Source: MoFED and own computation using data from MoFED

Over the last ten years, total revenue including grant and excluding grant has been growing at a rate of 23.8% and 23.9% respectively. As can be seen in table 3.3, the contribution of tax revenue to the total revenue excluding grant varies between 72.5% and 85.3% over the period 2001/02-2010/11. The interesting feature is that this proportion has been increasing in the last two years showing the improved capacity of tax collection resulted from increased effort in recent years.

Figure 3.1: Trend in Total expenditure, Total revenue and Fiscal deficit as % of GDP



Source: Own computation based on data from NBE annual report 2010/11.

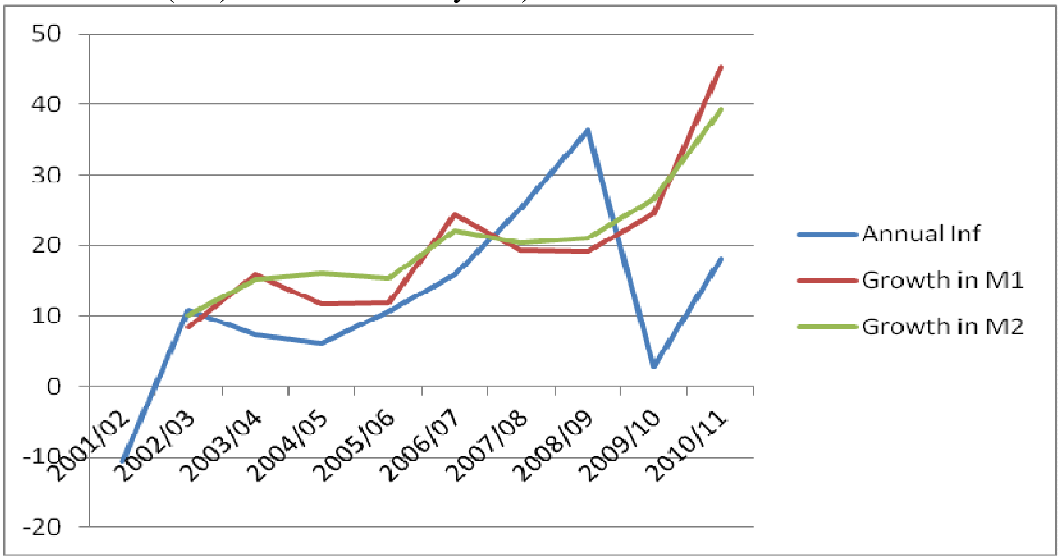
The fiscal deficit is negative throughout the period the country registered double digit growth showing persistent gap between general government expenditure and revenue. This is mainly due to lower tax revenue shown by lower ratio of revenue to GDP that is below Sub-Saharan African average (NBE, 2010/11). To sum up the government is an important sector in the economy with sustained and significant size. As indicated in figure 3.1, although the fiscal deficit is improving since 2008/09, more effort is still needed to increase revenue.

3.2 Trend in Deficit Financing, Money Supply and Inflation

In developing countries, fiscal policies are intertwined with monetary policy. Monetization of deficit is the major link between these two that ultimately causes inflation. The ever increasing government expenditure (mainly military expenditures) against low revenue collection and lack of external financing during the last years of the Derg regime and early period of the Transitional Government resulted in monetization of deficit and consequently higher growth of the money supply.

However, during that period, this was not a problem overall as historically inflation was not a serious problem (Haile, 2003).

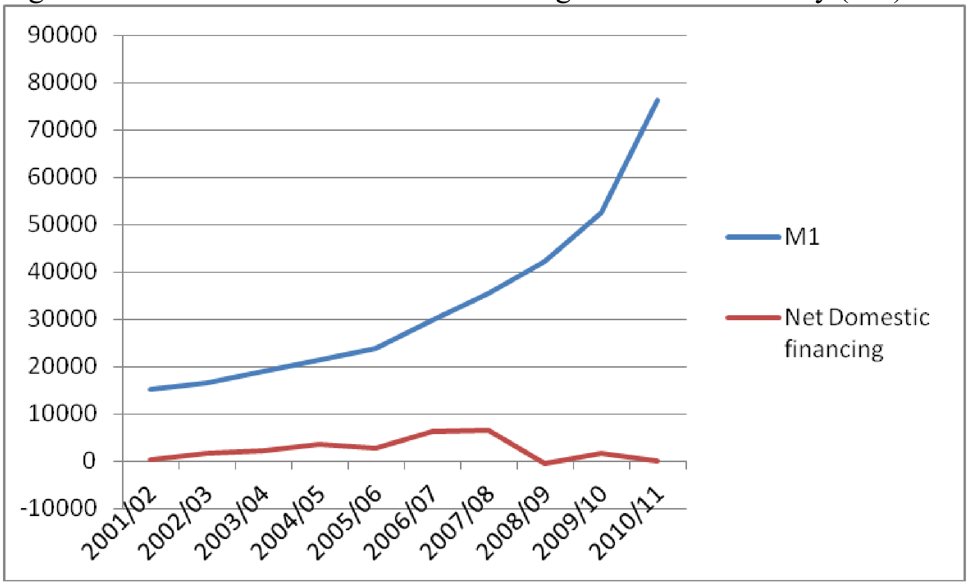
Figure 3.2 Trend in Inflation and Growth in Money supply (both narrow money (M1) and Broad Money M2)



Source: Own computation based on data from NBE annual reports.

The history in Ethiopia was that prices relate rainfall and thus output invesely. This co-movement reversed during the post 2002/03 period as both prices (especially agricultural) and output rise continuously (Alemayehu and Kibrom, 2008). Money supply growth has been considered as among the major causes of inflation in Ethiopia over this period (Alemayehu and Kibrom). Figure 3.2 reflects that inflation in the country is trending upwards together with the growth in money supply in many of the years from 2001/02 to 2010/11.

Figure 3.3 Trend in Net Domestic Financing and Narrow Money (M1)



Source: Own computation based on data from NBE annual reports

Figure 3.3 above shows the trend in net domestic borrowing and narrow money (M1). The former is the amount of fiscal deficit financed by the government from banking and non-banking systems. The broad money (not shown in the figure) and narrow money monotonically increase throughout the period over 2001/02-2010/11. Net domestic finance as well increases monotonically showing significant monetization of deficit but up to 2007/08. In the last three years this has been declining mainly due to the availability of external sources and consideration of conservative monetary policy thereby reducing monetization of fiscal deficit.

Therefore, it can be concluded from the discussion above that Ethiopian economy is growing sharply with sustained size of the government in the economy. While there are significant improvements in revenue mobilization, the fiscal deficit remains negative that led to monetization of deficit which might have contributed to the recent inflationary pressure. The following chapter takes these into account in modelling the dynamic effect of fiscal policy shock on macroeconomic variables.

CHAPTER FOUR

MODEL SPECIFICATION AND METHODOLOGY

4.1 Data Set and Sources

To analyse the dynamic impact of fiscal policy shock on major macroeconomic variables, the study include data on variables such as real net government expenditure, real net tax revenue, RGDP, CPI that proxy inflation and nominal interest rate in the baseline model. According to Perotti (2002) this is "the minimal set of macroeconomic variables necessary for the study of the dynamic effects of fiscal policy changes." It may seem irrelevant to include nominal interest rate in the model given that it is not that market determined in Ethiopia. However, the fluctuation in the series as can be seen in Appendix C can provide important information in the dynamics. Furthermore, the rigidity is taken into consideration while identifying structural shocks in the SVAR model.

The original series collected are in quarterly frequency and covers 52 observations over the period 1998/99:1-20010/11:4. The use of quarterly data allows for important intra-year dynamics, facilitates identification of structural shocks and minimizes the likelihood of structural break [Pedro, (2011); Blanchard and Perotti (2002)]. Real Net Government expenditure is defined, in this study, as current expenditures net of interest payments and pension payments plus capital expenditure. Real Net tax revenue includes the tax revenue from domestic as well as foreign sources excluding the interest payment on government debt. Ethiopia has no official quarterly GDP statistics. Quarterly observations on RGDP are usually generated by individual researchers for specific purpose and do not have much significance for wider econometric analysis. This study uses the recently generated RGDP series by industrial classification at EDRI in 2010. EDRI adopted robust method and estimated quarterly RGDP for Ethiopia from 1998/99:1-2008/09.[3] RGDP data for the period 2009/10:1 to 2010/11:4 are consistently estimated using quarterly simple average of the observation for the period over 2007/08:1-2008/09:4 and the annual data for 2009/10 and 2010/11. The source of the data series for fiscal variables is Ministry of Finance and Economic Development (MoFED) while Consumer Price Index and interest rate data series are obtained from National Bank of Ethiopia (NBE). The base year for the real values of the variables is 1999/00. All the variables enter in logs except interest rate.

4.2 Seasonal Adjustment of the Data

A time series data has four components: trend, cyclical, seasonal and irregular (random). The trend is the underlying long-term movement lasting many years. The cycle, also called business-cycle, is a quasi-periodic oscillation lasting for more than a year around the long- term trend. It is characterized by alternating periods of expansion and contraction. The trend and the cycle are difficult to estimate separately and thus are considered and analyzed as a whole as the trend-cycle. The irregular component represents random variations that are unforeseeable movements related to events of all kinds and which cannot be attributed to the trend-cycle component, the seasonal component or the calendar effects. Seasonal variation is a component of a time series which is defined as the repetitive and predictable movement around the trend line in one year or less. It is detected by measuring the quantity of interest for small time intervals, such as days, weeks, months or quarters. Seasonal effects are the intra-year (monthly, quarterly) fluctuations which repeat more or less regularly from

[3] See Appendix A for the description of the methodology employed.

year to year. They result from composite effects of events related to the climate, institutional decisions or modes of operation which repeat with a certain regularity within the year.

Seasonal adjustment, thus, helps to eliminate these effects that can be expected to recur at definite times each year under normal circumstances. It enables observations for consecutive quarters to be compared more meaningfully.

Seasonally adjusting a time series involve pre-adjustment that can be carried out manually. This is followed by estimation of the trend-cycle component of the pre-adjusted series through calculating centred moving average. This requires prior decision on whether the model should take multiplicative or additive form. In the multiplicative model, the time series is assumed to be the product of its four components mentioned above and the original series is divided by the estimated trend-cycle. The additive model, on the other hand, is the sum of the four components of the original series and the estimated trend-cycle component would be subtracted from the original series. In a multiplicative decomposition, the seasonal effects change proportionately with the trend. If the trend rises, so do the seasonal effects, while if the trend moves downward the seasonal effects diminish too. In an additive decomposition the seasonal effects remain broadly constant, no matter which direction the trend is moving in. In practice, most economic time series exhibit a multiplicative relationship and hence the multiplicative decomposition usually provides the best fit.

Prior to seasonally adjusting the data, the series should be examined for the presence of seasonality through statistical tests. In other words, one has to check whether the increase in the seasonal factors from year to year is too large to introduce distortion in the model. For seasonality to be identifiable, the series should be identified as seasonal by using the "Test for the Presence of Seasonality Assuming Stability" and "Nonparametric Test for the Presence of Seasonality Assuming Stability." Also, since the presence of moving seasonality can cause distortion, it is important to evaluate the moving seasonality in conjunction with the stable seasonality to determine if the seasonality is identifiable.

The test for identifiable seasonality is performed by combining the *F* tests for stable and moving seasonality, along with a Kruskal-Wallis test for stable seasonality.

The hypothesis for testing seasonality is given by:

H_0*: there is no significant seasonal component in the time series*

H_1*: there is a significant seasonal component in the time series*

After assuring the existence of seasonality through the above procedure, decision is needed on how the seasonal components should be estimated that will be used to seasonally adjust the series.

Most seasonal adjustment techniques are basically methods of computing seasonal indices (which attempt to measure the seasonal variation in the series). Those indices are then used to de-seasonalize (i.e. seasonally adjust) the series by removing the seasonal variations. Several methods are available for this purpose. Apart from regression models, most of them involve moving average filters. The difference between moving average procedures mainly lies in the way the filter is constructed. In other techniques such as X-11 and its variants, empirical filters are constructed. These filters do not depend on prior judgments about the series based on its statistical properties. In this study X-12 quarterly seasonal adjustment method that is a variant of X-11 installed on E-views-7 software is employed. This method first tests whether identifiable seasonality presents in the series. The test procedure is presented in Appendix B.

4.3 Stationarity and Unit Roots

A stationary series is a series whose data generating processes such as the mean, variance, and auto-covariances do not depend upon time. A series is said to be (weakly or covariance) *stationary* if the mean, and auto-covariances of the series are finite and independent of time. Any series that is not stationary is said to be non stationary. *Random walk* series, as an example, illustrates non-stationary series as follows:

$$y_t = y_{t-1} + e_t \quad \text{.. (4.1)}$$

where e_t is white noise. The forecast value based on the above series is clearly dependent upon time. Moreover, the variance of the series increases overtime. Differencing the above series yields a stationary process as shown below.

$$y_t - y_{t-1} = \Delta y_t = e_t \quad \text{.. (4.2)}$$

Since e_t is white noise, so does Δy_t implying that Δy_t stationary. A difference stationary series is said to be *integrated* and is denoted as I(d) where d is the order of integration. The order of integration is the number of unit roots contained in the series, or the number of differencing operations it takes to make the series stationary. For the random walk above, there is one unit root, so it is an I(1) series. Similarly, a stationary series is I(0). From economic point of view, an interesting distinction between I(0) and I(1) series is that the former has a limited memory of its past behaviour while the latter has an infinitely long memory. In other words, a particular random innovations in I(0) and I(1) series have transitory and permanent effects respectively (Verbeek, 2008).

Estimation of a model using non-stationary data can lead to spurious regression, a situation where the estimated regression has a high R^2 and significant t values without any economic relationship between the variables. Where what actually exist may be a correlated time trends rather than a meaningful economic relationship (Granger and Newbold, 1974). Therefore, to avoid the seemingly impressive and nice spurious regression results, various stationary testes are available. These include Augmented Dickey-Fuller Test (1979) (ADF), Phillips-Perron (1988) test (PP), the GLS-detrended Dickey-Fuller (Elliot, Rothenberg, and Stock, 1996), Kwiatkowski, Phillips, Schmidt, and Shin (KPSS, 1992), Elliott, Rothenberg, and Stock Point Optimal (ERS, 1996) and Ng and Perron (NP, 2001). ADF, PP and KPSS tests are discussed below as they are employed to investigate the stationarity of each series included in this study.

Given the Autoregressive Model of order 1 (AR(1)) as follows:

$$y_t = \theta y_{t-1} + \varepsilon_t \quad \ldots\ldots (4.3)$$

The series y_t is non-stationary when $|\theta| \geq 1$. A popular test of non-stationarity in the AR(1) model examines whether the series has a unit root i.e., whether $\theta = 1$.

Equation (4.3) is the basic equation from which three alternative equations are specified to allow different possibilities of non-stationarity. Before writing these expressions, the AR(1) model should be transformed by subtracting y_{t-1} from both sides and letting $\delta = \theta - 1$ so that the null hypothesis for unit root is specified as $\delta = 0$. The three alternative equations are:

$$\Delta y_t = \delta y_{t-1} + \varepsilon_t \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (4.3a)$$

$$\Delta y_t = \beta_1 + \delta y_{t-1} + \varepsilon_t \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (4.3b)$$

$$\Delta y_t = \beta_1 + t\beta_2 + \delta y_{t-1} + \varepsilon_t \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (4.3c)$$

The null hypothesis that the series has a unit root, i.e., $\delta = 0$ is the same for all the variants while the alternative is that δ is less than zero implying that the series is stationary. The first specification is pure random walk under the null hypothesis that does not allow any form of trend. In the second variant, the series has stochastic trend or a drift parameter while the third specification contains both deterministic and stochastic trend.

Under the null hypothesis, Dickey and Fuller have shown that the estimated t value of the coefficient δ follows the τ (tau) statistic and the critical values are computed on the basis of Monte Carlo simulations.

In order to account for the possibility of serial correlation in the above specifications, Said and Dickey (1986) augment lagged changes and re-specified the model as:

$$\Delta y_t = \beta_1 + t\beta_2 + \delta y_{t-1} + \sum_{i=1}^{m} \alpha_i \, \Delta y_{t-i} + \varepsilon_t \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (4.3d)$$

where $\Delta y_{t-1} = y_{t-1} - y_{t-2}$; $\Delta y_{t-2} = y_{t-2} - y_{t-3}$ etc. The ADF test based on equation (4.3d) is, therefore, appropriate especially when the assumption of uncorrelated error term is not reliable. Philips and Peron (1988) use non parametric statistical method that accounts for the presence of serial correlation in the error term ε_t without including the lagged changes as in the ADF test. The asymptotic distribution of the Phillips-Peron (PP) test has the same distribution with the ADF (Gujarati, 2004).

Unable to reject the null hypothesis of unit root may not necessarily make the series non-stationary. It just means that there is no sufficient information to reject the null hypothesis (Verbeek, 2008). To overcome the problem of low power of test, Kwiatkowski, Phillips, Schmidt and Shin (1992) propose an alternative test called KPSS where stationarity is the null hypothesis and the existence of a unit root is the alternative. This test decomposes a given time series into deterministic time trend, random walk and error term (not necessarily a white noise). It then tests trend stationarity under the null hypothesis that the random walk component has zero variance. The test is a Lagrange Multiplier (LM) test. The test statistic is computed from a regression of the series on the time trend. From the residual the following test statistic is computed.

$$KPSS = \sum_{i=1}^{t} \frac{S_t^2}{\hat{\sigma}^2} \quad \text{...} (4.4)$$

where $S_t = \sum_{i=1}^{t} e_s$ is the partial sum of the residual computed from the OLS regression of the series on intercept and time trend and $\hat{\sigma}^2$ is an estimator of the error variance. If the computed value is less than the given critical value, the series is stationary. It is non-stationary when it is the reverse.

4.4 Models in Fiscal Policy Analysis

In the literature, two major models are employed to analyse the macroeconomic effect of discretionary fiscal policy. These are structural macro-economic model and Vector Autoregressive models. The structural macroeconomic models were popular for decades in the second half of the 20th century. Structural macroeconomic models can be used to analyse the effects of discretionary fiscal policy and automatic stabilizers (Geoffery et al, 2006). In the sphere of fiscal policy, these models impose structure based on theory. For instance, studies that use this methodology often imposes Keynesian structure where output and consumption were made to respond positively to expenditure increase. These models, as a consequence, fail to explain the contradictory positive response of private consumption to fiscal contraction in US (Blanchard and Perotti, 2002). Nevertheless, these models show the channels (mainly consumption and investment) through which fiscal policy affects output (Geoffery et al, 2006). However, consumption and investment do not equate to the overall effect of fiscal policy on aggregate economy. This requires a dynamic model that traces these effects thereby incorporating the interdependence of different sectors (Alan, 2005). The second methodology based on Vector Autoregressive model achieves this and makes the difficulty of developing large-scale structural macroeconomic models unnecessary.

Since the early eighties, VAR models have become the standard tool to analyse macroeconomic policy and are found to be more successful in predicting than the complex structural macroeconometric models (Bahovec and Erjavec, 2009). The VAR approach aims at capturing the 'data generating process.' and imposes little economic theory thereby letting the data to speak. It doesn't require a-priori classification of variables as endogenous and exogenous. In the words of Sims these models do not require "incredible identification restriction" unlike complex simultaneous equation models (Enders, 2004). Once VAR is employed economic theory is used just to choose which variables to include in the model, to help identification of the system and to interpret the results (Pedro, 2011). Moreover, the VAR model is parsimonious with variables related to lagged values of the same variables.

4.5 The VAR Model

The VAR model in this study includes the minimum set of variables mentioned in section 4.1 that are necessary to study the dynamic effects of fiscal policy shocks. These are logarithm of real net government expenditure ($LRNGE_t$), logarithm of real net tax revenue ($LRNTR_t$), logarithm of real Gross Domestic Product ($LRGDP_t$), logarithm of Consumer Price index (CPI_t) that proxy inflation and nominal interest rate (r_t).

Accordingly the baseline VAR model with p lags, $VAR(p)$, is specified in its reduced form as:

$$Y_t = a_o + a_1(t) + A_1Y_{t-1} + A_2Y_{t-2} + \cdots + A_pY_{t-p} + u_t \ldots\ldots\ldots\ldots\ldots\ldots (4.5)$$

where a_o is a $(k \times 1)$ vector of constants; $a_1(t)$ is a $(k \times 1)$ vector of linear time trend; $t = 1, \ldots, T$; A_i are $(k \times k)$ coefficient matrices, k being the number of endogenous variables in the system and $Y_t = (LRNGE_t, LRGDP_t, LCPI_t, LRNTR_t, R_t)$ is the vector of endogenous variables. The $(k \times 1)$ vector $u_t = (u_t^g, u_t^y, u_t^p, u_t^{tr}, u_t^r)$ consists of reduced form residuals ordered with their corresponding observed endogenous variables in vector Y_t. Furthermore, each residual is a mean zero white noise process that is serially uncorrelated, i.e., $u_t \sim N(0, \Sigma_u)$. Applying OLS on each equation in the model yields consistent estimates of the reduced form parameters in A_i's and the reduced form error u_t and their covariance matrix $E(u_t u_t') = \Sigma_u$. Together the residuals, however, have non-zero correlation.

4.6 The Structural VAR Model

Non-zero correlations in the vector of residuals imply that different sets of impulses can be computed from same underlying VAR (Lütkepohl, 2005). Therefore, these impulse responses based on the reduced form residuals do not allow drawing conclusion about the true state of relationship unless identifying restrictions are imposed from economic theory. SVAR models use these restrictions (also called non-sample information) to specify unique innovations and, thus, unique impulse responses that have economic interpretation (Lütkepohl, 2005).

The SVAR representation of the model can be derived by Pre-multiplying equation (4.5) by $(k \times k)$ matrix A_0 as follows:

$$A_0 Y_t = A_0 a_o + A_0 a_1(t) + A_0 A_1 Y_{t-1} + A_0 A_2 Y_{t-2} + \cdots + A_0 A_p Y_{t-p} + A_0 u_t \quad \ldots\ldots (4.6)$$

Equation (4.6) can be written more compactly as:

$$A_0 Y_t = B_0 + B_1 + B_L(L) Y_{t-1} + B e_t \quad \ldots\ldots (4.7)$$

where $B_0 = A_0 a_o$, $B_1 = A_0 a_1(t)$, $B_L(L)$ is the polynomial shift operator of order $P-1$ and the coefficients matrices B_L are the product of A_0 and A_i's. In equation (4.7), the expression $B e_t = A_0 u_t$ describes the relationship between structural disturbances e_t and residual disturbances u_t. The A_0 and B matrices yield parameters on which short run restrictions are imposed. In particular, the matrix A_0 describes contemporaneous relationship among the variables in Y_t whereas the B matrix represents a diagonal variance matrix of the structural innovation. This model is called the AB model since it is a combination of the two otherwise separate models, i.e., the A-model and the B-model.

The A-Model identifies the structural innovations directly from the instantaneous relationship among the observed variables. In the A-model, a structural model is formulated in a way such that $e_t = Au_t$. Au_t is obtained by subtracting conditional expectation of the vector of endogenous variables from both sides of the structural VAR model. Once the contemporaneous relationship between the reduced form residuals and structural innovations are known, then A matrix and, hence, the structural innovations can be obtained. The B-model, on the other hand, recovers the structural innovation from the forecast error or reduced form residuals. In the B-model, the reduced form residuals u_t are assumed to be a linear combination of the structural innovations. The variance covariance matrix of the reduced form residuals, Σ_u, can be orthogonalized as follows:

Given $u_t = Be_t$ and $e_t \sim (0, \mathrm{I}_k)$

$$\Sigma_u = B\Sigma_e B'$$

$$\Sigma_u = BB'$$

where the variance covariance matrix of structural innovation, Σ_e, is assumed to be a unit matrix.

The AB model, used in all of studies that investigate effects of fiscal policy, considers two types of restrictions that will be solved simultaneously. In the AB model "simultaneous equation system is formulated for the errors of the reduced form rather than the observable variables directly thereby the model accounts for the shift from specifying direct relations for the observable variables to formulating relations for the innovation variables" (Lütkepohl, 2005; pp.364). Once the AB model is chosen to represent the SVAR model, $2k^2 - \frac{1}{2}k(k+1)$ number of constraints is required for the model to be just identified (Lütkepohl, 2005). This number of restrictions is equal to the total number of coefficients in A and B minus the number of the distinct elements in the variance-covariance matrix.

In the literature, there are four approaches to identifying exogenous fiscal shocks as mentioned in the previous chapters. These are the recursive approach introduced by Sims (1980) and first employed to the analysis of fiscal policy shock by Fatas and Mihov (2001); the Blanchard and Perotti (2002) SVAR approach that is based on the features of the tax system; the sign restriction structural VAR approach applied to similar topic by Mountford and Uhlig (2002 and 2008), and the event identification employed by Romer and Romer (1989), Ramey and Shapiro (1997) and Burnside et al. (2003). This study uses the first two identification approaches on which the AB model can be employed. While the Blanchard and Perotti (2002) approach is used as the major identification approach, the study employs the recursive approach as a means of checking robustness.

4.6.1 The Recursive Approach

Given the AB-model, the recursive approach assumes matrix B as a unit matrix and restricts A_0 to a lower triangular matrix (a matrix whose elements above the diagonal are zero). This implies the variance covariance matrix of the reduced form residual, $\Sigma_u = A_0^{-1}\Sigma_e(A_0^{-1})'$.[4] This is based on Cholesky decomposition that decomposes a given positive definite matrix S_u into a lower (upper) triangular matrix P (P') with positive main diagonal such that $P^{-1}S_u(P^{-1})' = I$ or $S_u = PP'$. Accordingly, the decomposition is obtained by defining a diagonal matrix D which has the same main

[4] Given that $A_0u_t = B_te_t \rightarrow u_t = A_0^{-1}Ie_t$ since B_t is assumed to be unit matrix.
$E(u_tu_t') = \Sigma_u = E(A_0^{-1}Ie_t) = A_0^{-1}\Sigma_e(A_0^{-1})'$.

diagonal as P and by specifying $A_0^{-1} = PD^{-1}$ and $\Sigma_e = DD'$. In this way the structural shocks are identified i.e., the elements on the main diagonal of D and P are equal to the standard deviation of the structural shocks. The recursive approach implies causal ordering. Altering the order implicitly changes the relationship structure of innovations. In the baseline SVAR model in this study, there are 120 ($k! = 5!$) possible orderings of the endogenous variables. The variable that is thought to occur first should be ordered first and the most endogenous variable should be ordered last. In this study the ordering of the variables is taken from Caldara and Camps (2008).

Real net government spending is ordered first; real GDP comes second followed by inflation; real net tax revenue is ordered fourth and interest rate is ordered fifth. Accordingly, the relationship between the reduced form and structural innovations can be written as follows:

$$\begin{bmatrix} 1 & 0 & 0 & 0 & 0 \\ \gamma_{y,g} & 1 & 0 & 0 & 0 \\ \gamma_{p,g} & \gamma_{p,y} & 1 & 0 & 0 \\ \gamma_{tr,g} & \gamma_{tr,y} & \gamma_{tr,p} & 1 & 0 \\ \gamma_{r,g} & \gamma_{r,y} & \gamma_{r,p} & \gamma_{r,nt} & 1 \end{bmatrix} \begin{bmatrix} u_t^g \\ u_t^y \\ u_t^p \\ u_t^{tr} \\ u_t^r \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} e_t^g \\ e_t^y \\ e_t^p \\ e_t^{tr} \\ e_t^r \end{bmatrix} . \quad (4.8)$$

where the $\gamma_{i,j}$'s denote the contemporaneous relationship between the reduced form residual of *i* and *j* variable in the model. The above ordering of the variables has the following implications; (1) Government spending does not contemporaneously react to any shock in the system as movements in government spending are unrelated to the business cycle. Therefore, it seems plausible to assume that shocks originating in the private sector do not contemporaneously affect government spending. (ii) Output does not react contemporaneously to shocks in inflation, net tax and interest rate but is affected contemporaneously to spending shocks. (iii) Inflation does not contemporaneously respond to shocks in net tax and interest rate but is affected contemporaneously by government spending and output shocks. Output and inflation are ordered before net tax revenue because shocks to these two variables have an immediate effect on tax base thereby contemporaneously affecting tax receipts. (iv) net tax revenue does not react contemporaneously to shock in interest rate but are affected contemporaneously by all of the other variables in the system. Lastly interest rate responds contemporaneously to shocks in each variable making interest rate the most endogenous variable in the system. This can be justified on the ground of a central bank reaction function as pointed out in Caldara and Kamps (2008) implying that the interest rate is set as a function of the output gap and inflation. Secondly government spending and taxes are defined as net of interest payment in this study; hence, they are insensitive to change in interest rate shocks within a quarter. It is important to note that the restrictions are valid only in the initial period and the latter effect is transmitted through the VAR based on the specification.

4.6.2 The Blanchard and Perotti Approach

Blanchard and Perotti (2002) developed the methodology of structural identification of fiscal policy shocks. They use institutional information on the tax and transfer system and the timing in the collection of taxes to construct automatic responses of government spending and tax to economic activity thereby infer fiscal shocks.[5] The underlying argument in this methodology is that systematic discretionary policy will

[5] This identification approach was first introduced in a three variable VAR model and latter extended by Perotti (2002) to a five variable VAR model.

be slow to respond to shocks in economic activity due to lags in recognizing these shocks and implementing fiscal policy.

According to Perotti (2002), extended from Blachard and Perotti (1999), in a five variable VAR, reduced form residuals in government spending (u_t^g) and tax revenue (u_t^{tr}) are linear combination of three components:

1) Automatic response of government spending and tax revenue to output (u_t^y), inflation (u_t^p) and interest rate (u_t^r) shocks.
2) Systematic discretionary response of policymakers on output, inflation and interest rate innovation.
3) Random discretionary shocks to fiscal policy. i.e., structural forms of innovation of government spending (e_t^g) and tax revenue shocks (e_t^{tr}).

Thus, the reduced form innovations in government spending and tax revenue can be formally expressed as:

$$u_t^g = \alpha_y^g u_t^y + \alpha_p^g u_t^p + \alpha_r^g u_t^r + \beta_{tr}^g e_t^{tr} + \beta_g^g e_t^g \text{ .... (4.9)}$$

$$u_t^{tr} = \alpha_y^{tr} u_t^y + \alpha_p^{tr} u_t^p + \alpha_r^{tr} u_t^r + \beta_{tr}^{tr} e_t^{tr} + \beta_g^{tr} e_t^g \text{ .... (4.10)}$$

Since it is assumed that the government cannot react to economic shocks within a quarter, α_j^i's reflect only the first component of the VAR residuals explained above. In other words, no systematic discretionary response of policymakers within a quarter implies the coefficient $\alpha_y^g, \alpha_p^g, \alpha_r^g, \alpha_y^{tr}, \alpha_p^{tr}$ and α_r^{tr} in the above two equations represent only the automatic response of government spending and tax to shocks in output, inflation and interest rate. As e_t^g and e_t^{tr} are associated through reduced form innovations, they cannot be obtained by OLS (Heppke-Falk, Tenhofen and Wolff, 2006). In particular, $\alpha_y^g, \alpha_p^g,$ and α_r^g represents the within-quarter output, price and interest rate elasticity of government spending respectively. Similarly, $\alpha_y^{tr}, \alpha_p^{tr}$ and α_r^{tr} indicate the within-quarter output, price and interest rate elasticity of net tax revenue, respectively. The estimates of these exogenous elasticities are presented in the following section along with the methodology employed to estimate them.

Reduced form innovations in government spending and tax can be expressed in form of cyclically adjusted residual as:

$$u_t^{g,CA} = u_t^g - \left(\alpha_y^g u_t^y + \alpha_p^g u_t^p + \alpha_r^g u_t^r\right) = \beta_{tr}^g e_t^{tr} + \beta_g^g e_t^g \quad \text{……………} (4.11)$$

$$u_t^{tr,CA} = u_t^{tr} - \left(\alpha_y^{tr} u_t^y + \alpha_p^{tr} u_t^p + \alpha_r^{tr} u_t^r\right) = \beta_{tr}^{tr} e_t^{tr} + \beta_g^{tr} e_t^g \quad \text{…………} (4.12)$$

A decision is required at this stage as to whether government spending or net tax revenue comes first in order to identify the model. Perotti (2002) argues that although there is neither theoretical nor empirical basis to put one of these first, it is more plausible to assume that tax decisions follow spending decisions. i.e., $\beta_{tr}^g = 0$. The opposite assumption is also tested in Heppke-Falk, Tenhofen and Wolff (2006), Caldara and Kamps (2006), de Castro and de Cos (2006) as well as in Lozano and Rodriquez (2008).

Under the assumption that $\beta_{tr}^g = 0$ (this study adopts), cyclically adjusted residuals of government spending and tax can be written as:

$$u_t^{g,CA} = \beta_g^g e_t^g \quad \text{………………………………………...…} (4.13)$$

$$u_t^{tr,CA} = \beta_g^{tr} e_t^g + \beta_{tr}^{tr} e_t^{tr} \quad \text{………………………...………} (4.14)$$

As in Perotti (2002), the other equations of the reduced form innovations are estimated using instrumental variables, where the structural shock in respective equation is used as instruments since it is orthogonal. Therefore, the other equations of the reduced form innovations can be formally written as:

$$u_t^y = \alpha_g^y u_t^g + \alpha_{tr}^y u_t^{tr} + \beta_y^y e_t^y \quad \text{……………………………….. (4.15)}$$

$$u_t^p = \alpha_g^p u_t^g + \alpha_{tr}^p u_t^{tr} + \alpha_y^p u_t^y + \beta_p^p e_t^p \quad \text{………………………… (4.16)}$$

$$u_t^r = \alpha_g^r u_t^g + \alpha_{tr}^r u_t^{tr} + \alpha_y^r u_t^y + \alpha_p^r u_t^p + \beta_r^r e_t^r \quad \text{………………… (4.17)}$$

Before presenting the identified SVAR model, the exogenous elastiticities should be obtained.

4.6.2.1 Short Term Elasticities of Government Spending and Net Tax Revenues

To achieve full identification of the SVAR model, short term elasticities of government spending and revenue to changes in macroeconomic variables are estimated based on the methodology in Blanchard and Perotti (1999), Perotti (2002), Caldara and Kamps (2006, 2008) and Lozano and Rodriquez (2008) as well as in de Castro and de Cos (2006). These elasticities measure the contemporaneous effects of GDP, prices and interest rate on the fiscal variables.

Since interest payments are excluded from the definition of government spending, the elasiticity of government spending to interest rate is set as zero. No contemporaneous relationship between interest rate and net tax revenue is assumed as it could not be identified any measurable relationship between the two implying $\alpha_r^{tr} = 0$ in the model. The contemporaneous effects of GDP and prices on the fiscal variables are discussed below.

I. Elasticity of Government spending to changes in GDP and Prices

There is no automatic component of government spending that change with output. Moreover, government spending decisions take more than one quarter, as discussed in the previous sections. In other words, the government sector does not respond either contemporaneously or as a reaction to changes in output within a quarter. Therefore, the elasticity of government spending to the change in GDP is zero in the SVAR model. The issue is less straightforward for the change in prices. Given that wage payments are not indexed to quarterly change in inflation, the elasticity of wage can be taken as -1. However, current expenditures on goods and services other than wage payments as well as investment spending of governments are often made on contractual basis implying little or no response for a change in inflation. Perotti (2002) suggested -0.5 value for elasticity of government spending to a one percent increase in prices. The baseline model takes this value and robustness check has been conducted for slightly higher (-0.7) and lower (-0.3) values.

II. Elasticity of Net Tax Revenue to changes in GDP and Prices

The calculation of elasiticity of net tax revenue to GDP is composed of the elasticity of each tax category to their tax base, and the elasticity of each tax base to GDP. This is becasue changes in GDP affect tax revenue differently through the different components of GDP (i.e., tax bases). The elasiticity of net tax revenue to GDP can be written more formally in mathematical form as shown below:

$$\alpha_y^t = \sum_{i=1}^{n} \varepsilon_{B_i}^{t_i} \times \varepsilon_y^{B_i} \times \frac{T_i}{T} \quad \text{..(4.18)}$$

where $\varepsilon_{B_i}^{t_i}$ is the elasticity of each tax category to its tax base, $\varepsilon_{y}^{B_i}$ is the elasticity of the tax base to GDP and $\frac{T_i}{T}$ is the share of the tax category to the total tax revenue. Unlike the conventional classification (see Blanchard and Perotti (2002), Ravnik and Zilic (2010)), there are fewer category of taxes in this study. The tax categories are divided into three, namely, real direct tax, real indirect tax (excluding custom duties) and real custom duties. Excise tax and Value Added Tax (VAT) are summed into real indirect tax along with others such as sales tax. The aggregation is on the basis of the argument that these specific tax categories have common proxy base i.e, private consumption (see Ravnik and Zilic, 2010). The following table presents the proxy bases for each tax category.

Table 4.1: Proxies for Tax Bases

Tax Category	**Base Proxy**
Real Direct Tax	Real Gross Domestic Product (RGDP)
Real Indirect Tax (excluding custom duties)	Private Consumption
Real Custom Duties	Value of Import of Goods and Services

Source: Ministry of Finance and Economic Development and own modification

The data on quarterly direct tax, indirect tax (excluding custom duties) and real custom duties are obtained from MoFED and are changed to real value where 1999/00 is the base year. Quarterly data on private consumption is constructed by multiplying each quarterly value of GDP by annual percentage of private consumption to GDP. Furthermore, the share of each tax category, $\frac{T_i}{T}$, is obtained by calculating the average share of individual taxes over the sample period 1998/99:1-2010/11:4. Accordingly, Real direct tax, Real Indirect tax (excluding custom duties) and Real Custom duties have share of 45.36%, 30.39% and 24.25% respectively. $\varepsilon_{B_i}^{t_i}$ and $\varepsilon_{y}^{B_i}$ are estimated in autoregressive distributed lag and simple linear regression models as shown in Appendix D. The impact multipliers are taken into consideration in the autoregressive distributed lag models as the interest is in the short run elasticities.[6] Table 4.2 shows the calculation of all elasticities where elasticity of net tax revenue to change in GDP equals 0.55. This value is similar with the coefficient (0.56) in the regression of change in total tax revenue on change in output, among other variables, in Alemayehu and Befekadu (1998).[7] Comparing the estimate with other countries shows that the computed value for Ethiopia is smaller.

Table 4.2: The elasticity of net tax revenue to change in output

Revenue	$\varepsilon_{B_i}^{t_i}$	$\varepsilon_{y}^{B_i}$	$\varepsilon_{B_i}^{t_i} \times \varepsilon_{y}^{B_i}$	$\frac{T_i}{T}$	$\varepsilon_{B_i}^{t_i} \times \varepsilon_{y}^{B_i} \times \frac{T_i}{T}$
Real Direct Tax	0.95	1.00	0.95	0.454	0.513
Real Indirect Tax	0.59	0.11	0.065	0.304	0.0197
Real Custom duties	0.22	0.26	0.057	0.242	0.0138
$\alpha_y^t = \sum_{i=1}^{n} \varepsilon_{B_i}^{t_i} \times \varepsilon_{y}^{B_i} \times \frac{T_i}{T}$					**0.55**

Source: Own calculation

For instance, for Germany Tenhofen and Wold (2006) obtained 0.95 while in Perotti (2002) it is 0.92. For Spain an elasticity of 0.62 is calculated by de Castro and de Cos

[6] The long-run coefficients were also computed and found to be 0.93. Impulse responses based on the long-run coefficients do not diverge that from those estimated based on the short-run coefficient, 0.55.

[7] See Alemayehu "Readings on the Ethiopian Economy" (2011), pp.350.

(2006); Perotti (2002) calculated 1.85 for the USA, 0.81 for Australia and 1.86 for Canada. Therefore, the estimate for Ethiopia is smaller than that from the literature. The lower output elasticity of tax revenue in the country reflects the narrow tax base as can be observed from the table where real indirect tax and real custom duties have very low response to the change in their respective bases.

The price elasticity of net tax revenues is also calculated as 0.34. It is the weighted average of the elasticity of each tax category with respect to consumer price index. The regression results shown in appendix 4.2 are summarized in the following table.

Table 4.3: The elasticity of net tax revenue to change in price

Revenue	$\varepsilon_p^{B_i}$	$\frac{T_i}{T}$	$\varepsilon_p^{B_i} \times \frac{T_i}{T}$
Real Direct Tax	0.41	0.454	0.186
Real Indirect Tax	0.46	0.304	0.139
Real Custom duties	0.07	0.242	0.016
$\alpha_p^t = \sum_{i=1}^{n} \varepsilon_p^{B_i} \times \frac{T_i}{T}$			**0.34**

Therefore, the AB representation of the SVAR model in which Blanchard and Perotti (2002) identification approach is applied can be written as:

$$\begin{bmatrix} 1 & 0 & 0.5 & 0 & 0 \\ \gamma_{y,g} & 1 & 0 & \gamma_{y,nt} & 0 \\ \gamma_{p,g} & \gamma_{p,y} & 1 & \gamma_{p,nt} & 0 \\ 0 & -0.55 & -0.34 & 1 & 0 \\ \gamma_{r,g} & \gamma_{r,y} & \gamma_{r,p} & \gamma_{r,nt} & 1 \end{bmatrix} \begin{bmatrix} u_t^g \\ u_t^y \\ u_t^p \\ u_t^{tr} \\ u_t^r \end{bmatrix} = \begin{bmatrix} \beta_{g,g} & 0 & 0 & 0 & 0 \\ 0 & \beta_{y,y} & 0 & 0 & 0 \\ 0 & 0 & \beta_{p,p} & 0 & 0 \\ \beta_{tr,g} & 0 & 0 & \beta_{tr,tr} & 0 \\ 0 & 0 & 0 & 0 & \beta_{r,r} \end{bmatrix} \begin{bmatrix} e_t^g \\ e_t^y \\ e_t^p \\ e_t^{tr} \\ e_t^r \end{bmatrix}$$

The above system is just-identified as $2k^2 - \frac{1}{2}k(k+1) = 35$ restrictions are imposed in total in both matrices. Matrix B has 19 coefficients with zero value and the main diagonal of matrix A provides another 5 restrictions. The argument that government spending is entirely under the control of economic policy which does not contemporaneously respond to any shock in the system except for inflation (for which external information equal to 0.5 is used) yields four additional restrictions. The assumption that interest rate changes do not contemporaneously affect any of the variables gives three more restrictions. As the impact of government spending on net tax revenue is modelled in matrix B, the relationship is taken as zero in matrix A. Moreover, output does not respond contemporaneously to inflation. The system gets fully identified given the calculated output and price elasticity of net tax revenue. However, financial agents in Ethiopia do not respond that through altering the interest rate. Therefore, the contemporaneous response of interest rate to all the other variables in the model except inflation and itself is set to be zero to reflect that interest rate is not freely market determined. This implies, in the above matrix A, the coefficients, $\gamma_{r,g} = \gamma_{r,y} = \gamma_{r,nt} = 0$.

4.7 Impulse Response and Variance Decomposition Analysis

4.7.1 Impulse Response Functions

Impulse Response Function (IRF) traces out the effect of an exogenous shock or innovation in one of the variables on some or all of the other variables in the system. The innovation is usually one standard deviation and the effect on current and future values of the endogenous variables in the system is transmitted through the dynamic structure of the VAR model (Stock and Watson, 2001). In a VAR model, IRF are obtained by imposing the usually unrealistic assumption that there is no innovation in other variables at the same time which in turn obscures the actual relationship between the variables. However, IRF from SVAR models does not force innovations from other variables to have a value equal to zero.

From the two identifications approaches mentioned in the previous section, two IRF are estimated. These are Structural IRF for the SVAR model identified by the procedure in Blachard and Perotti (2002) and the IRF for the model identified by Cholesky decompositio. In this study, IRF are estimated mainly to trace out the dynamic impact of an innovation in net government spending and net tax revenue on GDP, inflation and interest rate. The non-fiscal shocks are also explored.

4.7.2 Variance Decomposition

Variance Decomposition (VD) decomposes variation in endogenous variable into the component shocks to the endogenous variables in the VAR. It measures the forecast error variance of an endogenous variable that is accounted for by an innovation in other variable in the system. This analysis is sometimes called innovation analysis (Lütkepohl, 2005).

VD gives information about the relative importance of each random innovation to the variables in the model. In this study, Variance decomposition enables to analyse the percentage of variance in GDP, inflation and interest rate innovations as well as the fiscal variables that is explained by net government spending and net tax revenue in a given period thereby shedding light on the relative importance of fiscal policy variables in explaining those macroeconomic variables in the model.

4.8 Pre-estimation and Post-estimation Diagnostic Tests of the VAR Model

4.8.1 Lag Length Selection Criteria

Before estimating the VAR model, it is critical to choose the order of the model that yields good model and hence precise forecast. The order of the VAR model refers to the optimal number of lags that should be included in the VAR model. Lütkepohl (1993) indicates that over-fitting (selecting a higher order lag length than the true lag length) causes an increase in the mean-square forecast errors of the VAR and that under-fitting the lag length often generates autocorrelated errors.

There are different test and information criterions that help choose the optimal lag. These are the Likelihood Ratio (LR) test, Final Prediction Error (FPE), Akaike Information Criterion, Schwartz Information Criterion (SIC) and Hannan and Quinn Information criterion (HQ). When these criterions choose different lag length, residual correlogram[8] from VAR models with different order are examined. Residual correlogram provide a summary of the autocorrelation properties of the estimated residuals. It helps to find a model in which no residuals autocorrelations are significant.

4.8.2 Stability of VAR Model

The test for stability is one of the post estimation diagnostic tests conducted before using the estimates of the baseline VAR model for policy analysis and forecasting. This test checks whether the roots of the characteristic polynomial lies inside the unit circle.

[8] Harris (2007) suggested that looking at residuals correlograms is a good idea when there are uncertainties in choosing the lag length of a VAR model.

The VAR model in equation (4.7) can be written in Lag Operator notation as:

$$B(L)Y_t = B_0 + B_1 + Be_t$$

where $B(L) = I_n - B_1L - B_2L^2 - \cdots - B_pL^p$. The $VAR(p)$ is stable if the roots of

$$\det(I_n - B_1L - B_2L^2 - \cdots - B_pL^p) = 0$$

lies outside the complex unit circle (have modulus greater than one)., or, equivalently the eigen values of the companion matrix

$$F = \begin{pmatrix} B_1 & B_2 \cdots & & B_n \\ I_k & 0 & \cdots & 0 \\ 0 & \ddots & 0 & \vdots \\ 0 & 0 & I_k & 0 \end{pmatrix}$$

have modulus less than one.

4.8.3 Residual Autocorrelation

Residual autocorrelation is the other post estimation test that helps to diagnose if the current value residual is correlated with any of its lagged values. The Brusch-Godfrey Lagrange Multiplier test is conducted for this purpose. This involves specifying the order of serial correlation which is consistent with that used in estimating the VAR model. The null hypothesis of the LM test for autocorrelation is that the residuals are not serially correlated, while the alternative is that the residuals are serially correlated. If the P-value is less than 0.05 then we reject the null hypothesis (Harris, 1995).

4.8.4 Multivariate Normality of the Residuals

The other post estimation diagnostic test is to check whether the residuals are normally distributed. Testing this distributional assumption is desirable in setting up forecast intervals. This test is developed based on the third and fourth central moments (skewness and kurtosis) of normal distribution. More formally the Jarque-

Berra test is conducted in this study which under the null hypothesis of normally distributed errors has a test statistic that possesses a Chi-Square distribution. Thus, if the Jarque-Bera statistic is significant, that is, the p-value is less than 0.05; the null of normality is rejected at the 5% level of significance.

4.8.5 Heteroscedasticity Tests for the Residuals

The test for heteroscedasticity investigates whether the variance of the errors in the model are constant or not. In White's (1980) test for heteroscedasticity the null hypothesis states that residuals are homoscedastic and independent of the regressors, and that there is no problem of misspecification. If the White test statistic is significant, that is, P-value is less than 0.05; the null hypothesis of homoscedasticity and no misspecification will be rejected.

CHAPTER FIVE

RESULTS OF THE ANALYSIS

5.1 Seasonal Adjustment

The fact that the study employs quarterly observations makes the series susceptible to seasonal variation. Seasonal variation is a disturbing factor that economic models do not take into consideration. This study uses X-12 quarterly seasonal adjustment method that is a variant of X-11 installed on E-views-7 software.

Table 5.1: Stable seasonality test result

Name of Variable		Sum of Squares	Degrees of Freedom	Mean Square	F-value
LRNGE	Between quarters	305.84	3	101.95	53.44**
	Residual	91.57	48	1.91	
	Total	397.41	51		
LRGDP	Between quarters	257.33	3	85.78	2187.58**
	Residual	1.88	48	0.039	
	Total	259.21	51		
LCPI	Between quarters	6.72	3	2.241	12.16**
	Residual	8.84	48	0.184	
	Total	15.56	51		
LRNTR	Between quarters	32.40	3	10.80	17.91**
	Residual	28.94	48	0.603	
	Total	61.33	51		
R	Between quarters	84.21	3	28.069	4.39*
	Residual	306.73	48	6.39	
	Total	390.94	51		
LRNCGE	Between quarters	234.34	3	78.115	37.92**
	Residual	98.89	48	2.06	
	Total	333.24	51		
LRKGE	Between quarters	760.82	3	253.61	24.30**
	Residual	500.97	48	10.44	
	Total	1261.79	51		

** Stable seasonality is present at 0.1 percent significance level.
*Stable seasonality is significant at 5% significance level

The decomposition of the time series components for each series is made by assuming multiplicative model as it is the case for most macroeconomic variables. Prior to seasonally adjusting the series, test for identifiable seasonality is conducted. Table 5.1

shows that stable seasonality present for all variables at 0.1 percent significance level except for interest rate for which stable seasonality presents only at 5 percent level of significance.

Table 5.2: Moving seasonality test result

Name of Variable		Sum of squares	Degrees of Freedom	Mean Square	F-value
LRNGE	Between Years	37.36	12	3.114	2.31*
	Error	48.46	36	1.346	
LRGDP	Between Years	0.77	12	0.064	2.06*
	Error	1.12	36	0.031	
LCPI	Between Years	3.68	12	0.307	2.30*
	Error	4.80	36	0.133	
LRNTR	Between Years	7.06	12	0.588	1.72
	Error	12.31	36	0.342	
R	Between Years	163.25	12	13.60	5.17**
	Error	94.65	36	2.63	
LRNCGE	Between Years	24.98	12	2.082	1.135
	Error	66.03	36	1.834	
LRKGE	Between Years	204.21	12	17.02	2.276*
	Error	269.17	36	7.48	

**Moving seasonality present at the one percent level.
*Moving seasonality is present at 5% significance level.

The test for existence of moving seasonality indicates no evidence of moving seasonality for net tax revenue and net current government expenditures and a strong evidence of moving seasonality for interest rate that is significant at one percent. The other series have moving seasonality at five percent level of significance.

The combined test for identifiable seasonality eventually provides benchmark to decide whether a particular series needs to be seasonally adjusted. This test is based on the above two tests and Kruskal-Wallis test.[9] The detail procedure and results of the combined tests for each series is presented in Appendix B. The following table is constructed from the last row of each of these tables. From table 5.3 presented below, it is concluded that all the series except interest rate are suitable for seasonal adjustment and are, therefore, seasonally adjusted.

Table 5.3 Result of the combined test for identifiable seasonality

Name of Variable	Remark
LRNGE	Identifiable Seasonality Present
LRGDP	Identifiable Seasonality Present
LCPI	Identifiable Seasonality Present
LRNTR	Identifiable Seasonality Present
R	Identifiable Seasonality NOT Present
LRNCGE	Identifiable Seasonality Present
LRKGE	Identifiable Seasonality Present

Source: Own compilation

5.2 Test Results for Stationarity

ADF, PP and KPSS tests are conducted on each of the series to examine stationarity. Table 5.4 presents the results of the tests using ADF and PP tests while the result using KPSS test are shown in Table 5.5. LRNTGE_SA and LRNTR_SA are unanimously suggested to be trend stationary in all of the tests. On the other hand, the three tests indicate that LRGDP_SA and LCPI_SA are integrated of order one. Although, there is an evidence of trend stationarity for interest rate series, it is indicated as an I(1) variable according to ADF and PP test results.

[9] It is a non-parametric test.

Table 5.4 Unit Root test results using ADF and PP tests

H0: Variable has Unit Root	Augmented Dickey Fuller Test P-values				Philips-Perron Test P-values			
	Level	First Diff.	Intercept	Trend	Level	First Diff.	Intercept	Trend
LRNTGE_SA	0.0002			✓	0.000			✓
LRGDP_SA		0.000	✓	✓		0.000	✓	✓
LCPI_SA		0.0127	✓	✓		0.000	✓	✓
LRNTR_SA	0.0218			✓	0.023			✓
R		0.000	✓	✓		0.000	✓	✓
LRNCGE_SA	0.000		✓	✓	0.000		✓	✓
LRKGE_SA	0.049			✓	0.044			✓

The null is rejected for p-values smaller than 5%.

Though the evidence is not strong (i., only at 5 percent in ADF and PP tests and only at 1 percent in KPSS test), LRKGE_SA is trend stationary. All of the tests speak strongly that LRNCGE_SA is stationary at level.

Table 5.5 Stationarity test results using KPSS

H_0: Variable is Stationary	Kwiatkowski, Phillips, Schmidt and Shin Test LM statistic			
	Level	First Difference	Intercept	Trend
LRNTGE_SA	(0.116)*			✓
LRGDP_SA		0.329* (0.061)*	✓	✓
LCPI_SA		0.484***(0.049)*	✓	✓
LRNTR_SA	(0.071)*			✓
R	0.369**		✓	
LRNCGE_SA	0.427** (0.062)*		✓	✓
LRKGE_SA	(0.148)***			✓

*Variable is stationary at 10% significance level.
**Variable is stationary at 5% significance level.
***Variable is stationary at 1% significance level.
The statistic in parenthesis indicate trend statioanrity.

5.3 Dynamic Effects of Fiscal Policy shock on GDP, Inflation and Interest rate

Despite the fact that some of the series contain unit roots, the VAR model is estimated in levels and the long run structure is unrestricted. This is common in such studies (Perotti, 2002; de Castro and de Cos, 2006; Mancellari (2011); Ravnik and Zilic (2010) and Heppke-Falk, Tenhofen and Wolf, 2006). According to the VAR literature, when cointegration relationship exist with high cointegrating rank where the short run coefficients are ignored (i.e., when the primary interest is in the dynamics rather than parameter estimation), the VAR model can be estimated in levels (Peersman and Smets, 2001, and Lütkepohl and Krätzig, 2004). Accordingly, Johansen cointegration test is performed in the baseline VAR model. As can be seen in Appendix E4, the test suggests that there are two cointegrating relationships among the variables in the benchmark VAR model. Moreover, Franchon and Wondel (1992) argue that resorting to differencing non-stationary data in multivariate VAR model introduce distortions into the model.[10] Since this study measures the impact of fiscal policy through impulse responses of the relevant economic variables, rather than their short run coefficients, level estimation is justified.

Prior to estimating the VAR model the lag length has to be chosen. The maximum lag length is restricted to be six given the sample size. AIC in this case chose a lag length of six while the other criterions such as LR, FPE, SC and HQ chose a lag length of one. Due to different outcomes of the various criterions employed to select the optimal lag, residual correlogram[11] from VAR models with different order are

[10] They instead suggested three alternatives among which estimating the VAR model in level when co-integration exists is considered to justify the VAR in level estimation in this study.

[11] Harris (2007) suggested that looking at residuals correlograms is a good idea when there are uncertainties in choosing the lag length of a VAR model.

examined. This study conducts residual correlograms for different order VAR models and the results are presented in Appendix E2. Accordingly, in the VAR(1) model, the interest rate residuals are found to be correlated with consumer price index and net government spending residuals at lags one and two respectively. In the VAR(6) model, on the other hand, consumer price index residuals are correlated with government spending and output residuals at lags three and interest rate residuals are correlated with net tax revenue at lag six. Since there is no autocorrelation of residuals at any lag in the VAR(4) model with constant and trend, it is chosen as the benchmark model.

The validity of further analysis based on the benchmark model depends on how the estimated residuals perform when investigated with a battery of post-estimation diagnostic tests. These are test for stability of the model and test for autocorrelation, heteroscedasticity and normality of the estimated residuals. The results are shown in appendix E3. The test for stability shows that all roots of the characteristic polynomial lie inside the unit circle suggesting that the model is stable. Therefore, impulse responses can be used to examine the dynamic effects of fiscal policy shock.

The LM test for residual autocorrelation indicates no evidence of autocorrelation at any of the first four lags at five percent significance level. The white test for heteroscedasticity is performed on the residuals. Due to the small sample size, only levels and squares[12] of residuals are considered. The result in Appendix E3.3 shows that the null hypothesis of no heteroscedasticity could not be rejected with the given information.

[12] No cross terms are included.

The Jarque-Bera test for residual normality indicates that the residuals are not normal. As can be seen in Appendix E3.4, the null hypothesis that residuals are multivariate normal is rejected. However, normality is an asymptotic or large sample property and given the small sample size, the residual normality can be improved with larger sample. Nevertheless, the sample size could not be increased in this study as more quarterly data on many of the variables is not available. This suggests that there could be problem of small sample property that reduces the power of tests.

In the following sub-sections, impulse responses estimated from the SVAR model for a period of four years is discussed. In the figures, the solid lines denote the impulse responses while the dotted line represents the 2 standard error band of the estimated impulse responses.[13] Accumulated Impulse responses are also estimated for the baseline model and the result is presented in Appendix G figure G1.3.

5.3.1 Dynamic Effects of Fiscal Policy Shocks – Impulse Response Analysis

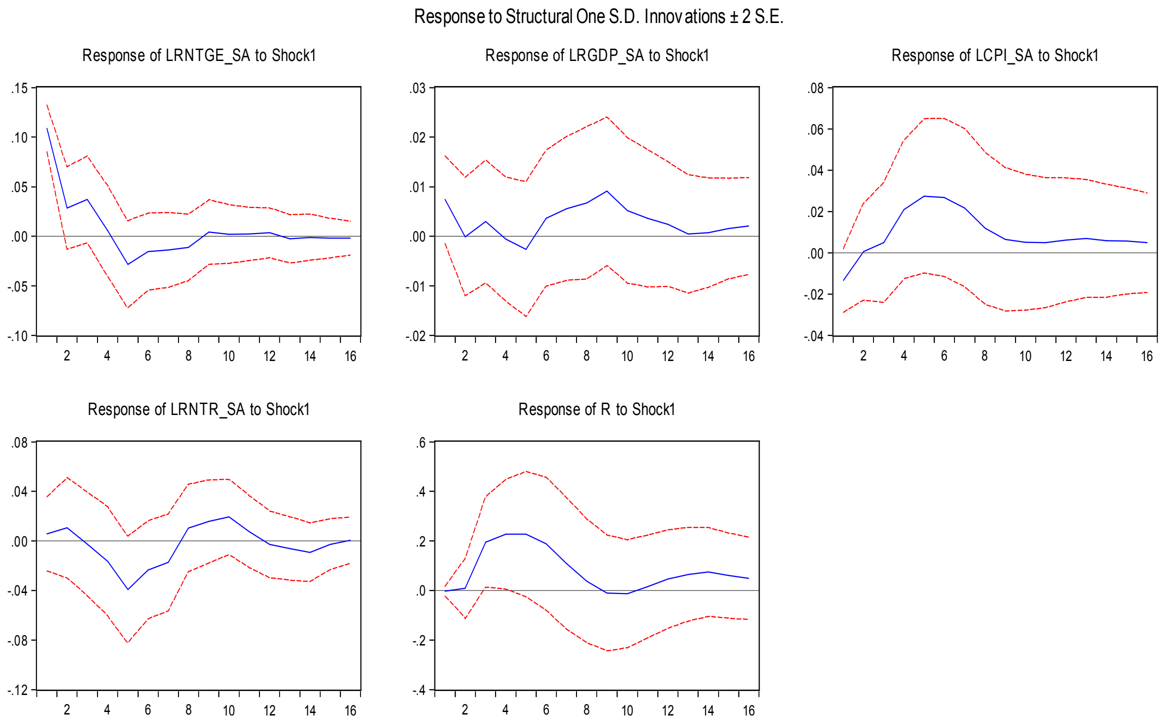
As can be seen in figure 5.1 below, expenditure shocks are stabilized after three quarters of the initial shock showing that future levels of government spending do not depend on independent expenditure shocks. Following the shock in government spending, net tax revenue changes cyclically over the estimated horizon with the highest (negative) response in the fifth quarter. The small positive and insignificant and at times negative response of net tax revenue to government spending shock imply tax revenues do not totally finance government expenditures. This is consistent with evidences that reveal persistent fiscal deficit in the country that is among others monetized. This form of deficit financing in the country is increasingly experienced in

[13] These confidence intervals are sometimes unreliable when the normality assumption is not satisfied. Many, for instance, Mancellari (2011) rely on bootstrapping the impulse response distribution.

recent years mainly due to low level of government revenue and unreliable external sources[14] to finance fiscal deficits (Alemayehu and Kibrom, 2008).

Output responds positively and significantly to a shock in government spending on impact. It then responds cyclically up to the fifth quarter then increase in a hump shaped manner till the thirteenth quarter. It then tends to rise again. Significant response of output to government spending shock in the first quarter indicates that the economy is not saturated and expansionary government spending stimulates the economy.

Figure 5.1: Impulse Response Functions – response to Structural one standard deviation innovations in government spending



[14] External sources are mainly borrowing and aid. Both are subject to political considerations. For instance, there has been considerable fall in external assistance in the country following the 2005 election (Alemayehu and Kibrom, 2008). Even at normal times donor funding follows fixed schedule of allocation and disbursement making such sources hardly accessible (Weeks, 2009).

It also suggests that private spending is not crowd out at least in the first quarter where the interest rate does not change and inflation reduces following expenditure shock. This is the standard outcome of deficit financed spending in a typical Sub-Saharan economy where output is below full potential (Weeks, 2009).

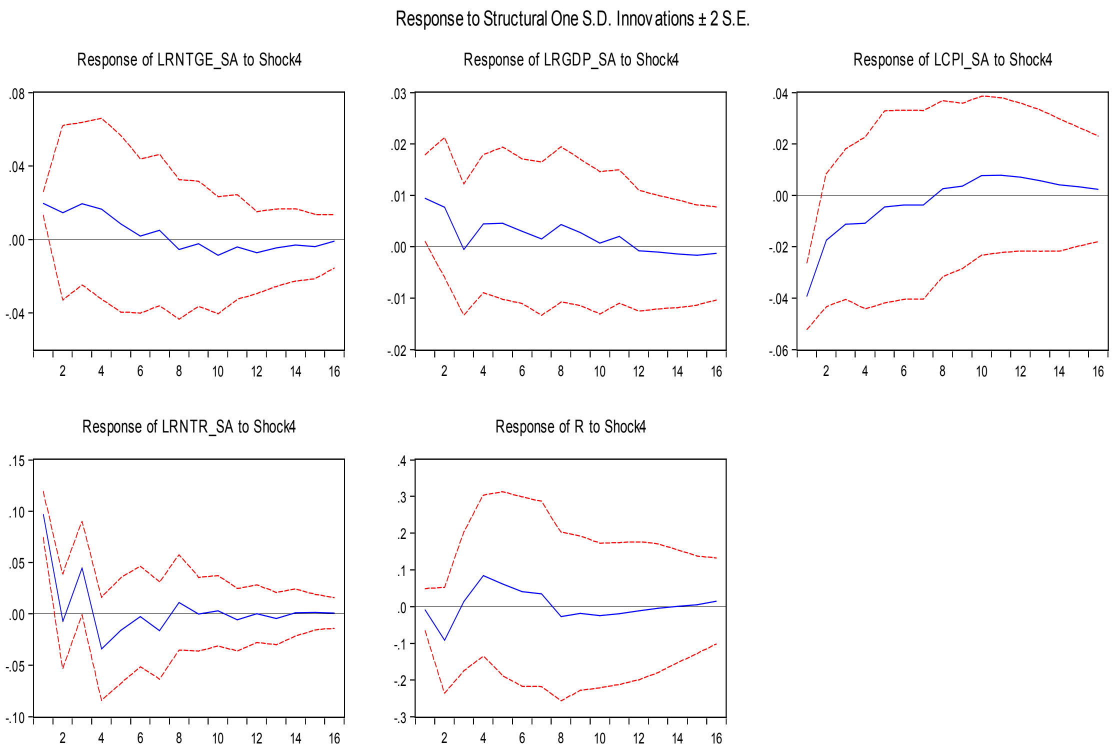
Strong (in magnitude) inflationary response to government spending shock from the third to the fifth quarter (hump shaped manner)and the slightly negative response of output in the fifth quarter might denote, respectively, the effect of monetized deficits and deficit financing from commercial banks. The latter imply crowding out of private spending as evidenced by higher interest rate following shock in net government spending. The response of inflation is at its peak in the fifth quarter and the following quarter output starts rising. This lagged increase in output for government expenditure shock reflects the relatively long term nature of public spending. Following the rise in output, inflation declines and persists at a smaller (but still positive) level. The transitory and minor impact of deficit financed government spending shock on inflation is consistent with theoretical predictions as discussed in the theoretical literature section (Weeks, 2009). The response of interest rate to government spending shock is similar with the standard result but with some lag. Nominal interest rate increases significantly in the third and fourth quarters. It then declines to trend before increasing persistently with smaller magnitude. This result seems striking in the light of the fact that financial agents in Ethiopia do not respond that through altering the interest rate. Nevertheless, this study takes the average deposit rate of commercial banks that change over time[15], albeit not every quarter. Moreover, the contemporaneous relationship between interest rate and the other

[15] See the series in Appendix A

variables in the model except inflation is set to be zero to reflect that interest rate is not freely market determined.

Figure 5.2 shows impulse response functions to structural one standard deviation innovation in net tax revenue. Following its own shock, net tax revenue increases significantly only on impact and in the third quarter. After negative insignificant response and cyclical response in the quarters four to seven and eight to thirteenth respectively, net tax revenue stabilizes to trend.

Figure 5.2: Impulse Response Functions – response to Structural one standard deviation innovations in net tax revenue



The quickly stabilizing impact of net tax revenue shock is less intuitive given that these shocks are normally expected to persist as increases in tax in the country usually undertaken under tax reforms that permanently increase net tax revenue. Government spending responds positively and significantly on impact. Though insignificant, the positive response continues up to the sixth quarter. It then stabilizes at small negative and insignificant level after seven quarters following the eventual insignificant negative response of government spending shock. Output increases significantly on impact as a result of net tax revenue innovation mainly due to the rise in government spending financed through tax revenues. This continues being insignificant as the other variables. Inflation responds negatively and insignificantly following a shock in net tax revenue and turns into to small positive persistent response from quarter nine onwards reflecting that price effect of tax shocks dominates eventually. Interest rate responds cyclically and the response is insignificant in each quarter.

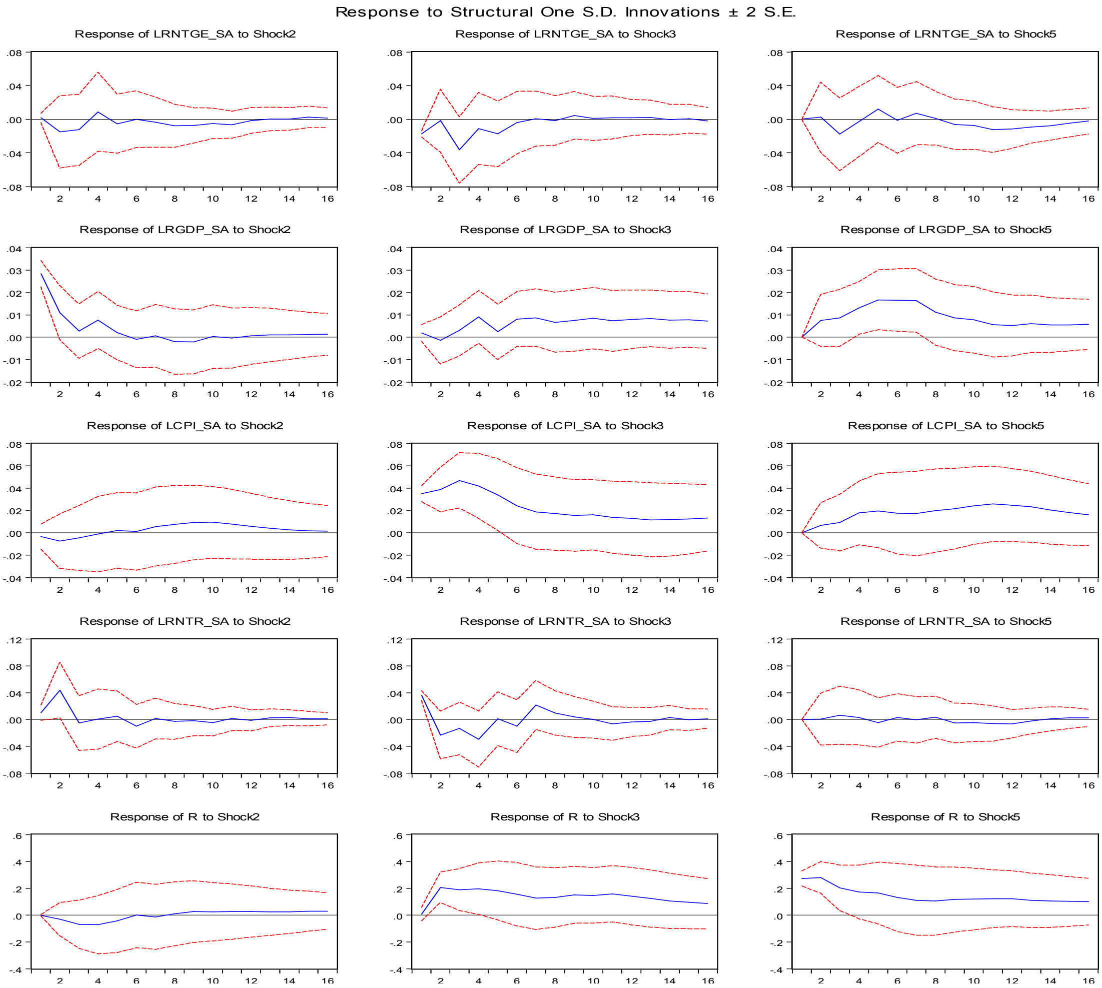
5.3.2 The Impact of Non-fiscal shocks-Impulse Response Analysis

The response of government spending and net tax revenue to output, inflation and interest rate shocks entails important information about the response of fiscal variables to non-fiscal shocks. Though these shocks are not pure as discussed in the methodology, they provide important evidence about the dynamics of automatic stabilizers in the Ethiopian economy. Figure 5.3 depicts these responses based on the SVAR model identified by Blanchard and Perotti approach. Given zero within quarter elasticity of government spending to output, the response of output starts in the second quarter. Moreover, there is no significant response of government spending to output shock reflecting no government spending automatic stabilizer. This is not surprising in the light of the fact that unlike developed countries such schemes as unemployment benefit are non-existent in the economy. More importantly, it shows that government spending is inelastic to economic activity.

Although the elasticity of net tax revenue to output is small as presented in the previous chapter, automatic response of net tax revenue is works better than government spending as shown by the significant increase in the first two quarters.

There are no significant responses in inflation and interest rate to output shock in the projected period.

Figure 5.3: Impulse Response Functions – response to Structural one standard deviation innovations in non-fiscal variables



Shock two refers to shock in output; shock three represents inflation shock and shock five stands for interest rate shock.

Government spending responds negatively to a shock in inflation as predicted in standard text books. However, this response is not significant and persists for five quarters. As can be seen in the second column of figure 5.3, net tax revenue increases significantly on impact and responds insignificantly in cyclical manner over the trend and stabilizes after the ninth quarter. The response of inflation to its own shock is striking evidence that describes the recent inflationary experience in the economy. Inflation shocks are positive and persistent. Moreover, such responses are significant for more than a year pointing the importance of inflation inertia and expectation in explaining price dynamics in the economy. The fact that output is responding positively after two quarters following shock in inflation is intuitively appealing for primary commodity exporting country. Interest rate also responds positively and persistently after one quarter. Shock to interest rate is positive, persistent and at times significant. Fiscal variables do not respond significantly to a shock in interest rate while output has positive, persistent and at times significant response. The weak response of fiscal variables and the theoretically opposite response of output to a shock in interest rate might be a direct reflection of the fact that the interest rate is not freely market determined.

5.3.3 Dynamic effect of Disaggregated Government Spending Shocks-Current Vs Capital Spending-Impulse Response Analysis

A six variable VAR model is constructed to disaggregate the dynamic effect of current and capital spending on macroeconomic variables. The pre and post estimation diagnostic test results as well as the Johansen cointegration test result can be seen in Appendix F. While many of the information criterions chose only one lag, to allow for dynamic interaction, four lag is chosen as suggested by AIC and residual correlogram for VAR(4) model. The model stability test shows that all the roots of the characteristic polynomial lie inside the unit circle and thus the model is stable. Unlike the five variable VAR model, the residuals are found to be multivariate normal. Heteroscedasticity test could not be performed because of positive or non-negative arguments included in the six variable VAR(4) model. At lag three, the residuals are autocorrelated. VAR model specification in level is justified as in the five variables case as there are many cointegrating vectors.

The structural form residuals are identified from the reduced form residuals using the Blanchard and Perotti approach for which the AB model is employed to represent the SVAR model as in the five variable specification. Similar restrictions are imposed as in the baseline model discussed in chapter four. Current spending is ordered before capital spending. This is not of a concern because the alternative ordering is also performed and no significant deviation is observed as discussed in the robustness analysis.

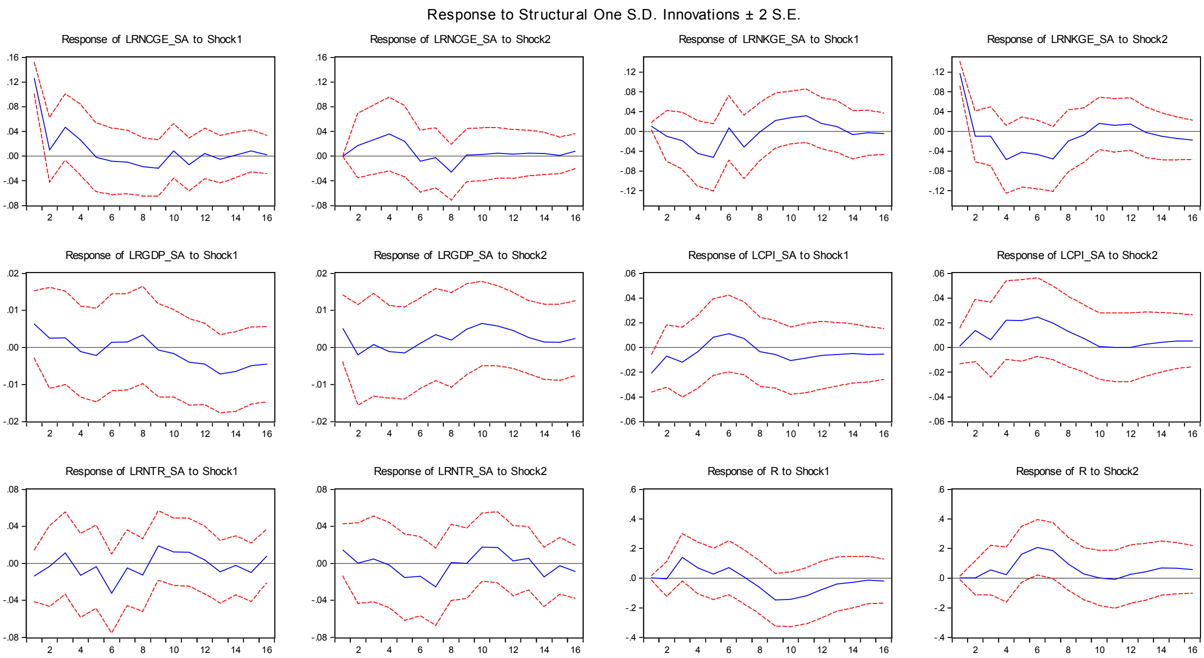
Output reacts cyclically following current spending shock. However, it can be seen that output increases in the first three quarters following the shock in current spending. Over the long term output reduces below the trend that may be due to inefficiency of these spending.[16] The implication is that current spending can be used to stabilize the economy in the very short-time at the expense of lower output in the long term. Similar prediction is found in Weeks (2009) for developing countries[17] and Shaheen and Turner (2009) for Pakistan. Current spending shocks are not financed from future endogenous net tax revenues as can be traced from the response of current spending and the corresponding response from net tax revenue implying that these deficits are financed from non-tax sources or other means of financing. Current spendings are inflationary in quarters from five to seven.

[16] See Teshome, (2006).

[17] Weeks (2009) argues that even though capital spending are more productive as they raise growth potential of an economy, they take time to be implemented in time of need for short-time stimulation.

Capital spending shocks has similar impact on the variables in the model as the effect of net government spending shock in the five variables VAR model. In particular, output increases on impact and after one year pointing to long term nature of capital spending. Such spending are probably monetized since net tax revenue does not respond significantly to capital spending shock and there has been significant monetization in Ethiopia in the projected period. This explains positive response of inflation in a hump shaped manner counter to the response of output until the eleventh quarter in which the lagged response of output is maximum.

Figure 5.4: Impulse Response Functions – response to Structural one standard deviation innovations in current and capital government expenditure



Shock one refers to shock in current spending while shock two stands for capital spending shock.

5.4 The Relative Importance of shocks - Variance Decomposition Analysis

Variance decomposition for the benchmark SVAR model identified by the Blanchard and Perotti approach is estimated for four years. The main focus of this analysis is investigating the relative importance of shocks from the fiscal variables in explaining the forecaste error variance of the endogenous variables in the model. Shocks in the following table such as $e^g, e^y, e^p, e^{tr}, e^r$ denote the shock in net government spending, output, inflation, net tax revenue and interest rate respectively.

Table 5.6 Variance Decomposition of the SVAR model

	Period	Standard Error	e^g	e^y	e^p	e^{tr}	e^r
VD of LRNTGE_SA	1	0.1118	94.453	0.0916	3.6601	1.7944	0.0000
	4	0.1337	78.556	2.4001	12.702	4.4604	1.8806
	8	0.1415	77.046	2.6898	13.221	4.3824	2.6595
	12	0.1440	74.521	3.3342	13.009	4.7197	4.4149
	16	0.1449	73.698	3.3197	12.921	4.8714	5.1883
VD of LRGDP_SA	1	0.0309	5.6939	91.164	0.0645	3.0771	0.0000
	4	0.0403	3.9085	67.219	4.9412	5.3123	18.618
	8	0.0540	5.4832	37.763	7.9976	6.0398	42.715
	12	0.0592	8.2299	31.541	12.879	6.1671	41.182
	16	0.0624	7.5879	28.545	17.970	5.5561	40.339
VD of LCPI_SA	1	0.0543	6.0695	1.5513	61.988	30.390	0.0000
	4	0.0996	6.4493	1.1756	78.276	9.6405	4.4580
	8	0.1262	17.070	1.5286	63.679	6.2213	11.499
	12	0.1404	14.457	3.1681	54.751	6.4754	21.148
	16	0.1487	13.517	3.0824	51.067	6.4435	25.889
VD of LRNTR_SA	1	0.1037	0.3025	5.8668	1.7748	92.055	0.0000
	4	0.1338	2.3448	13.105	9.0176	75.247	0.2843
	8	0.1479	13.310	11.283	10.799	64.186	0.4197
	12	0.1511	15.746	10.917	10.575	61.818	0.9420
	16	0.1518	16.174	10.890	10.524	61.401	1.0090
VD of R	1	0.2742	0.0118	0.0030	0.1206	0.0591	99.805
	4	0.6770	19.558	1.3971	24.819	5.1464	49.078
	8	0.8524	26.097	1.0249	26.606	5.9942	40.277
	12	0.9387	21.812	1.3036	32.125	4.9950	39.763
	16	0.9934	21.068	1.6095	32.722	4.6581	39.941

The variance decomposition for net government expenditures shows that in the first quarter 94.5% of the forecast error variance in government expenditure is explained by the shock in itself and even after four years (sixteen quarters) it remains quite large amounting to 73.7%. This confirms that expenditure shocks are highly independent from other shocks in the economy. Perhaps shocks arising from inflation explain to some extent. As shown in table 5.6 above, inflation explains 3.7% and 12.9% of the error variance in net government expenditure in the first quarter and after almost four years, respectively.

Output shocks explain more than 91% of their forecast errors after one quarter. This proportion decreases rapidly and after four years becomes only 28.5%. Net government spending and net tax revenue shocks explain, respectively, 5.7% and 3.1% of the forecast error variance in output after one quarter. These proportions not only persist but also increase slightly to 7.6% and 5.6%, respectively, reflecting the importance of fiscal variables in explaining the forecast error variance of output.

Net government spending explains 6.1% of the forecast error variance in inflation after one quarter. The proportion increases to 17.1% after two years and then declines to 13.5% after four years. This is consistent with the result in the impulse response that net government expenditure has inflationary impact in a hump shaped manner. Net tax revenue shocks explain 30.4% of the forecast error variance of inflation after the first quarter which is less intuitive. However, it rapidly declines to 9.6% after one year and 6.4% after four years. This points that net tax revenue shocks are also important in explaining the forecast error variance of inflation.

More than 92% of the forecast error variance of net tax revenue is explained by itself after one quarter. This proportion declines to 75.2% after one year and 61.4% after four years. On the other hand, output explains around 5.9% of the forecast error variance of net tax revenue after one year and increases to 10.9% after four years which confirms the dependence of revenue on economic activity. Net government spending and inflation are also important in explaining the forecast error variance.

More than 99% of the forecast error variance in interest rate is explained by shock from itself after one quarter. This proportion rapidly declines to 49.1% after one year and close to 40% after four years. Inflation, net government spending and net tax revenue are important in their order in explaining the forecast error variance in interest rate.

5.5 Robustness Checks

Several robustness checks are performed to make sure that the model yields stable outcome. These checks include using different value of the exogenous parameters and use of different approach to identify the structural innovations. The first enables to analyse the sensitivity of the results when there is small change in value of the parameters used for identifying the contemporaneous relationships.

In order to check the sensitivity of parameters change, the value of price elasticity of government expenditure that is set 0.5 in the benchmark model as suggested in Perotti (2002) is changed to both lower (0.3) and higher (0.7) values. The output and price elasticity of net tax revenue is also examined for neighbouring values to acertain the robustness of the result even in case of inaccurate estimates. Very similar impulse responses (not reported here) are estimated in both cases.

The impulse responses from the baseline model are identified using Cholesky decomposition to make sure that the estimated impulse response disused above is robust to alternative identification. The results are shown in Appendix G. As can be seen from figure G1.1, the responses of the variables in the model to a shock in government spending is very similar with the one identified by the Blanchard and Perotti approach. However, the impulse response functions to a shock in net tax revenue are not as similar as in the case for government spending shocks. For instance, the response of output is still positive but with different dynamics from the one identified by Blanchard and Pertotti approach. Government spending does not respond significantly to a shock in net tax revenue. Inflation has persistent, positive and significant response unlike in the Blanchard and Perotti approach where it responds negatively before it turns to small, positive and persistent response in the ninth quarter. Nevertheless, the Cholesky decomposition is based on recursive ordering as discussed in the previous chapter and does not allow interpretation of pure shock in net tax revenue. A different ordering of the variables in which net tax revenue is ordered next to government spending yields a closer impulse response functions to the impulse response estimated from Blanchard and Perotti approach.[18]

[18] Compare Figures 5.2 and G1.2.

CHAPTER SIX

CONCLUSIONS AND POLICY IMPLICATIONS

6.1 Conclusions

This study empirically characterizes the dynamic effects of fiscal policy shock on major macroeconomic variables in Ethiopia. It uses seasonally adjusted quarterly data over the period 1998/99:1-2010/11:4. The impact of net government spending and net tax revenue shocks as well as disaggregated government spending shocks have been analysed through impulse response functions and variance decomposition from the SVAR model. Structural innovations are identified by the Blanchard and Perotti approach. The Recursive identification scheme based on Cholesky decomposition is also employed to substantiate the result.

In addition to the implied coefficients of the benchmark identification approach, exogenous elasticites are computed to achieve full identification. These elasiticies measure the automatic response of fiscal variables to a change in economic activity. The output elasticity of net tax revenue is 0.55 and it shows that the tax base over the estimated period is narrow for Ethiopia.

The descriptive analysis and the response of net tax revenue to government spending shock reveal that fiscal deficit is persistent over the estimated period. The result from the estimated impulse response function to government spending innovation indicates that output responds positively on impact and after one year. The effect on output in the transition is cyclical pointing the possibility of crowding out of private spending. It is also shown that these expenditures are inflationary in Ethiopia at least temporarily i.e., in quarters where the response of output is lower confirming the hypothesis that monetized deficit are the source of inflationary pressure. Inflationary pressures are better explained in the model by the shock in inflation itself, however.

This points the importance of inflation inertia and inflation expectation in explain the recent price dynamics. Interest rate increases after one period lag.

Shock in net tax revenue has a positive impact on output. This follows from the positive response of net government spending to the shock in net tax revenue. However, such a response is not long lasting as the shock to net tax revenue quickly stabilizes to trend. These shocks significantly reduces price on impact following the increase in output suggesting that tax financed expenditures suit the economy well as they are expansionary and reduces inflation. Net tax revenue shock has a minor positive impact on inflation in the long term. Interest rate does not respond significantly in any quarter to shock in net tax revenue.

Current spending innovations increase output in the first three quarters and it eventually turns into a negative response confirming the hypothesis that such spending are inefficient. This innovation has a cyclical impact on inflation. Innovation in Capital spending has similar impact as in the effect of net government spending innovations. Output responds positively in the first quarter and after one year indicating the long term nature of capital expenditure that raise the growth potential of the economy. These spendings also increase price in the periods where the response of output is weak supporting the hypothesis that deficits are monetized and are the source of the recent inflationary pressure in Ethiopia. Therefore, it can be concluded that fiscal policy in Ethiopia is growth enhancing through capital expenditures and has inflationary impact at least temporarily.

The variance decomposition analysis confirms that government expenditure shocks are highly independent from other shocks in the economy except inflation. Revenue shocks, on the other hand, are dependent on economic activity. Fiscal shocks, in general, are important in explaining the variation in major macroeconomic variables in Ethiopia.

6.2 Policy Implications

This study has the following useful implication for policy and future researches in the area of dynamic effects of fiscal policy shock on macroeconomic variables in Ethiopian economy.

Financing government spending needs a careful consideration so as to make such spending productive without or with low repercussions in the economy. Since deficit financed spendings usually either crowd out or cause inflation at least in the short run, they have to be cautiously implemented i.e fiscal deficit should be targeted appropriately. Tax shocks, on the other hand, are found to be expansionary and have negative or little positive impact on inflation. This, however, requires expanding the existing narrow tax base which in turn necessitates increasing the capacity to collect and administer tax.

Nevertheless, tax financed expenditures cannot be used conveniently as a tool to manage the demand when there are short run fluctuations in the economy. This is because as noted by Weeks (2010) taxes are clumsy instrument as approving and instituting new tax is likely time taking. In normal times capital spending is more expansionary than current spending as the former increases the growth potential of the economy. However, similar argument follows as in the case of tax instruments. Capital projects take time to initiate. Current spending can, therefore, be used to stimulating the economy at the expense of lower output in the long-run.

The applied methodology and conclusion of this study can be used as a benchmark for comparison with future researches about the effects of fiscal policy using other methods such as Bayesian Structural VAR models. The study can be extended by considering components of GDP such as exports, consumption and investment. For instance, in implementing government expenditure, Dutch disease effect arises from the fact that such expenditures are usually on domestic goods and services which in turn increase the price of non-tradables relative to tradables thereby appreciating the currency and lowering exports. Moreover, as consumption and investment are the two main channels through which fiscal policy effects transmits to the private sector, including these variables in the model articulates the issue. However, these remain a challenge until long enough quarterly observations on these variables are made available.

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Appendix A: Methodology for Estimating Quarterly RGDP for Ethiopia [19]

Quarterly disaggregation methods distinguish between methods that do not involve the use of related indicators and methods that make use of related series. The first method uses purely mathematical technique to obtain quarterly estimates based on annual data, while the latter estimate the quarterly figure on the basis of external quarterly information on logically and/or economically related variables. The first approach is used when there are series problems in availability of basic sub-annual information where the only data available are annual. The choice between these approaches mainly depends on the information available at quarterly level. In Ethiopia there are adequate, if not complete, sub-annual economic data that can enable quarterly GDP compilation. The table below presents economic indicators with their corresponding activity that are used in quarterly GDP estimation.

Table A1.1 : Activities and quarterly indicators

Activity	Quarterly Indicator
Agriculture	• Meher, Belg Production (CSA) • Cropping calendar by zone
Manufacturing	Quarterly volume of industrial electricity sales (EEPCO)
Electricity	Quarterly volume of electricity generation (EEPCO)
Quarrying	Quarterly volume of construction activity

[19] It is taken from EDRI (2010)

Construction	A composite index of: • Deflated quarterly general government capital expenditure **(MOFED);** • Deflated quarterly loan disbursement to 'Housing & Construction' by banks **(NBE).**
Trade & Hotel	A composite index of: • Deflated quarterly import & export value **(ECA)**; • Deflated quarterly loan disbursement to local trade **(NBE)**; • Quarterly number of tourist arrivals to the country **(EMSA).**
Transport	Quarterly volume of local sales of petroleum (Benzene and Diesel) **(EPE)**
Communications	Quarterly volume of telecommunications output (metered calls, internet traffic...) **(ETC)**
Financial Intermediation	Quarterly deflated outstanding value of loans and deposits by banks **(NBE)**
Education	Deflated quarterly general government current expenditure on education **(MOFED)**
Health	Deflated quarterly general government current expenditure on health **(MOFED)**
Public Administration & Defense	Deflated quarterly general government total current expenditure (except education & health)**(MOFED)**

Source: EDRI (2010)

There are few economic activities, which do not have sub-annual indicators. For such sectors, a purely mathematical technique is used for disaggregating annual estimates into quarterly value added. Such activities are usually either less significant in their contribution to the GDP like fishing, mining or domestic services or seasonally inert in their nature like forestry or real-estate. Applying a pure mathematical technique on these activities would not endanger the accuracy of the overall quarterly GDP estimate.

The Proportional Denton method is used as a mathematical technique for disaggregating annual estimates based on quarterly indicators. The Denton method is preferred over the other alternatives for the following reasons:

- It is optimal if the general benchmarking objective of maximal preservation of the movements of the quarterly indicator is specified as keeping the quarterly estimates as proportional to the indicator as possible and the benchmarks are binding.
- It is relatively simple, robust, and well suited for large-scale applications.
- The implied benchmark-indicator (BI) ratio framework provides a general and integrated framework for converting indicators into quarterly national account estimates through interpolation, distribution and extrapolation that is not sensitive to the overall level of the indicators.

The basic version of the proportional Denton benchmarking technique keeps the benchmarked series as proportional to the indicator as possible by minimizing (in a least-squares sense) the difference in relative adjustment to neighbouring quarters subject to the constraints provided by the annual benchmarks.

Numerically, it can be expressed as:

$$\underset{(X_2,\ldots,X_4,\ldots,X_T)}{\text{Minimize}} \quad \sum_{t=2}^{T} \left[\frac{X_t}{I_t} - \frac{X_{t-1}}{I_{t-1}} \right]^2$$

$$\text{under constraint} \quad \sum_{t=2}^{T} X_t = A_y$$

where:

t is time (e.g., t = 4y-3 is the first quarter of year y, and t=4y is the fourth quarter of year y);

X_t is the derived quarterly estimate for quarter *t;*

I_t is the level of the indicator for quarter *t*;

A_y is the annual data for year *y*;

T is the last quarter for which quarterly source data are available.

The proportional Denton technique implicitly constructs from the annual observed BI ratios a time series of quarterly benchmarked QNA estimates-to-indicator (quarterly BI) ratios that is as smooth as possible.

Appendix B: Steps in conducting combined test for seasonality and test results for each series

B1. Combined Test for Seasonality using E-views

The following are the steps involved in combined test for seasonality. It is also shown in Figure A2.1.

1. If the null hypothesis in the stable seasonality test is not rejected at the 0.10% significance level (0.001), then since the series is not seasonal, PROC X-11 in E-views displays "Identifiable Seasonality Not Present."
2. If the null hypothesis in step 1 is rejected, then compute the following quantities:

$$T_1 = \frac{7}{F_m}$$

$$T_2 = \frac{3T}{F_s}$$

where F_m and F_s denote the *F* value for the stable and moving seasonality tests, respectively.

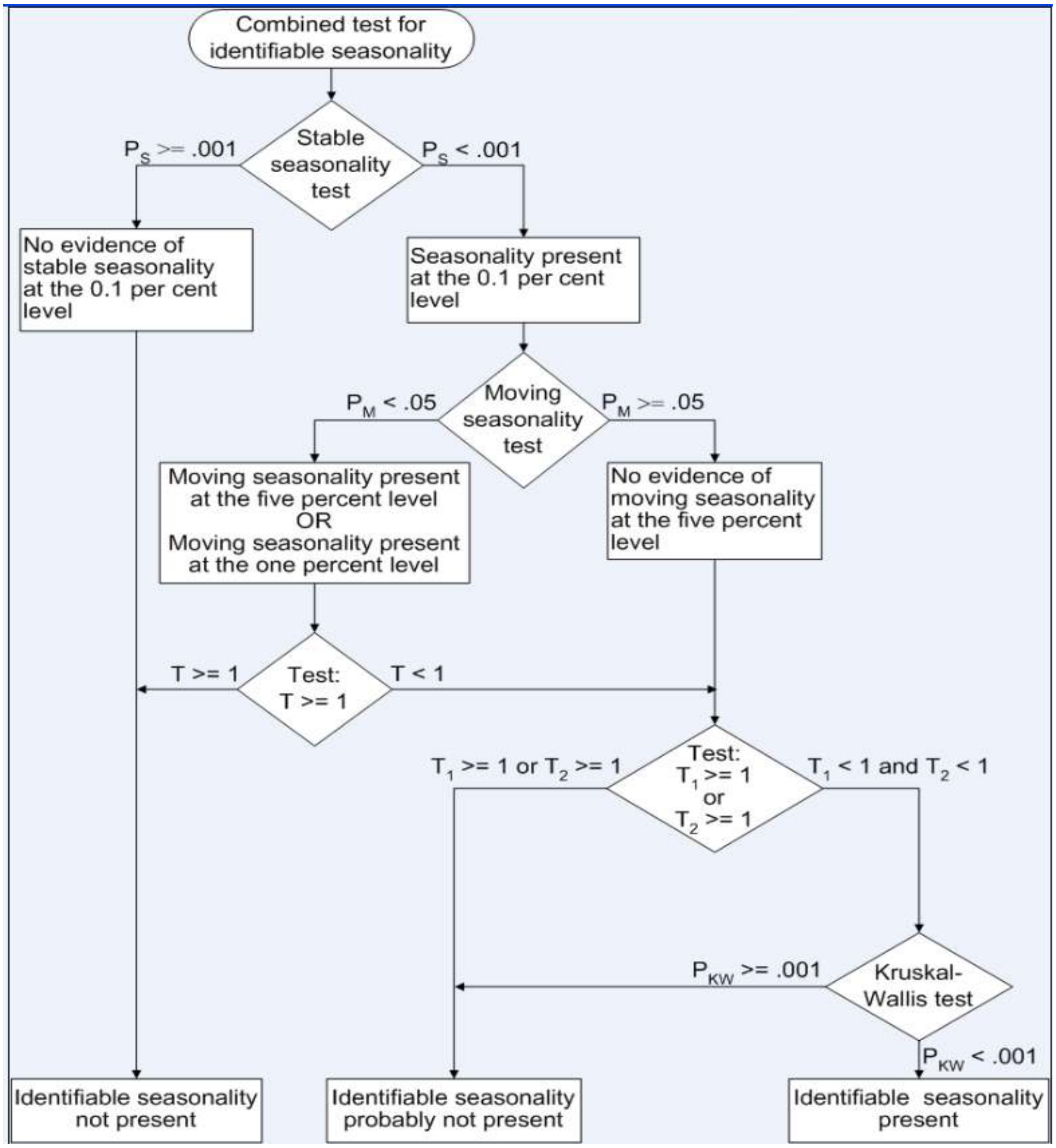
3. Let T denote the simple average of T_1 and T_2:

$$T = \frac{(T_1 + T_2)}{2}$$

4. If the moving seasonality null hypothesis is not rejected at the 5.0% significance level (0.05) and if $T \geq 1.0$, the null hypothesis of identifiable seasonality *not* present is accepted and PROC X-11 displays "Identifiable Seasonality Not Present."

5. If the null hypothesis of identifiable seasonality *not* present has not been accepted, but $T_1 \geq 1.0$, $T_2 \geq 1.0$, or the Kruskal-Wallis chi-squared test fails at the 0.10% significance level (0.001), then PROC X-11 displays "Identifiable Seasonality Probably Not Present."

Figure B1.1 combined Seasonality test flowchart



Source: E-views X-12 ARIMA manual version 6.

6. If the F_S and Kruskal-Wallis chi-squared tests pass, and if none of the combined measures described in steps 2 and 3 fail, then the null hypothesis of identifiable seasonality *not* present is rejected, and PROC X-11 displays "Identifiable Seasonality Present."

B2. Summary results for Combined Test for the Presence of Identifiable Seasonality

The "Summary of Results for Combined Test for the Presence of Identifiable Seasonality" tables display the T_1, T_2, and T values for each series and the significance levels for the stable seasonality test, the moving seasonality test, and the Kruskal-Wallis test. The last item in the each table is the result of the combined test for identifiable seasonality presented in table 5.3 in chapter five. The following tables are computed from the result provided by E-views-7 software.

Table B2.1: Combined seasonality test for LRNTGE

Observation =DD		H_0: No signs of seasonality
Seasonality test	Probability Level	Remarks
Stable Seasonality F-test	.001	Stable seasonality present
Moving Seasonality F-test	0.1	Moving seasonality present
Kruskal-Wallis Chi-square Test	0.000	Identifiable seasonality present
Combined Measures:	Value	
T1 = 7/F_Stable	0.131	
T2 = 3*F_Moving/F_Stable	0.130	
T = (T1 + T2)/2	0.1305	Identifiable seasonality present
Combined Test of Identifiable Seasonality		Identifiable Seasonality Present

Table B2.2 Combined seasonality test for LRGDP

Observation =DD		H_0: No signs of seasonality
Seasonality test	Probability Level	Remarks
Stable Seasonality F-test	.001	Stable seasonality present
Moving Seasonality F-test	0.1	Moving seasonality present
Kruskal-Wallis Chi-square Test	0.000	Identifiable seasonality present
Combined Measures:	Value	
T1 = 7/F_Stable	0.003	
T2 = 3*F_Moving/F_Stable	0.03	
T = (T1 + T2)/2	0.0165	Identifiable seasonality present
Combined Test of Identifiable Seasonality		Identifiable Seasonality Present

Table B2.3 Combined seasonality test for LCPI

Observation =DD		H_0: No signs of seasonality
Seasonality test	Probability Level	Remarks
Stable Seasonality F-test	.001	Stable seasonality present
Moving Seasonality F-test	0.1	Moving seasonality present
Kruskal-Wallis Chi-square Test	0.000	Identifiable seasonality present
Combined Measures:	Value	
T1 = 7/F_Stable	0.58	
T2 = 3*F_Moving/F_Stable	0.58	
T = (T1 + T2)/2	0.58	Identifiable seasonality present
Combined Test of Identifiable Seasonality		Identifiable Seasonality Present

Table B2.4 Combined seasonality test for LRNTR

Observation =DD		H_0: No signs of seasonality
Seasonality test	Probability Level	Remarks
Stable Seasonality F-test	.001	Stable seasonality present
Moving Seasonality F-test	0.1	Moving seasonality not present
Kruskal-Wallis Chi-square Test	0.001	Identifiable seasonality present
Combined Measures:	Value	
T1 = 7/F_Stable	0.39	
T2 = 3*F_Moving/F_Stable	0.29	
T = (T1 + T2)/2	0.34	Identifiable seasonality present
Combined Test of Identifiable Seasonality		Identifiable Seasonality Present

Table B2.5 Combined seasonality test for r

Observation =DD		H_0: No signs of seasonality
Seasonality test	Probability Level	Remarks
Stable Seasonality F-test	.001	Stable seasonality not present
Moving Seasonality F-test	0.1	Moving seasonality present
Kruskal-Wallis Chi-square Test	0.000	Identifiable seasonality present
Combined Measures:	Value	
T1 = 7/F_Stable	1.59	
T2 = 3*F_Moving/F_Stable	3.53	
T = (T1 + T2)/2	2.56	Identifiable seasonality NOT present
Combined Test of Identifiable Seasonality		Identifiable Seasonality NOT Present

Table B2.6 Combined seasonality test for LRNCGE

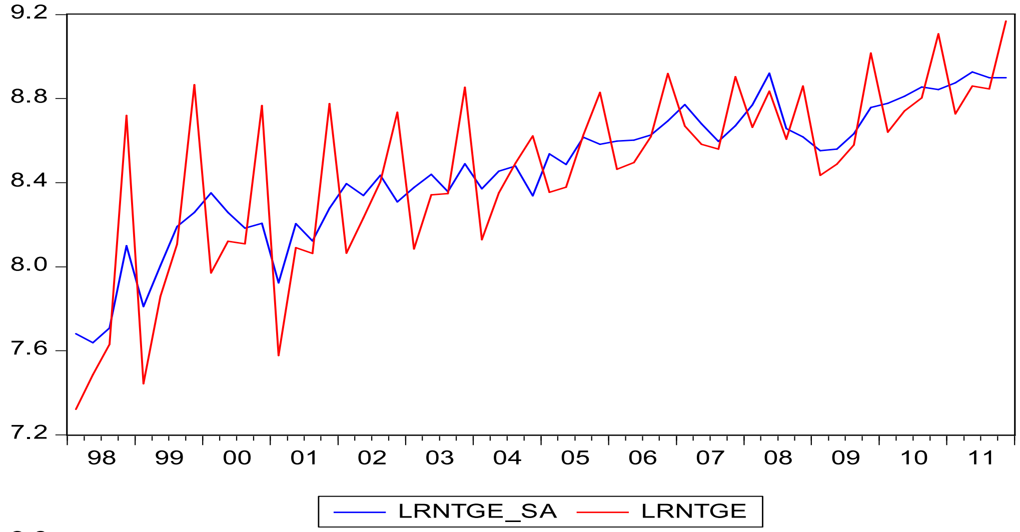
Observation =DD		H_0: No signs of seasonality
Seasonality test	Probability Level	Remarks
Stable Seasonality F-test	.001	Stable seasonality present
Moving Seasonality F-test	0.1	Moving seasonality not present
Kruskal-Wallis Chi-square Test	0.000	Identifiable seasonality present
Combined Measures:	Value	
T1 = 7/F_Stable	0.19	
T2 = 3*F_Moving/F_Stable	0.09	
T = (T1 + T2)/2	0.14	Identifiable seasonality present
Combined Test of Identifiable Seasonality		Identifiable Seasonality Present

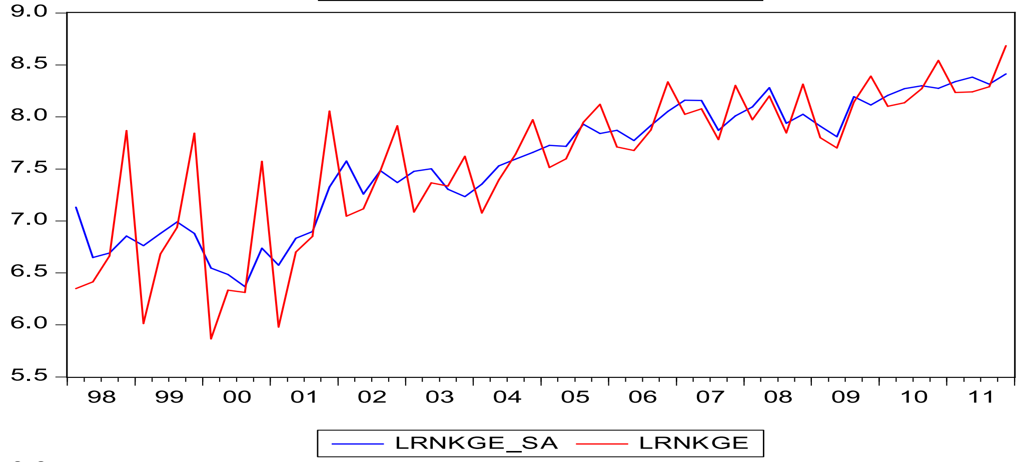
Table B2.7 Combined seasonality test for LRKGE

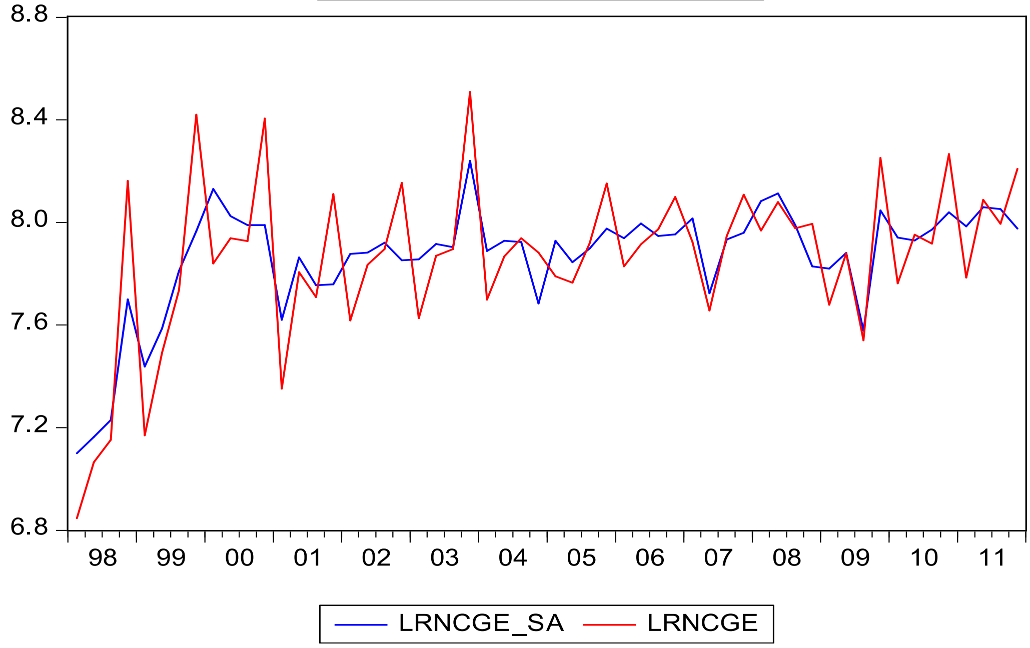
Observation =DD		H_0: No signs of seasonality
Seasonality test	Probability Level	Remarks
Stable Seasonality F-test	.001	Stable seasonality present
Moving Seasonality F-test	0.1	Moving seasonality present
Kruskal-Wallis Chi-square Test	0.000	Identifiable seasonality present
Combined Measures:	Value	
T1 = 7/F_Stable	0.29	
T2 = 3*F_Moving/F_Stable	0.28	
T = (T1 + T2)/2	0.29	Identifiable seasonality present
Combined Test of Identifiable Seasonality		Identifiable Seasonality Present

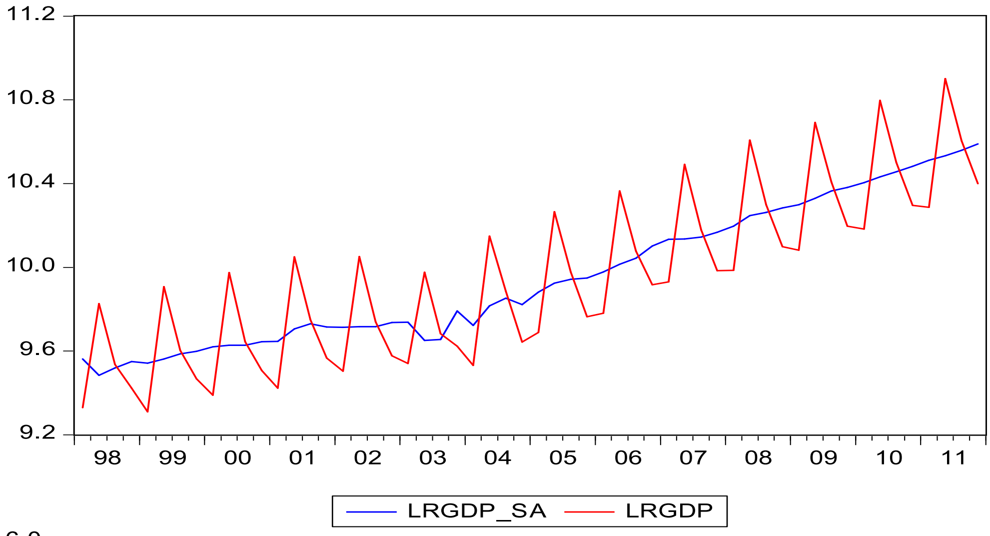
Appendix C: Time Series Plots of seasonally unadjusted and adjusted series

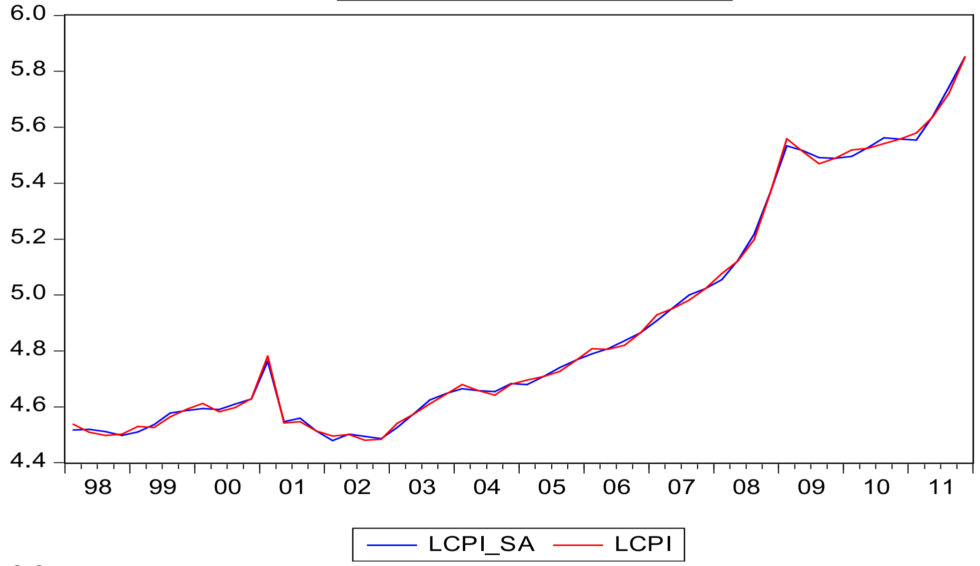
Figure C1.1 Time series plots of seasonally unadjusted and adjusted data

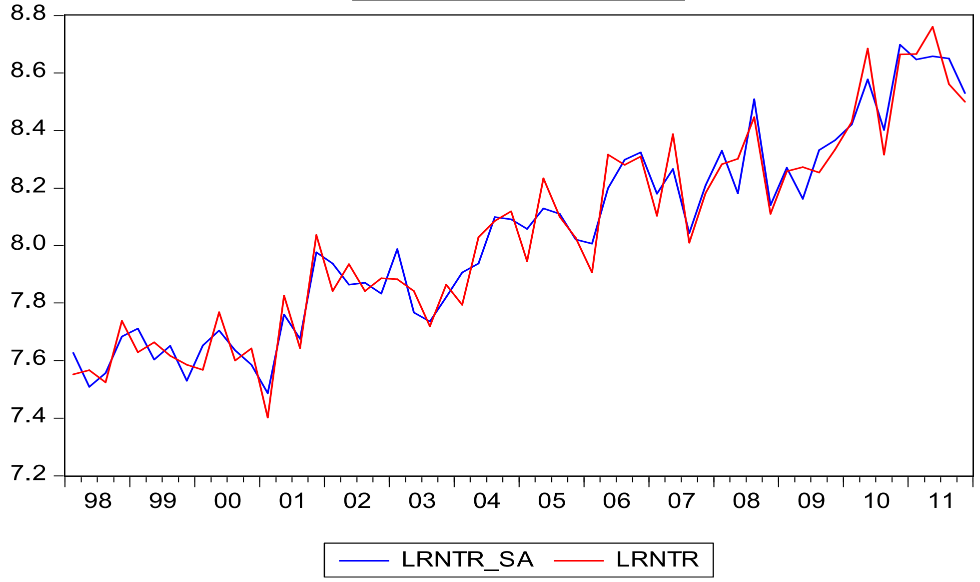


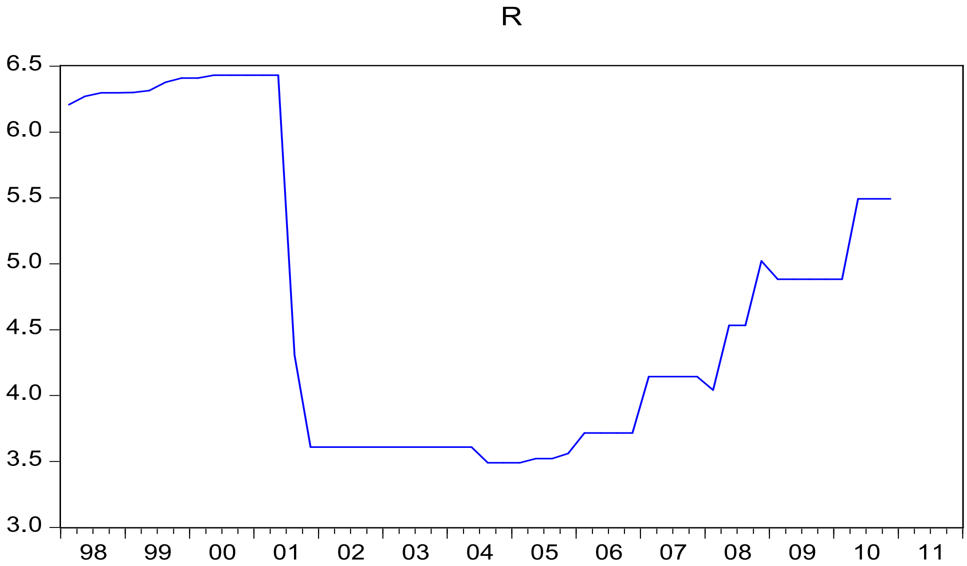





11.2
10.8
10.4
10.0
9.6
9.2
98 99 00 01 02 03 04 05 06 07 08 09 10 11
LRGDP_SA
LRGDP


6.0
5.8
5.6
5.4
5.2
5.0
4.8
4.6
4.4
98 99 00 01 02 03 04 05 06 07 08 09 10 11
LCPI_SA
LCPI


8.8
8.6
8.4
8.2
8.0
7.8
7.6
7.4
7.2
98 99 00 01 02 03 04 05 06 07 08 09 10 11
LRNTR_SA
LRNTR


R
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
98
99
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11

Appendix D: Estimation result for output and price elasticity of net tax revenue

D1. Estimation result for output elasticity of net tax revenue

Dependent Variable: LRDT_SA
Method: Least Squares
Date: 03/15/11 Time: 11:04
Sample (adjusted): 1998Q1 2010Q4
Included observations: 52 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LRGDP_SA	0.952620	0.079703	11.95219	0.0000
C	-2.681264	0.790007	-3.393975	0.0014

R-squared	0.740738	Mean dependent var	6.756829
Adjusted R-squared	0.735552	S.D. dependent var	0.331272
S.E. of regression	0.170355	Akaike info criterion	-0.664163
Sum squared resid	1.451040	Schwarz criterion	-0.589115
Log likelihood	19.26825	Hannan-Quinn criter.	-0.635392
F-statistic	142.8549	Durbin-Watson stat	1.053481
Prob(F-statistic)	0.000000		

Dependent Variable: LRIT
Method: Least Squares
Date: 03/15/11 Time: 10:48
Sample (adjusted): 1998Q2 2010Q4
Included observations: 51 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LPRC_SA	0.598539	0.154703	3.868955	0.0003
LRIT(-1)	0.400612	0.145149	2.760001	0.0082
C	-2.073195	0.761390	-2.722909	0.0090

R-squared	0.858467	Mean dependent var	6.368290
Adjusted R-squared	0.852570	S.D. dependent var	0.421317
S.E. of regression	0.161772	Akaike info criterion	-0.748240
Sum squared resid	1.256163	Schwarz criterion	-0.634603
Log likelihood	22.08011	Hannan-Quinn criter.	-0.704816
F-statistic	145.5719	Durbin-Watson stat	1.938848
Prob(F-statistic)	0.000000		

Dependent Variable: LPRC_SA
Method: Least Squares
Date: 03/15/11 Time: 10:54
Sample (adjusted): 1998Q3 2010Q4
Included observations: 50 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LRGDP_SA	0.112521	0.097224	1.157341	0.2531
LPRC_SA(-1)	0.880624	0.155796	5.652396	0.0000
LPRC_SA(-2)	0.022832	0.145291	0.157150	0.8758
C	-0.138839	0.281780	-0.492720	0.6246

R-squared	0.989610	Mean dependent var	9.875915
Adjusted R-squared	0.988933	S.D. dependent var	0.379084
S.E. of regression	0.039880	Akaike info criterion	-3.529279
Sum squared resid	0.073158	Schwarz criterion	-3.376317
Log likelihood	92.23196	Hannan-Quinn criter.	-3.471030
F-statistic	1460.515	Durbin-Watson stat	2.025493
Prob(F-statistic)	0.000000		

Dependent Variable: LRCT
Method: Least Squares
Date: 03/15/11 Time: 10:57
Sample (adjusted): 1998Q2 2010Q4
Included observations: 51 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LRIM_SA	0.222769	0.073851	3.016480	0.0041
LRCT(-1)	0.568290	0.114697	4.954690	0.0000
C	0.719790	0.419871	1.714313	0.0929

R-squared	0.776739	Mean dependent var	6.128958
Adjusted R-squared	0.767436	S.D. dependent var	0.313404
S.E. of regression	0.151139	Akaike info criterion	-0.884214
Sum squared resid	1.096461	Schwarz criterion	-0.770577
Log likelihood	25.54744	Hannan-Quinn criter.	-0.840790
F-statistic	83.49744	Durbin-Watson stat	1.675038
Prob(F-statistic)	0.000000		

Dependent Variable: LRIM_SA
Method: Least Squares
Date: 03/15/11 Time: 10:45
Sample (adjusted): 1998Q2 2010Q4
Included observations: 51 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LRGDP_SA	0.262398	0.189038	1.388067	0.1715
LRIM_SA(-1)	0.792247	0.114083	6.944499	0.0000
C	-0.781692	1.063052	-0.735328	0.4657

R-squared	0.888650	Mean dependent var	8.674358
Adjusted R-squared	0.884011	S.D. dependent var	0.491881
S.E. of regression	0.167521	Akaike info criterion	-0.678398
Sum squared resid	1.347031	Schwarz criterion	-0.564761
Log likelihood	20.29916	Hannan-Quinn criter.	-0.634974
F-statistic	191.5375	Durbin-Watson stat	2.365646
Prob(F-statistic)	0.000000		

D2. Estimation result for price elasticity of net tax revenue

Dependent Variable: LRDT_SA
Method: Least Squares
Sample (adjusted): 1998Q2 2010Q4
Included observations: 51 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LCPI_SA	0.408527	0.105798	3.861384	0.0003
LRDT_SA(-1)	0.499103	0.117481	4.248382	0.0001
C	1.421129	0.494044	2.876524	0.0060

R-squared	0.771354	Mean dependent var	6.762408
Adjusted R-squared	0.761827	S.D. dependent var	0.332091
S.E. of regression	0.162070	Akaike info criterion	-0.744549
Sum squared resid	1.260807	Schwarz criterion	-0.630913
Log likelihood	21.98601	Hannan-Quinn criter.	-0.701126
F-statistic	80.96578	Durbin-Watson stat	2.135157
Prob(F-statistic)	0.000000		

Dependent Variable: LRCT
Method: Least Squares
Sample (adjusted): 1998Q2 2010Q4
Included observations: 51 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LCPI_SA	0.074985	0.073466	1.020668	0.3125
LRCT(-1)	0.807008	0.083181	9.701782	0.0000
C	0.829200	0.459281	1.805431	0.0773

R-squared	0.740058	Mean dependent var	6.128958
Adjusted R-squared	0.729227	S.D. dependent var	0.313404
S.E. of regression	0.163083	Akaike info criterion	-0.732096
Sum squared resid	1.276606	Schwarz criterion	-0.618460
Log likelihood	21.66846	Hannan-Quinn criter.	-0.688673
F-statistic	68.32823	Durbin-Watson stat	2.003551
Prob(F-statistic)	0.000000		

Dependent Variable: LRIT
Method: Least Squares
Sample (adjusted): 1998Q2 2010Q4
Included observations: 51 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LCPI_SA	0.466319	0.133782	3.485656	0.0011
LRIT(-1)	0.566659	0.116055	4.882684	0.0000
C	0.523220	0.359614	1.454947	0.1522

R-squared	0.851834	Mean dependent var	6.368290
Adjusted R-squared	0.845660	S.D. dependent var	0.421317
S.E. of regression	0.165519	Akaike info criterion	-0.702438
Sum squared resid	1.315035	Schwarz criterion	-0.588801
Log likelihood	20.91217	Hannan-Quinn criter.	-0.659014
F-statistic	137.9804	Durbin-Watson stat	2.225081
Prob(F-statistic)	0.000000		

Appendix E: VAR Pre-estimation and Post-estimation Diagnostic and Cointegration Test Results for the baseline model

E1. VAR Lag order selection criterion

VAR Lag Order Selection Criteria
Endogenous variables: LRNTGE_SA LRGDP_SA LCPI_SA LRNTR_SA R
Exogenous variables: C @TREND
Sample: 1998Q1 2011Q4
Included observations: 46

Lag	LogL	LR	FPE	AIC	SC	HQ
0	167.2305	NA	7.39e-10	-6.836108	-6.438577	-6.687191
1	272.5087	**178.5152***	**2.28e-11***	-10.32647	**-8.935107***	**-9.805254***
2	293.5550	31.11199	2.85e-11	-10.15457	-7.769383	-9.261063
3	311.7803	22.97973	4.32e-11	-9.860015	-6.481004	-8.594217
4	337.7929	27.14351	5.26e-11	-9.904038	-5.531200	-8.265947
5	363.3201	21.08771	7.95e-11	-9.926961	-4.560296	-7.916576
6	416.5783	32.41800	5.03e-11	**-11.15558***	-4.795084	-8.772898

* 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

E2. Residual Correlogram

Figure E2.1 Residual correlogram of VAR(1)

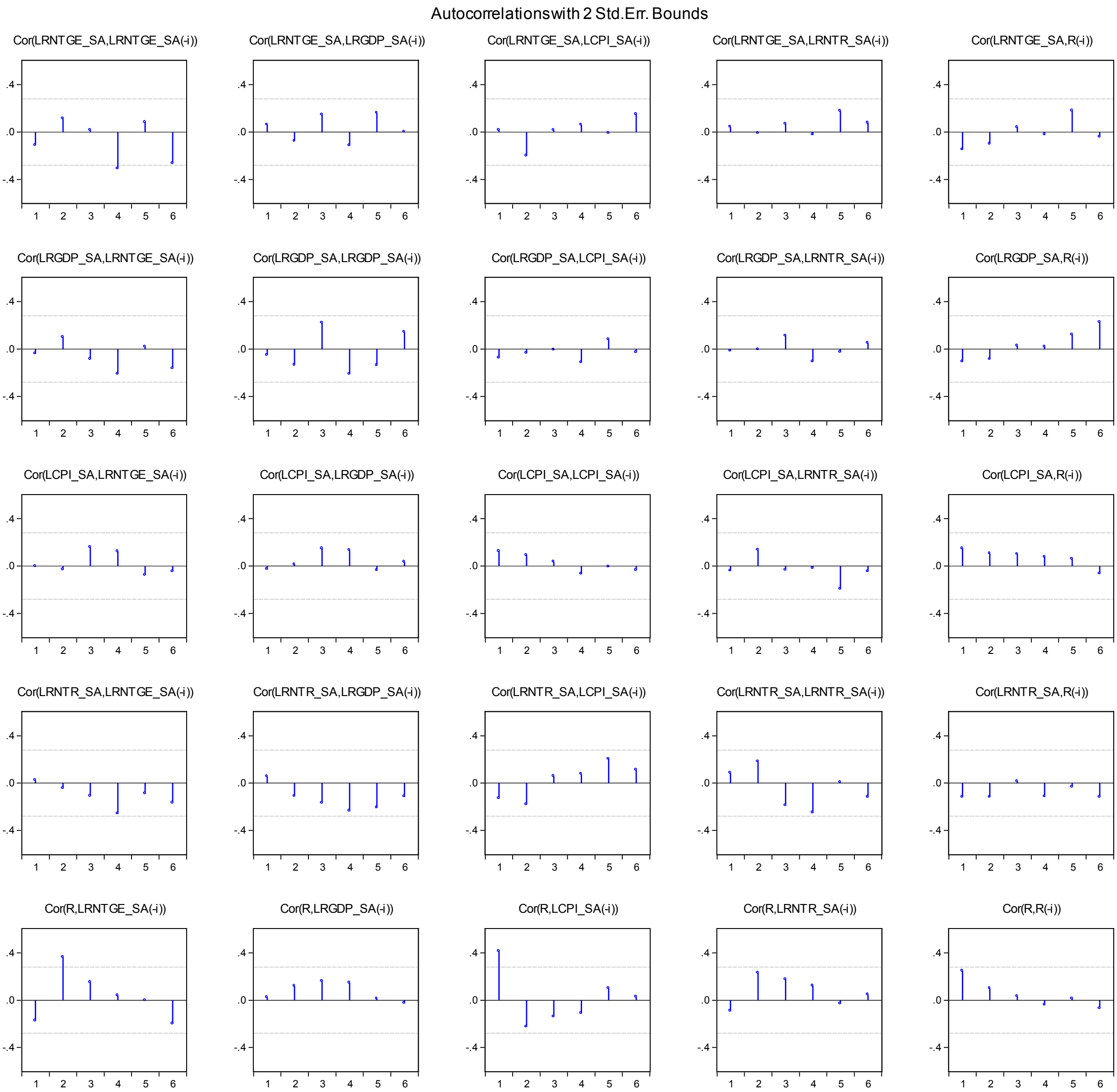


Figure E2.2 Residual correlogram of VAR(4)

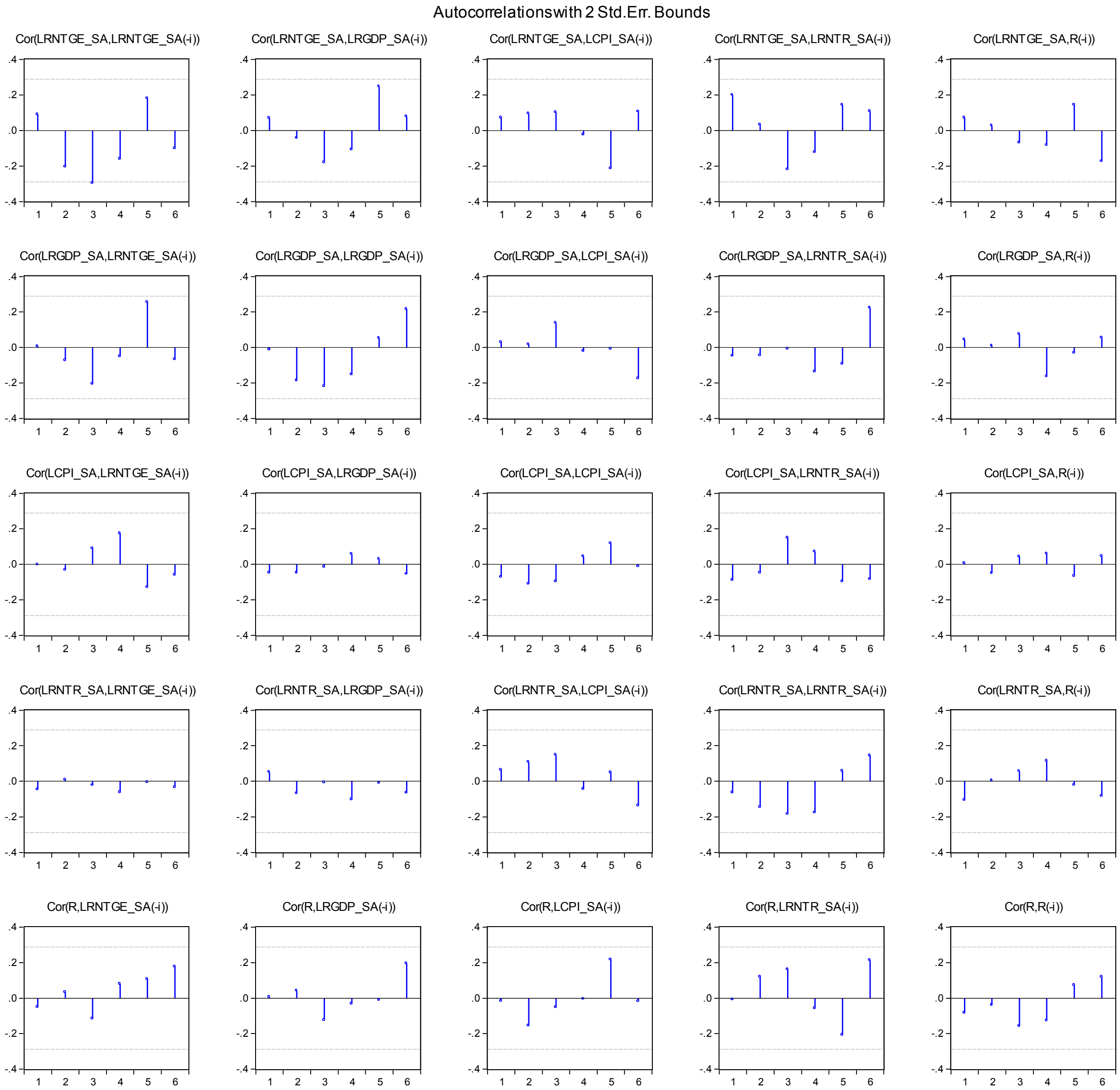
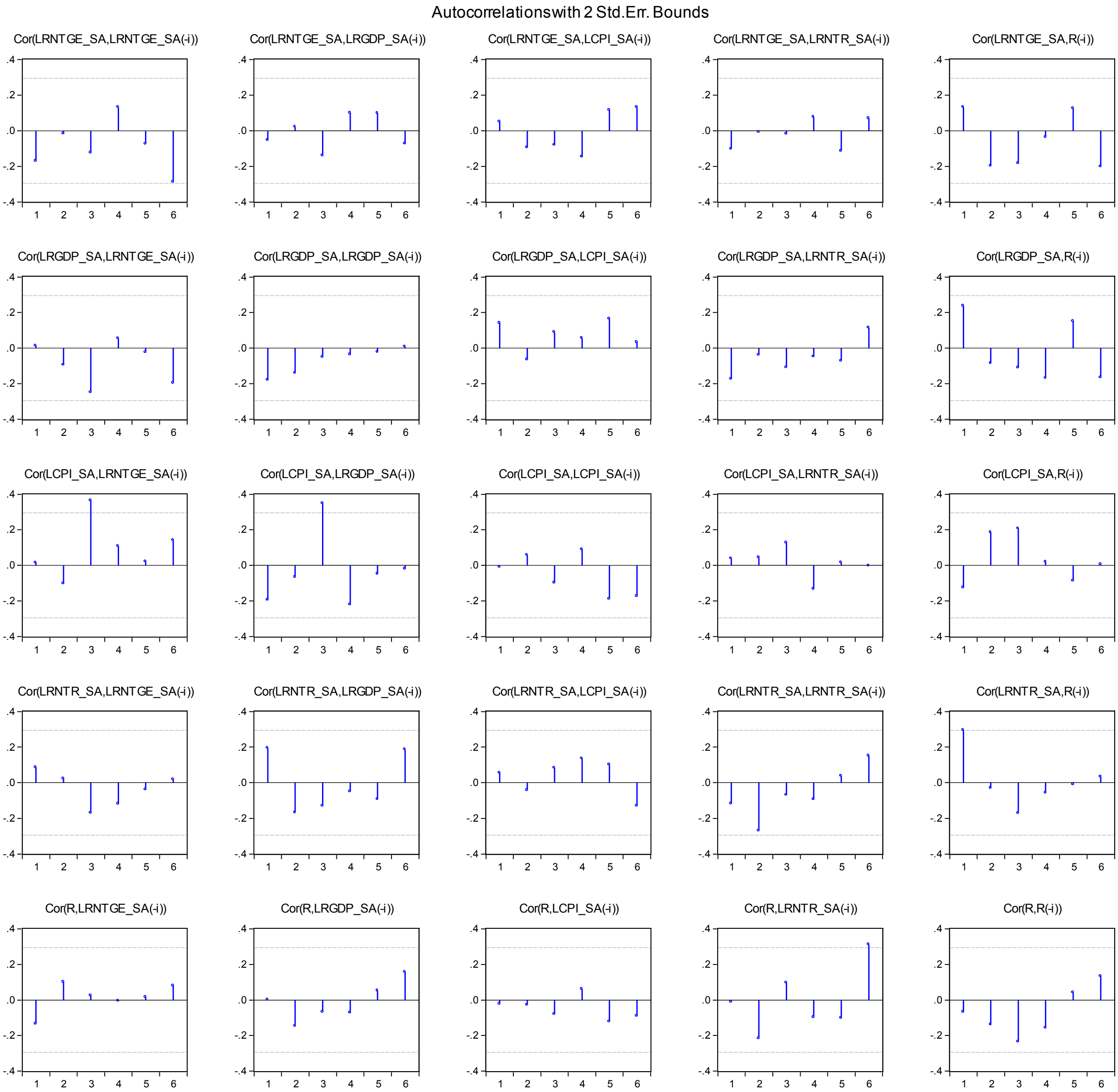


Figure E2.3 Residual correlogram of VAR(6)



E3. Post-estimation diagnostic test results

E3.1 Stability Test Results

Roots of Characteristic Polynomial
Endogenous variables: LRNTGE_SA LRGDP_SA LCPI_SA LRNTR_SA R
Exogenous variables: C @TREND
Lag specification: 1 4

Root	Modulus
0.956330	0.956330
0.847878 - 0.299270i	0.899144
0.847878 + 0.299270i	0.899144
0.520720 - 0.644373i	0.828472
0.520720 + 0.644373i	0.828472
0.651049 - 0.503742i	0.823178
0.651049 + 0.503742i	0.823178
-0.760896 + 0.248109i	0.800326
-0.760896 - 0.248109i	0.800326
-0.492221 + 0.608322i	0.782519
-0.492221 - 0.608322i	0.782519
-0.293609 - 0.671917i	0.733266
-0.293609 + 0.671917i	0.733266
-0.518742 + 0.455015i	0.690023
-0.518742 - 0.455015i	0.690023
0.611488 - 0.226979i	0.652256
0.611488 + 0.226979i	0.652256
0.014931 - 0.554963i	0.555164
0.014931 + 0.554963i	0.555164
0.155467	0.155467

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

E3.2 Test result for Residual Autocorrelation

VAR Residual Serial Correlation LM Tests
Null Hypothesis: no serial correlation at lag order h
Sample: 1998Q1 2011Q4
Included observations: 48

Lags	LM-Stat	Prob
1	25.63437	0.4273
2	27.83979	0.3153
3	37.10959	0.0564
4	15.13140	0.9383

Probs from chi-square with 25 df.

E3.3 Heteroskedasticity Tests Result

VAR Residual Heteroskedasticity Tests: No Cross Terms (only levels and squares)
Sample: 1998Q1 2011Q4
Included observations: 48

Joint test:

Chi-sq	df	Prob.
661.9421	630	0.1831

E3.4 Test result for Normality of Estimated Residuals

VAR Residual Normality Tests
Orthogonalization: Cholesky (Lutkepohl)
Null Hypothesis: residuals are multivariate normal
Sample: 1998Q1 2011Q4
Included observations: 48

Component	Skewness	Chi-sq	df	Prob.
1	-0.273423	0.598083	1	0.4393
2	-0.914171	6.685667	1	0.0097
3	0.045387	0.016480	1	0.8979
4	0.267744	0.573495	1	0.4489
5	-0.351296	0.987273	1	0.3204
Joint		8.860998	5	0.1147

Component	Kurtosis	Chi-sq	df	Prob.
1	3.661619	0.875478	1	0.3494
2	6.522255	24.81256	1	0.0000
3	4.119037	2.504485	1	0.1135
4	3.073634	0.010844	1	0.9171
5	3.109106	0.023808	1	0.8774
Joint		28.22718	5	0.0000

Component	Jarque-Bera	df	Prob.
1	1.473561	2	0.4787
2	31.49823	2	0.0000
3	2.520965	2	0.2835
4	0.584339	2	0.7466
5	1.011081	2	0.6032
Joint	37.08818	10	0.0001

E4. Test result of Johansen Cointegration Test

Sample (adjusted): 1999Q2 2010Q4
Included observations: 47 after adjustments
Trend assumption: Linear deterministic trend (restricted)
Series: LRNTGE_SA LRGDP_SA LCPI_SA
LRNTR_SA R
Lags interval (in first differences): 1 to 4

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.660425	124.3712	88.80380	0.0000
At most 1 *	0.495845	73.60839	63.87610	0.0061
At most 2	0.325144	41.41940	42.91525	0.0700
At most 3	0.274041	22.93637	25.87211	0.1111
At most 4	0.154432	7.884075	12.51798	0.2613

Trace test indicates 2 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.660425	50.76282	38.33101	0.0012
At most 1 *	0.495845	32.18900	32.11832	0.0490
At most 2	0.325144	18.48303	25.82321	0.3413
At most 3	0.274041	15.05230	19.38704	0.1908
At most 4	0.154432	7.884075	12.51798	0.2613

Max-eigenvalue test indicates 2 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Appendix F: VAR Pre-estimation and Post-estimation Diagnostic and Cointegration Test Results for six variable VAR model

F1. VAR Lag order selection criterion

VAR Lag Order Selection Criteria
Endogenous variables: LRNCGE_SA LRNKGE_SA LRGDP_SA LCPI_SA LRNTR_SA R
Exogenous variables: C @TREND
Sample: 1998Q1 2011Q4
Included observations: 48

Lag	LogL	LR	FPE	AIC	SC	HQ
0	177.3192	NA	4.11e-11	-6.888298	-6.420498	-6.711516
1	301.5776	**207.0974***	**1.06e-12***	-10.56573	**-8.694532***	**-9.858604***
2	330.2922	40.67908	1.56e-12	-10.26218	-6.987575	-9.024700
3	370.3207	46.69990	1.64e-12	-10.43003	-5.752028	-8.662207
4	411.2007	37.47334	2.11e-12	**-10.63336***	-4.551961	-8.335193

* indicates lag order selected by the criterion

F2. Test results for Model Stability

Roots of Characteristic Polynomial
Endogenous variables: LRNCGE_SA LRNKGE_SA LRGDP_SA LCPI_SA LRNTR_SA R
Exogenous variables: C @TREND
Lag specification: 1 4

Root	Modulus
0.943971	0.943971
-0.860053 + 0.347305i	0.927530
-0.860053 - 0.347305i	0.927530
0.872642 - 0.294587i	0.921025
0.872642 + 0.294587i	0.921025
0.513802 - 0.704412i	0.871888
0.513802 + 0.704412i	0.871888
-0.500261 + 0.703551i	0.863276
-0.500261 - 0.703551i	0.863276
0.706425 - 0.442545i	0.833596
0.706425 + 0.442545i	0.833596
0.575708 - 0.523594i	0.778197
0.575708 + 0.523594i	0.778197
-0.696780 - 0.324860i	0.768789
-0.696780 + 0.324860i	0.768789
-0.335143 - 0.670921i	0.749971
-0.335143 + 0.670921i	0.749971

0.235022 + 0.663925i	0.704295
0.235022 - 0.663925i	0.704295
0.697397	0.697397
-0.058626 + 0.602225i	0.605072
-0.058626 - 0.602225i	0.605072
-0.315627 + 0.325418i	0.453340
-0.315627 - 0.325418i	0.453340

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

F3. Test result for Residual Autocorrelation

VAR Residual Serial Correlation
LM Tests
Null Hypothesis: no serial
correlation at lag order h
Sample: 1998Q1 2011Q4
Included observations: 48

Lags	LM-Stat	Prob
1	47.71840	0.0916
2	47.19290	0.1003
3	54.01568	0.0273
4	42.56267	0.2094

Probs from chi-square with 36 df.

F4. Test result for Normality of Estimated Residuals

VAR Residual Normality Tests
Orthogonalization: Cholesky (Lutkepohl)
Null Hypothesis: residuals are multivariate normal
Sample: 1998Q1 2011Q4
Included observations: 48

Component	Skewness	Chi-sq	df	Prob.
1	0.220557	0.389162	1	0.5327
2	0.294636	0.694481	1	0.4046
3	-0.616588	3.041447	1	0.0812
4	0.248707	0.494840	1	0.4818
5	0.038143	0.011639	1	0.9141
6	-0.262770	0.552386	1	0.4573
Joint		5.183954	6	0.5204

Component	Kurtosis	Chi-sq	df	Prob.
1	2.248938	1.128188	1	0.2882
2	2.688433	0.194148	1	0.6595
3	5.272772	10.33099	1	0.0013
4	3.300833	0.181001	1	0.6705
5	2.387837	0.749486	1	0.3866
6	2.990239	0.000191	1	0.9890
Joint		12.58400	6	0.0501

Component	Jarque-Bera	df	Prob.
1	1.517349	2	0.4683
2	0.888629	2	0.6413
3	13.37243	2	0.0012
4	0.675841	2	0.7133
5	0.761126	2	0.6835
6	0.552576	2	0.7586
Joint	17.76795	12	0.1229

F5. Test result of Johansen Cointegration Test

Sample (adjusted): 1999Q2 2010Q4
Included observations: 47 after adjustments
Trend assumption: Linear deterministic trend (restricted)
Series: LRNCGE_SA LRNKGE_SA LRGDP_SA LCPI_SA LRNTR_SA R
Lags interval (in first differences): 1 to 4

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.831544	227.1162	117.7082	0.0000
At most 1 *	0.715516	143.4054	88.80380	0.0000
At most 2 *	0.474495	84.32277	63.87610	0.0004
At most 3 *	0.447617	54.08317	42.91525	0.0027
At most 4 *	0.277202	26.18807	25.87211	0.0457
At most 5	0.207504	10.93069	12.51798	0.0908

Trace test indicates 5 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.831544	83.71081	44.49720	0.0000
At most 1 *	0.715516	59.08261	38.33101	0.0001
At most 2	0.474495	30.23960	32.11832	0.0833
At most 3 *	0.447617	27.89510	25.82321	0.0263
At most 4	0.277202	15.25738	19.38704	0.1800
At most 5	0.207504	10.93069	12.51798	0.0908

Max-eigenvalue test indicates 2 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Appendix G: Results of Robustness Analysis

Figure G1.1 Impulse responses using Cholesky Decomposition

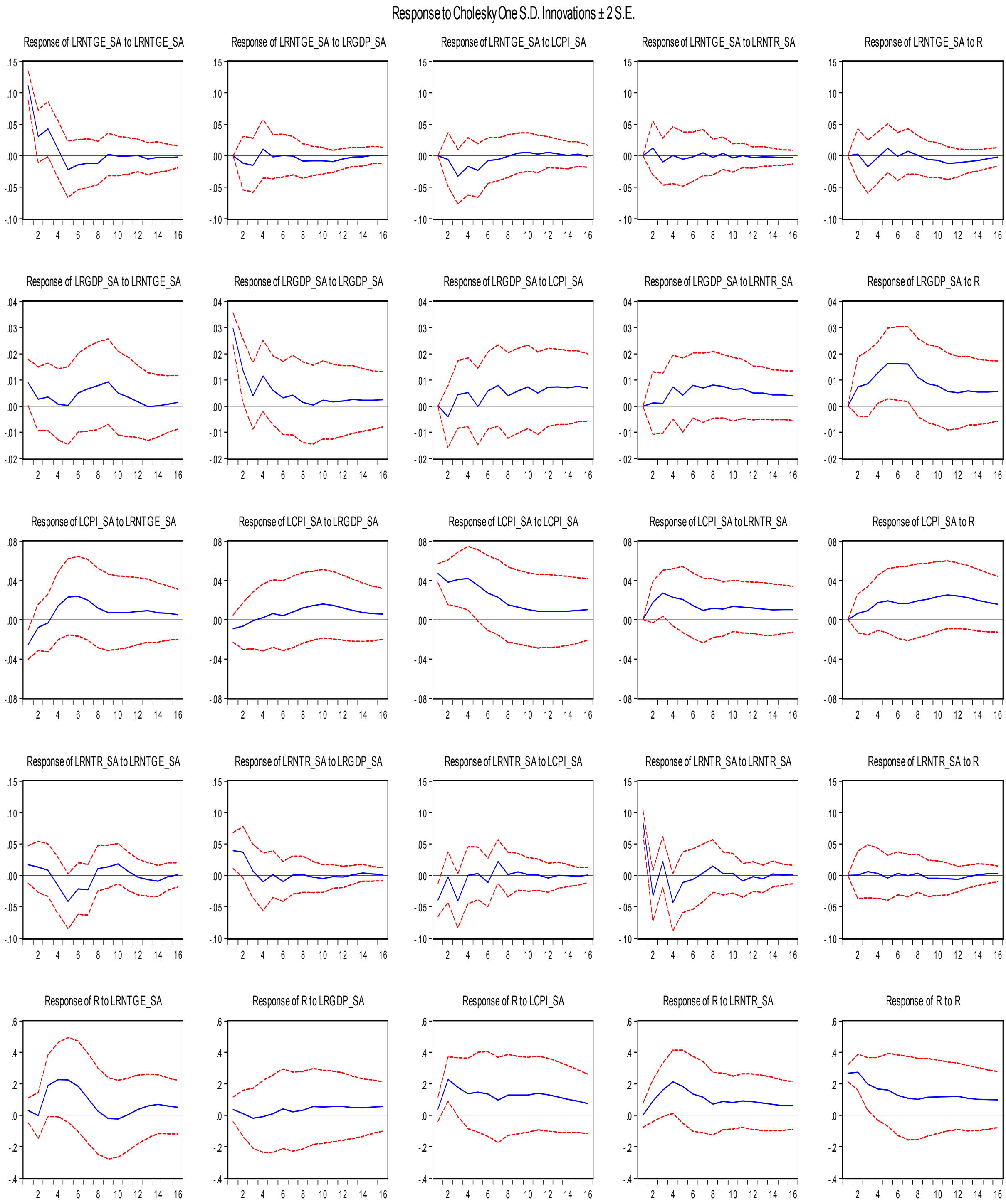


Figure G1.2 Impulse responses using Cholesky Decomposition where net tax revenue is ordered next to net government spending

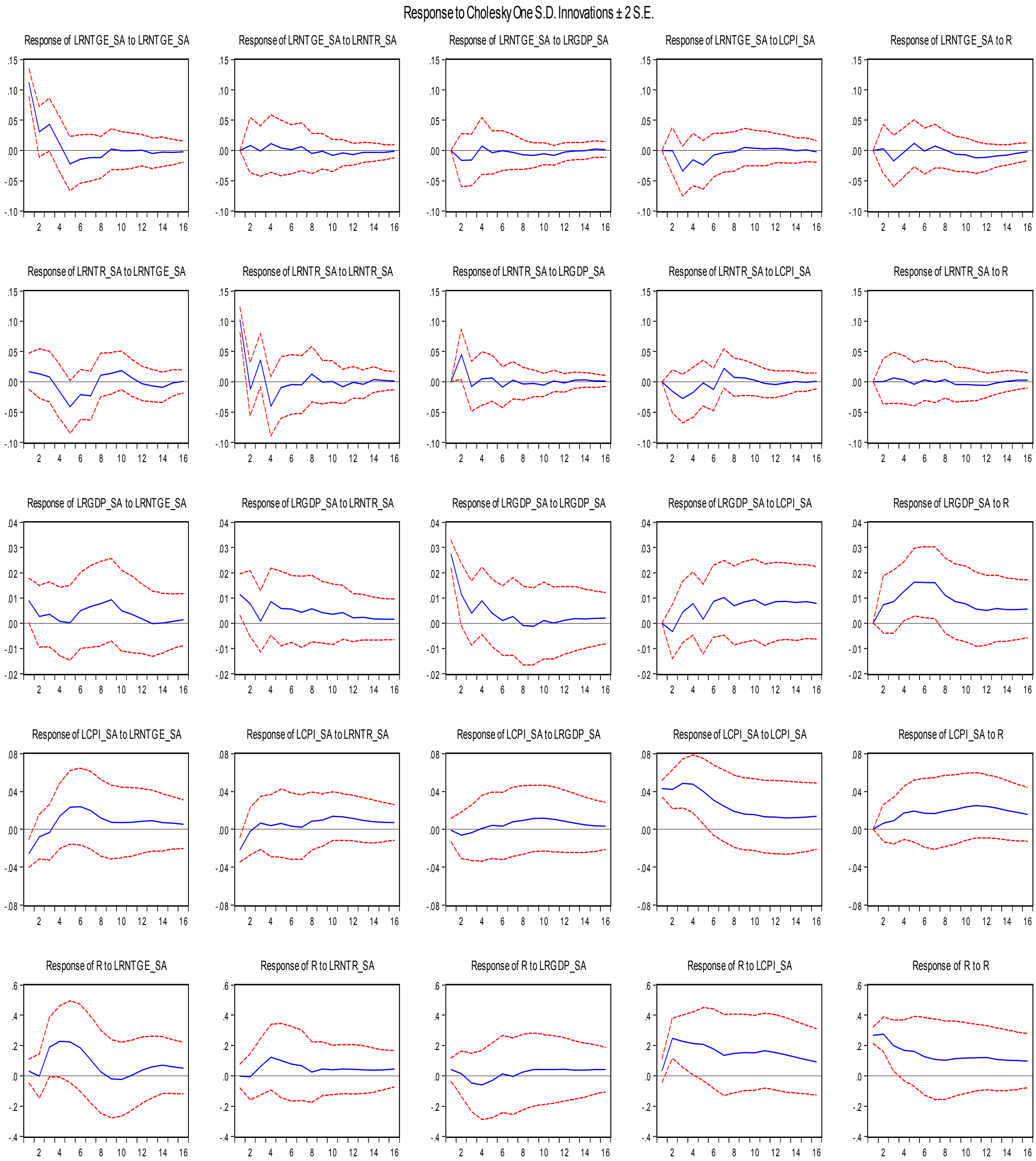
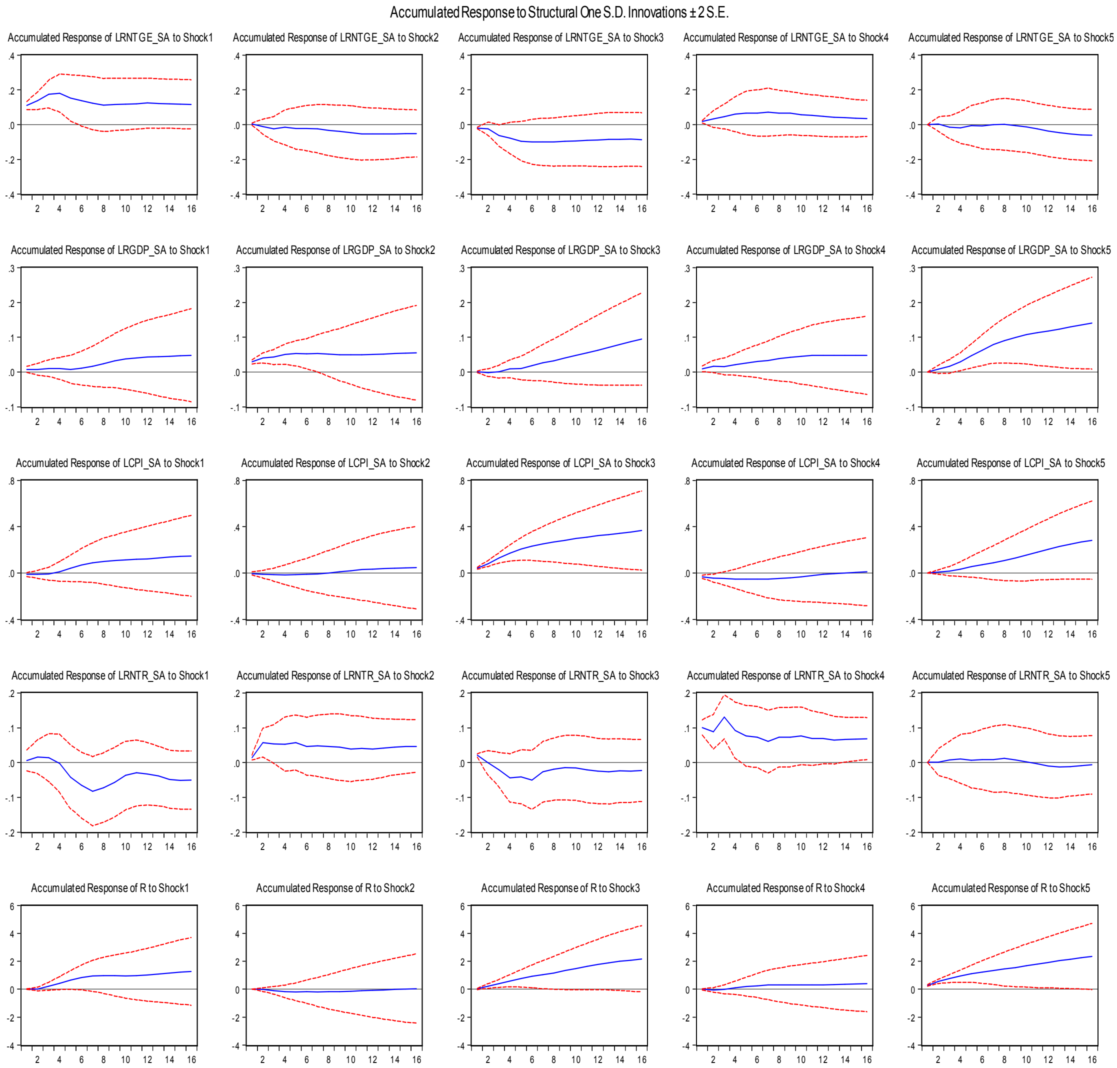


Figure G1.3 Accumulated response to Structural one standard deviation innovation



Shock 1 to shock 5 refer net government spending, output, inflation, net tax revenue and interest rate respectively.