Fiscal Policy and Economic Growth: Empirical Evidence from Ethiopia

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This is to certify that the thesis prepared by Mulay Weldu, entitled: *Fiscal Policy and Economic Growth: Empirical Evidence from Ethiopia* and submitted in Partial Fulfillment of the Requirements for the Degree of Master of Arts in Applied Economic Forecasting and Modeling (Fiscal Policy Analysis and Management) complies with the regulations of the University and meets the accepted standards with respect to originality and quality.

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Abstract

This study examines the effects of taxes and government spending on economic growth in Ethiopia. This was accomplished using a SVAR framework following Blanchard and Perotti's (1999) identification methodology on data spanning from the second quarter of 1995 to the second quarter of 2008 Ethiopian fiscal year. The result for the contemporaneous effect of government spending and revenues on real GDP growth has the expected signs. The result shows that the effect of government spending on GDP is positive (0.57 percent) and significant. This means government can stimulate the economy through its spending. Similarly, the sign on tax effect on GDP is negative. However, the effect of tax is statistically insignificant. We have also examined the dynamic responses of real GDP growth rate to changes in real government spending and real government tax revenues. We find that the effects of government expenditure shocks in Ethiopia appear to be positive but small as compared to the Keynesian fiscal multiplier. The sign of the effects of tax policy changes are less clear cut, but again the effects on GDP appear similarly modest. Past fiscal policy is analyzed through a historical decomposition of the shocks in the model and much of the changes in GDP come from itself followed by government spending. The important policy implication of the study is government to continue the expenditure trend but be cautious of the tax. Financing government spending needs a careful consideration so as to continue spending's effect in stimulating the economy. The effect of Tax on GDP growth is negative, which requires expanding the existing narrow tax base which in turn necessitates increasing the capacity to collect and administer tax. Therefore, the key policy implication is that the Government should continue investing in what has been the trend in the study period; however, it should be cautious of the impact of taxes.

***Key Words**: Fiscal Policy, Economic Growth, Structural VAR, Identification.*

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List of Tables

List of Figures

List of Acronyms and Abbreviations

ADF - Augmented Dickey-Fuller Test

AIC – Akaike Information Criteria

AIRF – Accumulated Impulse Response Function

DSGE – Dynamic Stochastic General Equilibrium

GDP - Gross Domestic Product

IMF - International Monetary Fund

IRF – Impulse Response Function

MoFEC - Ministry of Finance and Economic Cooperation

NBE – National Bank of Ethiopia

OLS – Ordinary Least Square

RBC – Real Business Cycle

RGDP - Real Gross Domestic Product

SVAR - Structural Vector Autoregression

VAR – Vector Autoregression

VEC – Vector Error Correction

VD – Variance Decomposition

Table of Contents

SECTION 1
INTRODUCTION

"Policymakers and far too many economists seem to be arguing from ideology rather than evidence. … the evidence is stronger than it has ever been that fiscal policy matters—that fiscal stimulus helps the economy add jobs, and that reducing the budget deficit lowers growth at least in the near term. […]. We are never going to solve our problems if we can't agree at least on the facts. Evidence-based policymaking is essential if we are ever going to triumph over this recession and deal with our long-run budget problems,"Romer, C. (2013, PP. 24).

Economists are divided into two different and mutually incompatible strands of theories, regarding fiscal policy as measured by government expenditures or taxes. On the one hand, the Keynesians argue that there is a critical market failure. In such scenario, fiscal policy has the role to positively affect aggregate demand thereby to affect the distribution of wealth, the capacity of the economy to produce goods and services. According to this view, the expansionary fiscal policy, in the short-run, creates more employment, increase consumption thereby enables demand constrained firms to sell more output and thus boost their income for further production and investment. This means fiscal policy has the stamina to affect the allocation of the economy's resources and productive capacity via its influence on the returns to factors of production, human capital development, the allocation of capital spending, and investment in technological innovations. To this view, fiscal policy can alter both the magnitude and the pattern of demand for goods and services.

On the contrary, the neoclassical argue whenever there is disturbance that displaces the economy from its full employment, it quickly returns to full capacity by the power of market. Accordingly, fiscal policy measures taken by the government to correct the disequilibrium have little potential for stabilizing and boosting the economy. Moreover, inevitable delays in timely recognition of economic disturbances, in enacting a fiscal response, and in the economy's reacting to the change in policy can aggravate, rather than diminishing, business-cycle fluctuations. Therefore, to this view displacement from the full employment should be left to the market and the government should stay aside.

These two controversial views led economists and policy makers for further debate and empirical investigations. However, the empirical researches carried out employing different methodologies and studies for different countries can give different results, both in sign and magnitude of effects. This shows the lack of consensus both in the theoretical and empirical literature with regards to the true effects of fiscal policy on economic growth. The lack of consensus in the effect of fiscal policy in both the theoretical and empirical findings continues to the scrutiny of the methodologies applied in this sector (Kamps and Caldara, 2008). They argue that the effect of government spending and tax on economic activity can differ from country to country based on the type of methodology employed. Some economists argue against the use of VAR based innovations as measures of fiscal policy shifts and suggest using dummies as exogenous fiscal shocks (Ramey and Shapiro, 1998 and Burnside et al. 1999).

According to Gemmell (2004) the empirical findings in the effect of fiscal policy on economic growth are summarized into three 'generations' of studies. The first generation covers the studies carried out during the period pre 1990. These studies were not based on theory; consequently, poorly specified cross-sectional regressions with non-robust results. According to him any of these researches cannot give the expected relationship. The second generation of empirical studies is those studies carried-out during the 1990s. The studies of this period were using the endogenous growth theories (Baro, 1990; King and Rebelo, 1990; Baxter and King, 1993). However, yet this generation continues to employ the cross-section econometric methods and fiscal variables selected on ad hoc basis. The results of this generation, like in the first generation, were still not robust. The third generation of empirical studies is that of the 2000 onwards, which considers theoretical basis in selecting fiscal variables decomposition, uses panel or time series data and tries to address other important issues.

Despite the lack of consensus on the role of fiscal policy in stimulating economic growth, both fronts continued for further investigations using different methodologies for countries at different levels of economic status, which so far focuses on the developed countries. Regardless of the continued arguments, the issue here is the absence of empirical study so far done for Ethiopia, at least as per the knowledge of the researcher. Therefore, the objective of this study is to try to investigate the effect of fiscal policy on the economic growth of Ethiopia. To this end, this study

utilizes SVAR approach, following Blanchard and Perotti's (1999) using quarterly data of 1995 second quarter to 2008 first two quarts. In this paper the Blanchared- Perotti approach is employed. Similarly, the macro variables incorporated are three, which are real Gross Domestic Growth, Real Government spending, and Real Tax Revenue.

The rest of this paper is allocated into six chapters. Chapter 2 presents the theoretical underpinnings, the empirical findings, and methodologies utilized in the literature on the link between fiscal policy and economic growth. Chapter 3 presents the specification of the model and the estimation procedures. Chapter 4 features the main results along with interpretation of the SVAR model employed and a discussion. Finally, chapter 5 presents conclusion and policy implications.

SECTION 2
LITERATURE REVIEW

The effects of monetary policy change in economic activities seem well understood and agreed with consensus. However, the case for fiscal policy seems inconclusive and open for debate, theoretically, empirically, and methodologically. The theoretical arguments regarding the magnitude and sign of fiscal policy on economic activity depends on the type of models employed, which intern are based on a number of assumptions leading to contradicting conclusions. To settle such controversy and show the true effect of fiscal policy, economists have carried out empirical studies employing different methodologies. Similarly, the empirical findings show the absence of common understanding with some studies coming with positive while others with either negative or inconclusive effects. In this section we are going to review the theoretical, empirical and methodological literature.

2.1. Theoretical view

Fiscal policy refers to the manipulation of taxes and public spending to effectively influence aggregate demand thereby induces economic growth. However, the theoretical view regarding the effect of fiscal policy, unlike that of the monetary policy, on economic growth is not in harmony. This fact is explained by Perotti, (2007; PP 3) as follows;

"Virtually all reasonable economists agree that an increase in the interest rate controlled by the monetary authorities will lead to some fall in the output gap and a slowdown in inflation […]. Things are different for fiscal policy: neoclassical and neokeynesian theories have opposite implications for the effects of a shock to government spending on goods and services on such key variables as private consumption, and the real wage."

The classical model starts assuming perfectly competitive market, flexible prices, flexible real wage and interest rates. Based on such assumptions they argue that market mechanism is the best guarantee for the production of goods and services at the level of full employment. Moreover, they assume that the aggregate supply curve is vertical; consequently, inelastic to the changes in the nominal values like the level of prices. In order to respond to the effectiveness of fiscal policy to stimulate demand then boost economic growth, the classical economists shoulder on

these assumptions. The government, through its fiscal policy, may try to stimulate economic growth by increasing demand. However, given the preceding assumptions, the policy implemented, increases in government spending for instance, results in competition for financing fund which eventually push up interest rates. The increase in interest rate then reduces the private consumption and penalizes private sector's investment. The classical model argues any positive impact contributed by fiscal policy is fully wiped out by the crowding-out[1]of the private sector. Therefore, the eventual effect of fiscal policy on the economy's performance is nil, which means fiscal policy is ineffective in stimulating the economy's short-run performance.

On the other hand, the Keynesian economists defend for the effectiveness of fiscal policy in boosting economic performance. The Keynesians assume prices are rigid in the short-run while individuals face money illusion[2]. This signifies that the existence of sizeable unexploited factors of production and the economy is below its full employment. The supply curve in the short-run, unlike in the classical model, is fully elastic at the level of the rigid price level determined by the non-competitive labor market. The supply curve is vertical and inelastic to prices only in the long-run at the full employment, the Keynesians argue. Therefore, in the Keynesian model fiscal policy is one among the determinants of aggregate demand which has the power to significantly influence economic performance in the short-run. However, the cumulative effect of fiscal policy, such as increase government spending, depends on the magnitude of the multiplier[3] and crowding-out effects (Mankiw, 2000).The Keynesian model predicts that as compared to tax-cuts increase in government spending has better ability to positively enhance the performance of the economy in the short-run.

In between the Classical and Keynesian models is the neoclassical model. This model refutes the prices and nominal wages rigidity, and money illusion assumptions of Keynesians. It rather assumes nominal wages and prices are flexible, and workers face no money illusion. Similarly, the neoclassical do not agree with the classical model of perfect foresight of the future prices and

[1] The crowding-effect is related to the offset in aggregate demand that results when expansionary fiscal policy raises the interest rate and thereby reduces investment spending. Tax-cuts increase consumers' disposable income and therefore shift aggregate demand. The higher income leads to greater money demand, which eventually increases the interest rates and reduces private investment.

[2] Money illusion is individual's failure to differentiate the distinction between real and nominal values.

[3]The multiplier effect is related to the additional shifts in aggregate demand that result when expansionary fiscal policy increases income and thereby increases consumer spending.

vertical supply curve. The neoclassical economists assume workers have the ability to predict the price levels across time based on their rational expectation at the real level of prices and demand an increase in wage accordingly. This means in the short-run[4] there is imperfections in price expectation, which paves the room for the government to affect economic performance through fiscal policy possible. However, in the long-run fiscal policy is ineffective since aggregate supply curve is vertical and fully inelastic to price levels.

The neo-Keynesian model is the extension from the Keynesian model with some changes in the underlying assumptions. The money illusion assumption in the Keynesian model is not an issue to the neo-Keynesian model. However, yet this model assumes the problem of prices and wages rigidities not as a result of money illusion instead features such as long-term employment contracts and other institutional factors (Erceg et al., 2000; Christiano et al. 2005). In this model aggregate supply curve is positively sloped and more elastic even as compared to its counterpart in the neoclassical model. Therefore, this model contends, policy makers can improve short-run economic performance through fiscal policy in more than what it is possible supported by the neoclassical model.

So far, we have seen the different theoretical models of different school of economics with regard to the effectiveness of fiscal policy in influencing the performance of the economy in the short-run. The views in its effectiveness to affect long-run growth rate of an economy too is not unanimity. The views are mainly grouped into two mutually exclusively unrelated effects of fiscal policy in the long-term economic growth. These are the advocates of neoclassical exogenous growth theory (Solow, 1956) and the endogenous growth theory (Romer, 1986 and Lucas, 1988).

The neoclassical growth theory intends to explain the determinants of long-run economic growth. According to this growth theory once the steady-state is attained long-term growth can only be changed by technological progress, which is exogenously determined. In this growth theory, any effort excreted to incentivize for more saving or investment for further capital accumulation through fiscal policy is ineffective because of diminishing returns to scale. If such policy can change anything it is only growth in the transition period as the economy moves onto its steady-state output level. Thus, according to this

[4]Short-run discrepancies between the real and the expected levels of prices can affect the level of equilibrium output and therefore the aggregate supply curve has a positive slope in the short-run.

growth theory, fiscal policy can, utmost, have a temporary effect on growth in the transition to the long-run growth rate and level of output and no effect on the long-run or steady-state growth.

Despite the neoclassical growth models, argument against the effectiveness of government policy in influencing the steady-state growth; endogenous growth models incorporate channels through which fiscal policy can affect long-run growth (Ram, 1986; King and Rebelo, 1990; Dowrick, 1992; Glomm, 1991; Jones et al. 1991; Romer, 1986; and Barro 1990). The latter models classify generally the fiscal policy instruments into as distortionary taxation[5], non-distortionary taxation[6], productive expenditures[7], and unproductive expenditures[8], according to their respective impact on growth. There are three important distortions with the capacity to undermine growth and leave the steady-state at its sub-optimal unless the government through its fiscal policy intervenes (Psarianos; 2002). These three important distortions are lack of incentives to invest in research and Development (R and D, inefficient allocation of capital goods, and market failure to reward technological inventions and innovation to reduce cost of production. Thus, there is room for fiscal policy to induce the private sector and the economy at large to attain the socially optimal outcomes.

"*Economic theorists have done work of high quality and great quantity in the field of taxation. Public expenditure seems to have been relatively neglected. […]Pigou's* ***A Study in Public Finance****, […] a book of some 285 pages, Pigou devotes […] at least 200 pages for taxes … about the pure theory of public expenditure pages of 30-34*," Paul A. Samuelson, PP. 332.

Recent studies, however, modeled the relationship between particular categories of spending[9] and rate of growth (Aschauer, 1988; Aschauer, 1989; Blankenau and Simpson, 2004; Agenor et al. 2006, and Semmler et al., 2007). These endogenous growth models give the possible mechanisms that fiscal policy can affect the steady-state rate of growth. This means, increase in government spending mainly in infrastructure and human capital production has the ability to influence the steady-state or long-run rate of growth.

[5]Distortionary taxation is the type of tax, such as income and profit taxes, which reduces the growth through eroding the incentives to invest in physical and/or human capital.

[6]Non-distortionary tax is the type of tax, such as consumption taxes, which does not affect the incentives to invest, hence not reducing growth.

[7]Productive expenditure is the category of spending which increases growth, through positive externalities or augmentation of the private sector, such as education spending, infrastructure spending, health spending etc.

[8]Unproductive expenditure is the type of government expenditure which does not affect the marginal product and growth, but boosts household utility or welfare directly.

[9] Infrastructure, education and health spending as inputs into private production function.

The effect of taxes on economic activity is one of the least contested areas in theoretical macroeconomics. Both neoclassical and Keynesian theoretical models, for example, predict that higher taxes reduce economic activity, even though there is less agreement on the exact mechanisms that generate this result. Its negative effect on economic growth is signified by its substitute of private consumption (Carlson and Spencer, 1975; Skinner, 1988; King and Rebelo, 1990; Baro 1990; and Dowrick, 1992)[10]. Keepingthe share of government spending per output constant, an increase in the marginal tax rate lowers the growth and savings rate. The work of Kneller et al. (1999) shows that productive expenditures financed by non-distortionary taxes enhance growth rates, while those financed by distortionary taxes have an ambiguous effect. Similarly, King and Rebelo (1990) concluded that for small developing economies with mobile capital, national taxation policies can lead to either 'development traps' or 'growth miracles'. Others argue a tax-financed increase in government spending has no effect on total spending. Under the Ricardian equivalence theorem[11] budget deficit and taxation have equivalent effects on the economy. Finally, national saving remains unchanged despite a decrease in public savings matched by an increase in private savings.

Some theorists link the relationship with the level of development of respective countries. The size of government is typically smaller in developing countries as compared to that of developed countries. Taking Wagner's law[12] Bergh and Henrekson (2011) argued that the effect of government size[13] on economic growth is positive in poor countries. In developing countries developing countries only the most fundamental functions of government intervention, such as the protection of property rights, are exercised at low level of taxation leading to a positive relationship between tax revenues and economic growth (Besley and Persson, 2009). On the

[10]An increase in taxes forces the private sector to forego present consumption, while saving rates remain constant. As a consequence, the increase in government consumption that is financed by additional taxation merely substitutes for private consumption.

[11] It stresses that a cut in current taxes to stimulate aggregate spending leads to higher future taxes that have the same present value as the initial tax cut to meet future debt service payment costs

[12]Named after the German economist Adolph Wagner, for any country the public expenditure rises constantly. It shows an upward sloping trend. The law predicts that the development of an industrial economy will be accompanied by an increased share of public expenditure in gross national product:

[13]The size of the government can be measured by its expenditures (outlays) or by its revenues (receipts).

contrary, the relationship is negative in developed countries because tax revenues are higher and exposed to rent-seekers (Bergh and Henrekson, 2011).

The theoretical literature has no consensus on the possible effect of fiscal policy and economic growth, be it in the short-run or long-run time horizon. This triggers economists for careful empirical investigation of the possible effect of fiscal policy on output growth.

2.2. Review of Empirical Findings

There has been a considerable amount of empirical research on the relationship between fiscal policy and economic growth, covering different fiscal measures, different sets of countries and using different econometric methods. In analysis of 41 studies exploring the impact of fiscal policies on long-run growth, Nijkamp and Poot (2004) found that 17 percent of studies showed positive relationships between different measures of fiscal policy and economic growth; 29 percent showed negative relationships; and 54 percent were inconclusive. While they found indications of strong effects of education and infrastructure spending on growth, there was no similar impact of fiscal variables in general. This is not surprising considering mixed effects of different fiscal aggregates, as well as the composition of spending and financing methods used.

Thus, several studies have explored how different categories of public spending influence economic growth. These studies predict that each type of government expenditure can influence growth through different channels. For instance, public investment in infrastructure may affect growth by increasing the quantity of factors of production, while public spending on education and health services have an impact on growth by improving the marginal productivity of human capital. At the same time, some types of public spending, such as subsidies and military expenditure – may not be productivity-enhancing.

The traditional approach of categorizing public expenditure into consumption or current spending, versus investment or capital spending, assumes that the latter generally promotes growth more than the former. Thus, for example, Gupta et al. (2005) analyze data on 39 low-income countries during the 1990s, demonstrating that higher wages tend to lower growth, while

higher capital and non-wage expenditure tend to increase it. However, the assumption that capital expenditures are more growth-promoting than current expenditures requires caution since some types of current expenditures, such as education and training, R&D, are beneficial for growth.

Moreover, there could be public investment projects that do not increase the country's productive capacity. Devarajan et al. (1996) studied the relationship between expenditure composition and growth for 43 developing countries for the period 1970-1990 and found no significant effect of total public spending on economic growth. But contrary to the commonly-held view, they found that public consumption had a significant positive effect on economic growth, while public investment had a significant negative effect. This negative effect also held for each of the components of government investment, including transportation and communication. The authors interpreted these results as a matter of over-investment in public projects with negative marginal returns.

However, a number of studies contradict the results of Devarajan et al. (1996), at least with respect to some types of investment spending. Fedderke et al. (2006) and Albala-Bertrand and Mamatzakis (2001) examine effects of infrastructure investment on long-run growth in South Africa and Chile respectively, using a vector error-correction model (VECM); both studies find a positive growth effect of 'productive' public expenditure in infrastructure. Using a similar methodology, M'Amanja and Morrissey (2005) examined the Kenyan case for 1964-2002, also finding a positive growth effect of public investment. Haque and Kim (2003) used fixed- and random effects models to analyze panel data for 15 developing countries for 1970-1987, finding that investment in transportation and communication has a positive impact on economic growth. Likewise, Easterly and Rebelo (1993) used cross-section and panel data of different samples for more than 100 countries and concluded that investment in transportation and communication has a positive and strong effect on growth. Using panel data for 28 developing countries for 1981-1991, Dessus and Herrera (2000) found that public capital accumulation has a positive long run growth effect.

Findings with respect to growth effects of other detailed categories of government expenditure are also varied. Using panel data on 120 developing countries, Baldacci et al. (2004) found that spending on human capital (i.e. education and health) is associated with higher economic growth. Baffes and Shah (1998) investigated the relationship between the sectoral allocation of public spending and economic growth, using a sample of 21 low- and medium-income countries from 1965 to 1984. They concluded that 'human development' capital investment has the highest output elasticity; investment in infrastructure capital had a positive but much smaller output elasticity, while military capital showed a negative output elasticity in half the countries in the study.

Similarly, Biletska and Rajaram (2007) have examined the possible growth impacts of fiscal policies based on 12 country case-studies. They argue that in most of the twelve countries, but especially in high aid-dependent countries, insufficient public expenditure allocation towards infrastructure, education and/or health, or inefficient use of spending in those areas, has been a critical constraint on their growth rates. Semmler et al. (2007), concluded that public investment should be directed primarily towards public infrastructure and then to education and health because the former facilitates market production directly, whereas the latter two expenditure categories have to first permeate the economic system before affecting the availability of public resources and thus growth.

Concerning the short-run effect of government spending, most studies report that a positive effect on aggregate demand in support of Keynesian views (Caldara and Kamps, 2008). However, in some studies the impact of shocks to fiscal policy on aggregate demand hinges on the response of private savings to changes in taxes and government spending. Thus, an increase in government spending may be offset by a compensating increase in private savings as larger budget deficits induces higher interest rates and negative wealth effects. Accordingly, some studies show a non-Keynesian response to a shock to government spending on private consumption (Blanchard and Perotti, 2004), on residential and non-residential investment (Mountford and Uhlig, 2009), on private investment (Blanchard and Perotti, 2004; Blanchard and Perotti, 2002), and.

There are no much empirical works with regard to the relationship between taxation and economy growth. Among the few available, Jens Arnold (2008) uses the review done by Myles (2006), but focuses on the most important analyses. The literature sources are differentiated in evidence on the tax level and growth and evidence on tax structure and growth. Arnold notes that the findings of the studies, analyzing the link between growth and tax structures provide somewhat more conclusive answers than the studies focused on the level of taxation. The work of Kneller et al. (1999) contributes to empirical analysis on this topic by identifying a depressing effect of 'distortionary taxes', which include taxes on income and property. They also find that productive government expenditure stimulate economy growth.

Experience of the OECD countries is analyzed by Widmalm (2001), Schwellnus and Arnold (2008), and Vartia (2008). Widmalm (2001) estimates a negative relationship between budget revenue accumulated by income taxes and economic activity growth and concluded that the negative effects of indirect taxes on economy are not confirmed. The empirical results from analyses of Schwellnus and Arnold (2008) and Vartia (2008) indicate a negative effect of corporate taxes on the productivity of firms and industries, based on large data sets of firms and industries across OECD countries. The significant negative correlation between statutory corporate tax rates and growth for 70 countries during 1970-1997, found by Lee and Gordon (2005), is noted as a similar result. The empirical outcome of studies analyzing OECD countries also varied across Keynesian and non-Keynesian lines. For example, Perotti (2004) obtained mixed results in his analysis of the effects of net taxes on GDP for five OECD countries, namely Australia, Canada, West Germany, United Kingdom and United States. He obtained non-Keynesian effects[14] of a tax cut on output for the U.S. in one subsample and the same for Canada in another.

Romer and Romer (2007) review other papers presenting evidence for various aspects of the relationship between taxation and economy growth employing different kinds of econometric approaches. The studies of Blanchard and Perotti (2002) and Perotti (1999) are considered as more sophisticated, because these researches assume that once one corrects for the impact of

[14] Non-Keynesian effect is when the fiscal policy multiplier less than one; as a result, the effect of fiscal policy on output or the privates sector is crowding-out.

economic activity on revenues and controls for the behavior of government spending, changes in revenues are uncorrelated with other determinants of output growth. A different approach is applied in studies, which are reviewed by Gale and Orszag (2004) and investigate the impact of tax changes on consumption. Such types of studies are made by Kormendi Roger (1983) and Cardia Emanuela (1997). The estimated impact of tax increases on consumption in these studies ranges from roughly no effect to a substantial negative effect.

The empirical findings for positive tax shock on economic growth generally seem negative but not yet conclusive. For instance, de Paiva et al. (2011) found that a positive shock to public revenue crowds-out output for Brazil, Chile and Mexico using the sign restriction approach, whereas Restrepo and Rincon (2006) found a transitory negative effect on output for Chile and no effect for Colombia using the Blanchard and Perotti (1999) approach. However, the finding of Giordano et al., (2007) shows that positive innovations to net revenues have negligible effects on macro-variables for Italy.

However, some of the empirical findings show positive fiscal policy shock results in positive effect on economic growth. This counterintuitive outcome reveals that these governments tend to spend lump-sum tax receipts in a manner that increases private consumption and private investment. In their empirical investigation de Castro and Hernández de Cos (2008) obtained a positive effect in the short-term but ultimately a Keynesian[15] response in the medium-term. Similarly, Ravnik and Zilic, (2011) found that a positive shock to revenue initially crowds-out industrial production for Croatia on impact as expected but later exerts an unexpected positive effect on economic activity after three months elapsed. Guy and Belgrave (2012) applied the Blanchard and Perotti (2002) approach to analyze the impacts of fiscal policy for Barbados, Guyana, Jamaica and Trinidad and Tobago and found a positive shock to taxes crowds-in output.

In general, Gemmell (2004) has summarized the empirical findings in 'fiscal policy' and economic growth into three 'generations' of studies. The first generation covers the studies carried out pre 1990. These studies were not based on theory; consequently, poorly specified

[15] Keynesian effect is when the fiscal policy multiplier is greater than one; consequently, the effect of fiscal policy on economic growth is positive or crowds-in the private sector.

cross-sectional regressions with non-robust results. According to him any of these researches cannot give the expected relationship. The second generation of empirical studies is those studies carried-out during the 1990s. The studies of this period were using the endogenous growth theories (Baro, 1990; King and Rebelo, 1990; Baxter and King, 1993). However, yet this generation continues to employ the cross-section econometric methods and fiscal variables selected on ad hoc basis. The results of this generation, like in the first generation, were still non-robust. The third generation of empirical studies is that of the 2000 onwards considers theoretical basis for fiscal variables decomposition, uses panel or time series data.

Until the influential work of Blanchard and Perotti (1999), empirical works on the effect of fiscal policy are quite rare compared to the large number of literature on the effect of monetary policy. Even the since then the empirical literature gives no result that can lead to consensus on the effect of fiscal policy on economic growth. Moreover, the empirical literature of fiscal policy differs from country to country and from methodology to methodology. In the absence of consensus on the theoretical and empirical works, the sole option left is to empirically determine the true effects of a country's fiscal policy on its economic activity. This paper too tries to empirically investigate the effect of fiscal policy on economic growth in Ethiopia.

2.3. Review of Methodological Approaches

In researches it is common to see researchers focusing on the theoretical and empirical literature giving little of no emphasis to the methodologies behind which is decisively important. Sims (1980) argues that it is hardly possible to get true exogenous variables. He notes that without having acceptable reason to consider them they are true strict exogenous variables, macroeconomic models consider them, by ad hoc, as exogenous variables. He further points out policy variables have considerable endogenous characteristics, which precludes treating them as exogenous. The problem robustness of empirical results on the nexuses between fiscal policy and economic growth carried before Blanchard and Perotti, (1999) introduced the SVAR models are related to the issue of methodology. Noting this fact, much emphasis is given to this sub-chapter.

The traditional macroeconometric techniques of policy analysis up until the beginning of 1970s were dominantly large scale. However, since the 1970s such methodologies failed to give any support to in solving the stagflation of the time. The problem has been explained by Lucas (1976) and is termed as the Lucas critic. According to the Lucas critic[16] as the assumption of the parameters of behavioral equations assumed to be policy invariant were proved to be inconsistent with the dynamic maximizing behavior of economic agents which actually were found to be not policy invariant. Since then the traditional large scale macroeconometric techniques of policy analysis which assumes parameters of behavioral equations are policy invariant has become less reliable; as a result, the quest for alternative estimation techniques evolved.

The new classical economists came up with the alternative model called the Real Business Cycle (RBC) models that emphasize real productivity shocks (Keydland and Prescott, 1982). However, the assumptions on which the RBC was based were unrealistic and attacked by the new Keynesians who came with the Dynamic Stochastic General Equilibrium (DSGE) models. Still the DSGE model demands strong assumptions; consequently, the look for alternative techniques persists. The most important alternative models to the highly criticized and questioned large scale macroeconometric models the introduction of the vector autoregressive (VAR) model by Sims (1980)[17]. He suggested empirical studies should use models of small-scale identified through small number of constraints which actually demands careful choice of key variables to be included as all possible variables cannot be included. This model has become applicable in macreconomic policy analysis and forecasting especially in monetary (Bernanke and Mihov, 1998; and Bernanke and Blinder, 1992) and later on for fiscal policy (Blanchared and Perotti).

However, the VAR still needs more improvement for better performance. Sims (1980) assumes the coefficients on the left hand-side of the structural equations are lower-triangular so that the Choleski decomposition[18] can be used for the orthogonalization of the reduced form equations. Though this can be helpful in evaluating macroeconomic models, it does not help to show the

[16] It is similarly argued by Haavelmo (1944)

[17] Sims (1980) argued that VARs provide a better systematic approach in imposing restrictions that could help one to handle empirical regularities remain hidden to standard procedures. On the contrary, the results from policy exercises through on large scale macroeconometrics models are hardly comparable and reconstruct, which makes difficult for users to amend with ex-post decisions.

[18] The most commonly used identification method imposes alternative sets of recursive zero restrictions on the contemporaneous coefficients to identify the shock.

contemporaneous effects and shocks of the structural models. In order to tackle this problem it is better to focus on the structural system of the VAR (SVAR) by choosing restrictions on the contemporaneous coefficients based on economic reasoning (Sims, 1986; Bernanke, 1986; Blanchard and Watson, 1986; and Blanchared and Perotti, 1999).

While this is the fact on the ground, the VAR and SVAR are less used in fiscal policy analysis and forecasting, unlike their extensive use in monetary policy, until the pioneer work of Blanchard and Perotti (1999). They contended that the VAR approach with high frequency data, quarterly, is even better suited to fiscal policy effects rather than monetary policy. Their argument is based on the fact that fiscal policy variables are more likely to be exogenous to output shocks than monetary variables. Besides, fiscal studies, unlike in monetary studies, can take advantage of lags in making decisions and in implementing fiscal policy measures. This means the impact of discretionary fiscal decisions by policy makers to unexpected contemporaneous shocks to output is hardly possible.

The techniques of investigation employed so far includes the use of dynamic general stochastic equilibrium (DSGE) models (Hall 1980; Barro, 1981; and Barro, 1989);univariate autoregressive models (Ramey and Shapiro, 1998); structural vector autoregressive models (Blanchard and Perotti, 1999) and simple regression techniques (Romer and Romer, 2007). The SVAR is preferable over DSGE modeling to study output response to fiscal policy shocks since the latter approach is difficult to model where non-clearing market in the economy exists demanding the imposition of strong assumptions (Auerbach and Gorodnichenk, 2011).

In addition to the advantages and the superiority that the SVAR models have over other models in analyzing the dynamic effects of fiscal policy, Blanchard and Perotti (1999) developed superior identification methodology based on institutional information about the tax and transfer systems and timing of tax. There are three other alternative strategies of identifying fiscal policy shocks in the empirical literature. First, the recursive method, which was introduced by Sims (1980), was later applied to identify fiscal shocks in semi-structural VAR frameworks by Favero (2002) and Fatás and Mihov (2001). However, a major criticism of this approach is that the Choleski ordering of the variables may lead to improbable assumptions regarding the causal interplay of the variables within the VAR model (Perotti 2004). As a consequence, the empirical

results obtained may differ solely based on ordering of the variables. This outcome is unsatisfactory to researchers, especially when there is a lack of theoretical justification for which variable should be ordered first.

Second, in order to analyze the effects of exogenous innovations to government spending on selected macroeconomic variables Ramey and Shapiro, (1998); Burnside et al., (1999)employed the 'narrative approach'[19]. Their identifying assumptions were extended in studies by Burnside et al., (2004) and Edelberg et al., 1999). With the same identification method, Romer and Romer (2009) identify exogenous tax changes between 1947 and 2006. The narrative approach's key advantage is that it permits the researcher define and identify truly exogenous and unanticipated shocks. However, this approach may result in overlooking 'substantial fiscal shocks' outside the researcher's defined interest. This is explained by the work of Perotti (2004) that identified the existence of significant increases in U.S. Government expenditure four quarters before the build-up of sizeable military spending Ramey and Shapiro (1998) ignored when setting their start date of the Korean War shock.

Lastly, Canova and Pappa (2007), Mountford and Uhlig (2009) and Dungey and Fry (2009) used an identification strategy in which they directly imposed 'sign restrictions'[20] on fiscal variables and restricted fiscal shocks to be orthogonal with other shocks. The sign restrictions approach has the advantages of restrictions are based on economic theory; monetary policy is directly taken into account; fiscal disturbances are precisely defined; and, there are no endogeneity (Canova and Pappa, 2007). However, the sign restrictions approach has no the ability to exactly identify when a shock occurs and may be overly powerful (Perotti, 2004).There are two key disadvantages of using. First, there is an inability to identify exactly when a shock occurs based on the persistence requirement imposed in defining a fiscal shock. Second, at times, the sign restrictions may be overly powerful, camouflage other plausible casual dynamic interrelations among the variables.

[19] Narratives method of identification is identification method which involves constructing a series from historical documents to identify the reason and/or the quantities associated with a particular change in a variable.

[20] Sign restrictions approach of identification is imposing restrictions on the signs of structural impulse responses for a given number of periods after the shock. The basic intuition is that structural shocks can be identified by checking whether the signs of the corresponding impulse responses (IR) are in line with economic theory.

Despite the superiority of the VAR and/or SVAR models over other models, they have their own limitations. Among the limitations of VAR approach the most important is it estimates only the lower orders of the variables leaving all other effects of higher orders variables and all other measurement errors are in the residuals. This can have effect on the impulse responses making them of less use for structural interpretations (Hendry, 1995). However, the approach is still for forecasting (Hendry and Doornik, 1997). The aforementioned limitations are not to mean that the impulse response done through VAR methods are of no importance, instead it has the message for the application of a careful empirical analysis following specification of the VAR model. Therefore, such limitations of the VAR models in do not reduce its superiority over the available models so far and, given the limited number of variables, it has to be noted that such response are not the exact but only the approximations to the structural models.

Cognizant of the aforementioned advantages and superiority of utilizing the SVAR approach over other alternative methods such as DSGE and VAR, many recent empirical studies are using this methodology. Moreover, the methodological review has shown that the Blanchard-Perotti identification strategy is still the superior, among the available identification strategies. Therefore, this study employs the SVAR methodology and the Blanchared-Perotti (1999) identification 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.

SECTION 3

MODEL SPESIFICATION AND ESTIMATION PROCEDURE

3.1. The Data Analysis

This study uses three variables with quarterly time series data that spans from the second quarter of 1995 to the fourth quarter of 20008 Ethiopian Fiscal Year. The first variable is real tax revenue. It consists of direct and indirect taxes, and import duties. The second variable is real government spending. It is defined as the sum of Central Government's capital expenditure and current expenditure. The third variable is the time series for real GDP. These quarterly data on taxes and government spending were directly obtained from the Ministry of Finance and Economic Cooperation (MoFEC) while real GDP is obtained from MoFEC's annual data and converted into quarterly data by the help of EViews frequency conversion.

The variables were pre-tested for the presence of unit root(s) to determine whether the series are stationary or difference-stationary to avoid spurious regression. Unit root tests were conducted using the Augmented Dickey-Fuller (1979). For the former, I choose to use the automatic lag length selection using a Schwarz Information Criterion (SIC) that used a maximum lag length of 10, while for the latter the default Kernel spectrum estimation method using the Andrews bandwidth was chosen. These methods were applied to all three time series. Table 1 show that taxes and spending are stationary at first-difference within the 1 percent critical level. In contrast, the test indicated that the GDP series was stationary at second differences.

It has been shown that the OLS estimator is consistent when a VAR has some unit roots equal to one but with fewer unit roots than variables. This eliminates the need to impose a cointegrating relationship or employ a vector-error correction model on the original data when our interest is not in drawing inferences about intercepts or about linear combinations of coefficients. Additionally, this modern approach get rid of concerns about the low power of the unit root tests, their sensitivity to structural breaks in the data as well as other pre-test biases associated with the traditional approach.

Table 1: Augmented Dickey-Fuller test statistic

Variables	t-Statistic for 1 to 10% c.v	t-Statistic 1% c.v	P-Value
D2RGDP	-4.708816	-4.165756	0.0004
DRG	-19.53249	-3.577723	0.0000
DRT	-27.10707	-4.152511	0.0001

All significant at 1 percent critical value

3.2. Model Specification and Estimation Procedure

As discusses in the review of methodologies, SVAR has superiorities over other approaches such as VAR. Therefore, this study employs the SVAR methodology and the Blanchared-Perotti identification 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 this end, it is important to make sure that the regression in VAR is not spurious.

The key to avoid spurious regression in VAR models, among others, is to add a sufficient number of autoregressive lags. Therefore, the process of determining the number of lagged values to include in the VAR model is an integral part of specifying a stable VAR model. Incorrectly specifying the lag length of a VAR model can result in inconsistent impulse responses and variance decompositions. Whereas over-fitting the model may lead to inefficiency, under-fitting the model may cause some dynamics in the system to be unrealized. Several methods and tests were used to identify the true lag length of the unrestricted VAR model with constant and trend. The correct lag length will depend on the criteria or measure we use. Akaike's information criterion (AIC) and Schwarz's information criterion (SIC) from the VAR system were analyzed to identify the appropriate lag length.

Table 2: VAR Lag Order Selection Criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	27.31370	NA	5.95e-05	-1.215685	-1.089019	-1.169886
1	72.13862	80.68485	9.94e-06	-3.006931	-2.500267	-2.823737
2	93.79729	35.73682	5.33e-06	-3.639865	-2.753203	-3.319276
3	138.3564	**66.83865***	**9.20e-07***	-5.417820	**-4.151160***	**-4.959835***
4	143.9532	7.555676	1.14e-06	-5.247659	-3.601002	-4.652280
5	146.7506	3.356885	1.66e-06	-4.937530	-2.910874	-4.204755
6	151.7524	5.251894	2.26e-06	-4.737620	-2.330967	-3.867450
7	161.9555	9.182808	2.50e-06	-4.797776	-2.011125	-3.790211
8	181.3495	14.54547	1.88e-06	-5.317474	-2.150825	-4.172514
9	195.2394	8.333974	2.10e-06	-5.561972	-2.015325	-4.279616
10	210.4516	6.845453	2.65e-06	**-5.872578***	-1.945933	-4.452827

Note: * indicates lag order selected by the criterion

The information criterion obtained through this method offers mixed results. Based on the AIC one should choose 10 lags, whereas the SIC suggests an order of 3 lag length. As mentioned already, the SIC criteria typically identifies the most parsimonious model while, in contrast, the AIC chooses the model with the largest lag length and asymptotically overestimates the true order (Lütkepohl, 1999). Therefore, most chosen is SC criterion for it is generally more conservative in terms of lag length than the AIC and this study too chooses SC with three lag length.

The other important test that has to be done before the VAR regression is the stability of the model. This test is carried out using the AR roots table and graph. The estimated VAR (3) is stable if the inverse roots of the modulus are less than one and lie inside the unit circle. The results of the impulse analysis will not be valid, if the VAR is not stable. There are 9 roots in the graph, equating the number of endogenous variables, 3, in the VAR multiplied by the number of lags, 3. The test verifies that no roots lie outside the unit circle, which implies that the unrestricted VAR model with an order of four lags is stable and fit to conduct impulse response

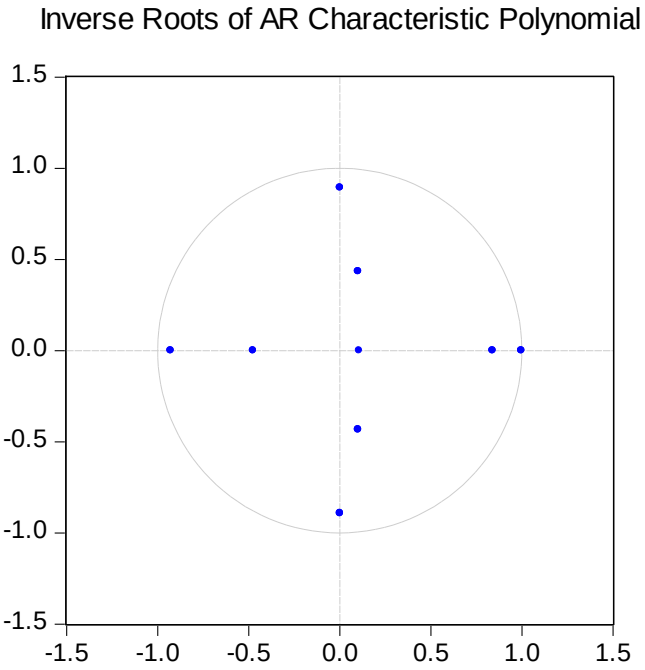
analysis. The Figure 1 shows the graphical representation of the inverse roots of the characteristic AR.

Table 3: VAR regression stability

Root	Modulus
0.998314	0.998314
-0.927732	0.927732
0.002245 - 0.892261i	0.892263
0.002245 + 0.892261i	0.892263
0.840627	0.840627
-0.474475	0.474475
0.101293 - 0.433466i	0.445144
0.101293 + 0.433466i	0.445144
0.107157	0.107157

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

Figure 1: VAR regression stability



Since it is assumed that all the variables in the VAR (3) are endogenous, the validity of this assumption was tested using the pairwise Granger causality tests. The statistic for joint significance of the lagged endogenous variables in all three equations revealed that we cannot reject the null hypothesis that the variables in the system can be treated as exogenous at a 10% level of significance. However, if any variable is found to be strictly exogenous, then the restrictions in the identification scheme should restrict the ability of the exogenous variable to react to innovations of other variables in the model.

Many diagnostic tests have been carried-out on the residuals for the VAR (3) model. Three autocorrelation tests namely, the pairwise cross-correlograms test, the Portmanteau Autocorrelation Test and the autocorrelation LM Test were conducted and revealed that there are no issues with serial autocorrelation in the stable VAR (3) model. Similarly, the results of the White Heteroskedasticity Test with no cross terms under the null of no heteroskedasticity or (no

misspecification) for the joint significance of the regressors showed favorably that we cannot reject the null of no misspecification at the 10% level of significance.

3.3. Structural Vector Autoregressive (SVAR)

Before immediately going to SVAR, let's first look at the reduced form VAR. The VAR is an econometric method to model multivariate time series. This method has distinct features such as; all variables of interest are endogenous, all equations use same explanatory variables, and explanatory variables are mainly lagged variables. Another interesting feature of VAR model is its dynamic characteristic which can be captured through impulse response function and variance decompositions. Moreover, its ease of using and success in prediction as compared to the complex simultaneous models makes it more appealing to macroeconomists. The use of VAR approach became increasingly predominant in the empirical literature, in particular on the effect of monetary policy, since the 1980s. However, it is difficult to find empirical work on fiscal policy using VAR model until the late 1990s.The structural equations are;

$$g_t + a_{12}t_t + a_{13}y_t = b_{10} + \sum_{i=1}^{p} b_{11}^{i}\, g_{t-i} + \sum_{i=1}^{p} b_{12}^{i}\, t_{t-i} + \sum_{i=1}^{p} b_{13}^{i}\, y_{t-i} + e_t^{g} \quad \ldots\ldots\ldots\ldots (1)$$

$$a_{21}g_t + t_t + a_{23}y_t = b_{20} + \sum_{i=1}^{p} b_{21}^{i}\, g_{t-i} + \sum_{i=1}^{p} b_{22}^{i}\, t_{t-i} + \sum_{i=1}^{p} b_{23}^{i}\, y_{t-i} + e_t^{t} \quad \ldots\ldots\ldots (2)$$

$$a_{31}g_t + a_{32}t_t + y_t = b_{30} + \sum_{i=1}^{p} b_{31}^{i}\, g_{t-i} + \sum_{i=1}^{p} b_{32}^{i}\, t_{t-i} + \sum_{i=1}^{p} b_{33}^{i}\, y_{t-i} + e_t^{y} \quad \ldots\ldots\ldots (3)$$

Where e_t^y , e_t^g , and e_t^t are identically independently distributed with mean zero, and variance δ_t^y , δ_t^g , *and* δ_t^t *for GDP, Government spending and Tax, respectively and zero covarian among all variables. It can be written as follows in matrix form;*

$$\begin{pmatrix} e_t^g \\ e_t^t \\ e_t^y \end{pmatrix} \sim \text{i.i.d.} \left(\begin{pmatrix} 0\delta_t^g \\ 0 \\ 0 \end{pmatrix} \begin{pmatrix} 0 & 0 & \\ 0 & \delta_t^t & 0 \\ 0 & 0 & \delta_t^y \end{pmatrix} \right)$$

Then the above three simultaneous equations can be written in matrix form as follows;

$$\underbrace{\begin{bmatrix} 1 & a_{12} & a_{13} \\ a_{12} & 1 & a_{13} \\ a_{31} & a_{33} & 1 \end{bmatrix}}_{A} \underbrace{\begin{bmatrix} g_t \\ t_t \\ y_t \end{bmatrix}}_{Z_t} = \underbrace{\begin{bmatrix} b_{10} \\ b_{10} \\ b_{10} \end{bmatrix}}_{B_0} + \underbrace{\begin{bmatrix} b_{11} & b_{12} & b_{13} \\ b_{21} & b_{22} & b_{23} \\ b_{31} & b_{32} & b_{33} \end{bmatrix}}_{B} \underbrace{\begin{bmatrix} g_{t-i} \\ t_{t-i} \\ y_{t-i} \end{bmatrix}}_{Z_{t-i}} + \underbrace{\begin{bmatrix} e_t^g \\ e_t^t \\ e_t^y \end{bmatrix}}_{U_t} \quad \ldots\ldots (4)$$

Where I = 1, 2, … n.

In more compact way, the equation system of (4) can be expressed in a vector form as follows;

$AZ_t = B_0 + BZ_{t-1} + \varepsilon_t$ …….…… (5)

Where;

AZ_t = an (n by 1) vector containing real GDP growth, y_t, tax revenue, t_t, and government spending, g_t.

A = an (n by n) square matrices of contemporaneous coefficients.

B_0 = an (n by 1) vector of intercept terms.

B = an (n by n) square matrices of coefficients.

ε_t = an (n by 1) vector of error terms.

From equation 5, it follows that the reduced form of VAR can be derived by pre-multiplying both right hand-side and left hand-side with A^{-1} to get;

$Z_t = A^{-1} B_0 + A^{-1}BZ_{t-1} + A^{-1}\varepsilon_t$ …….…… ..(6)

Now define $F_0 = A^{-1} B_0$, $F_1 = A^{-1}B$, and $U_t = A^{-1}\varepsilon_t$, which gives the multivariate generalization of VAR, as follows;

$Z_t = F_0 + F_0Z_{t-1} + U_t$ …….…… (7)

In matrix form equation 7 can be written as follows;

$$\underbrace{\begin{bmatrix} g_t \\ t_t \\ y_t \end{bmatrix}}_{Z} = \underbrace{\begin{bmatrix} f_{10} \\ f_{10} \\ f_{10} \end{bmatrix}}_{F_0} + \underbrace{\begin{bmatrix} f_{11} & f_{12} & f_{13} \\ f_{21} & f_{22} & f_{23} \\ f_{31} & f_{32} & f_{33} \end{bmatrix}}_{F_1} \underbrace{\begin{bmatrix} g_{t-i} \\ t_{t-i} \\ y_{t-i} \end{bmatrix}}_{Z_{t-i}} + \underbrace{\begin{bmatrix} u_t^g \\ u_t^t \\ u_t^y \end{bmatrix}}_{U_t} \quad \ldots\ldots\ldots\ldots\ldots\ldots (8)$$

Each equation in equation 7 or 8 is the standard reduced form VAR which is plausible of estimating the Ordinary Least Square (OLS) method of estimation. This is because unlike in the SVAR this reduced form has the right hand-side consist of predetermined variables and a white-noise error terms. However, the errors are uncorrelated within an equation but correlated across equations, which makes it difficult to estimate using OLS. This means the existence of contemporaneous effects we use not OLS instead SVAR. The problem with VAR is explained by Amisano and Giannini (1997, PP. 16) as follows:

"[A] VAR model has to be considered as a reduced form model where no explanations of the instantaneous relationships among variables are provided. These instantaneous relationships are naturally hidden in the correlation structure of the Σ matrix, and left completely uninterpreted."

3.3.1. Imposing Short-Run Restriction

Following the so called the AB-model of Amisano and Giannini (1997), the relation between the reduced form residuals of equation7 or 8 and the structural shocks of equations 4 or 5 can be expressed as follows;

$$AU_t = B\varepsilon_t \quad \ldots\ldots\ldots\ldots\ldots\ldots (9)$$

$$\begin{bmatrix} u_t^g \\ u_t^t \\ u_t^y \end{bmatrix} = \begin{bmatrix} f_{10} \\ f_{10} \\ f_{10} \end{bmatrix} + \begin{bmatrix} 1 & a_{12} & a_{13} \\ a_{21} & 1 & a_{23} \\ a_{31} & a_{33} & 1 \end{bmatrix}^{-1} \begin{bmatrix} b_{11} & b_{12} & b_{13} \\ b_{21} & b_{22} & b_{23} \\ b_{31} & b_{32} & b_{33} \end{bmatrix} \begin{bmatrix} u_t^g \\ u_t^t \\ u_t^y \end{bmatrix} \quad \ldots\ldots\ldots\ldots (10)$$

The matrices A and B are the (n by n) matrices describing the contemporaneous relation between the variables and how the structural shocks affects the variables, respectively. The Enders (1995) SVAR estimation procedure is employed which assumes the structural shocks as orthogonal.

The SVAR and the alternatives identification approaches to Choleski decomposition, which lacks economic theory in imposing restrictions on the variables under-consideration, are important moves in the macroeconomic analysis. The problem of the standard reduced VAR and its Choleski decomposition and the need for alternative is explained by Enders (2015, PP 313) as follows;

"A researcher interested only in forecasting might want to trim down the over parameterized VAR model in order to improve the precision of the estimates and reduce the forecast-error variance. Nonetheless, it should be clear that forecasting with a VAR is multivariate extension of forecasting using a simple autoregression. However, given the somewhat ad hoc nature of Choleski decomposition, the beauty of the approach seems diminished when constructing impulse response functions and forecast error variance decompositions. Moreover, the VAR approach has been criticized as being devoid of any economic content."

The residuals from the standard reduced form VAR from equation 6 or 7 have little economic significance. The residuals are simply the linear combinations of the underlying structural output, government spending and tax revenue shocks. These relations can be written as;

$$u_t^g = b_1 u_t^y + b_2 e_t^g + e_t^g \quad \text{.......} \quad (11)$$

$$u_t^t = c_1 u_t^y + a_2 e_t^g + e_t^t \quad \text{.......} \quad (12)$$

$$u_t^y = a_1 u_t^t + a_2 u_t^g + e_t^y \quad \text{.......} \quad (13)$$

where e_t^y, e_t^r and e_t^r are mutually uncorrelated structural shocks; and e_t^r and e_t^g are the structural fiscal shocks of government taxes and expenditure with cov($e_t^r e_t^g$). Equation (13) defines unexpected movements in taxes, u_t^t, can be due to one of three factors: the response to unexpected movements in output, captured by $c_1 u_t^y$, the response to structural shocks to spending, captured by $a_2 e_t^g$, and to structural shocks to taxes, captured by e_t^t. The interpretation applies, in a similar fashion, for the unexpected movements for spending and output. The cumulative effect of fiscal policy on output, within a quarter, is given as the sum of the responses to structural shocks to tax revenue, spending

and output, captured by $a_1 u_t^t, a_2 u_t^g and\ e_t^y$respectively. To identify this system of equations, we need to follow three steps Blanchard and Perotti (1999).

Step 1

The parameters c_1 and b_1 can be constructed based on the institutional information about tax and spending. As the data used in this study are quarterly data, the discretionary adjustment to fiscal policy response to unexpected events within a quarter is hardly possible.This is mainly because, it is very difficult for policymakers in the government to learn about what is going on with output and respond to the shock with whatever approved fiscal policy within a quarter period of time, which may actually take them a year or more. Now, the coefficients are left to capture the automatic effects of output on taxes and spending under existing fiscal policy rules. However, it is not expected to have automatic feedback from output to government spending, hence, we take b_1 as zero. With regards toc_1, which is the elasticity of taxes is calculated as follows;

$$c_1 = \sum_1^2 \eta\, T_i, B_i \;\; \eta B_i, \text{y} \frac{Ti}{T} \qquad \text{(14)}$$

where, T_i,B_i denotes the elasticity of taxes of type I to their tax base, whereas, B_i,y denotes the elasticity of the tax base to output.

$$u_t^g = b_2 e_t^g + e_t^t \qquad \text{(15)}$$

$$u_t^t = c_1 u_t^y + a_2 e_t^g + e_t^t \qquad \text{(16)}$$

$$u_t^y = a_1 u_t^t + a_2 u_t^g + e_t^y \qquad \text{(17)}$$

Step 2

Once the c_1 and b_1 are estimated, the cyclically adjusted reduced form of tax and spending can be constructed respectively as; $u_t^{t\prime}$ = u_t^t - $c_1 u_t^y$ and $u_t^{g\prime}$ = u_t^g - $b_1 u_t^y$ or $u_t^{g\prime}$ = u_t^g as b_1 = 0. From this we can see that $u_t^{t\prime}$ and $u_t^{g\prime}$ are uncorrelated e_t^y to use them as instruments to estimate a_1 and a_2 in a regression of y_t on $g_t$andt_t.

Step 3

Now we are left with two coefficients to be estimated c_2 and b_2 in which $u_t^{t\prime}$ and $u_t^{g\prime}$are not helpful. The question now is what will happen to the responsiveness of taxes when the

government increases taxes and spending simultaneously? We can identify this in two ways, assuming the decision are taken at different times; first we may assumes the government first increase taxes then c_2 is zero then we can estimate b_2; second we assumes spending decision comes first then b_2 is zero and we can estimate c_2.

$$\begin{pmatrix} 1 & 0 & -a_{13} \\ -a_{21} & 1 & -a_{23} \\ -a_{31} & -a_{33} & 1 \end{pmatrix} \begin{pmatrix} u_t^g \\ u_t^t \\ u_t^y \end{pmatrix} = \begin{pmatrix} b_{11} & b_{12} & 0 & u_t^g \\ b_{21} & b_{22} & 0 & u_t^t \\ 0 & 0 & b_{33} & u_t^y \end{pmatrix} \quad \text{..... (18)}$$

The two coefficients that need to be identified using external information are the elasticities of real taxes and real spending with respect to each of output. These correspond to the coefficients a_{13} and a_{23}. The elasticity of tax revenue with respect to GDP is 0.9, found from the estimation of Total revenue against GDP. The elasticity of government spending with respect to GDP is set to zero. This is based on the assumption that real government spending would not respond to contemporaneous changes in GDP in a quarter. Now, our matrices, A and B, has the form;

$$\begin{pmatrix} 1 & 0 & 0.9 \\ -a_{21} & 1 & 0 \\ -a_{31} & -a_{33} & 1 \end{pmatrix} \begin{pmatrix} u_t^g \\ u_t^t \\ u_t^y \end{pmatrix} = \begin{pmatrix} b_{11} & 0 & 0 \\ b_{21} & b_{22} & 0 \\ 0 & 0 & b_{33} \end{pmatrix} \begin{pmatrix} u_t^g \\ u_t^t \\ u_t^y \end{pmatrix} \quad \text{..... (19)}$$

3.3.2. Imposing Long-Run Restrictions

So far, we have seen the SVAR model specification and estimation procedures. It is now time to see the model specification and estimation procedure for the long-run effect of fiscal policy. To impose the long-run restrictions, we need to return to the unrestricted VAR estimate:

$$Z_t = A^{-1}\mathrm{C(L)}Z_t + A^{-1}\mathrm{B}e_t \quad \text{..... (20)}$$

With some rearrangements, equation 20 can be written as follows;

$$[I - A^{-1}C(L)]\, Z_t = A^{-1}Be_t$$

$$Z_t = [I - A^{-1}C(L)]^{-1}\, A^{-1}Be_t \text{ …………………………………………. (21)}$$

From equation 21 we can see that the structural shocks affecting the long-run levels of the variables. If we define a matrix:

$$C = [I - A^{-1}C(L)]^{-1}\, A^{-1}B \text{ …..………………………………… (22)}$$

the aggregate effect of a shock e_t's is given by matrix C. Therefore, if we assume that the long-run cumulative effect of a sub-shock e_i on a variable Z_j is zero, then the column I and row j of matrix C should be zero. Knowing the value of matrix C something about matrices A and B. Due to the fact that the number of restrictions required EViews also imposes the restriction that matrix A is identity matrix. It uses matrix C to estimate matrix B.

The author imposes the following restrictions to matrix C:

A. Real spending shocks have no long-run effects on real tax and on its own; and
B. Real tax shocks have no long-run effect on itself.

Now let's put the C matrix with the imposed restrictions:

$$C = \begin{pmatrix} 0 & 0 & NA \\ 0 & \text{NA} & NA \\ NA & NA & NA \end{pmatrix} \text{ …………………………………….... (23)}$$

This can be then estimated using the long-run SVAR estimation method and results interpreted.

SECTION 5
EMPERICAL RESULTS AND INTERPRETATION

5.1. Empirical Results

The Maximum Likelihood estimates of coefficients of the short-run SVAR estimation with the corresponding p-values in parenthesis below each coefficient is given in table 4. The coefficients for the contemporaneous effect of government spending and revenues on income have the expected signs. The sign for government spending on GDP is positive and significant, which was supposed to be. This means government can stimulate the economy through its internment spending. Similarly, the sign on tax effect on GDP is negative, which was expected to be negative. However, the effect of tax is insignificant. While higher government spending has a positive contemporaneous effect on GDP about 0.57 percent, the immediate impact of increasing government revenues results in a decrease in GDP by about 0.18 percent. The effect is slightly higher in the case of government spending and statistically significant.

Table 4: Estimates of Matrices A and B of the Short-run

A

1.000000	0.000000	0.900000
-0.307841 (0.1501)	1.000000	0.000000
0.566039 (0.0095)	- 0.177674 (0.3647)	1.000000

B

0.101629 (0.0000)	0.000000	0.000000
0.000000	0.095615 (0.0000)	0.000000
0.000000	0.000000	0.096890 (0.0000)

The long-run estimation result also shows government spending has a positive impact on GDP of about 0.02 percent and of course very significant. However, the impact of tax is positive but very insignificant.

Table 5: Estimates of Matrix C for the Long-Run

C =

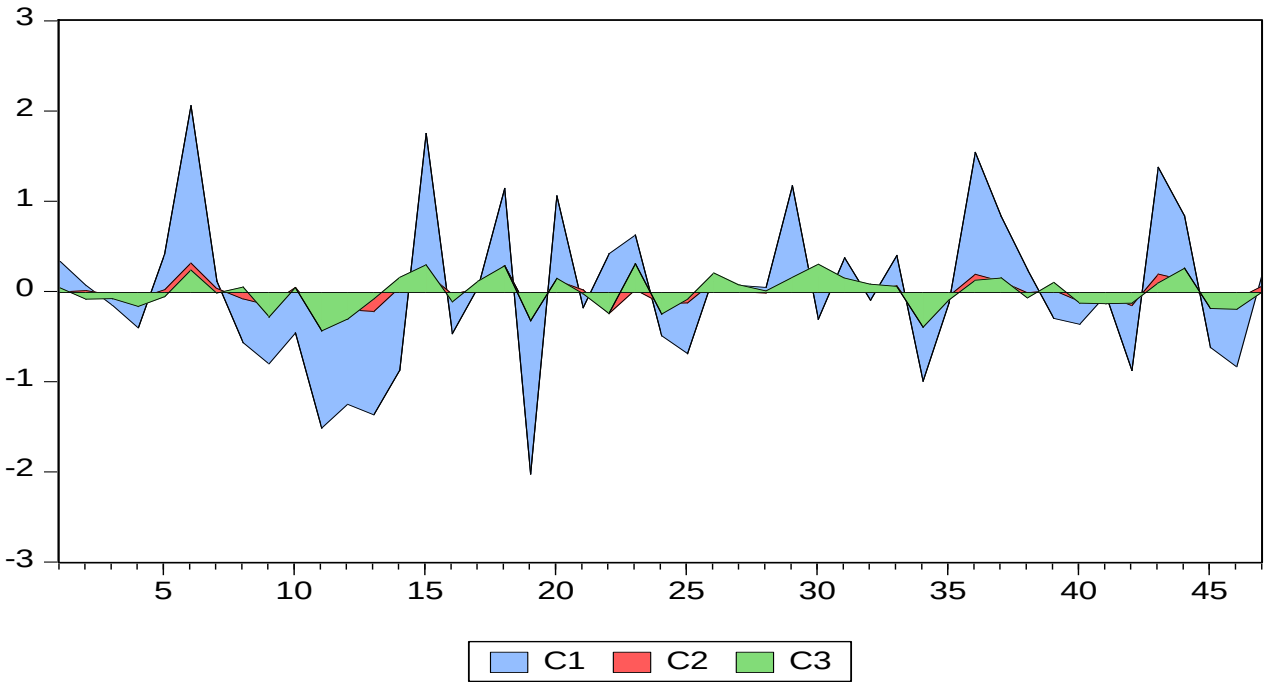
0.000000	0.000000	0.028403 0.0000
0.00000	0.044787 (0.0000)	0.023059 (0.0009)
0.021513 (0.0000)	0.002046 (0.5154)	-0.001717 (0.5853)

5.2. Interpretation of the Fiscal Shock

Now we are in a position to estimate or generate the structural shocks, $e_t's$, from the estimated structural VAR. This is very important to have an idea of what has been going on in the economy within the time period 1995 second quarter to 2008 second quarter with regard to government spending, government tax revenue, and GDP. To do this we use Ae_t =Bu_t , where is the error generated from the reduced VAR regression, and A and B are the matrices already identified in the estimated SVAR. Then, the structural shocks are given by: e_t = B^{-1}Au_t. Following these procedures, we reach at the estimated structural shocks of taxes, government spending and GDP as shown in Figure 2.

It would be useful to assess the shocks in relation to other methods of identifying fiscal shocks. One such approach is the narrative approach as employed in Romer and Romer (2010). Estimating shocks using the narrative approach would be a useful area of future work. Nevertheless, from visual inspection we can observe that there is some congruence between the shocks and some well-known policy changes.

Figure 2: Quarterly shocks in Real Government Spending – C1, Real GDP –C2, and Real Tax Revenue – C3.



The tax and GDP shocks are not that big as compared to the shocks in government spending. Positive tax shocks are harder to relate to policy changes, perhaps as structural revenue increases tend to occur over time through fiscal drag rather than through announced tax rate increases. The GDP, however, seems more stable. We can observe that there are large positive shock in the first 5^{th} to 6^{th} quarter and then large and sustained negative shocks in the next first 9 quarters or two years in government spending (see Figure 2). This timing is consistent with the war with Eritrea and the droughts that the country faced across time periods. In this case the downward spending may reflect the spending following the unexpected spending for war or draught of each year. The magnitude of shock and the shock volatility is higher for government spending than tax and GDP.

5.3. Impulse response functions

This section presents empirical results for pure government spending and tax shocks of real GDP. Impulse responses trace out the responsiveness of the dependent variables in the VAR or SVAR to shocks to the error term. Therefore, the impulses for the responses of output to the fiscal shocks can be interpreted as constant Birr multipliers and can be interpreted as giving the reaction of the responding variable, in percent of real GDP, to a fiscal shock of size 1 percent of real GDP, government spending and tax revenue, at their respective times.

5.3.1. Impulse Response of Real GDP to Government Spending

Figure 4 displays the impulse response function (IRFs)[21] of Real GDP to a positive government spending shock. The government spending shock is highly persistent with ups and downs in within the quarters. The immediate impact of a one percent of GDP increase in spending on Real GDP is around 0.04 percent with similar magnitude of -0.03 percent fall in the second quarter. Through time, the response of real GDP to the shock in government spending has come to about its long-run growth rate of or to almost zero response at the 12^{th} quarter or after three years of responses. The persistence of government spending shocks is not a strange result to Ethiopia as a

[21] IRFs measure the reaction of the system‘s variables at t+h, for h=0, …, H to a shock of the disturbance vector of e_i.

typical finding in the fiscal VAR studies supports this result (Blanchard and Perotti, 2002; Perotti, 2005; Fatas and Mihov, 2001).

The quarter after quarter impulse response of Real GDP to government spending shocks are positive for some quarters then negative etc. However, when we see the accumulated impulse response (AIRFs)[22] of Real GDP to government spending the result is different. As can be seen from Figure 5, the accumulated response is positive and decreases to almost zero after 12 quarters or there years. This means, the shock in government spending is positive, which reaches 0.04 percent increase in Real GDP in the first quarter then reaches to nearly zero percent in the 12th quarter after positive accumulated shocks within the quarters.

Figure 4: Response ofReal GDP to Structural One S.D. Government Spending

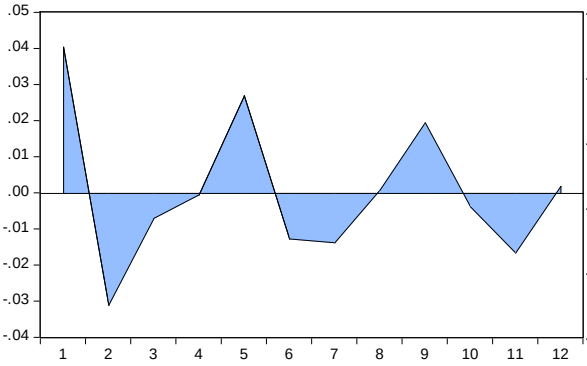
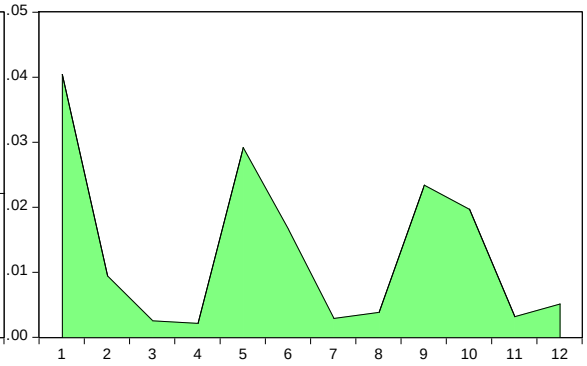


Figure 5: Accumulated Response of Real GDP to Structural One S.D. Government Spending



5.3.2. Impulse Response of Real GDP to Government Tax Revenue

The tax revenue shock results in a negative response in Real GDP growth. The immediate response of Real GDP to the shock revenue is about -0.01 percent (see figure 6). Such negative response is not that big as compared to the response to government spending. However, the response to tax revenues oscillates between negative and plosive until it reaches 0.01 in the 12th quarter. It seems that a negative effect of current year is fully offset by the negative response in the following quarter.

[22] AIRFs are the accumulated effect of a unit change in a structural shock on a variable, over time period.

When we come to the accumulated impulse response of Real GDP to the shock in tax revenue; the result seems similar to the immediate responses. However, as can be seen in figure 6 the negative response seems to outweigh the positive response that follows the negative response. This can clearly show that the negative impact of tax on Real GDP growth gets critical time after time. This entails, the positive response to government spending is partly offsite by the shock in tax revenue, which calls for government to be cautious of its way of financing spending. This means government should look alternative financing means for any spending above and over the finance available from the existing tax rates and leave the current tax rates unchanged.

Figure 6: Response of Real GDP to Structural One S.D. Tax Revenue

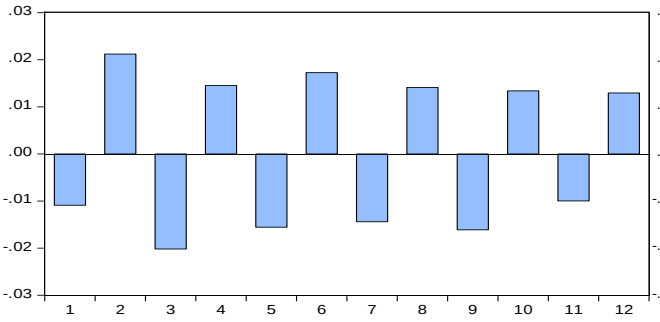
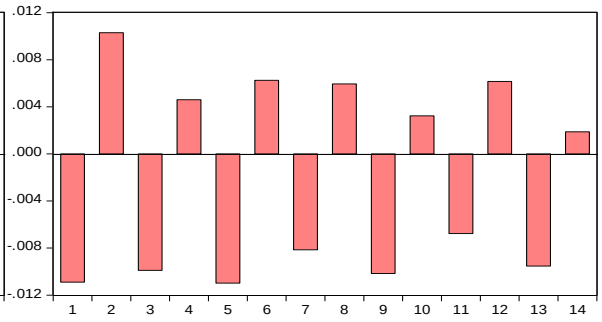


Figure 7: Accumulated Response of Real GDP to Structural One S.D. Tax Revenue



5.3.3. Impulse Response of Real GDP to Real GDP

Figure 9 displays the responses of Real GDP to its own unit shock. As compared to the response of Real GDP to government spending the response here is bigger and is about 0.06 percent. After ups and downs of responses, eventually the response comes to zero following 15 quarters of response. The accumulated response of Real GDP is positive and declines to around zero response after 16 quarters (see figure 8).

Figure 8: Accumulated Response of Real GDP to Structural One S.D. Real GDP

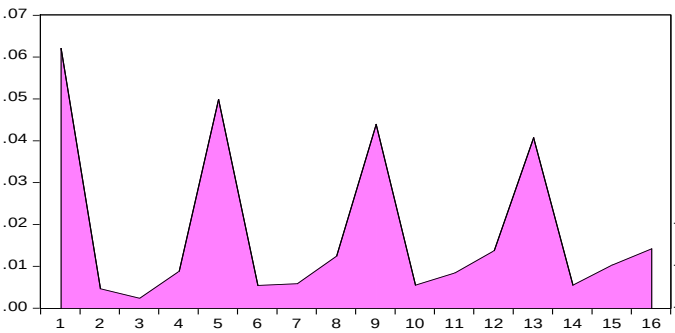
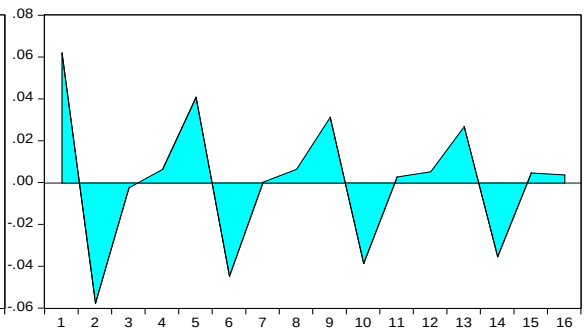


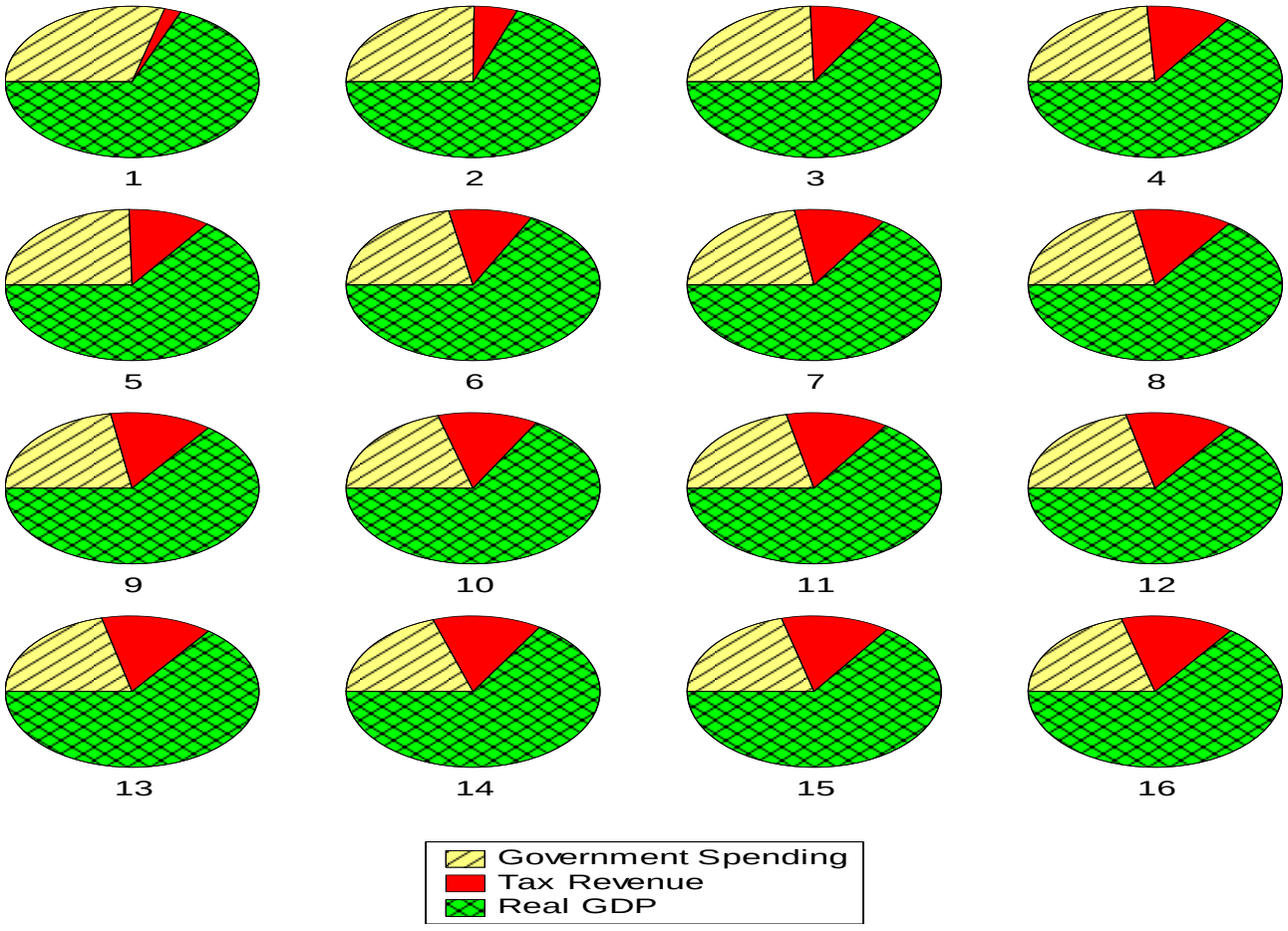
Figure 9: Response of Real GDP to Structural One S.D. Real GDP



5.4. Variance Decomposition of Real GDP

The Forecast Variance Error Decompositions (FVEDs) for each variable measures the contribution of each type of shock to the forecast error variance of that variable. Thus, they provide information about the relative importance of each shock in affecting the endogenous variables in the VAR or SVAR. Figure 10 shows the results of the variance decompositions of Real GDP. In line with the majority of fiscal VAR studies, the shocks to Real GDP itself explains almost all of its forecast error variance at short horizons. Fiscal shocks in total explain approximately 6 and 13 percent of the forecast error variation in output within 12 and 20 quarters respectively. Tax revenue shocks are found to have relatively small impact in the initial quarters and grows through time to the level that spending's impact. Thus, consistent with Claus et al. (2006), we find that the impact of fiscal policy on the GDP cycle has been relatively small.

Figure 10: Variance Decomposition of Real GDP



SECTION 6
CONCLUSION AND POLICY IMPLICATION

This paper has estimated a fiscal SVAR model for Ethiopia to investigate the effects of fiscal policies on Ethiopia's economic growth. It uses quarterly data over the period 1995 second quarter to 2008 second quarter of Ethiopian Fiscal Year. The impact of real government spending and real tax revenue shocks have been analyzed through impulse response functions and variance decomposition from the SVAR model. Structural innovations are identified by the Blanchard and Perotti approach. In addition to the implied coefficients of the benchmark identification approach, exogenous elasticites are computed, which is found to be 0.0.90

The result of the SVAR estimates of coefficients of the short-run SVAR for the contemporaneous effect of government spending and revenues on income have the expected signs. The sign for government spending on GDP is positive and significant, which was supposed to be. This means government can stimulate the economy through its spending. Similarly, the sign on tax effect on GDP is negative, which was expected to be negative. However, the effect of tax is insignificant. While higher government spending has a positive contemporaneous effect on GDP about 0.57 percent, the immediate impact of increasing government revenues results in a decrease in GDP by about 0.18 percent. The effect is slightly higher in the case of government spending and statistically significant.

In order to see the dynamic response of Real GDP to fiscal variables, the impulse response function is carried out. The result shows that a positive shock in government spending shock has a positive immediate response of 0.04 percent while it is a negative 0.01 for tax revenue. The accumulated response function shows a positive government shock has persistent positive impact on Real GDP, which actually falls through time from 0.04 percent in the first quarter to about zero percent in the 12^{th} quarter. However, the accumulated response of Real GDP to a positive tax revenue shock is negative followed by positive etc but the negative outweighs the preceding positive impact. This shows that, any attempt by the government to collect more revenue through increase in tax rate has persistent negative impact on Real GDP growth rate.

In order to see how important are the impacts of fiscal policy variables on Real GDP growth rate, the FVEDs estimation has been carried out and analyzed. The result shows that about 80 percent of the variation in Real GDP comes from the variation in itself. The shocks to Real GDP are explained by the forecast error variance of tax revenue and government spending approximately 2 and 18 percent, respectively, in the first quarter. This then has become almost each equally 10 percent in the later quarters.

The important policy implication of the study is government that the impact of government spending on Real GDP is positive and significant. Therefore, it is important for the government to continue its spending. However, it seems that the fiscal multiplier is very small, which calls for the government to focus on expenditures which are growth enhancing such as expenditures in infrastructure. Moreover, increase in tax revenue results in a decrease in Real GDP growth rate, which entails any spending in extra of the revenue from the current resources should be finance by other ways and not by an increase in tax rates.

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APPENDICES

Appendix I: Estimation result for output and elasticity of tax revenue

A. Estimation result for output elasticity of tax revenue

Dependent Variable: D2LNTR
Method: Least Squares
Date: 06/04/16 Time: 18:14
Sample (adjusted): 1996Q3 2007Q4
Included observations: 46 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D2LNY	0.920215	0.011285	81.54251	0.0000

R-squared	0.993276	Mean dependent var	-0.016374
Adjusted R-squared	0.993276	S.D. dependent var	1.172432
S.E. of regression	0.096137	Akaike info criterion	-1.824596
Sum squared resid	0.415900	Schwarz criterion	-1.784843
Log likelihood	42.96570	Hannan-Quinn criter.	-1.809704
Durbin-Watson stat	2.676428		

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

B. VAR Lag order selection criterion

VAR Lag Order Selection Criteria
Endogenous variables: DLNG D2LNY DLNT
Exogenous variables: C
Date: 06/03/16 Time: 06:27
Sample: 1 52
Included observations: 40

Lag	LogL	LR	FPE	AIC	SC	HQ
0	27.31370	NA	5.95e-05	-1.215685	-1.089019	-1.169886
1	72.13862	80.68485	9.94e-06	-3.006931	-2.500267	-2.823737
2	93.79729	35.73682	5.33e-06	-3.639865	-2.753203	-3.319276
3	138.3564	**66.83865***	**9.20e-07***	-5.417820	**-4.151160***	**-4.959835***
4	143.9532	7.555676	1.14e-06	-5.247659	-3.601002	-4.652280
5	146.7506	3.356885	1.66e-06	-4.937530	-2.910874	-4.204755
6	151.7524	5.251894	2.26e-06	-4.737620	-2.330967	-3.867450
7	161.9555	9.182808	2.50e-06	-4.797776	-2.011125	-3.790211
8	181.3495	14.54547	1.88e-06	-5.317474	-2.150825	-4.172514
9	195.2394	8.333974	2.10e-06	-5.561972	-2.015325	-4.279616
10	210.4516	6.845453	2.65e-06	**-5.872578***	-1.945933	-4.452827

* 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

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

Test results for Model Stability

Roots of Characteristic Polynomial
Endogenous variables: LNG LNY LNT
Exogenous variables: C
Lag specification: 1 3
Date: 06/05/16 Time: 12:25

Root	Modulus
0.998314	0.998314
-0.927732	0.927732
0.002245 - 0.892261i	0.892263
0.002245 + 0.892261i	0.892263
0.840627	0.840627
-0.474475	0.474475
0.101293 - 0.433466i	0.445144
0.101293 + 0.433466i	0.445144
0.107157	0.107157

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

Test result for Residual Autocorrelation

VAR Residual Serial Correlation LM Tests
Null Hypothesis: no serial correlation at lag order h
Date: 06/05/16 Time: 12:14
Sample: 1 52
Included observations: 46

Lags	LM-Stat	Prob
1	2.672175	0.9759
2	5.661024	0.7733
3	5.378017	0.8002
4	8.151890	0.5189
5	12.92886	0.1659
6	3.436530	0.9445
7	7.775596	0.5569
8	18.92655	0.0258
9	7.427086	0.5927
10	14.62294	0.1018
11	6.014781	0.7384
12	3.599421	0.9357

Probs from chi-square with 9 df.

Heteroskedasticity Tests Result

VAR Residual Heteroskedasticity Tests: No Cross Terms (only levels and squares)
Date: 06/05/16 Time: 13:16
Sample: 1 52
Included observations: 49

Joint test:

Chi-sq	df	Prob.
112.6010	108	0.3617

Test result for Normality of Estimated Residuals

VAR Residual Normality Tests
Orthogonalization: Cholesky (Lutkepohl)
Null Hypothesis: residuals are multivariate normal
Date: 06/05/16 Time: 13:19
Sample: 1 52
Included observations: 49

Component	Skewness	Chi-sq	df	Prob.
1	0.200829	0.329381	1	0.5660
2	1.048573	8.979293	1	0.0027
3	0.592852	2.870370	1	0.0902
Joint		12.17904	3	0.0068

Component	Kurtosis	Chi-sq	df	Prob.
1	3.189281	0.073147	1	0.7868
2	5.010983	8.256606	1	0.0041
3	2.799136	0.082374	1	0.7741
Joint		8.412127	3	0.0382

Component	Jarque-Bera	df	Prob.
1	0.402528	2	0.8177
2	17.23590	2	0.0002
3	2.952744	2	0.2285
Joint	20.59117	6	0.0022

Test result of Johansen Cointegration Test

Date: 06/05/16 Time: 13:20
Sample (adjusted): 4 52
Included observations: 49 after adjustments
Trend assumption: Linear deterministic trend
Series: LNG LNY LNT
Lags interval (in first differences): 1 to 2

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.630980	54.44469	29.79707	0.0000
At most 1	0.106799	5.596420	15.49471	0.7426
At most 2	0.001268	0.062188	3.841466	0.8031

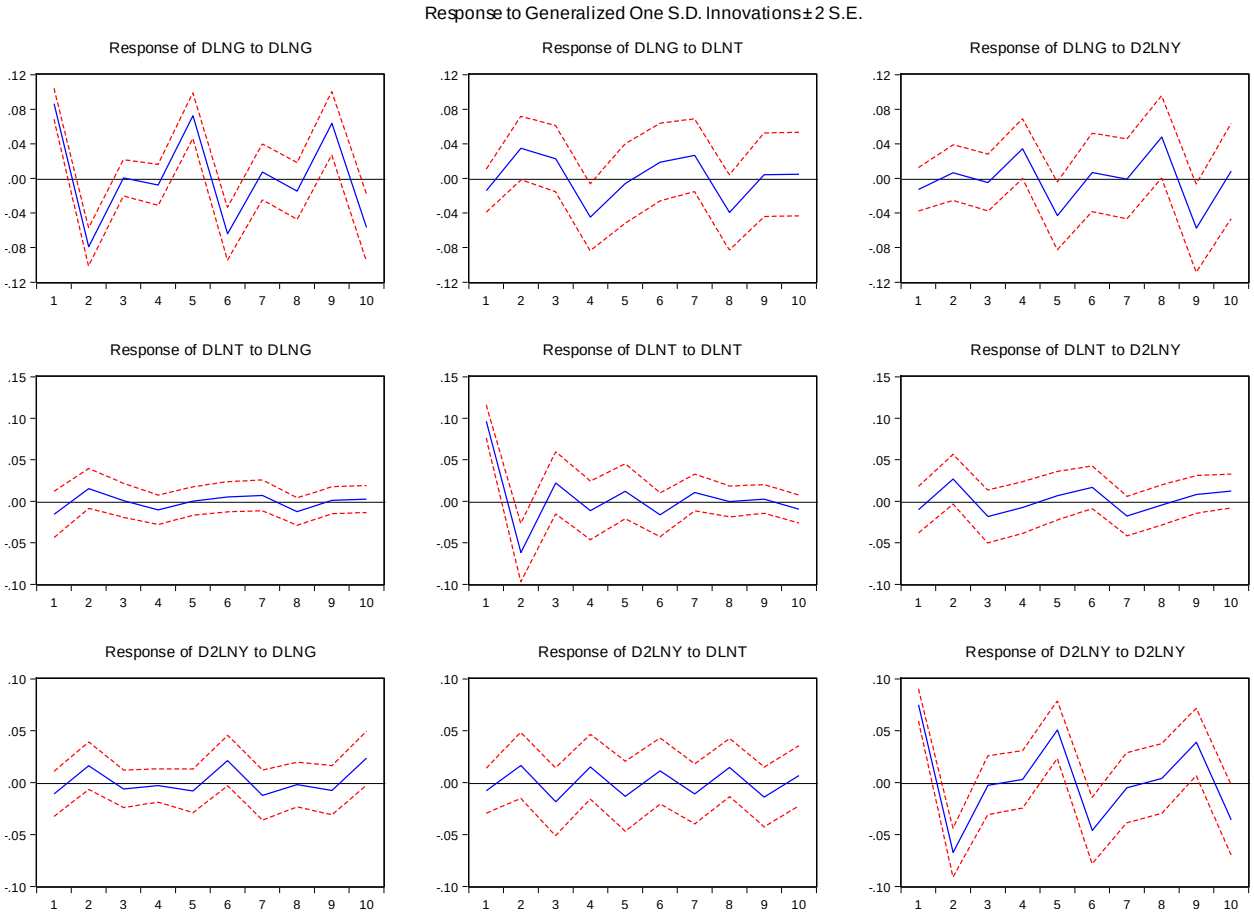
Trace test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

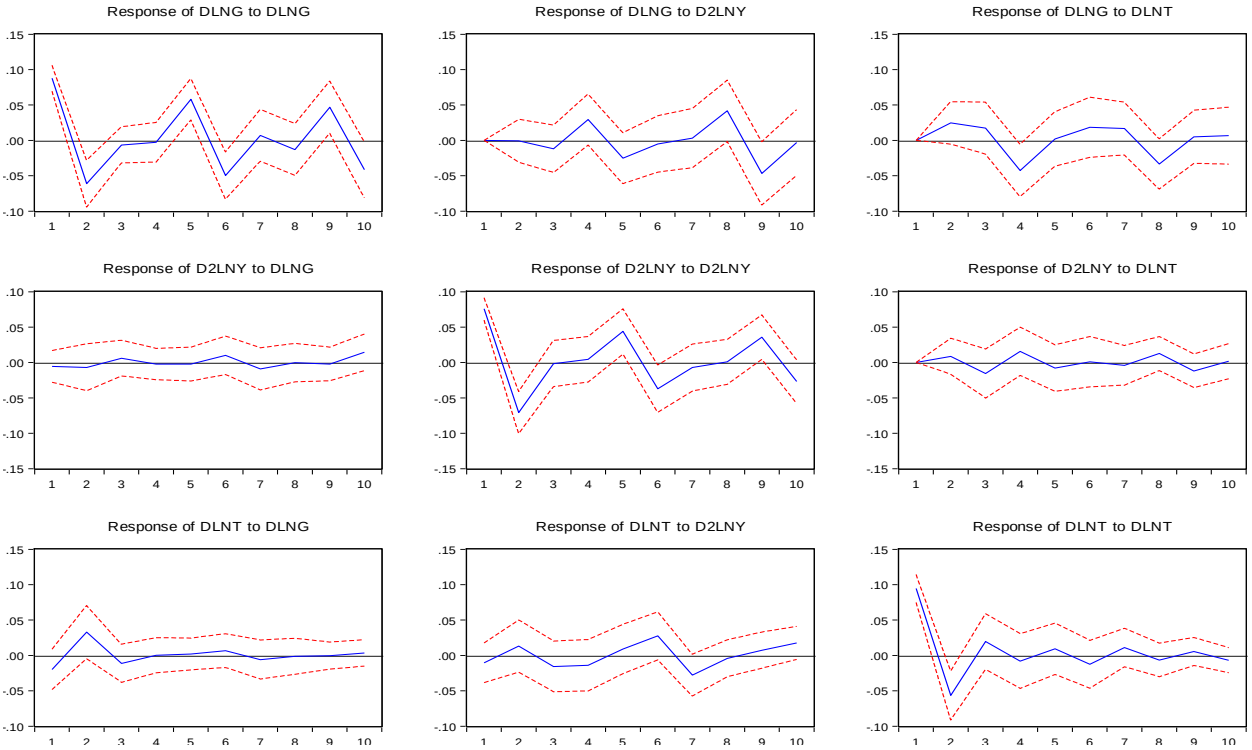
Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.630980	48.84827	21.13162	0.0000
At most 1	0.106799	5.534232	14.26460	0.6734
At most 2	0.001268	0.062188	3.841466	0.8031

Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

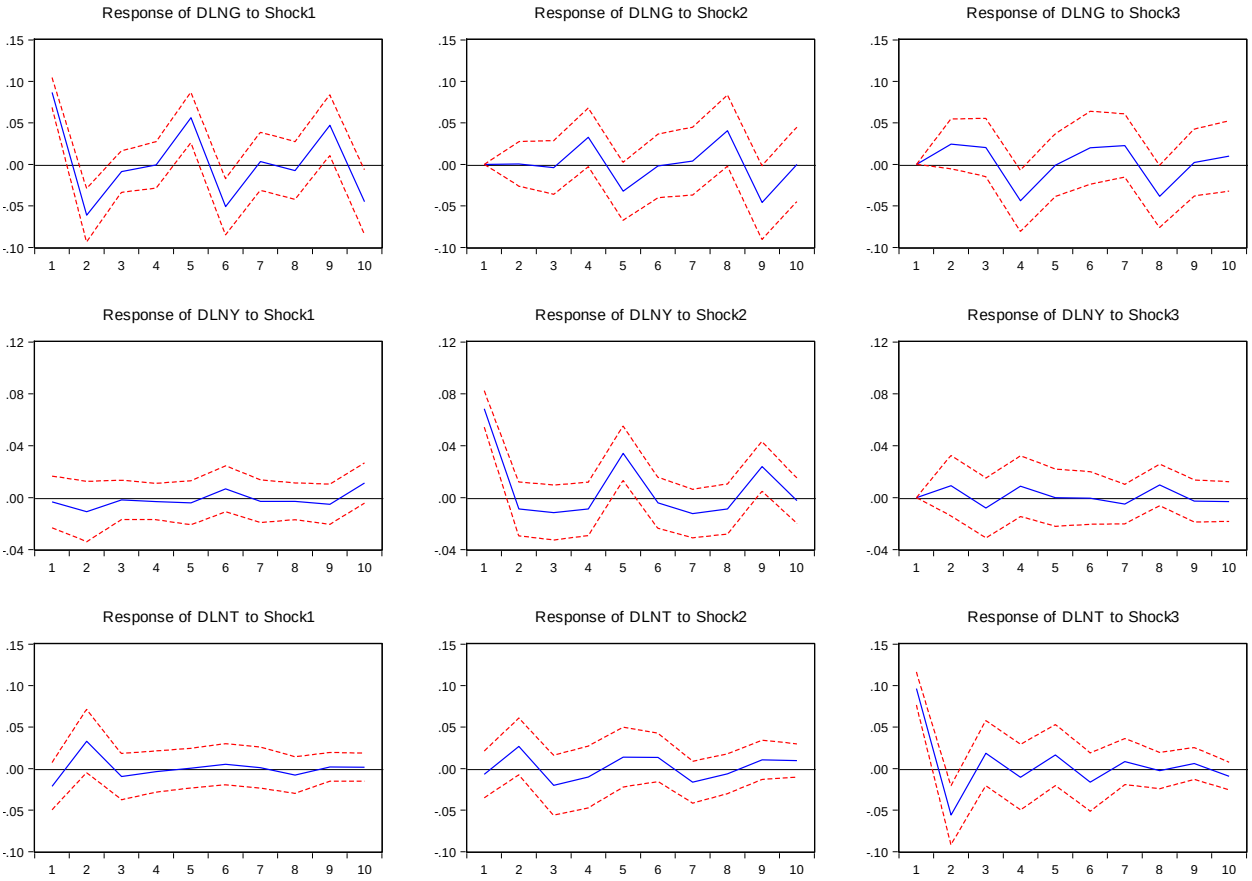
Appendix IV: Graphs of Impulse Response and Variance Decomposition



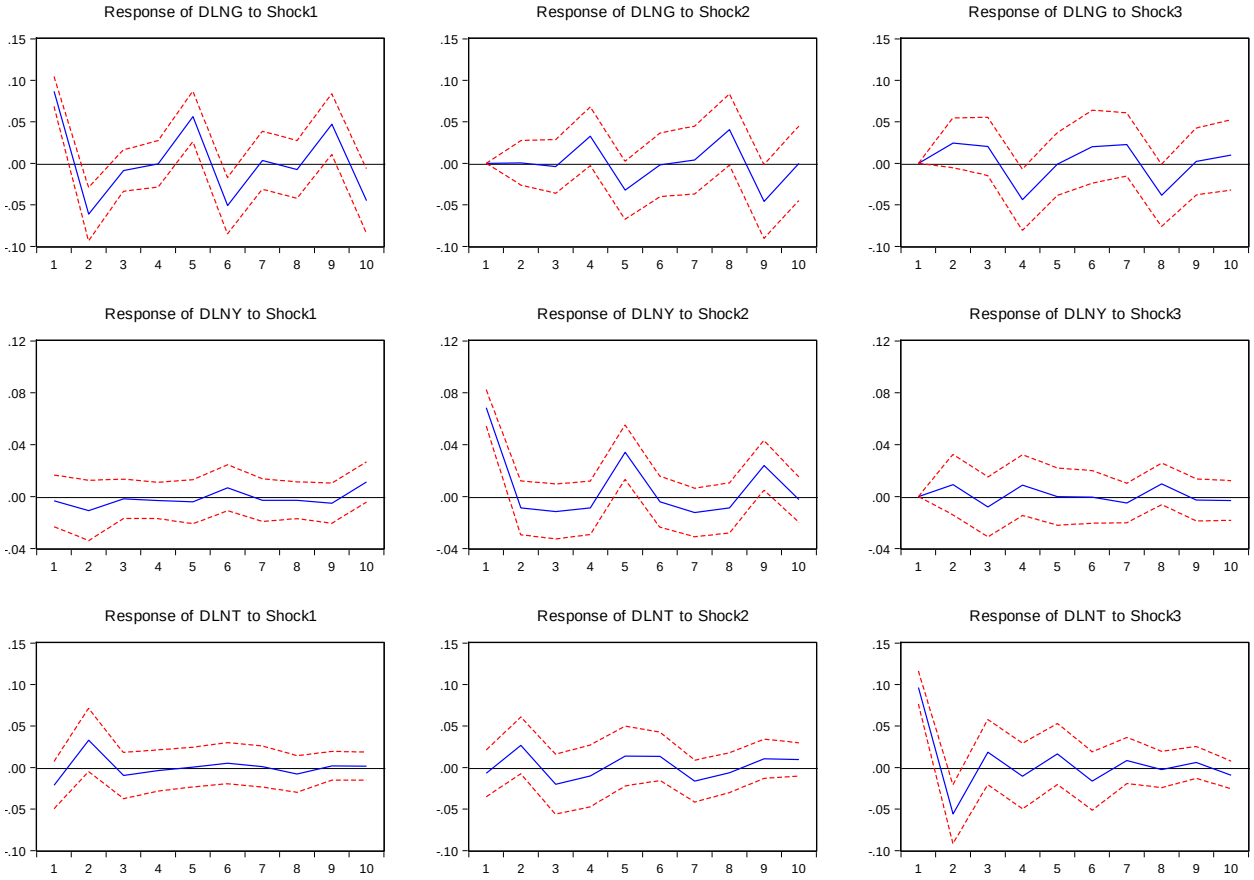
Response to Cholesky One S.D. Innovations ± 2 S.E.

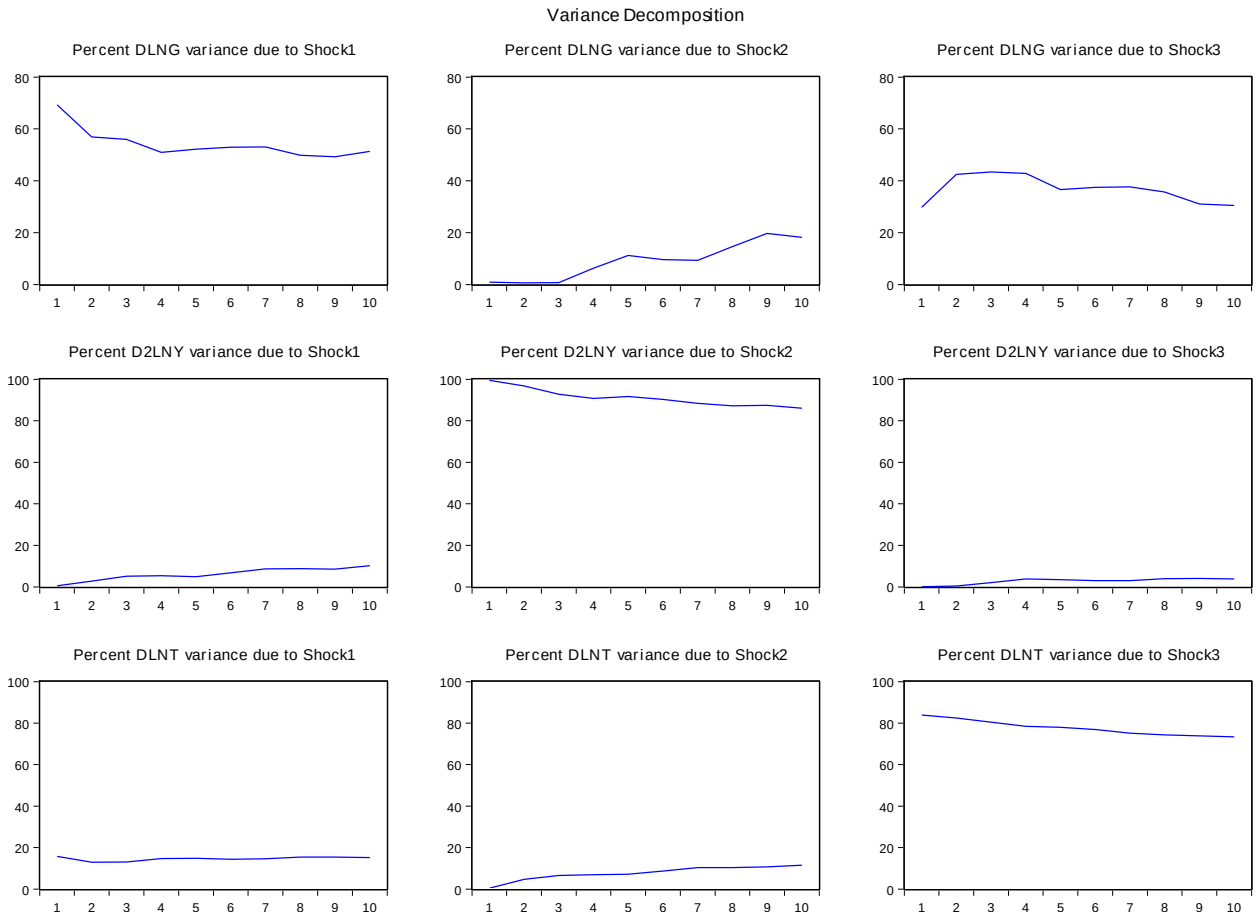


Response to Structural One S.D. Innovations ± 2 S.E.



Response to Structural One S.D. Innovations ± 2 S.E.





Note: Shock 1, Shock 2, and Shock 3 are Government spending, GDP, and Tax revenues respectively.

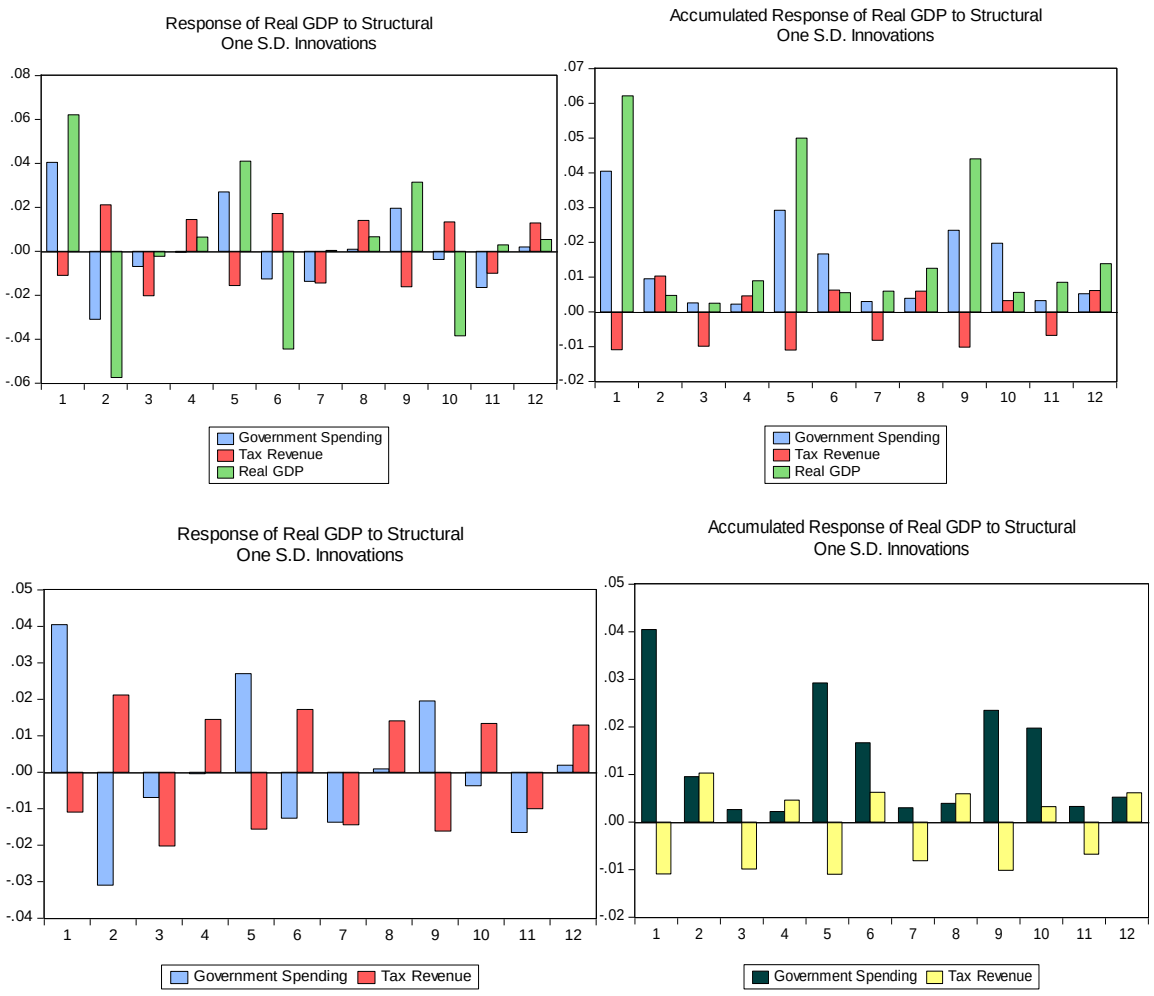


Figure 10: Accumulated Response of Real GDP to Structural One S.D. Innovations