The Effects of Fiscal Policy Shocks on a Selected Group of Macroeconomic Variables in Lesotho: Evidence from SVAR Model

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Abstract

THIS PAPER investigates the macroeconomic effects of fiscal policy shocks in Lesotho on output gap, consumer prices, private and public gross fixed capital formation and the interest rate spread under a structural vector autoregression (SVAR) framework using annual time series data from 1982 to 2015. The main results of the study show that a positive shock to government expenditure leads to a significant positive response in inflation. However, the effect on all other variables is insignificant. A positive shock to government revenue has no impact on the output gap and the interest rate spread but results in an increase in consumer prices, government expenditure as well as public and private gross fixed capital formation. It is recommended that government expenditure should be tilted towards the productive sectors of the economy. Government revenue should be increased by widening the revenue base and more efficient methods of revenue collection.

Keywords: Fiscal shocks, SVAR, Output Gap, Inflation, Interest Rate Spread
JEL classification: H3, H30, H5, H50

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1 INTRODUCTION

FISCAL POLICY IS a government tool designed to monitor and influence a nation's economy through its control over the size and structure of the government's revenues and expenditures (Rena and Kefela, 2011). Fiscal policy can therefore be recognised as a macroeconomic stabilisation instrument. Bank (2011), Rena and Kefela (2011) as well as Mathewos (2015) posited that following the global financial crisis of 2007-2008 that left many of the world's economies in a state of deep recession, various governments, from the developing and developed world employed fiscal policy in an attempt to ferry their respective economies out of the economic downturn. Empirical study into the effects of fiscal policy on macro variables has gained great prominence in recent years. According to Fatás and Mihov (2001), Perotti (2005), Giordano *et al* (2007), Caldara and Kamps (2008), Kamal (2010), Afonso and Sousa (2012) together with Mathewos (2015), fervent interest into how fiscal policy affects macroeconomic variables has been driven by the fact that unlike monetary policy[1], there is little or no consensus in economic literature on the effects of fiscal policy on key macroeconomic variables. Furthermore, although Fatás and Mihov (2001), Caldara and Kamps (2008), Kamal (2010) as well as Mathewos (2015) pointed out that there is increased evidence to suggest that the empirical literature into the effects of fiscal policy on the macroeconomy has been growing over the years, the research is predominantly confined to advanced economies. Adding to the point, to the best of the researcher's knowledge, the size, duration and nature (positive or negative) of the impact emanating from shocks[2] in fiscal policy variables on a select group of macro variables, using SVAR methodology has not yet been conducted on Lesotho. Not to mention, the effects of

[1] Monetary policy can be understood as a Central Bank's policy through which it controls a nation's money supply (Rena and Kefela, 2011).

shocks to fiscal policy on macro-variables differ across countries and across methodologies and also depend on the set of included variables. As if that was not enough, Masha *et al* (2007) pointed out that Lesotho is a member of the Common Monetary Area (CMA) and thus operates under a fixed exchange rate regime where the country's currency, the Loti is pegged at par with the South African Rand. This effectively means that the country has surrendered its monetary policy and only has at its disposal, the use of fiscal policy to influence the economy.

The aim of this paper is therefore to contribute to the body of knowledge and inform policy by investigating the dynamic effects of fiscal shocks on macroeconomic variables in Lesotho with the use of a structural vector autoregression (SVAR) model and annual time series data from 1982 to 2015. The macroeconomic variables[3] selected are the output gap, consumer prices, private and public gross fixed capital formation and the interest rate spread. The rest of the paper is organised as follows: Section 2 provides an evolution of the tax and expenditure history of Lesotho from 1982 to 2015. Section 3 reviews the relevant literature. Section 4 presents the empirical framework. Section 5 outlines the empirical results. Robustness checks are contained in section 6. Section 7 concludes.

2 EVOLUTION OF TAX AND EXPENDITURES IN LESOTHO: 1982 – 2015

Similar to most governments around the globe, the Government of Lesotho (GoL) collects revenues to finance infrastructure projects, social protection and well-being, and other public needs. From the early 1980s to the early 2010s, Lesotho's revenues (tax and non-tax) and expenditures have been volatile. The volatility has in part been driven by significant changes in the country's political economy. For instance, the year 1993 marked the country's political transition into a democracy since independence in 1966. This time also reflected a drastic change in fiscal policy as income tax rates were increased markedly from the rates of 1962. Specifically, the income tax rate was adjusted from 12.5 per cent in 1962 to 35 per cent in 1993.

[2] In the study, fiscal shocks are explained as positive shifts in government expenditure and government revenue, respectively. This is done in order to examine and conclude on the different effects of each shock on identified macro variables together with their mutual influence.

[3] According to Perotti (2002), Ravnik and Žilić (2011) and Chung and Leeper (2007), the chosen macro variables are sufficient to study the effects of shocks in fiscal policy. They have been chosen for the benefit of establishing a homogenous comparison with other fiscal policy VAR studies.

Table 1 presents the trends in fiscal policy indicators and Gross Domestic Product (GDP) in Lesotho from 1982 to 2015. During this 34-year period, real GDP grew by an average of 4.1 per cent while Government revenues and expenditures recorded an average of 49.9 per cent and 48.4 per cent of GDP, respectively.

Table 1 Trends in Fiscal Policy Indicators and GDP from 1982 to 2015 (In percentages of GDP)

	1982-1988	1989-1995	1996-2002	2003-2009	2010-2015
Revenue	37.8	49.2	45.4	58.4	58.6
Expenditure	37.4	41.7	50.5	52.4	60.1
o/w capital	10.8	5.7	7.1	5.8	13.5
Surplus/Deficit	0.4	7.5	-5.1	6.0	-1.5
Real GDP growth (% changes)	4.9	3.1	3.3	5.0	4.1

Source: Ministry of Finance and Central Bank of Lesotho.

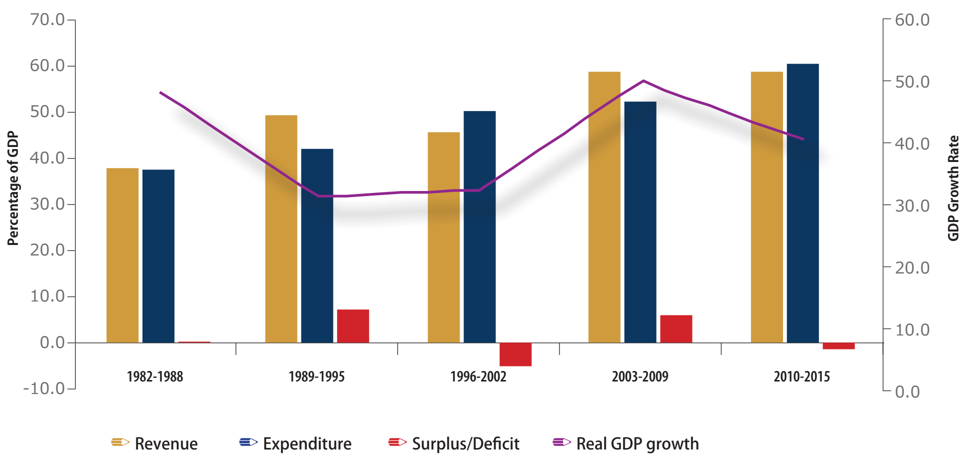
Between 1996 and 2002 the GoL registered an average fiscal deficit of 5.1 per cent of GDP. The government's biggest expenditure emanated from the liquidation and privatisation of State Owned Enterprises (SOEs) including two indigenous banks; Lesotho Bank and Lesotho Agricultural Development Bank. The cost of privatisation was estimated at M605.00 million that was spent on retrenchment packages. This led to an accumulation of public debt that was used for financing (Maope, 2000). There was also a rise in public capital expenditure from the implementation of the Lesotho Highlands Water Project[4] (LHWP). Spending on the LHWP constituted a major part of the government's capital expenditure during the period from 1996 to 1999. On a broader perspective, the period between 1996 and 2002 saw the real GDP growth increase marginally to 3.3 per cent from 3.1 per cent recorded between 1989 and 1995.

Figure 1 presents a graphical relationship between government revenue, expenditure, the fiscal balance and real GDP growth from 1982 to 2015. The fiscal balance exhibited a surplus of approximately 2.2 per cent of GDP between 2003 and 2015. According Tsekoa (2002), in 2003, as a way to strengthen the tax administration in the country, the GoL established the Lesotho Revenue Authority (LRA). The tax administration reform of 2003 contributed positively to tax revenue collection that registered an average of 33.2 per cent of GDP between 2003

[4] The Lesotho Highlands Water Project was signed in 1986 by the GoL and the Government of the Republic of South Africa (RSA) aiming to transfer water to RSA and generate hydropower for Lesotho. Upon completion, this introduced two revenue items that expanded the revenue base: royalties paid by the RSA on water transfer from Lesotho to RSA, and cash flows on electricity sales from hydropower component of the project.

and 2015 compared to 6.6 per cent of GDP between 1982 and 2002. Another important contribution to Lesotho's revenue during the period 2003 and 2015 were the sizeable inflows of Southern African Customs Union (SACU) receipts that registered 40.3 per cent of GDP. Thahane (2005) pointed out that together with domestic tax revenue (income tax and value added tax), foreign grants from the United States (US) Millennium Challenge Account (MCA) also boosted Lesotho's revenue base during the 2003 to 2015 period.

Figure 1 Relationship between Government Revenue, Expenditure, Fiscal Balance and Real GDP Growth from 1982 to 2015



Source: Central Bank of Lesotho

Total government spending from 2003 to 2015 stood at an average of 56.3per cent of GDP. This included the redemption of 5-year and 10-year bonds related to the privatisation process of SOEs, spending on *Old Age Pension Scheme*, pension liability to Public Officers Defined Contribution Pension Fund, unitary payments on health projects through public-private partnership financing, as well as international transport costs. There was also a significant increase in capital spending to finance the cost of building the Metolong Dam project, and other MCA-funded projects. The real GDP growth registered an average of 5.0 per cent.

3 LITERATURE REVIEW

3.1 Theoretical Literature

This section aims to briefly articulate the main arguments surrounding the theoretical literature on fiscal policy from the perspective of the neoclassical and Keynesian schools of thought. The discussion will focus on discretionary fiscal policy, which is explained by Mathewos (2015) as the purposeful change in government spending and revenue with the deliberate intention to promote employment, price stability and economic growth.

- *Neo Classical Theory*

The underpinnings of neoclassical theory as they relate to discretionary fiscal policy are touched on in Bank (2011) who explained that the neoclassical school, which assumes flexible prices does not regard discretionary fiscal policy as having any impact on the business cycle. The result of increased government expenditure rather leads to a contraction of the economy through the crowding out of private consumption and private investment. A similar conclusion is highlighted in Perotti (2007) and Mathewos (2015) who presented that according to neoclassical theory on fiscal policy, a shock to government consumption financed by higher taxation results in a negative wealth effect that discourages household consumption and increases labour supply. However, since labour supply increases along a given labour demand, the level of real wage falls.

- *Keynesian Theory*

According to Perotti (2007), Bank (2011) and Mathewos (2015), Keynesian economic theory is based on assumptions of price rigidity and postulates that an increase in government expenditure coupled with a cut in taxes leads to an increase in the real wage as well as private consumption and as a result an increase in aggregate demand. Subsequently, a higher level of aggregate demand will mean an increase in the level of output. However, an increase in taxes retards economic growth.

3.2 Empirical Literature

Empirical research on dynamic effects of shocks in fiscal policy variables on macroeconomic variables is vast as depicted in Table 2.

Table 2 Summary of Studies on Fiscal Shocks

Author(s) & Year	Country & Period	Methodology	Variables	Key Findings
Blanchard and Perotti (2002)	US. QI: 1947 – QIV: 1997	SVAR	Government spending, Government tax, GDP	Positive shocks to government spending lead to positive impact on output.
				Positive shocks to government spending and revenue lead to a crowding out of private investment.
Giordano *et al.* (2007)	Italy. QI: 1982 – QIV: 2004	SVAR	Government spending, Government revenue, private GDP, inflation and long-term interest rate	Positive shocks to government spending lead to positive impact on output, employment, private consumption, investment and inflation
				Positive shocks in government revenue have negligible effects on all selected variables.
Kamal (2010)	UK. QI:1971 - QII: 2009	BVAR	Government spending, Government revenue, GDP deflator, private consumption, private investment, monetary aggregates, real wages, producer price index, short-term interest rate, trade balance and the real effective exchange rate.	Deficit-financed spending increase (DFSI) and the deficit financed tax cut (DFTC) lead to a positive impact on output.
Kofi Ocran (2011)	SA. QI:1990 - QIV:2004	VAR	Government gross fixed capital formation, tax expenditure, government consumption expenditure, GDP and the budget deficit	Government consumption expenditure and gross fixed capital formation have a positive effect on economic growth.
				Positive shocks to tax receipts have a positive effect on economic growth.

Table 2	Summary of Studies on Fiscal Shocks (continued)			
Author(s) & Year	**Country & Period**	**Methodology**	**Variables**	**Key Findings**
Bank (2011)	Germany. QI: 1991 - QIV: 2009	SVAR	GDP, government expenditure, taxes, inflation and the interest rate.	Impact of government expenditure shock on output is positive and short-term.
				Impact of government revenue shock is insignificant.
Ravnik and Žilić (2011)	Croatia. 2001 - 2009	SVAR	Government spending, government revenue, Industrial production, price levels and short-term interest rates.	Positive shock in government revenue leads to increase in the rate of inflation, a reduction in the short-term interest rate and an increase in industrial production.
				Government expenditure shock led to a reduction in industrial production.
Afonso and Sousa (2012)	US. 1970: QIII -2007: QIV UK. 1964: QII - 2007: QIV Germany. 1980: QIII - 2006: QIV Italy. 1986: QII - 2004: QIV	BVAR	Government spending, government revenue, private investment, private consumption, stock prices and housing prices.	Positive government spending shocks have small but positive effect on GDP and varied effect on private consumption and private investment.

Blanchard and Perotti (2002) explored the dynamic effects of shocks in fiscal policy on economic activity in the US in the post war period by using a Structural Vector autoregression (SVAR) approach and quarterly time series data spanning QI:1947 - QIV:1997. The findings revealed that positive shocks in government spending result in a positive effect on output whereas positive shocks in revenue negatively affect output. Furthermore, the impacts of positive innovations in government spending and government revenue were discovered to crowd out private investment spending.

Giordano et al. (2007) studied the effects of fiscal policy in Italy on private GDP, inflation and the long-term interest rate using a SVAR model and quarterly time series data ranging from the QI:1982 to QIV:2004. The analysis concluded that shocks to total direct government expenditure positively affected output three quarters after the shock but the effect is transitory and goes to zero after two years. Furthermore, positive shocks to government expenditure led to a positive response in employment, private consumption and investment and inflation. A positive shock in government revenue was discovered to have negligible effects on all selected variables.

Kamal (2010) investigated fiscal policy shocks in the United Kingdom (UK) within a Bayesian Vector Autoregression (B-VAR) framework and the use of quarterly data spanning from QI:1971 to QII:2009. The study was interested in the impacts of three fiscal policy experiments, namely a deficit-financed spending increase (DFSI), a deficit financed tax cut (DFTC) and a balanced budget spending increase (BBSI), on a set of chosen macroeconomic variables. Twelve macro variables were included in the study, viz. government expenditures, government revenues, GDP deflator, private consumption, private investment, monetary aggregates, real wages, producer price index, short-term interest rate, trade balance and the real effective exchange rate. The analysis concluded that the DFSI and the DFTC lead to a positive impact on output, private investment and private consumption in the short-term while real wages, monetary aggregates and prices decline under both experiments. However, the DFSI has greater costs in the medium term relative to the DFTC, making the DFTC a more desirable option. In addition, under the BBSI experiment, it was discovered that the distortionary effects of an increase in tax outstripped the expansionary effects of increased government expenditure leading to a decline in output, private consumption, private investment and real wages coupled with an increase in prices.

Kofi Ocran (2011) analysed the impact of fiscal policy variables (government gross fixed capital formation, tax expenditure, government consumption expenditure and the budget deficit) on economic growth in South Africa (SA) by using a VAR model and quarterly time series data spanning 1990 to 2004. The investigation discovered that government consumption expenditure and gross fixed capital formation have a positive effect on economic growth but the former's impact on economic growth outweighed that of the latter. In addition, positive shocks to tax receipts had a positive effect on economic growth although the size of the budget deficit was found not to have a significant impact on growth outcomes.

Bank (2011) examined the effects of discretionary fiscal policy in Germany with the use of quarterly time series data from QI: 1991 to QIV: 2009 within a SVAR framework. The study included GDP, government expenditure, taxes, inflation and the interest rate as variables. Focusing on the impact of discretionary fiscal policy shocks on GDP, the study concluded that a positive shock to government expenditure leads to an increase of 0.20 per cent in GDP on impact but the influence falls quickly and becomes statistically insignificant from the second quarter onwards. On the other hand, a shock to government tax revenue was found to have small and insignificant effects on GDP. Generally, the findings supported the neoclassical view of discretionary fiscal policy and found discretionary fiscal policy ineffective in spurring economic growth in Germany.

Ravnik and Žilić (2011) researched the dynamic effects of fiscal policy shocks in Croatia by investigating the impact of fiscal policy shocks on economic activity (where industrial production was used as a proxy variable for output), price levels and short-term interest rates using a SVAR methodology and monthly time series data from January 2001 to December 2009. The study concluded that the interest rate responded the strongest to fiscal shocks whereas inflation responded the weakest. A shock in government revenue was found to lead to an increase in the rate of inflation and a reduction in the short-term interest rate while an expenditure shock decreased inflation in the short-term and increased the short-term interest rate. On the same token, a shock in government expenditure led to a reduction in industrial production whereas a shock in government revenue resulted in an increase in industrial production.

Afonso and Sousa (2012) used a Bayesian SVAR (B-SVAR) and quarterly time series data to investigate the effects of government spending and government revenue shocks on the composition of GDP (private investment and private consumption) as well as on asset markets (stock prices and housing prices). Their study analyses empirical evidence from the US, the UK, Germany and Italy for the periods, 1970: QIII -2007: QIV, 1964: QII - 2007: QIV, 1980: QIII - 2006: QIV and 1986: QII - 2004: QIV and includes a debt feedback component to account for the government intertemporal budget constraint. In general, positive government spending shocks were found to have a small but positive effect on GDP, a key discovery that is in support of the Keynesian theory on fiscal policy. The impact of expansionary fiscal policy on private consumption and private investment varied across selected countries but had a positive effect on housing prices, the price level and the average cost of refinancing debt. On the other hand, positive shocks to government revenue were found to result in a positive effect on GDP and private investment but a varied effect on private consumption and housing prices. In addition, increased levels of government revenue showed a positive impact on stock prices, a mixed effect on the interest rates but a no impact on the price level. When the debt feedback was taken into consideration, long-term interest rates and GDP became more responsive to changes in fiscal policy and the effect of fiscal policy on the macro variables was more persistent.

The empirical review of the literature indicates that studies on the dynamic effects of fiscal policy shocks across developed and developing countries yield diverse results. This is especially true considering the differences in periods and methodologies used. However, what is a general consistency among the reviewed studies is the inclusion of output, inflation, private investment and interest rates as macro variables upon which the impact of shocks in fiscal policy variables is assessed. This common feature has played a significant role in informing the choice of variables to include in our study.

4 EMPIRICAL FRAMEWORK

4.1 Data Description

The study uses annual time series data from 1982 to 2015. Table 3 presents the variable description and consists of the general government expenditure[5] (GExp), output gap (Ygap[6]), consumer price index (LesP), general government revenue[7] (GRev), the interest rate spread[8] (R), public gross fixed capital formation (PubGFCF) and private gross fixed capital formation (PriGFCF). GExp, Ygap, LesP and GRev were obtained from the International Monetary Fund (IMF) World Economic Outlook (WEO) data base, R was sourced from the World Bank (WB) development indicators while PubGFCF and PriGFCF were acquired from the Central Bank of

[5] General government expenditure consists of total expense and the net acquisition of nonfinancial assets.

[6] The output gap is calculated as the difference between the log of real GDP and expected output.

[7] General government revenue consists of taxes, social contributions, grants receivable, and other revenue.

[8] This is calculated as the difference between lending rates and deposit rates.

Lesotho (CBL). The variables in the model are all expressed in logarithmic form except R which is expressed in percentages.

Table 3	Variable Description	
Variable	Descriptor	Database/Source
GExp	General Government Expenditure	IMF WEO Data base
Ygap	Output Gap	Author's Own Calculations[9]
LesP	Consumer Price Index	IMF WEO Data base
GRev	General Government Revenue	IMF WEO Data base
R	Interest rate spread	WB Development Indicators
PubGFCF	Public Gross Fixed Capital Formation	CBL
PriGFCF	Private Gross Fixed Capital Formation	CBL

4.2 Model Specification

In this study, a VAR model is used to assess the response of specific Lesotho macro-variables; the output gap (Ygap), consumer prices (LesP), the interest rate spread (R), public gross fixed capital formation (PubGFCF) and private gross fixed capital formation (PriGFCF) to shocks in domestic fiscal policy, that is, positive changes in general government expenditure (GExp) and general government tax revenue (GRev). Caldara and Kamps (2008) together with Ravnik and Žilić (2011) indicated that VAR models have become the main econometric tool for analysing the effects of fiscal and monetary policy shocks on macroeconomic variables. Clarida (2001), Jacobsson *et al* (2002), Lütkepohl (2011), Ravnik and Žilić (2011), Kofi Ocran (2011) as well as Kilian (2011) concurred. They posited that the VAR's superiority over other methods such as the use of simultaneous equations lies in its ability to quantify the average contribution of a given structural shock to the variability of the data over time through forecast error variance decompositions.

The reduced form of the VAR is presented as follows:

$$Z_t = G_0 + G_1 Z_{t-1} + G_2 Z_{t-2} + \cdots + G_s Z_{t-s} + \varepsilon_t \qquad (1)$$

[9] The GDP series used to develop the output gap was taken from the IMF WEO Data base.

Where Z_t is a (7x1) vector of endogenous macroeconomic variables (GExp, Ygap, LesP, GRev, R, PubGFCF and PriGFCF) observed at time t. G_0 is a vector of constants, $G_{1,2,\dots,s}$ is a (7x7) matrix of coefficient estimates, ε is a (7x1) vector of serially uncorrelated system innovations and s is the optimal lag length of each variable. When unpacked, equation 1 is a system of seven equations as follows:

$$GExp_t = \beta_{1,0} + \sum_{i=1}^{s} \theta_{1,i} GExp_{i,t-1} + \sum_{i=1}^{s} \lambda_{1,i} Ygap_{i,t-1} + \sum_{i=1}^{s} \phi_{1,i} LesP_{i,t-1} + \sum_{i=1}^{s} \varpi_{1,i} GRev_{i,t-1} + \sum_{i=1}^{s} \delta_{1,i} R_{i,t-1} + \sum_{i=1}^{s} \pi_{1,i} PubGFCF_{i,t-1} + \sum_{i=1}^{s} \Omega_{1,i} PriGFCF_{i,t-1} + \varepsilon_{1,t} \quad (2)$$

$$Ygap_t = \beta_{2,0} + \sum_{i=1}^{s} \theta_{2,i} GExp_{i,t-1} + \sum_{i=1}^{s} \lambda_{2,i} Ygap_{i,t-1} + \sum_{i=1}^{s} \phi_{2,i} LesP_{i,t-1} + \sum_{i=1}^{s} \varpi_{2,i} GRev_{i,t-1} + \sum_{i=1}^{s} \delta_{2,i} R_{i,t-1} + \sum_{i=1}^{s} \pi_{2,i} PubGFCF_{i,t-1} + \sum_{i=1}^{s} \Omega_{2,i} PriGFCF_{i,t-1} + \varepsilon_{2,t} \quad (3)$$

$$LesP_t = \beta_{3,0} + \sum_{i=1}^{s} \theta_{3,i} GExp_{i,t-1} + \sum_{i=1}^{s} \lambda_{3,i} Ygap_{i,t-1} + \sum_{i=1}^{s} \phi_{3,i} LesP_{i,t-1} + \sum_{i=1}^{s} \varpi_{3,i} GRev_{i,t-1} + \sum_{i=1}^{s} \delta_{3,i} R_{i,t-1} + \sum_{i=1}^{s} \pi_{3,i} PubGFCF_{i,t-1} + \sum_{i=1}^{s} \Omega_{3,i} PriGFCF_{i,t-1} + \varepsilon_{3,t} \quad (4)$$

$$GRev_t = \beta_{4,0} + \sum_{i=1}^{s} \theta_{4,i} GExp_{i,t-1} + \sum_{i=1}^{s} \lambda_{4,i} Ygap_{i,t-1} + \sum_{i=1}^{s} \phi_{4,i} LesP_{i,t-1} + \sum_{i=1}^{s} \varpi_{4,i} GRev_{i,t-1} + \sum_{i=1}^{s} \delta_{4,i} R_{i,t-1} + \sum_{i=1}^{s} \pi_{4,i} PubGFCF_{i,t-1} + \sum_{i=1}^{s} \Omega_{4,i} PriGFCF_{i,t-1} + \varepsilon_{4,t} \quad (5)$$

$$R_t = \beta_{5,0} + \sum_{i=1}^{s} \theta_{5,i} GExp_{i,t-1} + \sum_{i=1}^{s} \lambda_{5,i} Ygap_{i,t-1} + \sum_{i=1}^{s} \phi_{5,i} LesP_{i,t-1} + \sum_{i=1}^{s} \varpi_{5,i} GRev_{i,t-1} + \sum_{i=1}^{s} \delta_{5,i} R_{i,t-1} + \sum_{i=1}^{s} \pi_{5,i} PubGFCF_{i,t-1} + \sum_{i=1}^{s} \Omega_{5,i} PriGFCF_{i,t-1} + \varepsilon_{5,t} \quad (6)$$

$$PubGFCF_t = \beta_{6,0} + \sum_{i=1}^{s} \theta_{6,i} GExp_{i,t-1} + \sum_{i=1}^{s} \lambda_{6,i} Ygap_{i,t-1} + \sum_{i=1}^{s} \phi_{6,i} LesP_{i,t-1} + \sum_{i=1}^{s} \varpi_{6,i} GRev_{i,t-1} + \sum_{i=1}^{s} \delta_{6,i} R_{i,t-1} + \sum_{i=1}^{s} \pi_{6,i} PubGFCF_{i,t-1} + \sum_{i=1}^{s} \Omega_{6,i} PriGFCF_{i,t-1} + \varepsilon_{6,t} \quad (7)$$

$$PriGFCF_t = \beta_{7,0} + \sum_{i=1}^{s} \theta_{7,i} GExp_{i,t-1} + \sum_{i=1}^{s} \lambda_{7,i} Ygap_{i,t-1} + \sum_{i=1}^{s} \phi_{7,i} LesP_{i,t-1} + \sum_{i=1}^{s} \varpi_{7,i} GRev_{i,t-1} + \sum_{i=1}^{s} \delta_{7,i} R_{i,t-1} + \sum_{i=1}^{s} \pi_{7,i} PubGFCF_{i,t-1} + \sum_{i=1}^{s} \Omega_{7,i} PriGFCF_{i,t-1} + \varepsilon_{7,t} \quad (8)$$

Equation 1, the reduced form VAR can be estimated using the ordinary least squares (OLS) method. First, the choice of optimal lag order has to be made and this is done with due consideration of information criterion such as the Schwarz Information Criterion (SIC) and or Akaike Information Criterion (AIC). The smallest information criterion is the most preferred. Once the appropriate lag order has been selected, the stationarity of the system, or the stability of the system is tested with the help of the AR roots table. The system will be found to be stationary if the modulus of each root is within the unit circle, (Lütkepohl, 2011).

4.3 Unit Root Tests

Lütkepohl (2011) explained that VAR models are designed for stationary variables. To ascertain the order of integration of the variables, the study uses Augmented Dickey and Fuller (1979, 1981) (ADF) and Phillips-Perron (1988) test. The Phillips-Perron (PP) test is used together with the ADF because of the PP test's non-parametric character and its ability to correct for any serial correlation and heteroskedasticity in the errors. The two tests are utilized to establish whether the series are either $I(0)$ or $I(1)$.

4.4 Model Checking

Since the reduced form VAR, represented in equation 1 underlies the structural VAR, it is important to check the adequacy of the reduced form VAR in the data generation process (DGP), (Lütkepohl, 2011). For this purpose, the study focuses on tests for residual autocorrelation , non-normality, heteroskedasticity and structural stability.

4.5 SVAR Identification

Following the model checking process and confirmation that equation 1 passes the relevant residual diagnostics and structural stability tests, what comes next is the specification and

[10] To test for autocorrelation in the residuals, the study uses the Breusch-Godfrey LM test. According to Luetkepohl (2011), this is the most suitable test for checking autocorrelation in VARs..

estimation of the structural VAR (SVAR). According to Kilian (2011), the SVAR, unlike the reduced form VAR, isolates the structural shocks and allows for the development of impulse response functions (IRFs) and the forecast error variance decompositions. The SVAR is represented in equation 9

$$AX_t = \beta_0 + \beta_1 X_{t-1} + \beta_2 X_{t-2} + --- + \beta_s X_{t-s} + \upsilon_t \quad (9)$$

Where; A is a (7x7) matrix of contemporaneous relations among the endogenous variables where the diagonal elements are normalized to equal one but the off diagonal elements may be arbitrary. X_t is a (7x1) vector of endogenous macroeconomic variables (GExp, Ygap, LesP, GRev, R, PubGFCF and PriGFCF) observed at time t. β_0 is a vector of constants, $\beta_{1,2,\ldots,s}$ is a (7x7) matrix of coefficient estimates, υ is a (7x1) vector of serially uncorrelated structural errors and s is the optimal lag length of each variable.

The SVAR cannot be estimated with OLS because of the contemporaneous relations between the endogenous variables in matrix A that are correlated with the structural errors. Therefore, to estimate the SVAR and develop IRFs and forecast error variance decompositions (FEVDs), equation 9 needs to be identified. This is done by imposing restrictions on elements of matrix A in equation 9. Kilian (2011) explained that imposing restrictions to matrix A^- in equation 9 also means imposing restrictions on the inverse of matrix A, that is; A^{-1}. Multiplying the right and left hand sides of the SVAR by A^{-1} results in the reduced form VAR in equation 1 such that

$$Z\mathrm{t} = A^{-1} AX_t \quad (10)$$

The relationship between the forecast errors and structural shocks is represented by equation 11

$$\varepsilon_t = {}^{A-1} \upsilon_t \quad (11)$$

In order to obtain the structural innovations in equation 11, the study employed a strictly recursive Cholesky decomposition technique where ((n^2-n))/2 zero (exclusion) restrictions[11] are imposed. Perotti (2004) and Mathewos (2015) point out that there is not much theoretical or empirical guidance on how best to identify the fiscal policy structural shocks. As a benchmark, Perotti (2004) ordered the government expenditure first. The Cholesky decomposition used in this study has the ordering of (GExp, GRev, PubGFCF, PriGFCF, Ygap, LesP and R). With this ordering, similar to Perotti (2004) and Ravnik and Žilić (2011), the study assumes that the government expenditure (GExp) is not contemporaneously affected by changes in other macroeconomic variables. This means that government expenditure's movements are solely dependent on government decisions and all other macro-variables can only affect the GExp with a lag. On the other hand, GRev, M2, PubGFCF, PriGFCF, Ygap, LesP and R are assumed to likely respond to contemporaneous changes in the government expenditure. Once successful identification of the structural shocks is attained, the IRFs and FEVDs can then be developed.

5 EMPIRICAL RESULTS

5.1 Results of the Unit Root Tests

Before estimation of the reduced form VAR model (equation 1), the ADF and PP unit root tests were performed. Their respective results are presented in Table 4. Granger (1986) underscored that the unit root test is conducted in order to ensure that there is no spurious regression. From Table 4, all of the macro-variables, except LesP and PriGFCF are non-stationary at levels under both the ADF and PP tests. In addition, all of the variables, except LesP are stationary at first difference under the ADF and PP tests.

[11] Where n is the number of endogenous variables in the model.

Table 4	ADF and PP Unit Root Test Results			
Variable	Levels		First differences	
Variable	ADF Statistic	PP Statistic	ADF Statistic	PP Statistic
GExp	-1.874424 (0.3397)	-2.258009 (0.1909)	-5.558582 (0.0001)	-5.560730 (0.0001)
Ygap	-2.529244 (0.1180)	-2.599543 (0.1032)	-5.804944 (0.0000)	-5.805107 (0.0000)
LesP	-6.029111 (0.0000)	-6.869833 (0.0000)	-2.717103 (0.0822)	-2.717103 (0.0822)
GRev	-2.732499 (0.0794)	-2.818728 (0.0665)	-4.705376 (0.0007)	-4.696117 (0.0007)
R	-2.605088 (0.1024)	-2.410763 (0.1466)	-4.912862 (0.0004)	-4.902138 (0.0004)
PubGFCF	-2.654923 (0.0933)	-1.805733 (0.3505)	-3.79275 (0.0071)	-3.840568 (0.0063)
PriGFCF	-3.077130 (0.0382)	-3.069664 (0.0388)	-7.681794 (0.0000)	-10.11885 (0.0000)
Note:	H_0: non-stationary and p-values are in parentheses			
Authors' Calculations				

Herrera and Pesavento (2013) advocated that the variables that are non-stationary but stationary of the same order of integration (in this case, Ygap, GExp, GRev, PubGFCF and R) should be tested for the presence of cointegration. However, even if cointegration is found to exist between the variables, the most robust form of model specification would be to estimate the VAR in levels. This point is echoed by Sims (1980) alongside Khan and Ali (2003) who highlighted that the intention of VAR analysis is to determine interrelationship between macro variables and not the development of parameter estimates. From Appendix 1, the Johansen cointegration test (considering only the trace statistic) shows that cointegration does not exist between the five variables. Following the recommendation of Sims (1980), Khan and Ali (2003) coupled with Herrera and Pesavento (2013), equation 1 is estimated in levels.

5.2 Optimal Lag Selection

The lag length selection criteria are presented in Table 5. The AIC and SC propose the use of 1 lag respectively. In order to make a final decision, the study performs an autocorrelation LM test. The results of the autocorrelation LM test are presented in Table 6 and indicate that the study fails to reject the null hypothesis of no serial correlation under a lag order of 1 and a lag order of 2. Furthermore, when the VAR is estimated under a lag order of 1, it is found to be stable and is sufficient to explain the dynamics in the model. This is evidenced by results from Appendix 2 that show that under a lag length of 1, no root lies outside the unit circle. Equation 1 is therefore estimated using OLS with a lag length of 1.

Table 5 VAR Lag Order Selection Criteria

VAR Lag Order Selection Criteria
Endogenous variables: GEXP GREV PUBGFCF PRIGFCF YGAP LESP R
Exogenous variables: C
Sample: 1982 2015
Included observations: 32

Lag	LogL	LR	FPE	AIC	SC	HQ
0	184.2637	NA	3.64e-14	-11.07898	-10.75835	-10.97270
1	399.5472	322.9252*	1.20e-18*	-21.47170*	-18.90666*	-20.62146*
2	443.9310	47.15773	2.60e-18	-21.18319	-16.37374	-19.58899

* 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

Authors' Calculations

Table 6	VAR Residual Serial Correlation LM Test	
VAR Residual Serial Correlation LM Tests Null Hypothesis: no serial correlation at lag order h Sample: 1982 2015 Included observations: 33		
Lags	**LM-Stat**	**Prob**
1	53.67782	0.2997
2	35.99841	0.9166
Probs from chi-square with 49 df.		
Authors' Calculations		

5.3 Results of the Residual Diagnostic Tests

The reduced form VAR estimated with a lag order of 1 has no evidence of serial correlation in the residuals as can be seen from Table 6. In addition, there is no heteroskedasticity in the residuals and the residuals are normal, as evidenced from Appendix 3 and Appendix 4, respectively.

5.4 Impulse Responses

The impulse responses generated from the SVAR and calculated over a 10 year period are presented in Figure 2 and Figure 3. Figure 2 presents the impulse responses of GExp, GRev, PubGFCF, PriGFCF, Ygap, LesP and R following a shock to GExp. Figure 3 on the other hand shows the impulse responses of GExp, GRev, PubGFCF, PriGFCF, Ygap, LesP and R following a shock to GRev. In the study, impulse response functions (presented as solid lines in the figures) are interpreted as the percentage change in one variable after a one per cent increase in another variable. Moreover, similar to Giordano et al. (2007), the study defines "statistically significant" impulse responses as those estimates for which the narrow error band[12] does not include zero.

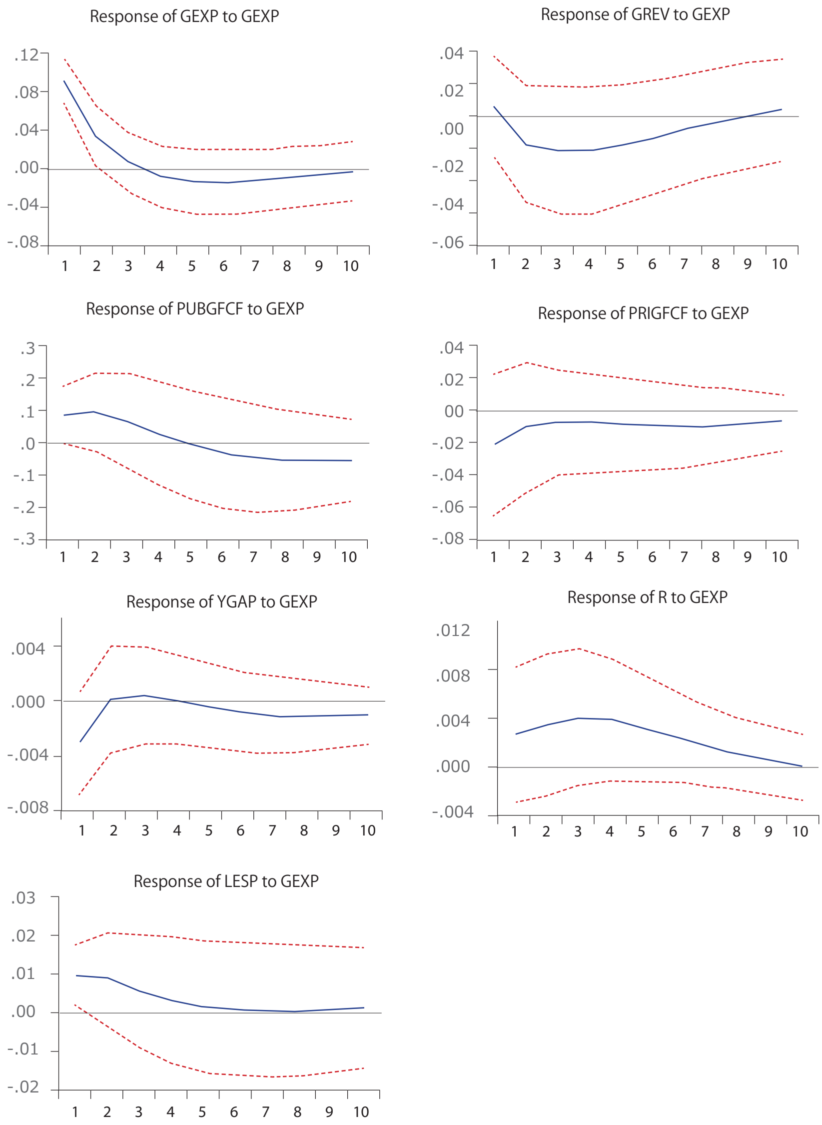
From Figure 2, a per cent increase in government expenditure results in an immediate and highly significant positive response to itself in the first two years. The impact becomes statistically insignificant after that period. A positive shock in government expenditure leads

[12] One standard deviation bands computed by analytic (asymptotic) simulations.

to a positive change of 0.01 per cent in the level of consumer inflation upon impact, for the first year only, thereafter the impact becomes insignificant. This finding is similar to that obtained by Giordano et al. (2007). The impact of government expenditure on all the other macro variables including government revenue and the output gap is found to be statistically insignificant. According to Ravnik and Žilić (2011), the irresponsiveness of taxes to increases in government expenditure could mean that government expenditure is financed not through revenue increments but through increases in the public debt level. Furthermore, increased levels of government expenditure appear not to mean increased revenue generation capacity for the government.

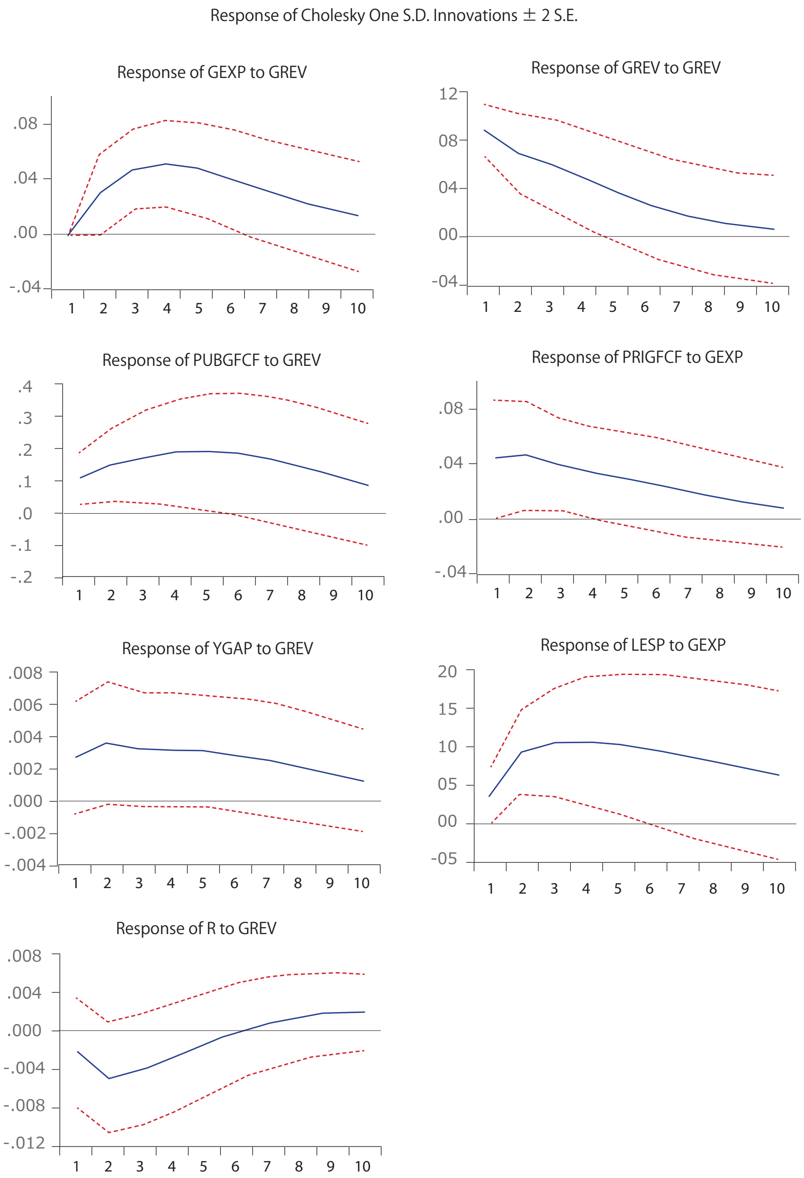
Figure 2 Impulse Response to Government Expenditure Shock

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



Authors' Calculations

Figure 2 Impulse Responses to Government Tax Shock



Authors' Calculations

Figure 3 indicates that a one per cent increase in government revenue leads to a positive and highly significant impact on government expenditure starting from the second year after the initial shock up until year six. The impact peaks in year four at about 0.052 per cent. Importantly, after the sixth year following the initial shock, the impact becomes statistically insignificant. Ravnik and Žilić (2011) together with Mathewos (2015) found a similar result and explained that it can be attributed to the fact that intuitively, increased government revenue allows for greater government expenditure in the future. Following its own shock, government revenue is found to have a positive and highly significant impact for the first four years upon impact before becoming insignificant. In addition, a positive shock in government revenue leads to a positive reaction in the public gross fixed capital formation upon impact for five years before becoming statistically insignificant. The impact peaks in year five at about 0.19 per cent. This suggests that an increased level of government revenue translates into additional funding for purposes of financing public capital expenditure. On the same token, a positive shock to government revenue results in a positive impact on private gross fixed capital formation for the first four years following the initial shock, after which it becomes insignificant. This impact peaks in year two at around 0.046 per cent. The results suggest that increases in government revenue crowd in private investment and are similar to those found by Ravnik and Žilić (2011).

Consumer prices react positively to a positive shock in government revenue from the second year following the shock and last until the fifth year. After that period, they become statistically insignificant. The impact on consumer prices peaks in year 4 at approximately 0.021 per cent. The positive impact of a government revenue shock on inflation was also found by Ravnik and Žilić (2011) and Mathewos (2015). To find a possible explanation, the supply side dynamics would have to be considered. An increase in taxes will lead to an overall incease in firm production costs. The burden is then passed on from the producers to the consumers in the form of indirect taxes. This results in higher services and goods costs which result in a rise in the level of inflation. Positive shocks in government revenue were found to have an insignificant impact on the interest rate spread and the output gap. Mathewos (2015) explained the insiginficant impact of government revenue on the output gap to possibly mean that government uses the inicrease in revenue to finance past debt obligations rather than stimulate output.

5.5 Forecast Error Variance Decomposition

According to Lütkepohl (2011), Kilian (2011) as well as Ravnik and Žilić (2011), forecast error variance decompositions present another tool to investigate the impact of shocks in VAR models. They provide historical decompositions that measure each structural shock's cumulative contribution to the evolution of each variable over time. Table 7 presents the forecast error variance decompositions extracted for the fifth and tenth years. The percentage of variation in the row variables, labelled 1 through 7, is explained by shocks to the column variables, labelled *a* through *g*.

Table 7 Forecast Error Variance Decomposition in Percentage

Forecast Horizon (Yrs)	a. GExp	b. GRev	c. PubGFCF	d. PriGFCF	e. Ygap	f. LesP	g. R
1. GExp							
5th Year	47.11768	39.23264	1.058548	1.753465	4.997804	2.027899	3.811970
10th Year	32.51433	38.70661	1.398945	2.765368	3.501054	14.89066	6.223042
2. GRev							
5th Year	6.321379	80.73708	1.550304	2.671541	1.367828	5.174382	2.177488
10th Year	5.170638	60.24132	1.592744	2.779953	0.983640	20.37559	8.856123
3. PubGFCFv							
5th Year	5.485993	35.42559	33.63916	0.202814	4.774884	7.070687	13.40087
10th Year	5.734962	40.11773	22.49555	0.189891	4.284435	8.459478	18.71796
4. PriGFCF							
5th Year	2.965526	28.69290	3.585913	53.78940	0.336426	4.065650	6.564181
10th Year	4.070378	30.14991	3.250295	47.51026	0.550518	5.184349	9.284291
5. Ygap							
5th Year	4.091847	21.49837	10.69538	4.322498	49.77697	4.794465	4.820472
10th Year	5.029551	25.99330	8.918998	3.682037	40.78539	6.356854	9.233872
6. LesP							
5th Year	5.442904	45.02692	4.003538	2.346423	1.812250	37.45386	3.914099
10th Year	3.045789	43.49755	2.715056	2.534480	2.262886	39.60571	6.338532
7. R							
5th Year	11.71924	10.71044	6.502173	1.053982	0.436367	14.49280	55.08500
10th Year	12.71588	11.64381	7.913585	0.997039	0.759635	13.92742	52.04263

Authors' Calculations

Table 7 indicates that in the fifth year, approximately 47 per cent of total variation in government expenditure is explained by own shocks while 39 per cent of the variation is explained by shocks in government revenue. In the tenth year, shocks to government revenue explain 38 per cent of the variation in government expenditure while own shocks explain 32 per cent. Furthermore, 14 per cent of the total variation in government expenditure is explained by shocks to consumer prices. 80 per cent of the total variation in government revenue is explained by own shocks in the fifth year. The remainder of the variation is explained by shocks to the rest of the macro-variables with the shocks in government expenditure explaining around 6 per cent of the variation in government revenue and shocks in consumer prices explaining around 5 per cent of the variation. In the tenth year, 60 per cent of the variation in government revenue is explained by own shocks while 20 per cent of the variation is explained by shocks in consumer prices.

In the fifth year, around 35 per cent of the total variation in public gross fixed capital formation is explained by shocks in government revenue and approximately 33 per cent of the variation is explained by own shocks. In addition, shocks in the interest rate spread explain around 13 per cent of the variation in public gross fixed capital formation in the fifth year. In the tenth year, shocks to government revenue take the lead once again and explaining around 40 per cent of the variation in public gross fixed capital formation while own shocks only explain about 22 per cent of the variation. Moreover, the interest rate spread explains about 18 per cent of the variation in public gross fixed capital formation in the tenth year.

Shocks in government revenue combined with own shocks explain most of the variation in private gross fixed capital formation in the fifth and tenth years. Similarly, most of the variation in the output gap and in consumer prices across the years under review is explained by own shocks and shocks in government revenue. The variation in the interest rate spread in the fifth and tenth years is mostly explained by own shocks, shocks to consumer prices, government expenditure and government revenue, respectively.

6 ROBUSTNESS CHECKS

This section investigates whether the previously stated findings are robust. As an initial robustness check, the reduced form VAR, equation 1 has to satisfy the stability condition that stresses that all roots of the characteristic polynomial should be inside the unit circle (Ravnik and Žilić, 2011). This condition is satisfied, as shown in Appendix 2. The second test for robustness is one similar to that used by Bank (2011) who analysed different specifications of the reduced form VAR. That is, equation 1 is estimated with a change in the ordering of the endogenous variables. In Section 4.5, the ordering, under the Cholesky decomposition was such that government expenditure was ordered first, then followed by government revenue, public gross fixed capital formation, private gross fixed capital formation, the output gap, consumer prices and last the interest rate spread. Christiano *et al* (1999) cautioned that under the Cholesky decomposition, the ordering of variables before and after the variables of interest (in this case the fiscal policy variables) does not have any consequence for the shock in the variables of interest. That is to say, if the ordering is not changed for the fiscal policy variables themselves but is changed for all variables that come after them, the same result as the initial ordering will be obtained.

Under the new ordering, the study maintains the use of the Cholesky decomposition with ((n^2-n))/2 zero (exclusion) restrictions but orders the government revenue first, followed by government expenditure, public gross fixed capital formation, and private gross fixed capital formation, the output gap, consumer prices and last the interest rate spread. The assumption here is that is that government revenue, especially tax decisions, does not follow the expenditure decisions of the government. Moreover, government expenditure rather responds to government revenue shocks contemporaneously and so do the other selected macro-variables. Judging by the forecast error variance decompositions presented in Appendix 6, the results remain broadly unchanged and provide proof of the robustness of the model used.

7 CONCLUSION

This paper analysed the impact of shocks to Lesotho's fiscal policy variables on a set of macro-variables within a structural vector autoregression (SVAR) framework covering the period 1982 to 2015 using annual data. The results are as follows: A positive shock to government expenditure leads to a positive response of 0.01 per cent in consumer prices upon impact for the first year only; thereafter the impact becomes statistically insignificant. Importantly, shocks in government expenditure were found to have an insignificant impact on all other selected macro variables, including government revenue. The insignificant impact of government expenditure shocks on government revenue implies that government spending, to a large extent is financed through greater levels public debt. Moreover, increased government expenditure does not translate into an increased revenue generation capacity for the government. Positive innovations in government revenue cause a positive and highly significant response in government expenditure for a period of four years from the second year after the initial shock. The impact peaks in year four at approximately 0.052 per cent. While the dynamic effects of government expenditure on the level of inflation as well as private and public gross fixed capital formation are insignificant, positive shocks in government revenue result in a rise in the level of inflation coupled with private and public gross fixed capital formation. The positive impact of government revenue shocks on consumer prices is realised from the second year following the shock and lasts until the fifth year. On the other hand, the positive innovations in government revenue affect private and public gross fixed capital formation positively upon impact for a period of four and five years, respectively.

The discovery that positive shocks to government expenditure do not affect any of the selected macro variables except inflation (in a positive fashion) is worrying. In the same vein, the finding that positive shocks in government revenue lead to increased levels of inflation is also of concern. In light of this, the following policy recommendations can be made. Government expenditure should favour more the productive sectors of the economy in order to stimulate higher economic output and growth. Last, government revenue should be increased through a widening of the revenue base and more efficient methods of revenue collection as opposed to increases in the tax rate as this could lead to inflation.

Although the results of this study are, in general, informative; it is advised that they be cautiously interpreted. This is due to three reasons. First; the relatively small number of observations used in the study due to lack of data. Second; the sensitivity of the results to the choice of shock identification approach. Last; the absence of a debt feedback effect in the model. A possible area for further research would therefore be to expand on the current work by replicating it with a longer data set, a different shock identification approach as well as the inclusion of a debt feedback effect in the model to capture the effect of the government intertemporal budget constraint.

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Appendix 1. Johansen Cointegration Test

Sample (adjusted): 1984 2015
Included observations: 32 after adjustments
Trend assumption: Linear deterministic trend
Series: YGAP R PUBGFCF GEXP GREV
Lags interval (in first differences): 1 to 1
Unrestricted Cointegration Rank Test (Trace)

Hypothesized		Trace	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None	0.548903	65.25882	69.81889	0.1095
At most 1	0.471844	39.78447	47.85613	0.2303
At most 2	0.243540	19.35685	29.79707	0.4675
At most 3	0.220454	10.42548	15.49471	0.2494
At most 4	0.073881	2.456071	3.841466	0.1171

Trace test indicates no cointegration at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Authors' Calculations

Appendix 2. AR Roots Graph (Roots of Characteristic Polynomial)

Roots of Characteristic Polynomial
Endogenous variables: GEXP GREV PUBGFCF PRIGFCF YGAP LESP R
Exogenous variables: C

Lag specification: 1 1	
Root	Modulus
0.962788	0.962788
0.803256 - 0.205088i	0.829024
0.803256 + 0.205088i	0.829024
0.747473	0.747473
0.434833	0.434833
0.224395	0.224395
0.084693	0.084693

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

Authors' Calculations

Appendix 3. VAR Residual Heteroskedasticity Tests: No Cross Terms (only levels and squares)

Sample: 1982 2015
Included observations: 33

Joint test:

Chi-sq	df	Prob.
411.4232	392	0.2400

Individual components:

Dependent	R-squared	F(14,18)	Prob.	Chi-sq(14)	Prob.
res1*res1	0.477781	1.176307	0.3672	15.76678	0.3278
res2*res2	0.566875	1.682746	0.1484	18.70688	0.1765
res3*res3	0.465918	1.121622	0.4029	15.37531	0.3530
res4*res4	0.261635	0.455585	0.9296	8.633957	0.8538
res5*res5	0.413475	0.906375	0.5677	13.64469	0.4765
res6*res6	0.300205	0.551559	0.8685	9.906766	0.7690
res7*res7	0.563756	1.661522	0.1543	18.60395	0.1806
res2*res1	0.526465	1.429428	0.2350	17.37335	0.2368
res3*res1	0.638513	2.271021	0.0517	21.07092	0.0998
res3*res2	0.511561	1.346577	0.2726	16.88150	0.2625
res4*res1	0.302979	0.558870	0.8631	9.998307	0.7623
res4*res2	0.408191	0.886801	0.5843	13.47030	0.4899
res4*res3	0.280268	0.500665	0.9030	9.248839	0.8148
res5*res1	0.679678	2.728107	0.0237	22.42938	0.0702
res5*res2	0.498983	1.280496	0.3064	16.46645	0.2857
res5*res3	0.368469	0.750156	0.7041	12.15949	0.5935
res5*res4	0.199022	0.319466	0.9824	6.567719	0.9501
res6*res1	0.333757	0.644083	0.7959	11.01397	0.6849
res6*res2	0.597726	1.910401	0.0982	19.72496	0.1391
res6*res3	0.334761	0.646996	0.7935	11.04712	0.6823
res6*res4	0.374018	0.768202	0.6881	12.34260	0.5788
res6*res5	0.298518	0.547141	0.8716	9.851102	0.7730
res7*res1	0.183855	0.289636	0.9886	6.067221	0.9648
res7*res2	0.472862	1.153333	0.3819	15.60445	0.3381
res7*res3	0.333091	0.642156	0.7975	10.99199	0.6867
res7*res4	0.482251	1.197563	0.3540	15.91428	0.3186
res7*res5	0.374546	0.769935	0.6865	12.36001	0.5774
res7*res6	0.436330	0.995255	0.4953	14.39889	0.4204

Authors' Calculations

Appendix	4. VAR Residual Normality Tests			
VAR Residual Normality Tests Orthogonalization: Cholesky (Lutkepohl) Null Hypothesis: residuals are multivariate normal Sample: 1982 2015 Included observations: 33				
Component	**Skewness**	**Chi-sq**	**df**	**Prob.**
1	-0.001354	1.01E-05	1	0.9975
2	0.386359	0.821001	1	0.3649
3	0.158166	0.137590	1	0.7107
4	-0.604012	2.006570	1	0.1566
5	-0.420714	0.973500	1	0.3238
6	-0.718449	2.838929	1	0.0920
7	-0.877532	4.235340	1	0.0396
Joint		11.01294	7	0.1381
Component	**Kurtosis**	**Chi-sq**	**df**	**Prob.**
1	2.143645	1.008348	1	0.3153
2	3.102805	0.014532	1	0.9040
3	3.054149	0.004032	1	0.9494
4	2.431341	0.444638	1	0.5049
5	2.286674	0.699646	1	0.4029
6	2.828073	0.040643	1	0.8402
7	3.871052	1.043257	1	0.3071
Joint		3.255096	7	0.8604
Component	**Jarque-Bera**	**df**	**Prob.**	
1	1.008358	2	0.6040	
2	0.835533	2	0.6585	
3	0.141622	2	0.9316	
4	2.451209	2	0.2936	
5	1.673146	2	0.4332	
6	2.879572	2	0.2370	
7	5.278597	2	0.0714	
Joint	14.26804	14	0.4299	

Authors' Calculations

Appendix 5. Forecast Error Variance Decomposition in Percentage

Period	S.E.	GEXP	GREV	PUBGFCF	PRIGFCF	YGAP	LESP	R
Variance Decomposition of GEXP:								
1	0.091490	100.0000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2	0.105546	85.34962	7.853827	0.487061	0.027301	3.162609	0.032957	3.086626
3	0.119192	67.21969	22.01749	0.722537	0.395722	4.961956	0.245881	4.436731
4	0.132645	54.56310	32.96714	0.888113	1.112294	5.259737	0.855327	4.354288
5	0.143964	47.11768	39.23264	1.058548	1.753465	4.997804	2.027899	3.811970
6	0.152900	42.60294	42.09093	1.224944	2.215114	4.628966	3.835630	3.401471
7	0.160080	39.45938	42.73993	1.355935	2.513581	4.283984	6.227643	3.419543
8	0.166249	36.89601	42.02054	1.428208	2.683266	3.984102	9.030597	3.957271
9	0.171942	34.60200	40.53281	1.437922	2.757185	3.724914	11.99864	4.946533
10	0.177414	32.51433	38.70661	1.398945	2.765368	3.501054	14.89066	6.223042
Variance Decomposition of GREV:								
1	0.089006	0.521143	99.47886	0.000000	0.000000	0.000000	0.000000	0.000000
2	0.117996	2.389533	92.13834	0.527952	0.832151	1.295772	0.224765	2.591487
3	0.137219	4.336811	87.76124	0.921230	1.728700	1.528986	1.071699	2.651336
4	0.150062	5.659251	84.31736	1.269874	2.319083	1.474499	2.722974	2.236957
5	0.159159	6.321379	80.73708	1.550304	2.671541	1.367828	5.174382	2.177488
6	0.166376	6.438829	76.72924	1.727026	2.857370	1.263047	8.230800	2.753686
7	0.172825	6.206160	72.40417	1.791648	2.925054	1.170868	11.56685	3.935247
8	0.179007	5.827148	68.04284	1.765962	2.913760	1.093212	14.84587	5.511214
9	0.185022	5.455050	63.92561	1.687493	2.856821	1.030727	17.82222	7.222071
10	0.190774	5.170638	60.24132	1.592744	2.779953	0.983640	20.37559	8.856123
Variance Decomposition of PUBGFCF:								
1	0.260127	10.22842	17.21436	72.55722	0.000000	0.000000	0.000000	0.000000
2	0.386243	10.97723	23.43163	59.10657	0.361858	2.600253	1.772808	1.749657
3	0.481197	8.969884	28.40373	48.39312	0.300019	4.101165	3.977137	5.854939
4	0.560732	6.854246	32.43584	39.90908	0.238365	4.678271	5.810354	10.07385
5	0.627322	5.485993	35.42559	33.63916	0.202814	4.774884	7.070687	13.40087
6	0.680720	4.879840	37.47031	29.23934	0.186131	4.684260	7.833183	15.70693
7	0.721121	4.805378	38.77244	26.27334	0.181144	4.550110	8.240911	17.17668
8	0.749763	5.029134	39.53893	24.35347	0.182344	4.430276	8.422399	18.04345
9	0.768677	5.376729	39.94287	23.17258	0.185992	4.341826	8.473399	18.50660
10	0.780216	5.734962	40.11773	22.49555	0.189891	4.284435	8.459478	18.71796

Authors' Calculations

Appendix	5. Forecast Error Variance Decomposition in Percentage (continued)							
Variance Decomposition of PRIGFCF:								
Period	S.E.	GEXP	GREV	PUBGFCF	PRIGFCF	YGAP	LESP	R
1	0.127744	2.808687	11.61089	0.058163	85.52226	0.000000	0.000000	0.000000
2	0.139556	2.979989	20.41338	2.125236	72.33921	0.011329	1.035760	1.095094
3	0.148987	2.877449	24.91082	3.291950	63.54413	0.062563	2.289634	3.023461
4	0.156415	2.858065	27.31576	3.610498	57.72214	0.199466	3.320959	4.973105
5	0.162077	2.965526	28.69290	3.585913	53.78940	0.336426	4.065650	6.564181
6	0.166202	3.172118	29.48368	3.471064	51.16532	0.434945	4.561161	7.711711
7	0.169034	3.427068	29.90829	3.363946	49.47168	0.494997	4.868354	8.465663
8	0.170848	3.681561	30.10232	3.293107	48.43070	0.527701	5.045426	8.919189
9	0.171920	3.901498	30.16046	3.258547	47.83030	0.543702	5.139358	9.166137
10	0.172500	4.070378	30.14991	3.250295	47.51026	0.550518	5.184349	9.284291
Variance Decomposition of YGAP:								
1	0.010743	7.850574	5.916462	4.755764	0.000123	81.47708	0.000000	0.000000
2	0.012747	5.585981	11.89656	9.706954	3.798703	68.13576	0.870908	0.005138
3	0.013751	4.912189	15.82257	11.23041	4.641220	60.28598	2.259351	0.848281
4	0.014513	4.416724	18.98188	11.24121	4.571569	54.39140	3.669897	2.727324
5	0.015175	4.091847	21.49837	10.69538	4.322498	49.77697	4.794465	4.820472
6	0.015730	4.023193	23.36127	10.06971	4.088108	46.32790	5.555067	6.574747
7	0.016158	4.174500	24.62282	9.559072	3.911874	43.90557	6.005194	7.820979
8	0.016460	4.449585	25.39503	9.211731	3.793854	42.31187	6.236309	8.601628
9	0.016654	4.755780	25.81048	9.011276	3.721892	41.33564	6.332519	9.032406
10	0.016766	5.029551	25.99330	8.918998	3.682037	40.78539	6.356854	9.233872
Variance Decomposition of LESP:								
1	0.023219	16.92967	10.07508	2.770378	0.124537	2.252392	67.84795	0.000000
2	0.037358	11.98513	29.00054	4.856637	1.406581	1.405508	47.93184	3.413762
3	0.047537	8.754412	37.67422	4.810716	1.912616	1.494171	41.54917	3.804691
4	0.055560	6.729011	42.48535	4.421344	2.183153	1.655180	38.69790	3.828058
5	0.062166	5.442904	45.02692	4.003538	2.346423	1.812250	37.45386	3.914099
6	0.067729	4.598809	46.08608	3.634450	2.446707	1.948716	37.14046	4.144775
7	0.072493	4.017813	46.16151	3.327821	2.505205	2.060465	37.39957	4.527616
8	0.076644	3.597936	45.59955	3.078530	2.534173	2.148073	37.99775	5.043984
9	0.080317	3.283760	44.65071	2.877204	2.541848	2.214297	38.77122	5.660963
10	0.083612	3.045789	43.49755	2.715056	2.534480	2.262886	39.60571	6.338532

Authors' Calculations

Appendix 5. Forecast Error Variance Decomposition in Percentage (continued)

Variance Decomposition of R:

Period	S.E.	GEXP	GREV	PUBGFCF	PRIGFCF	YGAP	LESP	R
1	0.016338	2.645794	1.727263	3.391015	1.915249	0.434594	16.17988	73.70620
2	0.019648	4.921788	7.350523	4.072003	1.355916	0.303193	16.44352	65.55306
3	0.021453	7.719530	9.992525	4.892520	1.147949	0.284872	15.72008	60.24253
4	0.022414	10.08139	10.76668	5.727398	1.074704	0.345700	15.00270	57.00144
5	0.022889	11.71924	10.71044	6.502173	1.053982	0.436367	14.49280	55.08500
6	0.023132	12.64742	10.49321	7.137104	1.046066	0.529306	14.19063	53.95626
7	0.023294	13.01819	10.45872	7.579900	1.036718	0.611416	14.04005	53.25500
8	0.023449	13.03650	10.69391	7.827852	1.023940	0.677196	13.97643	52.76416
9	0.023612	12.89164	11.12959	7.920183	1.009894	0.725899	13.94883	52.37396
10	0.023774	12.71588	11.64381	7.913585	0.997039	0.759635	13.92742	52.04263

Cholesky Ordering: GEXP GREV PUBGFCF PRIGFCF YGAP LESP R

Authors' Calculations

Appendix 6. Forecast Error Variance Decomposition in Percentage

Period	S.E.	GREV	GEXP	PUBGFCF	PRIGFCF	YGAP	LESP	R
Variance Decomposition of GREV:								
1	0.089006	100.0000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2	0.117996	91.01867	3.509207	0.527952	0.832151	1.295772	0.224765	2.591487
3	0.137219	85.82159	6.276461	0.921230	1.728700	1.528986	1.071699	2.651336
4	0.150062	81.97014	8.006477	1.269874	2.319083	1.474499	2.722974	2.236957
5	0.159159	78.23370	8.824758	1.550304	2.671541	1.367828	5.174382	2.177488
6	0.166376	74.23051	8.937557	1.727026	2.857370	1.263047	8.230800	2.753686
7	0.172825	70.00286	8.607467	1.791648	2.925054	1.170868	11.56685	3.935247
8	0.179007	65.77984	8.090145	1.765962	2.913760	1.093212	14.84587	5.511214
9	0.185022	61.80790	7.572764	1.687493	2.856821	1.030727	17.82222	7.222071
10	0.190774	58.25857	7.153384	1.592744	2.779953	0.983640	20.37559	8.856123
Variance Decomposition of GEXP:								
1	0.091490	0.521143	99.47886	0.000000	0.000000	0.000000	0.000000	0.000000
2	0.105546	9.547356	83.65609	0.487061	0.027301	3.162609	0.032957	3.086626
3	0.119192	23.57486	65.66232	0.722537	0.395722	4.961956	0.245881	4.436731
4	0.132645	33.84627	53.68397	0.888113	1.112294	5.259737	0.855327	4.354288
5	0.143964	39.49324	46.85708	1.058548	1.753465	4.997804	2.027899	3.811970
6	0.152900	41.93313	42.76075	1.224944	2.215114	4.628966	3.835630	3.401471
7	0.160080	42.34558	39.85374	1.355935	2.513581	4.283984	6.227643	3.419543
8	0.166249	41.51981	37.39674	1.428208	2.683266	3.984102	9.030597	3.957271
9	0.171942	40.00567	35.12914	1.437922	2.757185	3.724914	11.99864	4.946533
10	0.177414	38.19467	33.02626	1.398945	2.765368	3.501054	14.89066	6.223042
Variance Decomposition of PUBGFCF:								
1	0.260127	19.08879	8.353991	72.55722	0.000000	0.000000	0.000000	0.000000
2	0.386243	25.66640	8.742457	59.10657	0.361858	2.600253	1.772808	1.749657
3	0.481197	30.50770	6.865916	48.39312	0.300019	4.101165	3.977137	5.854939
4	0.560732	34.17017	5.119907	39.90908	0.238365	4.678271	5.810354	10.07385
5	0.627322	36.71812	4.193463	33.63916	0.202814	4.774884	7.070687	13.40087
6	0.680720	38.34681	4.003346	29.23934	0.186131	4.684260	7.833183	15.70693
7	0.721121	39.30194	4.275880	26.27334	0.181144	4.550110	8.240911	17.17668
8	0.749763	39.80178	4.766279	24.35347	0.182344	4.430276	8.422399	18.04345
9	0.768677	40.01493	5.304663	23.17258	0.185992	4.341826	8.473399	18.50660
10	0.780216	40.06325	5.789437	22.49555	0.189891	4.284435	8.459478	18.71796

Authors' Calculations

Appendix	6. Forecast Error Variance Decomposition in Percentage (continued)							
Variance Decomposition of PRIGFCF:								
Period	S.E.	GEXP	GREV	PUBGFCF	PRIGFCF	YGAP	LESP	R
1	0.127744	10.74267	3.676912	0.058163	85.52226	0.000000	0.000000	0.000000
2	0.139556	19.26088	4.132496	2.125236	72.33921	0.011329	1.035760	1.095094
3	0.148987	23.66918	4.119087	3.291950	63.54413	0.062563	2.289634	3.023461
4	0.156415	26.01044	4.163389	3.610498	57.72214	0.199466	3.320959	4.973105
5	0.162077	27.31871	4.339717	3.585913	53.78940	0.336426	4.065650	6.564181
6	0.166202	28.04060	4.615202	3.471064	51.16532	0.434945	4.561161	7.711711
7	0.169034	28.40527	4.930082	3.363946	49.47168	0.494997	4.868354	8.465663
8	0.170848	28.55364	5.230242	3.293107	48.43070	0.527701	5.045426	8.919189
9	0.171920	28.58135	5.480607	3.258547	47.83030	0.543702	5.139358	9.166137
10	0.172500	28.55356	5.666728	3.250295	47.51026	0.550518	5.184349	9.284291
Variance Decomposition of YGAP:								
1	0.010743	4.945120	8.821916	4.755764	0.000123	81.47708	0.000000	0.000000
2	0.012747	11.20404	6.278492	9.706954	3.798703	68.13576	0.870908	0.005138
3	0.013751	15.31347	5.421292	11.23041	4.641220	60.28598	2.259351	0.848281
4	0.014513	18.52555	4.873054	11.24121	4.571569	54.39140	3.669897	2.727324
5	0.015175	20.99293	4.597293	10.69538	4.322498	49.77697	4.794465	4.820472
6	0.015730	22.75227	4.632194	10.06971	4.088108	46.32790	5.555067	6.574747
7	0.016158	23.89810	4.899214	9.559072	3.911874	43.90557	6.005194	7.820979
8	0.016460	24.56870	5.275915	9.211731	3.793854	42.31187	6.236309	8.601628
9	0.016654	24.90793	5.658330	9.011276	3.721892	41.33564	6.332519	9.032406
10	0.016766	25.04109	5.981763	8.918998	3.682037	40.78539	6.356854	9.233872
Variance Decomposition of LESP:								
1	0.023219	11.99151	15.01323	2.770378	0.124537	2.252392	67.84795	0.000000
2	0.037358	31.32219	9.663484	4.856637	1.406581	1.405508	47.93184	3.413762
3	0.047537	39.75662	6.672012	4.810716	1.912616	1.494171	41.54917	3.804691
4	0.055560	44.24846	4.965907	4.421344	2.183153	1.655180	38.69790	3.828058
5	0.062166	46.50285	3.966980	4.003538	2.346423	1.812250	37.45386	3.914099
6	0.067729	47.33435	3.350541	3.634450	2.446707	1.948716	37.14046	4.144775
7	0.072493	47.24145	2.937875	3.327821	2.505205	2.060465	37.39957	4.527616
8	0.076644	46.56096	2.636527	3.078530	2.534173	2.148073	37.99775	5.043984
9	0.080317	45.53183	2.402640	2.877204	2.541848	2.214297	38.77122	5.660963
10	0.083612	44.32606	2.217278	2.715056	2.534480	2.262886	39.60571	6.338532

Authors' Calculations

Appendix 6. Forecast Error Variance Decomposition in Percentage (continued)

Variance Decomposition of R:

Period	S.E.	GEXP	GREV	PUBGFCF	PRIGFCF	YGAP	LESP	R
1	0.016338	1.424206	2.948852	3.391015	1.915249	0.434594	16.17988	73.70620
2	0.019648	6.496697	5.775614	4.072003	1.355916	0.303193	16.44352	65.55306
3	0.021453	8.741263	8.970792	4.892520	1.147949	0.284872	15.72008	60.24253
4	0.022414	9.310447	11.53761	5.727398	1.074704	0.345700	15.00270	57.00144
5	0.022889	9.194523	13.23516	6.502173	1.053982	0.436367	14.49280	55.08500
6	0.023132	9.002819	14.13782	7.137104	1.046066	0.529306	14.19063	53.95626
7	0.023294	9.026886	14.45002	7.579900	1.036718	0.611416	14.04005	53.25500
8	0.023449	9.318076	14.41234	7.827852	1.023940	0.677196	13.97643	52.76416
9	0.023612	9.790223	14.23101	7.920183	1.009894	0.725899	13.94883	52.37396
10	0.023774	10.31894	14.04075	7.913585	0.997039	0.759635	13.92742	52.04263

Cholesky Ordering: GREV GEXP PUBGFCF PRIGFCF YGAP LESP R

Authors' Calculations