

**The Macroeconomics of Fiscal Policy in Sierra Leone: An
Empirical Investigation of Fiscal Sustainability, Fiscal Policy
Shocks, and the Tax Smoothing Hypothesis**

Submitted by

Samuel Bonzu

Department of Economics

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Declaration of Authorship

I, Samuel Bonzu, hereby declare that this thesis and the work presented in it is entirely my own.

Where I have consulted the work of others, this is always clearly stated.

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Abstract

This thesis comprises three empirical chapters that examine the on-going issues in fiscal policy debates in Sierra Leone. The first empirical chapter, Chapter Two, assesses the sustainability of public finance in Sierra Leone. We examined sustainability by employing unit root tests on primary balance, cointegration between government revenues and expenditures, and finally, the fiscal reaction function showing the relationship between lagged debt ratio and primary balance ratio. A battery of unit root tests was performed on primary balance ratio and the results confirm sustainability. Likewise, different tests for cointegration between government revenues and expenditures were applied and the results show that fiscal policy over the years is weakly sustainable. Controlling for endogenous structural breaks, the results show that the sustainability became weaker post 1984. Finally, we estimated a policy rule that further confirms that fiscal policy in Sierra Leone under the review period was sustainable.

Chapter Three examines the short-run effects of fiscal policy shocks on key macroeconomic variables within the framework of structural vector autoregression. The key results show that output and private consumption are persistently crowded-in by positive innovation in government spending. Government spending moderately increases private investment and government revenue. Shocks to government revenue temporarily reduce output and investment. Both spending and tax shocks are inflationary and interest rate rise to spending increases in the short term. Additionally, government investment expenditure strongly stimulates the economy in contrast to government consumption expenditure.

Chapter Four investigates the existence of optimal taxation in Sierra Leone. ‘Optimality’ here means if the government smoothed tax over time. Following Barro (1979), we employed different unit roots tests on tax rate to examine its stationarity properties. Moreover, we employed univariate autoregression and vector autoregression to examine the unpredictability of tax rate. Both approaches confirm that tax rate changes are unpredictable which implies that tax smoothing hypothesis hold under the review period.

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To my late parents; Mr. Tamba Eric Bonzu and Mrs. Kumba Bonzu

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CHAPTER ONE

Introduction

1.1 Motivation

Fiscal deficit and its financing is a major problem and cause for concern for the government of Sierra Leone. For over three decades, Sierra Leone has been running persistent deficits. Recent fiscal policy, mainly the reduction of fiscal deficits, has been a tool used for short-term macro-stabilisation and medium-term adjustment programmes. Domestic revenue mobilization in Sierra Leone has been abysmal coupled with the increase spending needs by the government has put the budget in persistent deficits since 1980. The government has been struggling to raised tax revenue above 11.00 per cent per annul in GDP (Gupta 2007). Despite the various reforms to the tax system ranging from changes in tax rates, introduction of new taxes, tax harmonisation etc, revenue mobilisation continues to be inadequate to meets the government financing needs.

Large and persistent deficits have been highlighted as one reason for slow growth (Fischer, 1993; Adam and Bevan, 2005) and general macroeconomic instability (Schmidt-Hebbel, 1996). Moreover, fiscal deficits put a burden on future generations, as excessive public spending is financed by issuing debt. Large and persistent fiscal deficits could reduce growth and lead to fiscal crises (Romer, 2006). Such deficits may result also in excessive accumulation of public debt, which in turn raises some issues regarding public sector budgetary policies. One such issue is the sustainability of fiscal deficits, and another is if the government practises optimal fiscal policy measures such as tax smoothing.

Prior to the publication of Keynes', *The General Theory of Employment, Interest and Money* in 1936, the policy rule was for government to run balance budget (Buchanan and Wagner, 2000).

The idea was that government should not spend without imposing taxes. Present fiscal burden should not be shifted to the future by issuing bonds to finance excess public expenditure. Fiscal deficits should only be tolerated in extreme cases such as wars and/or recession, which means that public debt should increase only in extraordinary periods (for detail see Burkhead (1954), Buchanan (1958) and Buchanan and Wagner (1967)).

Approaches to fiscal policy entirely changed following Keynes' publication. In Keynesianism, government budget is assigned a key role to achieve important macroeconomic aims such as growth and employment (Pierce, 1971). Large deficits and debt accumulation are therefore not major sources of concern for government and policy makers if excess spending is used to stabilise the macroeconomy. Moreover, Keynesianism highlights that deficits do not matter if they are financed by domestic debts (Dalton, 1954; Feldstein, 1995), which means that government is not mandated to run a balanced budget. Because of the unbalanced budget rule, governments tend to make apparently irresponsible spending decisions (Feldstein, 1995). Also, unrestricted spending regulations result in rent-seeking activities. When fiscal policy involves non-Ricardian approaches, fiscal deficits increase interest rates and crowd-out private investment, which erodes long-term growth (Mühleisen, 2004; Mühleisen and Towe, 2004; Adam and Bevan, 2005). Additionally, fiscal deficits create huge deadweight loss to the economy (Feldstein, 1995).

Because governments understand the impacts of large fiscal deficits, recent fiscal policy measures have aimed to reduce the gap between government spending and revenue as a means of ensuring sustainable fiscal policy. In many countries, the size of the deficits has significantly reduced from their high figures in the 1990s (Auerbach, 2003; Adams and Bevan, 2005). According to Bohn (1998), one reason for the contractionary fiscal policy in recent years is the high debt accumulation in the past. In some developing countries, declining fiscal deficits are owing to policy targets set

by international agencies such as the World Bank and IMF. Governments themselves often create larger deficits, for example through spending increases and/or tax cuts for political gain. Fiscal deficits are difficult to avoid, and accumulation of debt is therefore inevitable. As such, this kind of fiscal policy obviously warrants macroeconomic concerns.

1.2. Fiscal Policy in Sierra Leone 1980-2015

The fiscal policy tools of Sierra Leone comprise mostly of taxes and government spending. The tax system is inherited from the British colonial era and has experienced significant reforms. The tax system is categorised into direct and indirect taxes. Direct taxes in Sierra Leone comprised of company income tax, personal income tax, payroll tax and property tax. Indirect taxes on the other hand comprised of import sales tax, domestic sales tax, entertainment tax, restaurant and food tax, message tax, hotel accommodation tax, professional tax and exercise duty. Other sources of revenues are categorised as non-tax revenue which includes among others non-exclusive prospective license, exclusive prospective license, exploration license, mining lease and royalties. Whereas government spending can be grouped into three main categories: Government investment spending (capital expenditures) also known as the gross capital formation which includes spending on infrastructures such as road, electricity, information technology etc, Government consumption expenditure spending (mostly recurrent expenditure) such as wage bill of government employees, and Transfer which includes subsidies, grants and other social benefits. Like other developing countries the agricultural sector of Sierra Leone contributes significantly to the GDP accounting for about 44 per cent per annum. Services sector is was next to agriculture followed by mining and manufacturing (Kargbo and Egwaikhide 2012).

Domestic revenue mobilisation over the sample period has been very low with tax revenue as a share of GDP less than 15%. The short fall in revenue coupled with government expansionary

spending resulted in persistent fiscal deficits. To address these obstacles of enhancing revenue collections, various reforms have been introduced in the tax system ranging from changes in tax rates, harmonisation of tariffs, introduction of new taxes and establishing an autonomous agency for tax collections. In 1989, the IMF conducted a review on the tax system in Sierra Leone and offered some technical advice to the government. The recommendations included the introduction of sales tax on imports and local manufactures, and to increase excise duty on petroleum. After a series of technical discussions with government experts and IMF, in 1990 the government of Sierra Leone finally adopted these measures and introduced the import sales tax and increased the exercise duty on petroleum products. In 2002, the National Revenue Authority hereafter NRA was formed by an act of parliament with the aim of establishing an efficient tax system. Prior to 2002, the tax system was fragmented with different sub-national units (Income Tax Department and Customs and Exercise Department) responsible for administering different categories of taxes, and these units were grossly inefficient. Finally, in 2009, the IMF recommended to the government of Sierra Leone for the introduction of the Goods and Services Tax (GST). After careful consideration, GST was officially passed into law in January 2010, and introduced at 15%.

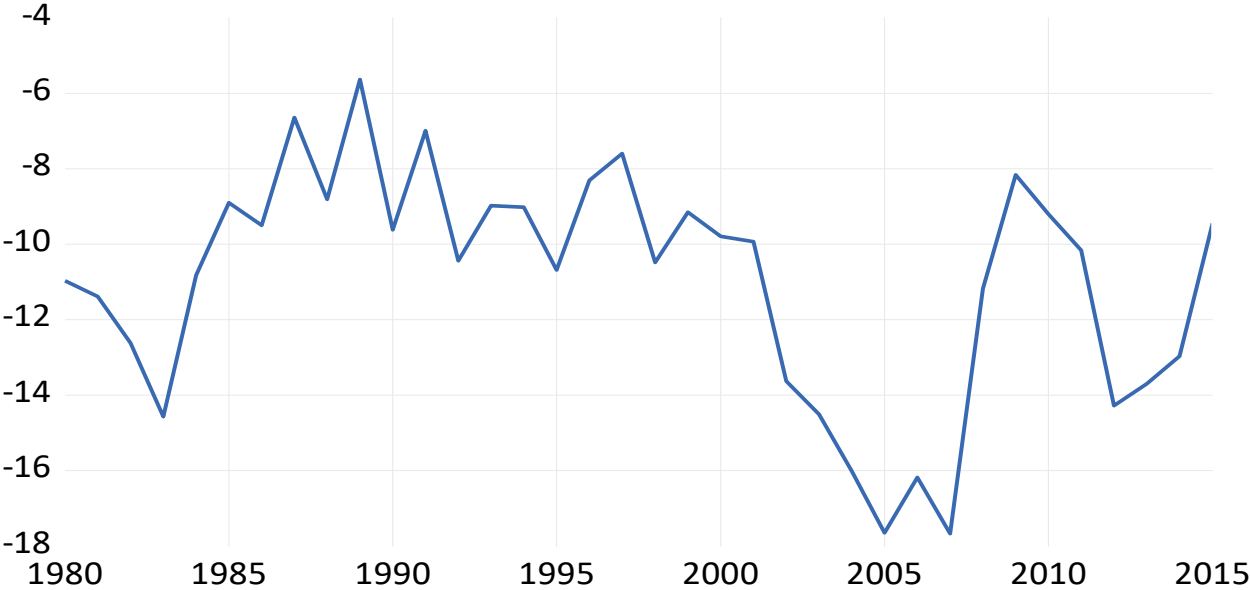
Sierra Leone fiscal performance over the sample period has been weak characterised by decades of fiscal deficits. This persistent deficit can be due to the shortfall in revenue mobilization coupled with the government's fiscal stance of expansionary spending. In the 1980s, the fiscal deficits excluding grants as a ratio of GDP was less than 15%.

Table 1.1 Fiscal Performance of Sierra Leone 1980-2015

YEAR	Government Revenue % of GDP	Government Spending % of GDP	Deficits Excluding Grants % of GDP
1980	13.94	24.91	-10.97
1981	14.78	26.17	-11.39
1982	10.41	23.03	-12.62
1983	7.41	21.98	-14.57
1984	6.42	17.24	-10.82
1985	5.72	14.62	-8.9
1986	3.82	13.32	-9.50
1987	4.69	11.33	-6.64
1988	5.86	14.67	-8.81
1989	8.54	14.17	-5.63
1990	7.03	16.65	-9.62
1991	7.74	14.73	-6.99
1992	4.99	15.43	-10.44
1993	10.25	19.23	-8.98
1994	11.04	20.06	-9.02
1995	9.05	19.73	-10.68
1996	8.53	16.84	-8.31
1997	4.65	12.25	-7.6
1998	6.33	16.81	-10.48
1999	6.28	15.43	-9.15
2000	10.12	19.91	-9.79
2001	12.01	21.94	-9.93
2002	11.31	24.94	-13.63
2003	11.33	25.84	-14.51
2004	10.91	26.92	-16.01
2005	10.02	27.67	-17.65
2006	9.18	25.36	-16.18
2007	11.01	28.68	-17.67
2008	9.68	20.86	-11.18
2009	11.23	19.39	-8.16
2010	11.21	20.41	-9.2
2011	10.6	20.76	-10.16
2012	9.86	24.14	-14.28
2013	10.23	23.93	-13.7
2014	9.89	22.86	-12.97
2015	10.76	20.2	-9.44

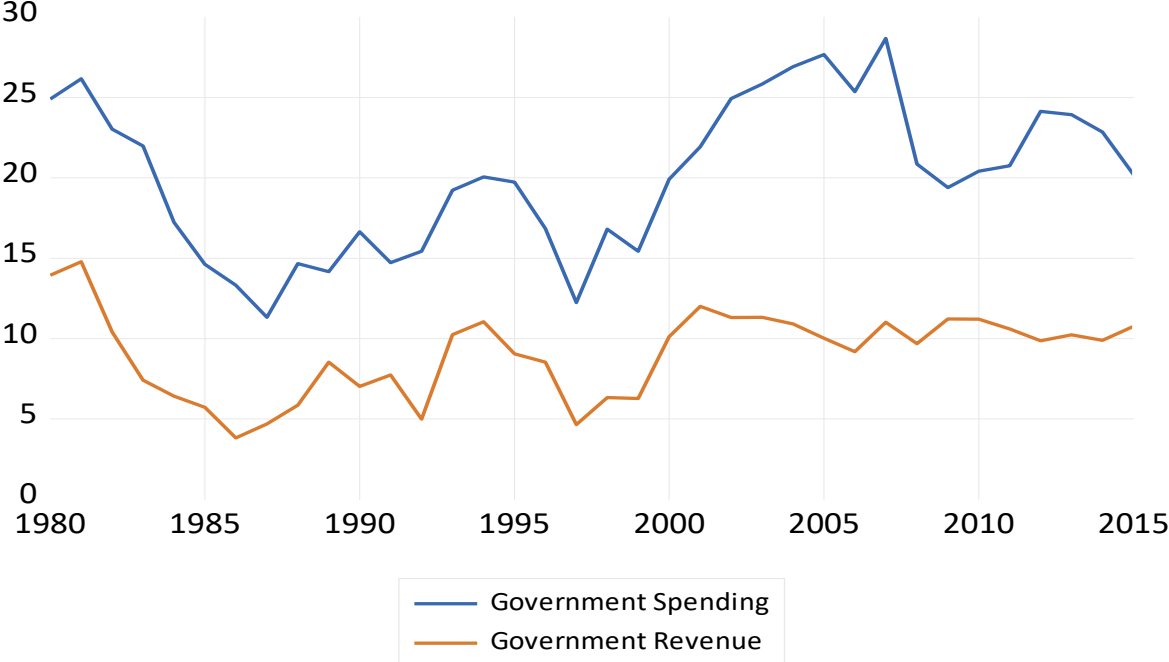
Source: Calculated by author from (i)World Bank database and (ii)National Revenue Authority

Figure 1.1 Fiscal Deficits as a percentage of GDP 1980-2015



(Sources: (i) World Bank (ii) National Revenue Authority Sierra Leone)

Figure 1.2 Government Spending and Revenue as a Percentage of GDP 1980-2015



(Sources: (i) World Bank (ii) National Revenue Authority Sierra Leone)

In 1980, Sierra Leone hosted the Organisation of Africa Unity (OAU) summit. The government increase its spending on infrastructure such as light and electricity ahead of the summit in order to boost the image of the country. The budget deficit improves from 10.97% in 1980 to 8.81% in 1988. The improvement in the budget deficits during these periods can be attributed to the decline in government spending on development and payroll expenditures, elimination of the rice subsidy for non-military personnel and transfer to public enterprises from 1980-1986. Also, the budget deficits improve from 10.44% in 1992 to 7.60% in 1997. These periods include part of the civil war era as it can also be observed that government spending fell from about 15.43% in 1992 to 12.25% in 1997. Revenue from taxation also deteriorated from 10.25% in 1993 to 6.28% in 1999. From 1992 to 1997, government spending fell more than tax revenue leading to an improvement in the deficits from 10.44% to 7.60%. However, the budget deficit sharply increased from 9.93% in 2001 to about 17.67% in 2007. This could be due to the post-war reconstruction drive by the government.

In the first half of the 1980s, the economic condition deteriorated abruptly. Government revenues plummeted sharply, from about 14% of the GDP in 1980 to about 6% in 1985, due to the fall-off in imports and official diamond exports reducing the tax base, coupled with the increasing negligence of public sector management, which eroded revenue generation efficiency. The fall in revenue generation in the first half of the 1980s forced the government to significantly reduce its spending, particularly wasteful public expenditures. These reductions heavily involved reductions in development and payroll expenditures. Government eliminated the rice subsidy for non-military personnel and transfer to public enterprises. In sum, government spending fell significantly from about 25% of GDP in 1980 to about 15% of GDP in 1988. It is worth to note that the following years 1996, 2002 and 2012 correspond to periods of multi-party presidential and parliamentary

elections in Sierra Leone. The increased government spending in the 2000s can be due to the post-war reconstruction drive to provide electricity, roads etc. Budget deficits during these periods worsen as it increased from 9.93% in 2001 to 13.70% in 2013. The deficits improve from 13.70 in 2013 to 9.44% in 2015. This improvement in the deficits can be due to the austerity measures introduced in 2014 comprised of spending cuts and tax increase.

1.3 Statement of the Research Problem

The first issue that this thesis addresses is the sustainability of fiscal policy in Sierra Leone. We examine this issue to determine if the current fiscal policy would lead the country into insolvency. The second topic investigated is the macroeconomic effects of fiscal policy shocks. We examine how the economy responds to both spending and tax shocks as well as how the different components of government spending and revenue affect the macroeconomy. The third problem that is examined in this thesis is whether the tax smoothing hypothesis holds for Sierra Leone. Because taxes create a distortionary effect, we investigate whether the government follows optimal tax principles such as tax smoothing to spread the tax burden over time. The objectives of this thesis are thus as follows:

- i) to examine whether the current fiscal policy is sustainable in Sierra Leone;
- ii) to explore how the government reacts to a rising debt-to-GDP ratio in Sierra Leone;
- iii) to determine the causal direction between government spending and revenue in Sierra Leone;
- iv) to investigate how the economy responds to shocks in both taxes and government spending in Sierra Leone;
- v) to determine which fiscal policy tool is most efficient in Sierra Leone
- vi) to investigate if the government of Sierra Leone follows optimal tax policy theory

1.4. Outline of the Thesis

This thesis comprises three empirical chapters of related themes on fiscal policy in Sierra Leone. The first issue examined in this thesis (in Chapter Two) is whether Sierra Leone's fiscal policy over the sample period is sustainable by exploring different methodological approaches. Unsustainable fiscal policy ultimately leads the government into fiscal crises characterised by late repayment of loans, debt reschedule, default, and so forth. The second issue (considered in Chapter Three) is how the economy responds to fiscal policy shocks. If the fiscal policy is weakly sustainable, unfavourable fiscal shocks will put budgetary operations into unsustainable path. It is therefore important to understand the impacts of fiscal policy shocks. The third empirical chapter (Chapter Four) examines whether the fiscal policy is consistent with the tax smoothing hypothesis. Taxation creates a distortionary effect, it is expected that the government should smooth tax over time to minimise the deadweight loss. Tax smoothing is therefore a precondition for fiscal sustainability. Moreover, financing any temporary spending and/or shocks to the tax base increases the stock of debt. It can be seen that all the three empirical chapters are closely related, with similar themes. Each of these chapters is discussed in more detail in the paragraphs that follow.

In the first empirical chapter, titled **“Fiscal Sustainability and Fiscal Reaction Function: Empirical Evidence for Sierra Leone”**, we examine the sustainability of fiscal policy in Sierra Leone using annual data spanning 1980-2015. We investigate the issue of sustainability using all three approaches in the empirical literature. First, we investigate the whether the government intertemporal budget constraint (IBC) is violated. We test for stationarity of the primary balance as proposed by Hamilton and Flavin (1986).

Second, the approach taken by Hakkio and Rush (1991) and Quintos (1995), among others, is adapted. These authors address the issue of the sustainability of fiscal policy by examining the cointegration relationship between government expenditure and revenue, if it is found that both government expenditure and revenue are stationary at first difference. Both the stationarity and cointegration approaches confirm that the IBC is satisfied, which means that over the sample period, the fiscal policy in Sierra Leone has been sustainable. Third, as argued by Bohn (1998), the traditional econometric approach of unit root and cointegration tests have low power in rejecting the null hypothesis of unit root from near-unit root alternatives. Bohn (2005) has shown that the IBC is not a sufficient condition for sustainability. He argues that it is possible to satisfy the IBC while having an explosive path to debt ratio. With this observation in mind, we estimate a fiscal reaction function (policy rule) by augmenting Bohn's (1998) fiscal reaction function. The results show that the primary balance ratio positively responds to variations in debt ratio. In sum, all three approaches confirm that Sierra Leone's fiscal policy over the sample period is sustainable. Moreover, we find that causality runs from government revenue to expenditure, which means that the decision to spend depends on the revenue. The causality result supports the tax-and-spend hypothesis as proposed by Friedman (1978).

In the second empirical chapter, "**Fiscal Policy Shocks in Sierra Leone: A Structural Vector Auto-Regression Approach**", we investigate the impacts of fiscal policy shocks within the framework of structural vector autoregression (SVAR). We adopt two approaches to achieve identification in the SVAR model, the recursive approach and Blanchard and Perotti's (2002) approach. We estimate a five-variable model following Perotti (2005). In addition, we estimate a six-variable VAR model to examine the impact of government spending and taxes on private consumption and investment.

The key results are that output and private consumption respond with strong and persistent effects to government spending shocks; both spending and tax shocks are inflationary; government investment expenditure strongly stimulates the economy compared to government consumption expenditure; and tax shock moderately reduces output and private investment.

In the final empirical chapter, “**Fiscal Policy and Optimal Taxation: Tests for Tax Smoothing Hypothesis in Sierra Leone**”, we investigate whether the fiscal behaviour of the government is consistent with optimal taxation in the context of Barro’s (1979) tax smoothing hypothesis. According to the tax smoothing theory, the timing of taxes matters due to the distortionary effects, and it is therefore necessary for the government to smooth tax over time. As such, the tax rate should follow a random walk. In addition, changes in tax rate should be unpredictable. We perform a battery of unit root tests and the results show that tax rate follows a random walk. Moreover, a univariate autoregression and VAR test were performed. We find that tax rate changes are unpredictable either by its own lagged values or by lagged values of other variables in the model. We therefore conclude that the fiscal behaviour in Sierra Leone over the sample period is consistent with optimal tax policy theory.

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CHAPTER TWO

Fiscal Sustainability and Fiscal Reaction Function: Empirical Evidence for Sierra Leone

2.1 Introduction

Is Sierra Leone fiscal policy sustainable? How do government react to the rising debt-to-GDP ratio? These questions have occupied the centre of public finance debates after the Latin American debt crisis in the 1980s (Brown and Hunter, 1999). It became even more interesting to policymakers, creditors and academics after the great financial crisis in 2008, when some countries' fiscal policy shifted towards an unsustainable trajectory characterised by late repayment of interest, debt reschedule or an outright default. While a sustainable fiscal policy is necessary for a healthy economy, large and persistent deficits have been highlighted as reasons for slow growth (Fischer, 1993; Adam and Bevan, 2005) and general macroeconomic instability (Schmidt-Hebbel, 1996). In addition to the above policy questions, we are also interested if the fiscal policy involves a structural break and the causal direction between government expenditure and revenue. Any causal direction between these two fiscal variables could offer valuable insight into how the government can manage the size of the deficits in the future.

The empirical literature on fiscal sustainability is categorised into three strands: i) the stationarity approach of public debt and/or primary deficits series, as seen in Hamilton and Flavin (1986), Trehan and Walsh (1988), Kremers (1989) and Wilcox (1989) among others; ii) the cointegration approach of public debt and deficits and/or revenue and expenditure as demonstrated by Hakkio and Rush (1991), MacDonald (1992), Haug (1995) and Quintos (1995); and iii) the policy rule or fiscal reaction as seen in, for example, Bohn (1998, 2005).

Following the seminal work by Hamilton and Flavin (1986), there has been a large volume of research on fiscal sustainability focusing mostly on the United States and European countries. Yet little has been done in the case of developing countries, especially Sierra Leone. The recent – and only – work that analysed Sierra Leone’s fiscal sustainability is by Oshikoya and Tarawalie (2010). These authors empirically test for the sustainability of fiscal policy in the West Africa Monetary Zone (WAMZ) countries, which comprise Ghana, Gambia, Guinea, Liberia, Nigeria and Sierra Leone, using annual data from 1980-2008. They test for cointegration relation between government expenditures and revenue and find that the fiscal behaviour for all the countries is sustainable except for Sierra Leone. There is no uniform fiscal policy across countries because each country is governed by different tax laws. The sustainability of fiscal policy therefore needs to be assessed at a country level. This current chapter therefore aims at providing answers to the above questions for Sierra Leone.

The aims of this chapter are therefore of two-fold: first, to empirically investigate whether the fiscal policy in Sierra Leone is sustainable, and second, to carefully document how the government responds to rising debt-to-GDP ratio. It is believed that such empirics are useful to creditors on one hand, serving as a guide for lending to the government, and, on the other hand are quite useful to government, cautioning policymakers to avoid public debt from exploding, leading to fiscal insolvency.

Comparing our work to Oshikoya and Tarawalie (2010), our contribution can be documented as follows: i) we use an extended data set, the longest available data set from 1980-2015; ii) we identify structural breaks endogenously in the cointegration relationships between government spending and revenue; and iii) we test for fiscal sustainability by adopting all different channels put forward in theoretical grounds – that is, stationarity tests of the primary-balance ratio, the

cointegration relation between government expenditure and revenue, and the relationship between lagged debt-to-GDP ratio and primary balance-to-GDP ratio (fiscal reaction function).

Overall, our results show that the fiscal policy in Sierra Leone is sustainable, and the cointegration between government spending and revenue is positive (but less than unity) and statistically significant. This finding implies that for each percentage point of GDP increase in government spending, government revenues increase by less than one percentage point of GDP. In terms of the error correction mechanism, the speed of adjustment from government expenditure tends to work faster than revenues to restore fiscal equilibrium. We find uni-directional causality running from government revenues to expenditure and the government is unable to raise the required revenue to finance the budgeted expenditure. Additionally, the estimated coefficient of the fiscal reaction is positive and statistically significant, which means the government takes prudent measures by adjusting the primary balance ratio (spending cut and/or tax increase) in response to rising debt ratio. The response of the output gap to primary balance ratio is negative, implying that the fiscal policy over the estimation period has been procyclical. The results also reveal that institutional capacity and political stability positively improve the primary balance ratio. Finally, the results confirm the existence of twin deficits in Sierra Leone as the response between the primary balance ratio and current account balance ratio is positive and statistically significant.

2.2 Theoretical Framework

Following Hakkio and Rush (1991), the government budget constraint is specified as:

$$B_t = (1 + r_t)B_{t-1} + G_t - R_t \quad (2.1)$$

where B_t represents the real stock of outstanding public debt, r_t represents the real interest rate, G_t is real government expenditure inclusive of interest payment and R_t is the real tax revenue.

Given that equation (2.1) holds for each period, taking expectation and solving recursively for government real debt, we obtain the intertemporal government budget constraint for the period $n=t$ to $t=T$ ¹:

$$B_t = \sum_{\tau=t+1}^T \left[\prod_{j=1}^{\tau-t} \frac{1}{(1 + r_{t+j})} (R_{\tau} - G_{\tau}) \right] + \left[\prod_{j=t}^{T-1} \frac{1}{(1 + r_j)} B_T \right] \quad (2.2)$$

Assuming a constant interest rate r , equation (2.2) is simplified as:

$$B_t = \sum_{\tau=t+1}^T \left[\frac{1}{(1 + r)^{\tau-t}} (R_{\tau} - G_{\tau}) \right] + \left[\frac{1}{(1 + r)^{T-t}} B_T \right] \quad (2.3)$$

which implies that the present-value government budget constraint is specified as:

$$B_t = \sum_{\tau=t+1}^{\infty} \left[\frac{1}{(1 + r)^{\tau-t}} (R_{\tau} - G_{\tau}) \right] + \lim_{T \rightarrow \infty} \left[\frac{1}{(1 + r)^{T-t}} B_T \right] \quad (2.4)$$

An existing fiscal policy is sustainable based on the second term of equation (2.4). If the transversality condition:

¹ See Hamilton and Flavin (1986) or Hakkio and Rush (1991).

$$\lim_{T \rightarrow \infty} \left[\frac{1}{(1+r)^{T-t}} B_T \right] \quad (2.5)$$

holds, the present value budget constraint of the government is specified as:

$$B_t = \sum_{\tau=t+1}^{\infty} \left[\frac{1}{(1+r)^{\tau-t}} (R_\tau - G_\tau) \right] \quad (2.6)$$

Equation (2.5) implies that the solvency conditions of the government must always be satisfied. This condition is known in the literature as ‘no Ponzi game’, which means the rate at which public debt is growing is no more than the rate at which interest rate is growing. This condition also rules out bubble financing – the option of servicing outstanding government debt by issuing new debt. In other words, it means that the government solvency condition must be satisfied in each period.

Equation (2.6) means that the government must achieve a future primary surplus whose present value is enough to offset the value of the existing public debt and the necessary and sufficient condition for the sustainability of fiscal policy is that the real interest rate should be less than the growth rate of public debt caused by the deficit. If the real growth rate exceeds the real interest rate, the transversality condition in equation (2.5) is sufficient but not necessary for the sustainability of fiscal policy (Domar, 1944).

2.3 Literature Review

The empirical studies on fiscal sustainability can be categorised into three methodological strands. The first category applies unit root tests on primary deficits and/or the public debt series. The existence of unit roots is thus taken as evidence for unsustainable fiscal policy. This approach was first pioneered by Hamilton and Flavin (1986) in tests for the sustainability of United States fiscal policy from 1960-1984. Hamilton and Flavin (1986) assume the interest rate is constant and test the following relationship:

$$\lim_{T \rightarrow \infty} \left[\frac{1}{(1+r)^T} B_T \right] = A_0 = 0 \quad (2.7)$$

as the null hypothesis where B_T is the stock of outstanding real public debt and r is the real interest rate and:

$$\lim_{T \rightarrow \infty} \left[\frac{1}{(1+r)^T} B_T \right] = A_0 > 0 \quad (2.8)$$

as the alternative hypothesis.

Hamilton and Flavin (1986) insert equation (2.8) into equation (2.4), and rearranging it gives:

$$B_t = \sum_{\tau=t+1}^{\infty} \left[\frac{1}{(1+r)^{\tau-t}} (R_t - G_t) \right] + A_0 (1+r)^t \quad (2.9)$$

where G_t is real government expenditure inclusive of interest payment and R_t is the real tax revenue.

Hamilton and Flavin (1986) argue that the sufficient condition for the validity of the government intertemporal budget constraint is the stationarity of the primary deficits ($G_t - R_t$). If $A_0 = 0$ in equation (2.9), it is interpreted as evidence of stationarity in debt and primary deficits, hence a

sustainable fiscal policy. On the other hand, if $A_0 > 0$, public debt/primary deficits will be non-stationary, which implies that the fiscal policy is unsustainable. Using annual United States data spanning from 1960-1984, Hamilton and Flavin (1986) apply the augmented Dickey-Fuller (ADF) to test the federal deficits and public debt series. Their empirical findings reject the hypothesis of a unit root in public debt and primary balance. On this basis, they conclude that the federal government budget is sustainable in present value terms. Other studies that adopt this approach include Trehan and Walsh (1988; 1991), Kremers (1989), Wilcox (1989) and Smith and Zin (1991).

Wilcox (1989) introduces a stochastic interest rate departing from Hamilton and Flavin's (1986) assumption of a constant interest rate and tests for the sustainability of United States fiscal policy. Using the same data set as in Hamilton and Flavin (1986), Wilcox (1989) arrives at a different conclusion. He argues that the sufficient condition for fiscal sustainability is for the discounted public debt to converge to zero. Wilcox (1989) further tests for structural breaks in the data and the hypothesis of no structural break was rejected. He split the data into two small samples with a break date occurring at 1974 and finds that fiscal policy in the United States was unsustainable post-1974.

MacDonald (1992) provides a comparable approach to Hamilton and Flavin's (1986) test of the intertemporal budget constraint based on the cointegration between public debt and fiscal deficits if these series are of the same order of integration. To derive a testable hypothesis, MacDonald (1992) modifies equation (2.4), takes expected values and substitutes S_t for primary fiscal deficits, so $S_t = R_t - G_t$.

Rearranging these, he arrives at:

$$B_t - \frac{1}{r} = E_t \left[\sum_{\tau=t+1}^{\infty} \frac{\Delta S_t}{(1+r)^{\tau-t}} \right] \quad (2.10)$$

Equation (2.10) means that the test for stationarity of ΔS_t is akin to the test of stationarity of $(B_t - \frac{S_t}{r})$, which implies that for fiscal policy to be sustainable, it requires the cointegration between S_t and B_t with cointegrating vector $[1 - r]$. MacDonald (1992) uses monthly United States data from 1951:1-1984:12 to test for the sustainability of United States fiscal policy over these horizons by employing both Engle and Granger's (1987) and Johansen's (1988) approach to cointegration. His results fail to reject the hypothesis of no-cointegration, and he concludes that the United States fiscal policy violates the intertemporal government budget constraint, hence an unsustainable fiscal policy was carried out over the sample period. The same methodology was applied by Haug (1991), who arrives at the same conclusion using quarterly United States data from 1960q1-1987q4.

The second category in the empirical literature tests for the cointegration relationship between government expenditure and government revenue to determine the sustainability of the intertemporal budget constraint, hence testing the sustainability of fiscal policy. Hakkio and Rush (1991) propose and rewrite equation (2.4) with total government expenditure and revenue in real per capita term as:

$$TG_t = G_t + rB_{t-1} = R_t + \sum_{\tau=t}^{\infty} \left[\frac{1}{(1+r)^{\tau-t-1}} (\Delta R_t - \Delta G_t) \right] + \lim_{T \rightarrow \infty} \left[\frac{1}{(1+r)^{T-t}} \Delta B_T \right] \quad (2.11)$$

where TG_t denotes the total government spending on goods and services, transfer payments and interest on government debt, G_t denotes government expenditures net of interest payment and R_t is the real tax revenue. Hakkio and Rush (1991) argue that if R_t and G_t are integrated of order 1, that is, both variable are I(1) processes, then ΔR_t and ΔG_t are stationary. If both R_t and G_t follow a random walk with drifts:

$$R_t = \alpha_1 + R_{t-1} + \epsilon_{1t}$$

$$G_t = \alpha_2 + G_{t-1} + \epsilon_{2t}$$

then equation (2.11) can be rewritten as:

$$TG_t = \alpha + R_t + \lim_{T \rightarrow \infty} \left[\frac{1}{(1+r)^{T-t}} B_T \right] + \epsilon_t \quad (2.12)$$

where

$$\alpha = \sum_{r=t}^T \frac{(\alpha_1 - \alpha_2)}{(1+r)^{r-t-1}} = \left(\frac{1+r}{r} \right) (\alpha_1 - \alpha_2)$$

and

$$\epsilon_t = \left(\frac{1+r}{r}\right) (\epsilon_{1t} - \epsilon_{2t})$$

Assuming the transversality condition holds – that is, the second term in equation (2.12) goes to zero – the testable equation for the sustainability of fiscal policy can be written as:

$$R_t = \alpha + \beta TG_t + \epsilon_t \quad (2.13)$$

If R_t and TG_t are both difference-stationary and cointegrated of order $I(1)$, Hakkio and Rush (1991) argue that the necessary condition for fiscal sustainability requires that government revenue and expenditure be cointegrated with $0 < \beta \leq 1$, which is also necessary for the transversality condition to hold in equation (2.5). Hakkio and Rush (1991) assume a stochastic real interest rate and test for the United States fiscal sustainability using quarterly data spanning from 1950q2-1988q4 using equation (2.13).

They found revenue and expenditure to be cointegrated with β significantly less than 1 and conclude that United States fiscal policy was sustainable. However, by accounting for structural breaks in the data and by using a subsample from 1964-1988, they show that the United States government violates its intertemporal budget constraint and the fiscal policy was not sustainable post 1964, owing to non-cointegration between revenue and expenditures. Haug (1995) arrives at the same conclusion using the same approach for United States quarterly data from 1950q2-1990q4.

Quintos (1995) uses methodology comparable to Hakkio and Rush (1991) but with the modified interpretation of the results. She introduces the concept of ‘strong’ and ‘weak’ conditions of fiscal sustainability. She proposes the following interpretation: i) strong sustainability requires the cointegration between revenue and expenditure with cointegrating vector [1 -1], ii) while weak sustainability requires $0 < \beta < 1$; and iii) the fiscal deficits is not sustainable when $\beta \leq 0$.

Using the same equation as in Hakkio and Rush (1991) in terms of first differences, Quintos (1995) rewrites equation (2.4) as:

$$\Delta B_t = \sum_{\tau=t+1}^{\infty} \left[\frac{1}{(1+r)^{\tau-t}} (\Delta R_t - \Delta G_t) \right] + \lim_{T \rightarrow \infty} \left[\frac{1}{(1+r)^{T-t}} B_T \right] \quad (2.14)$$

For equation (2.14) to converge to a stable solution, the last term should converge to zero, that is:

$$\lim_{T \rightarrow \infty} \left[\frac{1}{(1+r)^{T-t}} \Delta B_T \right] = 0 \quad (2.15)$$

Assuming the interest rate r is constant, under the condition that ΔB_T is stationary, Quintos (1995) derives the trajectory of the limit term depending on the stochastic characteristics of ΔB_t .

If this is stationary, the evolution of the term at the limit in equation (2.15) behaves as:

$$E_t \left[\lim_{T \rightarrow \infty} e^{-\lambda T} \right] = 0 \quad (2.16)$$

where λ is a constant ($\lambda \geq 0$). If ΔB_T is non-stationary, then the evolution of the limit term in equation (2.15) behaves as:

$$E_t \left[\lim_{T \rightarrow \infty} e^{-\lambda T} \sqrt{T} \right] = 0 \quad (2.17)$$

Quintos (1995) show that the stationarity of ΔB_T is a sufficient condition for equation (2.15) to go to zero. Moreover, if government revenue and expenditure are not cointegrated, equation (2.16) tends towards zero faster than equation (2.17). Quintos (1995) defines equations (2.16) and (2.17) as ‘strong’ and as ‘weak’ conditions for fiscal sustainability. The weak form of fiscal sustainability implies that primary deficits and undiscounted debt may be slightly volatile. In such a scenario, surprise shocks to government intertemporal budget constraint will put budgetary operations on the unsustainable path. Under this condition, the government faces potential difficulties in managing its debt and will likely face higher interest on debt service payment.

To derive the testable hypothesis, Quintos (1995) inserts equation (2.13) into equation (2.1). After rearranging, she obtains:

$$\Delta B_t = (1 - \beta)TG_t - \alpha - \epsilon_t \quad (2.18)$$

She shows that if $0 < \beta < 1$ in equation (2.18), ΔB is like TG nonstationary, irrespective of whether government revenue and expenditure are cointegrated. She further argues that the necessary and sufficient condition for fiscal sustainability is for $\beta = 1$ and for revenue and expenditure to be cointegrated for equation (2.15) to hold.

Quintos (1995) employs her modified methodology using United States quarterly data from 1947q1-1992q4 and finds that United States fiscal deficits are weakly sustainable. She further tests for structural shifts endogenously and find that revenues and expenditures are not cointegrated post-1980, which implies that the United States fiscal policy was unsustainable in the subsample period.

Finally, the third category examines fiscal sustainability from the perspective of how government responds to rising public debt. Bohn (1998, 2005) criticises the traditional approach to fiscal sustainability on methodological grounds, in that it makes certain contestable assumptions about the discounts rate on government debt and future state of nature, hence the approach is of limited concept of sustainability. Also, according to Adams, Ferrarini and Park (2010), the power of stationarity tests tends to be low in small samples in differentiating between situations when a fiscal policy may be close to being sustainable when it is not. In an event when debt-to-GDP ratio is declining, it becomes apparently difficult to reject a unit root test. In effect, we lack the ability to discern whether the fall in debt-to-GDP ratio is because of luck – for example, high economic growth – or prudent policy design. As Bohn (2005) puts it, the traditional approach relies on stationarity and/or cointegration tests, which is misplaced faith because in an infinite sample, any order of integration of debt is consistent with the transversality condition, meaning that IBC is always satisfied. As such, Bohn (1998, 2005) proposes a different approach to fiscal sustainability. His idea basically entails modelling a corrective approach of how government responds to rising public debt-to-GDP ratio. The idea underscored here is estimating a policy rule that investigates the response of primary balance to change in debt-to-GDP ratio, which is known as a fiscal reaction function in the existing literature.

This modelling-based sustainability (MBS) approach is based on the regression equation below:

$$s_t = \rho d_{t-1} + \alpha z_t + \epsilon_t = \rho d_{t-1} + \mu_t \quad (2.19)$$

where s_t is the primary balance-to-GDP ratio, d_t is the debt-to-GDP ratio, $\mu_t = \alpha z_t + \epsilon_t$ is a composite of other determinants of primary balance and ϵ_t is the residual. The parameter ρ is the fiscal response otherwise known as the fiscal reaction coefficient, which tells us how primary balance-to-GDP ratio responds to an increase in the debt-to-GDP ratio. According to Bohn (1998, 2005), a positive and significant response of primary balance fiscal to an increase in (lagged) stock of public debt both expressed as a share of GDP indicates a sufficient condition for fiscal sustainability.

He argues that in response to rising public debt stock, policymakers design and implement prudent measures to increase revenue and/or reduce government expenditures (austerity measures) to raise the primary balance to prevent the debt-to-GDP ratio from exploding. Following Barro's (1979) tax smoothing theory, Bohn (1998, 2005) proposes a measure of temporary government spending ($GVAR_t$) and business cycle indicator ($YVAR_t$) as other determinants of primary balance in Z_t . Tax smoothing theory suggests that either a temporary increase in government expenditure or a temporary decline in income (that is, in the tax base) will result in higher than nominal fiscal deficits. In studying how the United States government reacts to rising public debt-to-GDP ratio, Bohn (1998) estimates a policy rule in the regression below:

$$s_t = \rho d_{t-1} + \alpha_0 + \alpha_G GVAR_t + \alpha_Y YVAR_t + \epsilon_t \quad (2.20)$$

Bohn (1998) applies the MBS approach to study the sustainability of United States fiscal policy spanning from 1916-1995 based on the policy rule in equation (2.20) and finds that United States fiscal is sustainable.

Despite the large volume of literature on fiscal sustainability, most of the empirical studies are focused on the United States and other advanced economies or groups of countries, mostly in the Euro areas. There are few studies on developing countries, especially sub-Saharan African countries. Those that do exist include Oshikoya and Tarawalie (2010), who test for fiscal sustainability in the WAMZ countries using annual data spanning from 1980-2008. They employ both Engle and Granger's (1987) and Johansen's (1988, 1991 and 1995) cointegration approach and find evidence of fiscal sustainability in all countries except for Sierra Leone.

Ndoricimpa (2013) then examines whether east African economies' fiscal policy is sustainable. This researcher tests for cointegration between total government expenditures and revenues and finds evidence of weak fiscal sustainability in all the countries. In Botswana, Fincke and Greiner (2010) adopt the sustainability approach following Bohn (2005). They estimate a fiscal reaction function and find evidence of sustainable fiscal policy in Botswana. A similar conclusion was reached by Asiam, Akosah and Owusu-Afriyie (2014) for Ghana.

Before proceeding to the methodology section, it is important to close the present section by summarising some empirical findings of previous studies for both developed and developing countries. Table 2.1 shows the methodology, variables, and conclusion from selected empirical studies.

Table 2.1 Some Empirical Evidence on Fiscal Policy Sustainability

Author(s) and Date	Data Frequency	Period and Country	Test Performed	Sustainability?
Hamilton and Flavin (1986)	Annual	1962-1984 US	Stationarity tests (deficits and public debt)	Yes
Trehan and Walsh (1988)	Annual	1890-1983 US	Stationarity tests (deficits)	Yes
Kremers (1988)	Annual	1920-1985 US	Stationarity tests (public debt)	Yes until 1981, no afterwards
Wilcox (1989)	Annual	1953-1986 US	Stationarity tests (public debt)	
Hakkio and Rush (1991)	Quarterly	1950q1-1988q4 US	Public revenues and expenditures cointegration	No
Smith and Zin (1991)	Monthly	1946:1-1984:4 Canada	Stationarity and cointegration tests (deficits and public debt)	No
Trehan and Walsh (1991)	Annual	1960-1984 US	Stationarity tests (deficit and public debt)	Yes
MacDonald (1992)	Monthly	1951:1-1984:12 US	Stationarity tests (public debt) deficit and debt cointegration	No
Haug (1991)	Quarterly	1960:1-1987:4 US	Stationarity tests (public debt) deficit and debt cointegration	No
Ahmed and Rogers (1995)	Annual	1692-1992 US 1792-1992 UK	Public revenues and expenditures cointegration	Yes

Haug (1995)	Quarterly	1950:1-1990:4 US	Public revenues and expenditures cointegration	Yes
Quintos (1995)	Quarterly	1947:2-1992:4 US	Public revenues and expenditures cointegration	Yes until 1980, no afterwards
Caporale (1995)	Semi-annual and annual	1960-1991 EU countries	Stationarity tests (deficit and public debt)	No for Italy, Greece, Denmark and Germany
Payne (1997)	Annual	1947-1994 G7 Countries	Public revenues and expenditures cointegration	Yes, for Germany
Artis and Marcelino (1998)	Annual	1963-1994 EU countries	Stationarity tests (Public debt)	Yes, for Austria, Netherlands, UK
Bohn (1998)	Annual	1916-1995 US	Relationship between primary surpluses and debt ratio	Yes
Markydakis (1999)	Annual	1958-1995 Greece	Stationarity tests (public debt)	No
Uctum and Wickens	Annual	1965-1994 US and 11 EU countries	Stationarity tests (public debt)	Yes, for Denmark, Netherlands, Ireland and France
Afonso (2005)	Annual	1970-2003 EU 15	Stationarity tests public debt and public revenues and expenditure cointegration	No

Arghyrou and Luintel (2007)	Quarterly	Greece 1970:1-1998:3 Italy 1962:2-1997:4 Ireland and Netherlands 1957:1-1998:4	Public revenues and expenditures cointegration	Yes
Wolde-Rufael (2008)	Annual	13 African Countries	Public revenues and expenditures cointegration	
Oshikoya and Tarawalie (2010)	Annual	1980-2010 Gambia, Ghana, Guinea, Liberia, Nigeria and Sierra Leone	Public revenues and expenditures cointegration	No for Sierra Leone
Fincke and Greiner (2010)	Annual	Botswana	Relationship between primary deficits and debt ratio	Yes
Asiam, Akosah and Owusu-Afriye (2014)	Annual	Ghana	Relationship between primary deficits and debt ratio	Yes
Ndoricimpa 2013	Annual	1985-2012 Burundi, Kenya, Rwanda, Tanzania and Uganda	Public revenues and expenditures cointegration	Yes

As shown in Table 2.1, different approaches have been used to examine the sustainability of fiscal policy in both developing and developed countries. Unsustainable fiscal policy could lead to fiscal crises such as debt defaults, late repayment of interest on loans, slow growth etc. Also, during fiscal crises, the central bank may not have control over inflation especially in Sierra Leone- a country where the central bank is not independent. Some studies have applied the unit root tests to primary deficits and/or public debt series to investigate the sustainability following Hamilton and Flavin (1986), while other studies adopt the cointegration approach between government revenue and expenditure as a means of examining the sustainability of fiscal policy following the seminal work of Hakkio and Rush (1991). However, more recent studies have examined sustainability of fiscal policy by investigation the response of primary balance to debt ratio. As argued by Bohn (1998, 2005), sustainability needs to be examined how policy makers respond to rising debt ratio.

For the empirical analyses to be robust I adopt all three approach in the empirical literature to examine the sustainability of fiscal policy in Sierra Leone over the sample period of 1980-2015. First, unit root tests will be applied to primary deficits in line with Hamilton and Flavin (1986) and other studies. Second, I will examine sustainability based on the cointegration relationship between government revenue and expenditure following Hakkio and Rush (1991), Quintos (1995) etc. Finally, a fiscal reaction function (policy rule) will be estimated to show how government respond to rising debt ratio.

2.4. Data

To carry out the econometric analysis on fiscal sustainability in Sierra Leone, we use data on total government expenditure inclusive of interest payment and total government revenue excluding seigniorage. Our data source is the world development indicators (World Bank dataset) and the National Revenue Authority of Sierra Leone. The data frequency is annual, spanning from 1980-2015. We compute real government revenue and expenditure, deflating nominal series by the GDP deflator. As Hakkio and Rush (1991) argue, an analysis based on ratios is more appropriate for growing economies. Indeed, McCallum (1984), among others, deems these ratios – per capita spending and revenue, and spending and revenue as a fraction of GNP – are pertinent for a growing economy. With this concept in mind, the fiscal variables are expressed here as a percentage of GDP, as in Afonso (2005).

Time series econometric theory tells us that owing to the effect of small sample bias, unit root/stationarity and cointegration test are of little value if the series are too short to allow for the mean reversion or trend equilibrium. Hakkio and Rush (1991) and Otero and Smith (2000) have shown that increasing the frequency of the sample does not significantly raise the test power and the false null hypothesis is still easily accepted. Nor are the size distortions of the tests alleviated by increasing the frequency while staying at a relatively short time span: a true null hypothesis is still easily rejected.

2.5 Model

The testable model for fiscal sustainability is given below:

$$R_t = \alpha + \beta TG_t + \epsilon_t \quad (2.21)$$

where R_t and TG_t are total government revenue and expenditure respectively.

The approach adopted here to test for fiscal sustainability is based on the second strand in the empirical literature, as we are testing for the cointegration between total government revenue and total government expenditure in the regression equation above. Unlike testing for the stationarity of the discounted public debt series, this approach has an advantage over the former in the following ways. First, this approach avoids the unrealistic assumption of constant interest rate seen in Hamilton and Flavin (1986) as criticised by Wilcox (1989). Second, the fiscal variable used in this approach (total government revenue and total government expenditure) are mostly available over a long period unlike public debt data, which is not available for long period in most developing countries. Moreover, by focusing entirely on expenditure and revenue variables, this approach avoids the subjective assumption about the average interest rate on outstanding government debt. Third, the most adequate measure of debt series is the net market value that is officially unavailable in most economies, both developed and developing, except for the United States. Since debt is usually available in par value, it is difficult to transform it to net market value owing to the various financing sources. Using the discounted par value to test the sustainability of fiscal policy may give misleading results.

2.6 Econometric Methodology

The empirical procedure is carried out here by employing the standard methodology in the literature that tests for unit roots and/or cointegration in the budget variables. We summarise below the econometric methodologies adopted in this study.

2.6.1 Unit Root Tests

The first step in examining the sustainability of fiscal policy is to check for a unit root in the fiscal variables. The existence of unit roots in a series has both economic and econometric implications. Whether a series is stationary or non-stationary, it nevertheless provides useful information that helps to identify some features of the underlying data-generating process. If a series has no unit roots, it is characterised as stationary, and therefore exhibits mean reversion in that it fluctuates around a constant long-run mean. Also, the absence of unit roots implies that the series has a finite variance, implying that the series is time-invariant, which has an implication for forecasting. Additionally, the effects of shocks disintegrate over time. Otherwise, if there exists a unit root in the series, characterised as a non-stationary process, it has no tendency to return to a long-run deterministic path. Also, the variance of the series is time-dependent and goes to infinity as time approaches infinity, which results in severe problems for forecasting. Non-stationary time series suffer long-lasting effects from random shocks. If both government revenue and expenditure present a distinct order of integration, it means that they will not converge to equilibrium in the long run, which characterises unsustainable fiscal policy. Several approaches have been proposed and applied in the empirical literature to test for stationarity. We adopt the conventional econometric techniques to test for the existence of unit root in the fiscal series, i.e.: the ADF, Phillips and Perron's (1998) technique, known as the Phillips-Perron (henceforth PP) and the

Dickey-Fuller generalised least square (henceforth DF-GLS) tests. For robustness, we also employ the Kwiatkowski, Phillips, Schmidt and Shin (1992) (henceforth KPSS) test.

2.6.1.1 The Augmented Dickey-Fuller Test

Following the pioneering work by Dickey and Fuller (1979), which was popularised by Nelson and Plosser (1982), many studies have employed these tools in empirical macroeconomics. The standard ADF test is specified as:

$$\Delta Y_t = \alpha_0 + \alpha_1 t + \delta Y_{t-1} + \sum_{j=1}^L \beta_j \Delta Y_{t-j} + \epsilon_t \quad (2.22)$$

where α_0 is the constant, α_1 is the coefficient on the trend term t , ΔY_{t-1} is the first difference operator to control for serial correlation in the error term, and from the estimation of δ the ‘tau’ statistic is obtained and compared to relevant critical values. The null hypothesis is that δ is zero, i.e. there is a unit root. We reject this hypothesis when the computed statistic is more than the conventional critical values. The assumption for the validity of the original Dickey-Fuller test is that the residuals in the regression are not serially correlated. If they are, the aim of the ADF is to add lags to the dependent variable in the above equation until the serial correlation is overcome.

2.6.1.2 Dickey-Fuller Generalised Least Square Test

The DF-GLS proposed by Elliot, Rothenberg and Stock (1996), is akin to the ADF test, except that the series is transformed via a generalised least squares (GLS) detrending regression before performing the test. The detrended data is defined as:

$$\Delta Y_t^d = Y_t - \hat{\beta}'_{\varphi} D_t \quad (2.23)$$

where $\hat{\beta}'_{\varphi} = (D'_{\varphi} D_{\varphi})^{-1} D'_{\varphi} y_{\varphi}$. Using the GLS detrended data, estimate by least square the ADF test regression without deterministic term is given by:

$$\Delta Y_t^d = \pi Y_{t-1}^d + \sum_{j=1}^L \varphi_j \Delta Y_{t-j}^d + \epsilon_t \quad (2.24)$$

The null hypothesis is that π is zero. Elliot, Rothenberg and Stock (1996) have shown that this test has significantly greater power than the previous versions of the ADF. Just as the standard ADF test may be run with or without a trend term, there are two forms of DF-GLS: GLS detrending and GLS demeaning. With GLS detrending, the series is regressed on a constant and linear trend, and the residual series is used in a standard Dickey-Fuller regression. With GLS demeaning, only a constant appears in the first stage regression; the residual series is then used as the regressand in a Dickey-Fuller regression.

2.6.1.3 Phillips and Perron Test

To correct for the possible serial correlation and heteroscedasticity in the residuals of the Dickey-Fuller test, Phillips and Perron (1998) proposed an alternative unit root test. These authors use the Newey-West (Newey and West, 1987) heteroscedasticity and autocorrelation consistent covariance matrix estimator, a non-parametric correction of the Dickey-Fuller test in which allowance is made for possible heteroscedasticity and serial correlation in the residuals. The asymptotic distribution and the critical values for the PP test statistic are the same as in the ADF test. The PP test has a null hypothesis if the series is I(1). However, the PP test was shown to exhibit an inferior small sample performance relative to the ADF test, and therefore should be used only as a complement to other approaches (see for example Schwert (1989), Campbell and Perron (1991), Agiakloglou and Newbold (1992), De Jong et al. (1992) and Liu and Praschnik (1993)). The test equation is specified as:

$$\Delta Y_t = \beta_0 + \beta_1 t + \rho Y_{t-1} + \epsilon_t \quad (2.25)$$

where β_0 is the constant, β_1 is the coefficient on the trend term t and from the estimation of ρ the ‘tau’ statistic is obtained and compared to relevant critical values. The null hypothesis is that ρ is zero, i.e. there is a unit root. The rejection criteria of the PP test are the same as those for the ADF and DF-GLS.

2.6.1.4 Kwiatkowski, Phillips, Schmidt and Shin Test

In small samples, both the ADF and PP tests suffer from low power when the coefficient of the trend term β is close to one. Moreover, misspecification vis-à-vis a trend or the numbers of lags that ensure that the test captures any short-term dynamics may affect the size of the test, which may result in the through null being rejected. As an alternative test, we perform the KPSS test to the fiscal series as a robustness check. Unlike the ADF, DF-GLS and PP, this test has the opposite null hypothesis: that the series being tested has no unit root (stationary). Doing both ADF, DF-GLS, PP and KPSS tests guarantees robustness when the findings are not inconsistent at a given level of significance. The KPSS uses a similar autocorrelation correction to the PP but in parametric sense. The KPSS assumes the observed time series is disintegrated into deterministic trend, random walk and stationary error term. The KPSS statistic is a Lagrange multiplier (LM) statistic and is based on the residuals from the ordinary least squares (OLS) regression of a time series in question on exogenous variable y_t :

$$\tau_t = \hat{y}_t' \boldsymbol{\delta} + \epsilon_t$$

The associated KPSS LM test statistic is specified thus:

$$\text{KPSS} = \sum_{t=1}^T \frac{S_t^2}{T^2 f_0} \quad (2.26)$$

where

$$S_t = \sum_{s=1}^T \hat{\epsilon}_s$$

is a cumulative function based on the residuals, f_0 is an estimator of the residual spectrum at frequency zero and T is the sample size.

2.6.2 Cointegration

If both government revenue and expenditure are found to be stationary in levels after testing for unit roots, the test for cointegration is unnecessary and we should conclude that the fiscal policy is sustainable.² However, if both series are found to be stationary only at first difference, we proceed to test for cointegration. Granger (1981) introduced the concept of cointegration, acknowledging that a linear combination of nonstationary series could be itself stationary. The cointegration between total government revenues and total expenditures is the testable condition for fiscal sustainability here, and cointegration refers to a stationary linear combination of individually integrated variables. Haug (1996) compares several cointegration tests using Monte Carlo simulations and concludes that the Johansen's maximum eigenvalue test and the Engle and Granger ADF test reveal the least size distortions. Also using a Monte Carlo study, Gonzalo (1994) shows that the Johansen procedure has better properties than single-equation methods or alternative multivariate methods. It performs even better in the presence of problems of non-normality in the errors or over parameterisation by including too many lags in the model. Kremers, Ericsson and Dolado (1992), Banerjee (1995) and Zivot (1996) claim that the residual-based tests have low power. Phillips (1991) also argues that the Johansen maximum likelihood tests are generally superior to the residual-based cointegration tests. With this in mind, we perform the following cointegration methodologies.

² See figure 2.1 for the empirical procedure.

2.6.2.1 Johansen's Cointegration Approach

The system-based approach proposed by Johansen (1988, 1991 and 1995) is a test for cointegration that allows for more than one cointegrating relationship, unlike the Engle-Granger method. The methodology takes its starting point from the VAR of order p given by:

$$y_t = \mu + A_1 y_{t-1} + \dots + A_p y_{t-p} + \epsilon_t \quad (2.27)$$

where y_t is an $n \times 1$ vector of variables that are integrated of order one and ϵ_t is a $n \times 1$ vector of innovations. This VAR can be re-written as:

$$\Delta y_t = \mu + \Pi y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + \epsilon_t \quad (2.28)$$

where

$$\Pi = \sum_{i=1}^{p-1} A_i - I$$

$$\Gamma_i = - \sum_{j=i+1}^{p-1} A_j$$

If the coefficient matrix Π has reduced rank $r < n$ then there exists $n \times r$ matrices α and β each with rank r such that $\Pi = \alpha\beta'$ and $\beta'y_t$ is stationary. r is the number of cointegrating relationships, the elements of α and β are known as the adjustment parameters in the vector error correction model and each column of β is a cointegrating vector.

It can be shown that for a given r , the maximum likelihood estimator of β defines the combination of y_{t-1} that yields the r largest canonical correlations of Δy_t with y_{t-1} after correcting for lagged differences and deterministic variables when present. Johansen (1988) proposes two different

likelihood ratio tests of the significance of these canonical correlations and thereby the reduced rank of the Π matrix, which are the trace test and maximum eigenvalue test, shown as:

$$J_{trace} = -T \sum_{i=r+1}^n \ln(1 - \lambda_i)$$

$$J_{max} = -T \ln(\lambda_{r+1})$$

Here, T is the sample size and λ_i is the i th largest canonical correlation. The trace test tests the null hypothesis of r cointegrating vectors against the alternative hypothesis of n cointegrating vectors. The maximum eigenvalue test, on the other hand, tests the null hypothesis of r cointegrating vectors against the alternative hypothesis of $r + 1$ cointegrating vectors.

2.6.2.2 Dynamic Ordinary Least Square Approach

Additionally, we test for cointegration relationship between government revenue and expenditure by employing the dynamic ordinary least squares (DOLS) proposed by Stock and Watson (1993). This methodology is asymptotically equivalent to the Engle-Granger cointegration approach and also has the advantage of performing better in small-sample properties by controlling for potential endogeneity among the variables in the regression by the inclusion of lead and lags.

The DOLS is estimated based on the regression below:

$$R_t = \alpha + \beta G_t + \sum_{k=-k}^k \lambda_k \Delta G_{t-k} + \epsilon_t \quad (2.29)$$

where Δ represents the first difference operator, ϵ_t is the error term and k is the lead/lag order. There is no unique method for choosing the lead and lag order (Arghyrou and Luintel, 2007). If k is too large compared to the sample size, estimates from the regression above will not be feasible (Saikkonen, 1991). In view of the small samples in this study, we set the lead and lag to 1.

The Johansen's system approach and DOLS have shown to be superior to the Engle-Granger cointegration approach. Nevertheless, a major limitation of these methods is that they both assume that the cointegrating vector remains constant over time. Practically, it is possible that the long-run relationships between the underlying variables change. The reason for such might be technological progress, economic crisis, changes in people's preferences and behaviour, policy or regime alteration and institutional development.

To account for the possible shift in the structure of the fiscal policy, the empirical literature is grouped into two categories. The first group exogenously imposes a break in the data by selecting a date that the researcher believes corresponds to an event that has shifted or brought change to the existing policy. For example, Wilcox (1989), Hakkio and Rush (1991), MacDonald (1992) and Haug (1995) account for structural breaks in their studies by exogenously choosing the break dates. In contrast, Quintos (1995) and Gabriel and Sangduan (2011) account for structural breaks endogenously. The latter approach tends to be more credible than the former because by exogenously imposing a break in the data, the researcher is bound to miss the exact timing of the break.

2.6.2.3 Structural Break in the Cointegration Relationship

The issue of structural breaks in time series econometric has attracted considerable attention in applied macroeconomic research. Following Engle-Granger (1987) seminal work on cointegration large volume of research have spurred investigation the long-run relationship in time series variables. Engle-Granger approach to cointegration has been criticised on the ground that it does not take into account the presence of structural change which most is often in time series data. Also, the Engle-Granger approach is inapplicable to a multi-equation system. These two aforementioned pitfalls have been addressed in the empirical literature by subsequent studies.

Several approaches have been proposed to test to structural change. Earlier studies such as Hansen (1992b), Andrews (1993) among other studies developed the parameter stability tests with the null hypothesis of no change in a cointegrated models in which all coefficient are allowed to change. Phillips and Ouliaris (1990), Gregory and Hansen (1996) and Bai (1997) etc. test for structural change in the long-run relationship by means of least square equation methods. While Bai, Lumsdaine and Stock (1998) considered a single break in a multi-equation system, Inoue (1999) test for cointegration by allows for a one time shift in the trend function of the series at some unknown date, either in level for non-trending series and for both level and slope in trending series.

All the literature discussed so far test for single break in the cointegration relationship. However, in time series econometrics, it is possible to have more than a single break. Bai and Perron (1998, 2003) have addressed this problem by extending previous tests and estimation analysis in accounting for multiple structural change at an unknown time. Kejriwal and Perron (2008, 2010) extend the work of Bai and Perron (1998) in testing for multiple structural breaks at an unknown date by allowing for both stationary and non-stationary variables in the regression.

However, Bai and Perron (2006) have shown that the size and power of multiple break tests can be significantly distorted by a small sample size. Due to the small sample size for Sierra Leone (36 observations), I test for single break endogenously in the cointegration equation by adopting Gregory-Hansen (1996) approach. Also, in the empirical literature on fiscal policy sustainability, if there is a break in the cointegration relationship between government revenue and expenditure, the procedure is to split the data two subsamples and test for the sustainability of fiscal policy before and after the break date(s). See for example Wilcox (1989), Hakkio and Rush (1991) and Quintos (1995) etc. This idea also render testing for multiple breaks for Sierra Leone less required due to the sample small size.

Gregory and Hansen (1996) extend and modify the Engle-Granger (1987) cointegration approach to allow for an endogenous break in a univariate series.

Given that the series are I(1), Gregory and Hansen (1996) introduce four different models to consider for structural change in the cointegration relationship, which are as follows:

Model 1: Level shift denoted as C and defined as:

$$Y_t = \alpha + \beta D_t + \delta X_t + \mu_t \quad (2.30)$$

where Y_t is a scalar variable, X_t is a vector of explanatory variables, μ_t is the disturbance term, D_t is a step dummy variable defined as $D_t = 1 (t > T_b)$, where parameters α represents the intercept before the shift, β represents the change in the intercept at the time of the shift, δ is the parameter of the cointegrating vector and T_b is the break date.

Model 2: Level shift with trend denoted as C/T and defined as:

$$Y_t = \alpha + \beta D_t + \Phi t + \delta X_t + \mu_t \quad (2.31)$$

where t is time trend.

Model 3: Shift in regime denoted as C/S and defined as:

$$Y_t = \alpha + \beta D_t + \delta X_t + \Phi X_t D_t + \mu_t \quad (2.32)$$

where δ denotes the cointegrating slope coefficients before the regime shift and Φ denotes the change in the slope coefficients.

Model 4: Shift in regime with trend denoted as C/S/T and defined as:

$$Y_t = \alpha + \beta D_t + \Phi t + \delta X_t + \Phi X_t D_t + \mu_t \quad (2.33)$$

The advantage of the GH model over various types of unit root tests with structural breaks is that the approach only has a single structural break point for multivariate variables, thus making it empirically easier to test the null of no cointegration with regime shift.

All the GH tests are residual based, the null hypothesis of no cointegration corresponds to a unit root in the OLS residuals of models C, C/T, C/S and C/S/T and break point in the cointegrating relationship is calculated at the point where the t-statistic is at minimum

2.7 Empirical Results

This section presents the empirical findings that emerge from the sustainability tests. We proceed first to test for the sustainability of fiscal policy without accounting for breaks in the full samples. To do this, we start with testing for unit root in the fiscal variables followed by the cointegration tests. A battery of tests is performed, and the findings are summarised in Table 2.2.

2.7.1 Unit Root Tests Results

When both series of revenues and spending are found to be stationary, it is accepted that these are necessary conditions for the sustainability of fiscal policy – it is not necessary to proceed to check for a cointegration relationship. If both series are found to be non-stationary at levels, but are first difference stationary, we proceed to check whether both series are cointegrated. In an event that the series contain distinct orders of integration then fiscal policy will be unsustainable as both series will not converge to long-run equilibrium. Table 2.2 shows the unit root tests in levels and first difference for the full sample.

Table 2.2. Unit Root Tests Results

ADF TEST			
Variables	Constant	Trend	First Difference
Revenues	-2.74	-2.59	-6.09***
Expenditures	-2.59	-4.17	-4.70**
Primary Balance	-3.82***	-4.09**	
DF-GLS TEST			
Revenues	-2.00	-2.59	-6.09***
Expenditures	-2.77	-3.79	-4.81**
Primary Balance	-3.21***	-4.12***	
PP TEST			
Revenues	-2.77	-3.70	-6.05***
Expenditures	-2.79	-2.90	-8.55***
Primary Balance	-2.95**	-3.79**	
KPSS TEST			
Revenues	0.27**	0.15**	0.12
Expenditures	2.84**	0.21**	0.29
Primary Balance	0.23	0.13	

ADF-lags selections were based on the Schwarz Information Criterion. ***, ** and * represent statistical significance of 1%, 5% and 10% respectively

PP and KPSS lags selections were based on the Newey-West Bandwidth using Bartlett Kernel Criterion. ***, ** and * represent statistical significance of 1%, 5% and 10% respectively

ADF, DF-GLS and PP has the null hypothesis that there is unit root

KPSS has the null hypothesis that the series is stationary

We start with the interpretation of the primary balance ratio as a means of sustainable fiscal policy. The ADF, DF-GLS and PP all have the null hypothesis that the series been examined is non-stationary (i.e. there is unit root). For the ADF, the test statistics are -3.82 and -4.09 for constant and trend which are significant at 1% and 5% respectively. The DF-GLS have test statistics of -3.21 and -4.12 for constant and trend terms respectively which are both significant at 1%. The PP test have test statistics of -2.95 and -3.79 for constant and trend respectively which are significant at 5%. The null hypothesis of unit root in primary balance is rejected by the ADF, DF-GLS and PP tests.

For robustness, we perform the KPSS test. This unit root test differs from the other tests in that it has the null hypothesis of stationarity in the series been examine. As shown in Table 2.2, the test statistics are 0.23 and 0.13 for constant and trend respectively which I fail to reject. The KPSS complement the findings from the ADF, DF-GLS and PP tests that primary balance is stationary. Following Hamilton and Flavin (1986) and in other studies in the literature, we conclude that the fiscal policy in Sierra Leone over the sample period is sustainable.

The ADF test statistics for revenues are -2.74 and -2.59 for constant and trend respectively, also, for expenditures are -2.59 and -4.17 for constant and trend respectively. These statistics are found to be insignificant. Therefore, I fail to reject the null hypothesis of unit root in these series and conclude that both revenues and expenditure are non-stationary. However, they are found to be stationary are first difference with ADF test statistic of -6.09 and -4.70 which are significant at 1% and 5% respectively.

The DF-GLS test statistics for revenues are -2.00 and -2.59 for constant and trend respectively, also, for expenditures are -2.77 and -3.79 for constant and trend respectively. These statistics are insignificant. I therefore fail to reject the null hypothesis of unit root in these series and conclude

that both revenues and expenditure are non-stationary. However, they are found to be stationary are first difference with DF-GLS test statistic of -6.09 and -4.81 which are significant at 1% and 5% respectively.

The PP test statistics for revenues are -2.77 and -3.70 for constant and trend respectively, also, for expenditures are -2.79 and -2.90 for constant and trend respectively. I fail to reject the null hypothesis of unit root in these series as the test statistics are insignificant and conclude that both revenues and expenditure are non-stationary. However, they are found to be stationary are first difference with PP test statistic of -6.05 and -8.55 which are significant at 1% respectively.

Finally, KPSS with the null hypothesis that the series been examine is stationary is employed. The test statistics for revenues are 0.27 and 0.15 respectively for constant and trend, also, for expenditures re 2.84 and 0.21 for constant and trend respectively. For both revenues and expenditures, the null hypothesis is rejected at 5% which implies revenue and expenditure are not level stationary. However, the null hypothesis is not rejected at first difference with test statistics of 0.12 and 0.29 for revenues and expenditures respectively.

I proceed to tests for sustainability using an alternative approach – the cointegration relationship between total government revenue and expenditure. The unit root tests results displayed in Table 2.2 do not allow us to reject the null hypothesis of unit roots in both government revenue and expenditure in levels for both constant and trend terms at the conventional 5% significance level. However, both variables are found to be stationary at first difference. The KPSS test that is employed for robustness also rejects the null hypothesis that the series are stationary in levels at 5% significance levels. Given that all the tests confirmed both government revenue and expenditure are I(1) series, we proceed to test for cointegration.

2.7.2 Cointegration Test Results

For comparability, I interpret the cointegration coefficient as in the empirical literature on fiscal policy sustainability³. Table 2.3 summarised the interpretation of the cointegration coefficient as in the empirical literature.

Table 2.3 Interpretation of the Cointegration Coefficient

Cointegration Coefficient	Value	Conclusion	Implications
β	1	Strong form of sustainability	
β	$0 < \beta < 1$	Weak form of sustainability	Government Expenditure is growing faster than revenue
β	≤ 0	Unsustainability	Fiscal crises, debt defaults, late repayments etc.

As the results of stationarity indicate the existence of unit root in both revenues and expenditures, the next step is to check for cointegration. We employ both DOLS and Johansen's system approach. We start with the DOLS test, which is performed by running a DOLS regression and test the residual for unit root. The ADF test statistic is compared to the critical value to determine whether there is cointegration or not. If the ADF test statistic is greater than the critical value, we conclude that a long-run relationship exists, and the variables are cointegrated, which means the fiscal policy is sustainable. We fail to reject the hypothesis if the opposite occurs. The result of the DOLS is presented in Table 2.4.

³ See Quintos (1995), Afonso (2005) for survey.

Table 2.4. DOLS Cointegration Test Result

Cointegration test without	Break full sample
	DOLS 1980-2015
Estimated equation $R_t = \alpha + \beta TG_t + \epsilon_t$	
α [p-value]	3.46[0.201]
β [p-value]	0.21[0.048]
F-Wald test, $H_0: \beta = 1$ [p-value]	64.65[0.000]
F-Wald test, $H_0: \beta = 0$ [p-value]	4.17[0.005]
t-ADF stat. on ϵ_t	-3.42**
5% critical value	-3.21
S.E. of regression	2.098

The value of ADF test statistic is -3.42, which is greater than the 5% critical value of -3.21, which suggests that government revenue and expenditure are cointegrated, indicating sustainable fiscal policy. The estimated cointegration β is 0.21, indicating that for each 1% point of GDP increase in government expenditure, government revenue increases by approximately 0.21% of the GDP⁴. Government expenditure exhibits a higher growth rate than government revenue for the period under consideration in Sierra Leone. Shown in Table 2.4, the Wald test for coefficient restriction with a null hypothesis of $\beta = 1$ (strong form of sustainability) is rejected at 1% and the alternative hypothesis of $\beta = 0$ (unsustainability) is rejected at the 5% significance level. These results imply that the strong form of fiscal sustainability as well as unsustainability are rejected for Sierra Leone. The cointegration coefficient β satisfies the inequality constraint $0 < 0.21 < 1$. Following Quintos' (1995) definition, we conclude that the fiscal policy in Sierra Leone is weakly sustainable with cointegration vector [1 -0.21]

⁴ Remember that government revenue and expenditure are both expressed as a percentage of GDP

In addition to the DOLS test, we perform Johansen's cointegration, or the system approach. The trace test as well as the maximum eigenvalue test are performed to test for the number of cointegrating vectors in the system. Lütkepohl, Saikkonen and Trenkler (2001) suggest that in a small sample simulation, the trace test performs better and is superior to the maximum Eigen test. They do however suggest using both tests. As such, we report both tests for robustness in Table 2.5.

Table 2.5. Johansen Cointegration Test Results

Null	Alternative	Rank Test	5% Critical Value	prob
Panel A Unrestricted	Cointegration	Trace Statistic		
r =0	r =1	23.73490*	15.4947	0.0023
r ≤ 1	r =2	9.478016*	3.84166	0.0021
Panel B Unrestricted	Cointegration	Max-Eigen Stat.		
r =0	r =1	14.25688	14.26460	0.0521
r ≤ 1	r =2	9.478016*	3.841466	0.0012
	Vector			
	[1 -0.457]			0.000

* denotes rejection of the hypothesis at the 0.05 level.

**MacKinnon-Haug-Michelis p-values.

r indicates the number of cointegrating vectors.

Panel A shows the result of the trace test. The null hypothesis of no cointegration for $r = 0$ is rejected at 5% significance level. The trace statistic of 23.73490 and 9.478018 are more than the 5% critical value of 15.4947 and 3.84166 and the probability values 0.0023 and 0.0021 are less than the conventional probability value of 0.05. In summary, the trace test indicates the existence of a cointegration relationship between government revenue and expenditure.

Panel B shows the result of the maximum eigenvalue test and the hypothesis of at most one cointegrating relationship is not rejected. The maximum eigenvalue 9.478016 is more than the 5%

critical value of 3.841466 and the probability value 0.0012 is less than conventional probability value of 0.05. In summary, the maximum eigenvalue test indicates that the system has at most one cointegration.

Having established that the Johansen approach confirms that both government revenue and government expenditure are cointegrated, which implies sustainable fiscal policy, we proceed further to interpret the cointegration coefficient. In the last panel, the estimated cointegration vector β is 0.46, indicating that for each 1% point of GDP increase in government expenditure, government revenue increases by approximately 0.46% of the GDP. Government spending exhibits a higher growth rate than government revenue for the period under consideration in Sierra Leone. This result also confirms that the fiscal policy is sustainable in Sierra Leone but only in a weak sense. The cointegration coefficient β is larger in Johansen's approach compared to the DOLS.

The DOLS and Johansen approach both confirm that the fiscal policy in Sierra Leone is weakly sustainable. However, under such conditions, unfavourable fiscal shocks will put the economy's budgetary operations toward an unsustainable path and the government will find it difficult to market its debt instrument. The DOLS and Johansen approach to cointegration assumes the cointegrating vector remains constant over the time series period (stable cointegration).

However, such an assumption only holds for specific cases and not in general cases, because there are factors such as technological progress, financial and economic crises, policy and regime change, wars and institutional development that will change the long-run relationship among variables. We therefore proceed to further test for cointegration between government revenues and spending by accounting for an endogenous structural shift in the deficits process.

Table 2.6. Summary of Cointegration Test Results

	DOLS	Johansen approach
Dependent Variable	Cointegrating Vector	Cointegrating Vector
Revenues	[1 -0.21] **	[1 -0.46] ***

** and *** indicates 5 and 1% significance level respectively.

2.7.3 Fiscal Sustainability Subjected to Structural Shifts

In this section, we test for the sustainability of fiscal policy accounting for an endogenous shift in the deficits process. Following Gregory and Hanson (1996), we check for a single break in the cointegration relationship between government revenue and expenditure. We are unable to test for multiple breaks as we are constrained by the number of observations. We present in Table 2.7 the Gregory-Hansen test for cointegration with single break date.

Table 2.7. Gregory-Hansen Cointegration Test Results

Model 1		Level Shift		Asymptotic	Critical	Value	Reject H ₀ of No Cointegration
Test Statistics	Break Date						
				1%	5%	10%	
ADF	-5.31	1984		-5.13	-4.61	-4.34	Yes
Zt	-6.04	1984		-5.13	-4.61	-4.34	Yes
Za	-39.79	1984		-50.07	-40.48	-36.19	Yes
Model 2		Level Shift & Trend		Asymptotic	Critical	Value	Reject H ₀ of No Cointegration
Test Statistics	Break Date						
				1%	5%	10%	
ADF	-5.71	1984		-5.45	-4.99	-4.72	Yes
Zt	-6.32	1984		-5.45	-4.99	-4.72	Yes
Za	-40.91	1984		-57.28	-47.96	-43.22	Yes
Model 3		Change in Regime		Asymptotic	Critical	Value	Reject H ₀ of No Cointegration
Test Statistics	Break Date						
				1%	5%	10%	
ADF	-5.22	1984		-5.47	-4.95	-4.68	Yes
Zt	-5.99	1984		-5.47	-4.95	-4.68	Yes
Za	-39.92	1984		-57.17	-47.04	-41.85	Yes
Model 4		Change in Regime & Trend		Asymptotic	Critical	Value	Reject H ₀ of No Cointegration
Test Statistics	Break Date						
				1%	5%	10%	
ADF	-6.37	2011		-6.02	-5.50	-5.24	Yes
Zt	-6.46	1984		-6.02	-5.50	-5.24	Yes
Za	-41.00	1984		-69.37	-58.58	-53.31	Yes

Note: Critical values are from Gregory-Hansen (1996a).

Though the results of all the four GH models are presented, our focus here is on model 3 (regime change) denoted as C/S as it is the most relevant for empirical discussion of fiscal policy sustainability. IBC is based on a theoretical restriction preventing a long-run relationship with deterministic trend (an ever-growing deficit) – that is, the absence of ‘the Ponzi game’. Doing so automatically renders models 2 and 4 irrelevant for our discussion. In all four GH models, the null

hypothesis of no cointegration is rejected. The findings here confirm the earlier result that government revenues and expenditures are cointegrated and that the fiscal policy is sustainable but with a structural shift in deficits in 1984. The break date corresponds to the policy measure introduced by the government in 1983 to severely cut on its spending to reduce the size of the deficits. In the 1980s, Sierra Leone's economy deteriorated sharply, experiencing a decline in government revenues from 16% in 1980 to 5% in 1985. Coupled with the fall in imports and official exports of diamonds reducing the tax base, the increasing laxness of the central government eroded the efficiency of revenue mobilisation (World Bank, 1994). The government responded with severe expenditure cuts as a means of reducing the deficits owing to fall in revenues generation. Government expenditures declined from 31% of GDP in 1981 to 18% in 1986. Payroll expenditure declined from 48% of total recurrent expenditures to 22% in 1986. In addition, development expenditures also fell from 4.9% of the GDP to 2.2%, together with government outlays for goods and service from 31.5% of recurrent expenditures to in 1980 to 22% in 1984.⁵

2.7.4 Fiscal Sustainability Post Structural Break

Since the break occurred in the early years of the sample, it is practically impossible to test for sustainability before the break (pre-break) because of insufficient observations. We therefore proceed to test for sustainability of the fiscal policy after the break (post-break). The reason for this test is to validate whether fiscal policy is sustainable after the structural shift in the deficits process. The results for the post-break are shown in Table 2.8 and 2.9 respectively.

⁵ For a detailed analysis, see World Bank (1994).

The results of the DOLS (Table 2.8) show that there exists a long-run relationship between government revenues and spending. This finding is shown by the t-ADF test on the residual -3.25, which is more than the 5% critical value of -2.79. The cointegration coefficient β is 0.17, which means that for each 1% point of GDP increase in government spending, government revenue increase by 0.17% of the GDP. The Wald test for coefficient restriction with a null hypothesis of $\beta = 1$ (strong form of sustainability) is rejected at 1% and the alternative hypothesis of $\beta = 0$ (unsustainability) is rejected at 5% significance level. As such, the strong form of fiscal sustainability as well as unsustainability are rejected for Sierra Leone. However, the cointegration coefficient (β) satisfies the inequality constraint $0 < 0.17 < 1$. Following Quintos' (1995) definition, we conclude that the fiscal policy in Sierra Leone is weakly sustainable with cointegration vector [1 -0.17].

Table 2.8. DOLS Cointegration Test Result Post-Break Date

Cointegration test with	Break Sub-sample	DOLS
Estimated equation	1987-2015 (after adjustment)	
$R_t = \alpha + \beta TG_t + \epsilon_t$		
α [p-value]		4.39[0.077]
β [p-value]		0.17[0.046]
F-Wald test, $H_0: \beta = 1$ [p-value]		85.62[0.000]
F-Wald test, $H_0: \beta = 0$ [p-value]		4.02[0.006]
t-ADF stat. on ϵ_t		-3.25**
5% critical value		-2.97
S.E. of regression		1.983

Alternatively, we test for cointegration using the Johansen cointegration approach. The results are presented in Table 2.9.

Table 2.9. Johansen Cointegration Test Results Post Break Date

Null	Alternative	Rank Test	5% Critical Value	Prob
Panel A Unrestricted	Cointegration	Trace Statistic		
r =0	r =1	16.84374*	15.4941	0.0311
r ≤ 1	r =2	7.008928*	3.84166	0.0081
Panel B Unrestricted	Cointegration	Max-Eigen Stat.		
r =0	r =1	9.834810	14.26460	0.2230
r ≤ 1	r =2	7.008928*	3.841466	0.0081
Dependent Variable	Vector			
Revenue	[1 -0.439]			0.000

* denotes rejection of the hypothesis at the 0.05 level.

**MacKinnon-Haug-Michelis p-values.

r indicates the number of cointegrating vectors.

Panel A shows the result of the trace test. The null hypothesis of no cointegration when $r = 0$ is rejected at 5% significance level. The trace statistics 16.84374 and 7.008928 are more than the 5% critical value of 15.4941 and 3.84166 and the probability values 0.0311 and 0.0081 are less than the conventional probability value of 0.05.

Panel B shows the result of the maximum eigenvalue test and the hypothesis of at most one cointegrating relationship is not rejected. The maximum eigenvalue 7.008928 is more than the 5% critical value of 3.841466 and the probability value 0.0081 is less than conventional probability value of 0.05. In summary, both the trace and maximum eigenvalue test show that government revenue and expenditure are cointegrated after the break and that there is sustainability in the fiscal policy.

We proceed further to interpret the cointegration coefficient. In the last panel, the normalised cointegrating vector is [1 -0.43]. The result here also suggests the fiscal policy in Sierra Leone is sustainable in a weak sense. Comparing to the coefficients of the sub-sample to the full sample, we observe that the cointegration coefficient became smaller after the break as indicated by both cointegration methods.

2.7.5 Vector Error Correction Estimates

Having established a cointegration relationship among the variables, the appropriate procedure is to estimate the vector error correction model (VECM).⁶ The VECM model is specified as follows:

$$\Delta y_t = \mu + \Pi y_{t-1} + \sum_{i=1}^p \Gamma_i \Delta y_{t-1} + \epsilon_t \quad (2.34)$$

where $\Pi = \alpha\beta'$ represents the long-run relationship, $\Pi y_{t-1} = (\alpha\beta') y_{t-1} = \alpha(\beta' y_{t-1})$, Δy_t is an $m \times 1$ vector of the first difference of the variables in y_t (i.e. government revenue and expenditures), μ is an $m \times 1$ vector of intercept coefficient, Γ_i is $(k \times k)$ parameter matrices of the lagged stationary differences of y_t , β is the $(k \times r)$ matrix of k -dimensional cointegrating vectors and α is the corresponding $(k \times r)$ matrix of error correction coefficients (otherwise called the adjustment coefficient).

We estimate a VECM to ascertain whether fiscal policy reacts to deviations from the long-run equilibrium trajectory, estimates of ECM will provide us information as to whether the adjustment comes through the revenue or expenditure side, or both. In the VECM, if the dependent variable is government revenue, a negative error correction term gives rise to deficits and must be accompanied by an increase in revenues to move the economy towards a surplus to eliminate the

⁶ See Granger (1988) and Rambaldi (1997) for detailed discussion.

disequilibrium resulted from the deficits. Likewise, if the error correction term takes a positive value, this give rise to a surplus. In this regard, government revenues may be allowed to decline until the disequilibrium term become zero, leading to a balanced budget scenario.

If the dependent variable is government expenditure and the disequilibrium term takes a positive value (significant or insignificant) so that the budget will be in surplus, the government can afford to increase its spending until the disequilibrium term converges to zero, leading to balanced budget scenario. Conversely, if the error correction term is negative, which implies the budget is in deficit, government should decrease its spending to restore a balanced budget. The result of the error correction model is shown in Table 2.10

Table 2.10. Vector Error Correction Estimates

Dependent Variable		Government	Revenue		
Parameters	Coefficients	St-error	t-stat	p-value	
α_r	-0.129	0.147	-0.87	0.383	
Dependent Variable		Government	Expenditure		
Parameters	Coefficients	St. error	t-stat	p-value	
α_g	-0.245	0.171	-1.432***	0.002	

*** indicate 1 % significant level

From the results above, the error correction term when revenue is the dependent variable (revenue adjustment model) α_r is negative and statistically insignificant. As such, the budget is in deficit and should be accompanied by an increase in revenue to restore fiscal equilibrium. The estimated coefficient of -0.129 implies that about 13% of the fiscal disequilibrium in government budget deficits is corrected annually by government revenues. The error correction term α_g when government expenditure is the dependent (expenditure adjustment model) is negative and statistically significant, which implies the budget is in deficits. The estimated coefficient is -0.245 which implies that about 25% of the disequilibrium in government budget deficit is corrected annually by government expenditures. Though both coefficients are of the expected sign, spending adjustments work faster than revenue to restore budget balance.

2.7.6 Granger Causality Test

As a complement to the previous sustainability test, we test for causality between government revenue and spending following the intuitive notion of a variable's forecasting ability (Granger, 1969). Granger causality should be interpreted as a forecast, i.e. whether one thing that happens before another thing helps predict it (Hamilton, 1994). Government revenue is said to Granger-cause expenditure when both the lagged and present values for government revenue help in forecasting government expenditure. The existing literature offers four hypotheses on the causal relationship between government revenue and expenditure.

The first proposition is that the government's decision to tax should come before the decision to spend, known as the tax-and-spend policy. Friedman (1978) and Buchanan and Wagner (1977) among others are proponents of this hypothesis, which assume a unidirectional causality from government revenue to government spending with no feedback effect.

Friedman (1978) predicts this relation to be positive in that an increase in revenue will bring about an increase in government spending and reducing taxes will possibly lower the existing budget deficits. This belief is in contradiction to Buchanan and Wagner (1977), who predict this causal relation from government revenue to government expenditure to be negative – that is, an increase in revenue will lower the outstanding fiscal deficits. They argue that if government reduces taxes to boost aggregate demand as a means of stimulating the economy, the public will suffer from fiscal delusion. In other words, the public will perceive the reduction in taxes as a fall in the cost of government programmes. As such, the public tends to demand more from the government, which puts an upward pressure on the deficits. A plausible means of reducing deficits is to increase revenue and set some fiscal limits to financing deficits (Buchanan and Wagner 1977).

The second hypothesis is that a government's decision to spend should come before the decision to tax, known as the spend-and-tax hypothesis in the literature. Proposed by Barro (1979) and Peacock and Wiseman (1979), it assumes a unidirectional causality from spending to revenue with no feedback effect. Positive shocks to government spending, such as in times of crisis, could lead to a permanent increase in government revenue (Peacock and Wiseman, 1979). Increase in current government spending will bring about an additional borrowing, imposing a constraint on household consumption, which in turn will increase household tax liability in the future to finance the deficits (Barro 1979).

The third hypothesis is based on bidirectional causality between government revenue and government spending. The idea here is analogous to the equilibrium condition of utility maximising agents in a free market. Public sector decision makers make simultaneous decisions on tax and spending policies by accounting for the cost and benefits of providing government projects. This hypothesis conforms to the classicalist opinion of public finance (Musgrave, 1966).

The last proposition is based on the belief that there is no causality between government spending and government revenue, due to the fiscal autonomy between institutions that determine tax and spending policies. This hypothesis means there is no cointegration between spending and revenue, which has an implication for fiscal sustainability (see, for example, Wildavsky (1988)).

The Granger causality test involves estimating the VAR system, which in general can be written as:

$$y_t = c + \sum_{i=1}^{\rho} \psi_i y_{t-1} \epsilon_t \quad t = 1, 2, 3, \dots, T \quad (2.35)$$

where y_t is a $(m \times 1)$ vector of jointly determined endogenous variables, ψ_i is $(m \times m)$ coefficient matrices, p is order of lag and ϵ_t is a $(m \times 1)$ vector of innovations and is a white noise process. For this paper, $y_t = (R_t, G_t)$, where R_t is the government revenue-to-GDP ratio and G_t is the government expenditure-to-GDP ratio. Based on the VAR, the Granger causality between revenue and expenditure can be tested by applying the block exogeneity Wald test (Enders, 2009). This test detects whether the lags of one variable can Granger cause any other variables in the VAR system.

The null hypothesis is that all lags of one variable can be excluded from each equation in the VAR system. The test statistic is:

$$(T - 3\rho - 1)(\log |\Sigma_{re}| - \log |\Sigma_{ru}|) \sim \chi^2(2\rho) \quad (2.36)$$

where T is the number of observations, Σ_{re} is the variance/covariance matrix of the restricted system, Σ_{ru} is the variance/covariance matrix of the unrestricted VAR system and p is the number of lags of the variable excluded from the VAR system. Based on the Granger causality/block exogeneity Wald test, we can obtain the information about the direction of causality between variables. The Granger causality test results are presented in Table 2.11

Table 2.11. VAR Granger Causality/Block Exogeneity Test Results

Dependent Variable	Excluded Variable	Chi-sq.	df	p-value
Revenue	Spending	0.0592	2	0.9708
Expenditure	Revenue	8.167**	2	0.0168

** indicates 5% significance level

The Granger causality/block exogeneity Wald test suggests that when expenditure is excluded from the revenue equation, we fail to reject the null hypothesis of expenditure does not Granger-cause revenue because the p-value of 0.9708 for the chi-square is greater than the 5% significance level. Conversely, when revenue is excluded from the expenditure equation, we can reject the null hypothesis of revenue does not Granger cause expenditure because the p-value of 0.0168 for the chi-square is less than the 5% significance level. Based on the above result, we conclude that there exists a unidirectional causality running from revenue to spending – that is, the decision to tax is taken before the decision to spend. A similar conclusion was reached by Oshikoya and Tarawallie

(2010) for Sierra Leone and Wolde-Rufael (2008) for Ethiopia, Ghana, Kenya, Nigeria, Mali and Zambia. This result conforms to the tax and spend hypothesis.

2.7.7 Fiscal Reaction Function for Sierra Leone

In this section, I address to the second research question regarding how policymakers respond to the rising public debt-to-GDP ratio in Sierra Leone by estimating a policy rule (fiscal reaction function). As Bohn (1998, 2005) argues, in an event when debt-to-GDP ratio is declining, it is difficult to tell whether the fall in debt-to-GDP ratio is because of luck (for example, high economic growth) or prudent policy design. The objective here is to ascertain whether government takes prudent policy measures when the debt-to-GPD ratio starts rising by adjusting the primary balance-to-GDP ratio to ensure fiscal sustainability. We estimate the fiscal policy reaction function using the augmented Bohn (2005) model in the regression equation below:

$$pb_t = \alpha_0 + \rho d_{t-1} + \sum_{n=1}^k \beta_n X_t + \epsilon_t \quad (2.36)$$

where pb_t is the primary balance-to-GDP ratio, d_{t-1} is the lagged debt to-GDP-ratio, ρ is the fiscal reaction coefficient and X_t is a set of macroeconomic and political determinants of primary balance ratio. In the regression above, X_t comprises the following: election dummy, which represents a political indicator that captures the effect of political stability on primary balance, current account balance, capturing any effect of the twin deficit hypothesis (i.e. if fiscal deficits lead to current account deficits and hence balance of payment problem) and institution dummy capturing the effect of the establishment of Sierra Leone National Revenue Authority in 2002.

The two main policy variables in the literature are cyclically adjusted primary balance (CAPB) or primary balance (PB). We chose PB following Bohn (2005), since models with CAPB do not reflect business cycles whereas models with PB are associated with output gap. As in Bohn (1998) in the spirit of Barro's (1979) tax smoothing hypothesis, we employ other non-debt determinants of primary balance-to-GDP ratio: temporary measure of government spending, GVAR (spending gap), and temporary change in output, YVAR (output gap). GVAR and YVAR are computed using the Hodrick-Prescott (HP) filter with the smoothing parameter set to 100 for annual series. The parameters YVAR gives the deviation of real output from its trend. Positive values show signs of a boom and negative values indicate a recession. GVAR represents the deviation of real government spending from its nominal trend. Positive value means public spending is above the nominal value and negative value means government spending is below the nominal value. The political dummy and institutional dummy are time dummies. The political dummy captures the effect of 1996 regime change in Sierra Leone when the country return to multi-party democracy from dictatorial military government. The dummy is constructed as follows- all periods between 1980-1996 takes the value of 1 and 0 otherwise. The institution dummy is employed to captures the effect of the establishment of the Sierra Leone National Revenue Authority in 2002, an autonomous institution charged with the responsibility of collecting tax revenues. Prior to 2002, different government institutions were collecting revenues on behalf of the government which was deemed as inefficient. The institution dummy is also a time dummy taking the value of 1 from 1980-2002 and 0 otherwise. The result for the fiscal reaction is given in Table 2.12.

Table 2.12. Fiscal Reaction Function Estimates

Variables	Coefficients	Newey- West St. Error	t-Statistics	Prob. value
Constant	-.222	.012	-19.17	0.000
Lagged Debt Ratio	.010	.004	2.43**	0.026
GVAR	-.946	.059	-16.10***	0.000
YVAR	-.004	.072	-0.05	0.957
Current Account Balance	.403	.168	2.41**	0.027
Election Dummy	.060	.0140	4.31***	0.000
Institution Dummy	.006	.0115	0.56	0.582
F (6, 18) = 115.50		p-value [0.000]		

Note: standard errors and t-statistics are computed using the Newey-West heteroskedasticity and autocorrelation consistent (HAC) method where *, **, and *** indicate 10%, 5% and 1% significance level respectively

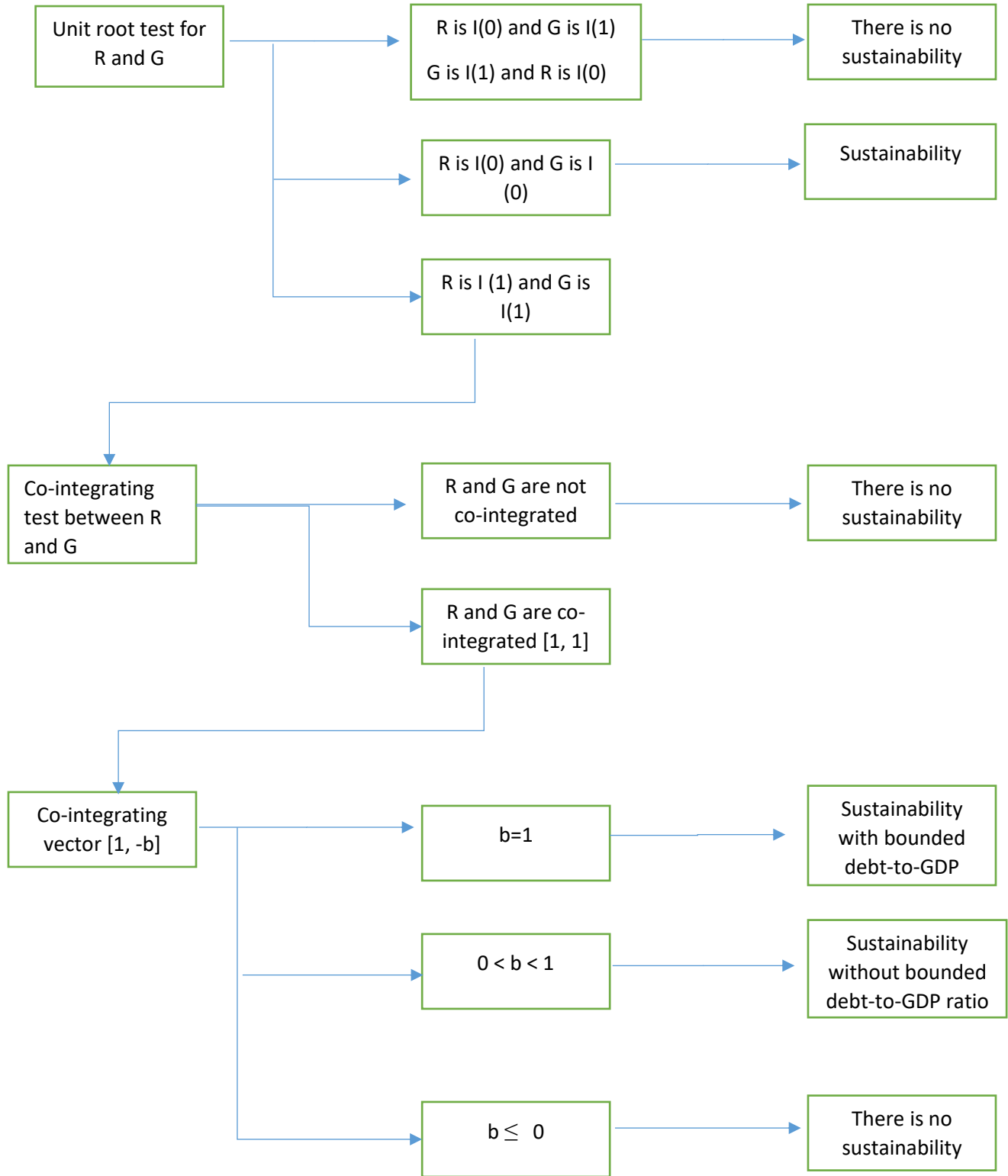
The coefficient of the lagged debt (fiscal reaction coefficient) is 0.010, which is positive and statistically significant. The estimated coefficient implies that for each 1% point of GDP increase in public debt, primary balance increased by 0.010% of the GDP. The finding suggests that the government improves the primary-to-GDP ratio (either through tax increase and/or spending cut) in response to the rising debt ratio. Our findings are in line with Fincke and Greiner (2010) and Asiana, Akosah, and Owusu-Afriyie (2014) for Botswana and Ghana respectively. The positive response of deficit ratio to public debt ratio means sustainable fiscal policy, which is due to prudent policy response from fiscal authorities in Sierra Leone. The coefficient YVAR (output gap) is -0.004, which is negative but statistically insignificant. The negative response of primary balance to output gap indicates that the fiscal policy in Sierra Leone over the sample period is procyclical. In other words, the government implements fiscal expansion during good times (boom) and fiscal contraction in bad times (recession). This means that the primary deficits ratio rises in booms and falls in downturns. Similar results were reported by Gavin and Perotti (1997) for Latin American

countries, Iizekzki and Vegh (2008) and Catão and Sutton (2002) for developing countries and Kaminsky, Reinhard and Vegh (2004) for a sample of 104 countries, noting that procyclical fiscal policy is a common trend in many although not all developing countries. In Sierra Leone, the procyclicality observed could be due to that fact that during recession (bad times), the government finds it difficult to borrow at higher interest rate. Thus, in periods of downturns, the government cannot run deficits and should reduce spending and/or increase taxes, while in periods of good times (booms), the government can borrow more easily and usually chooses to do so, increasing public spending. Other reasons could be due to weak institutions (Manasse, 2006) and election mistrust of corrupt politicians (Alesina and Tambellini, 2005). GVAR (spending gap), otherwise known as the spending gap, is negative and statistically significant with estimated coefficient of -.946. This finding means that public spending is below trend and it is associated with lower primary balance-to-GDP ratio. It is plausible for government to increase spending. We find evidence of the twin deficit hypothesis in Sierra Leone. The estimated coefficient of current account balance is 0.403 which is statistically significant, showing that fiscal deficits in Sierra Leone contribute to current account deficits. The dummy used to capture the effect of political stability on primary balance-to-GDP ratio is also positive and statistically significant, meaning a stable political environment positively impacts primary balance. The dummy used to capture institutional capacity is positive but insignificant, meaning that improving the capacity of revenue institution will help to increase the revenue base for the government which helps in reducing the size of the primary deficits.

2.8. Conclusion

This chapter examines the sustainability of fiscal policy in Sierra Leone spanning from 1980-2015. I employed all three approaches presented in the empirical literature: the stationarity approach, the cointegration between government revenues and expenditures and finally, the fiscal reaction function approach. The results show that the primary deficits is stationary which is a necessary condition for sustainable fiscal policy. Also, I find evidence of cointegration between government revenues and expenditure, with the cointegrating vector significantly less than one. This result means the fiscal policy in Sierra Leone over the years is sustainable but in a weak sense. This finding is further supported by estimates from the policy rule, which show that the government consistently manages the size of the deficits ratio in response to rising debt ratio to ensure fiscal sustainability. The latter finding implies that the sustainability of fiscal policy in Sierra Leone is due to prudent policy design by the government and not just luck (for example high economic growth). With all three approach arrives at similar conclusions, I finally conclude that over the sample period, fiscal policy in Sierra Leone has been sustainable.

Figure 2.1. Empirical Procedure to Test for Fiscal Policy Sustainability



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CHAPTER THREE

Fiscal Policy Shocks in Sierra Leone: A Structural Vector Auto-regression Approach

3. 1 Introduction

Over the past decades, the use of discretionary fiscal policy has been a subject of great controversy. Unlike monetary policy where there is some agreement on how it affects the macroeconomy following Taylor's rule, there is no such consensus among macroeconomists regarding fiscal policy. Prior to the first and second oil price shocks of 1973 and 1979, fiscal policy was extensively viewed as a powerful tool for stabilisation. However, its inability to boost economic recovery following these shocks and the related increase in fiscal deficits and public debts have led some macroeconomists and policymakers to be doubtful about its potential to smooth business cycle fluctuations (Beetsma and Giuliadori, 2011), and thus its effectiveness as a stabilisation tool (Afonso and Sousa, 2012). However, during the 2008 financial crisis when many advanced economies were experiencing zero lower bound interest rates that hindered the effectiveness of monetary policy for economic recovery, policymakers in these economies resorted to fiscal policy as an alternative tool for stabilisation and growth. According to Auerbach (2012), the United States government approved a fiscal stimulus package as part of the American Recovery and Reinvestment Act (ARRA) of 2009, which comprised tax cuts, transfers and spending expansion amounting to 5.5% of the GDP. In a similar vein, the European Union adopted the European Economic Recovery Plan (EERP) equivalent to 1.5% of the EU GDP (Beetsma and Giuliadori, 2011). Fiscal policy is once again at the centre of macroeconomic policy debate.

On both theoretical and empirical fronts, there exists some considerable disagreement in terms of the qualitative and quantitative effect of fiscal policy, the transmission mechanisms and the magnitude of its effects. One key reason for such disagreement on the impact of fiscal policy stems from theoretical predictions regarding the response of private consumption and private investment to government spending. The former is the largest component of aggregate demand, and how it responds determines the size of the government spending multiplier.

Macroeconomic models that analyse the effect of fiscal policy on the macroeconomy offer heterogeneous predictions stemming from different underlying theoretical assumptions. Irrespective of the relevance of fiscal policy as a stabilisation tool, there has been no clear agreement on how fiscal policy affects the economy (Perotti, 2001). The neoclassical real business cycle model claims that economic agents make decisions based on rational expectations, which implies they are forward-looking with respect to consumption and labour supply decisions. In effect, the model predicts that discretionary changes in taxes, for example temporary tax cuts, have no effects on household intertemporal budget constraints, resulting in a consumption pattern. Moreover, the model states that discretionary changes in government spending that are expansionary create a negative wealth effect for representative households. Increase in government spending creates a deficit that should be financed by higher taxes in the future. Households respond by reducing current consumption and increasing labour supply, which raises output. This effect is at odds with the conventional Keynesian wisdom, which assumes that consumers are not forward-looking and expansionary government spending crowds-in household consumption and private investment leading to an increase in output.

Some earlier studies on fiscal policy often depend on the cyclically adjusted primary deficits as determinants of fiscal policy stance. Though cyclically adjusted deficits do offer insight into current fiscal policy, their use is unsuitable in dynamic macroeconomic analysis, because competing macroeconomic theories predict different effects from spending increases and tax cuts on the macroeconomy (Fatás and Mihov 2001). SVAR is more appropriate in the dynamic macroeconomic context (Blanchard and Perotti, 2002).

In the framework of SVAR, the identification of fiscal shocks can be documented in five methodological groups. First, fiscal policy shocks can be identified by using dummy variables that capture specific episodes, such as the military-build ups (i.e. the Korean and the Vietnam wars) or the Reagan fiscal expansion in US (Ramey and Shapiro, 1998; Edelberg, Eichenbaum and Fisher, 1999; Burnside, Eichenbaum and Fisher, 2000). Second, sign restrictions can be imposed on the impulse-response functions (Mountford and Uhlig, 2002) and third, fiscal shocks can be identified based on recursive ordering (Fatás and Mihov, 2001; Favero, 2002). Fourth, fiscal policy shocks can be identified by assuming decision lags in policy-making and information about the elasticity of fiscal variables to economic activity (Blanchard and Perotti 2002; Perotti, 2005) and finally, fiscal shock can be identified by exploiting the conditional heteroscedasticity of the structural shocks (Bouakez, Chihi and Normandin, 2014). This chapter employs on the third and fourth identification strategies stated above.

The aim of this chapter is to answer the following questions: What are the dynamic effects of discretionary changes in government spending and taxes on economic activity?⁷ What is the most efficient fiscal tool in stabilising the economy? Though such questions are useful and are often asked in academic and policy discussions about the efficacy of fiscal policy in stimulating growth and welfare, such has not been done for the case of Sierra Leone despite the large volume of literature. Little is known about how this economy responds to fiscal surprises. Specifically, there are no known studies that characterise the dynamic effect of fiscal policy shocks on the macroeconomy in the framework of the VAR model given the various tax reforms that have been introduced over the past decades and the corresponding changes in government spending behaviour.

Against this backdrop, this chapter exploits this grey area and contributes to the literature in the following ways. (i) We employ higher frequency data in our empirical analyses as it is uncommon in empirical analyses for developing countries. Doing so makes this study and findings comparable to the existing literature as most, if not all, fiscal VARs employ quarterly data. (ii) To the best of our knowledge, we not aware of any studies that have analysed the macroeconomic effect of fiscal policy shocks for Sierra Leone in the context of SVAR. This study is the first to offer recent findings on the dynamic effects of fiscal surprises for Sierra Leone.

Our results are in line with studies documented in the literature. Output and private consumption respond to government spending shocks with strong and persistent effects. Government spending moderately increases private investment and government revenue. Shocks to government revenue temporarily reduce output and private investment.

⁷ The aim of this chapter is to assess the short-run impacts of discretionary fiscal policy. There are however other studies that have examined the long-run impact of discretionary fiscal policy which is outside the scope of this chapter.

The response of private consumption to tax shocks is insignificant – close to zero on impact. Both spending and tax shocks are inflationary and interest rates rise with spending increase in the short run. Investigating the response of output to shocks in the components of government spending and revenue gives a broader picture. The results reveal that government investment expenditure strongly stimulates the economy in contrast to government consumption expenditure.

3.2 Literature Review

Theoretical predictions and empirical findings still offer contrasting views on the effects of fiscal policy. The new Keynesian model with price rigidity predicts that positive government spending shocks will stimulate labour demand, household consumption and a rise in real wages, thereby increasing output. Models with increasing return to scale and perfect competition have shown that positive shocks to government spending increase real wage (Rotemberg and Woodford, 1992) and consumption and real wage (Devereux, Head and Lapham, 1996). Ravn, Schmitt-Grohé and Uribe (2006) assume habit persistence regarding consumption, which gives rise to countercyclical mark-ups of price over the marginal cost in an imperfectly competitive market. They show that positive shocks to government spending create a negative wealth effect, but also increase aggregate demand to which firms respond by reducing their mark-ups. In response, labour demand increases and offsets the initial negative wealth thereby increasing real wage and consumption. Galí LópezSalido and Vallés (2007) introduce the sticky price model adapted to capture the presence of ‘rule-of-thumb consumers’ with non-Ricardian consumption pattern. They show that due to countercyclical mark-up, real wages increase, and consumption respond positively to spending shocks because of the presence of ‘rule-of-thumb’ consumers.

However, the standard neoclassical real business cycle model, which assumes a perfect competitive market with constant return to scale, shows that following a positive shock to government spending, output increases and produces a negative wealth effect, because of the assumption that consumers are forward-looking. Increase in government spending creates deficits that have to be financed by higher taxes in the future. This increase in taxes influences households to lower consumption and increase labour supply, which leads to a fall in the real wage. Positive spending shocks that are financed by non-distortionary taxes cause a negative wealth effect for representative households, where output and real interest rise but consumption and real wage fall (Aiyagari, Christiano and Eichenbaum, 1992; Christiano and Eichenbaum, 1992; Burnside and Eichenbaum, 1996). If the shock is persistent, marginal productivity of capital may rise, leading to an increase in investment (Baxter and King, 1983). Ramey and Shapiro (1998) introduce the narrative approach, following Hamilton (1985) and Romer and Romer (1989) to capture exogenous increase in defence spending, implying government spending. The methodology involves constructing a dummy in a series of univariate equations to account for the increase in defence spending that takes value one at quarter and zero otherwise when large military build-ups took place in the United States to identify episodes of discretionary fiscal policy. Edelberg, Eichenbaum and Fisher (1999) present a modified version of the neoclassical model by disaggregating investment into residential and non-residential categories in the context of VAR. They argue that persistent shocks to government spending increases taxes on households, leading to a fall in consumption and increase in hours of work. Marginal productivity of labour and real wage decline but employment increases.

Because of the complementarity in production between hours of work and market capital, non-residential investment rises and residential investment falls in the form of consumer durables.

Burnside, Eichenbaum and Fisher (2004) show that their estimated neoclassical model can account for the qualitative effect of spending shocks with distortionary taxes. Edelberg, Eichenbaum and Fisher (1999) employ this methodology in a multivariate setting, and Burnside, Eichenbaum and Fisher (2004) as well as Eichenbaum and Fisher (2005) present modified versions. Notwithstanding the minor methodological modifications, these studies reach similar conclusions. From a qualitative point of view, in response to a discretionary positive government spending shock, output and non-residential investment increase and consumption, wages and residential investment fall. In effect, these findings support the neoclassical business cycle theory. The disparities in predictions between the new Keynesian and the neoclassical model are due to the theoretical assumptions underpinning consumers' behaviour. The new Keynesian model assumes consumption depends on current disposable income, which implies consumers to be non-Ricardian. In the neoclassical real business cycle model, however, consumption depends on lifetime wealth, which implies that consumers are Ricardian optimising agents (Galí, LópezSalido and Vallés, 2007).

Recent empirical literature that examines the effects of fiscal policy shocks do so within the framework of SVAR to determine the dynamic responses of macroeconomic variables. Fatás and Mihov (2001) employ the recursive approach to achieve identification in a five-variable VAR system. They find strong, positive and persistent impacts of fiscal expansions on economic activity. Consumption, real wage and residential investment rise in response to positive government spending shocks.

Blanchard and Perotti (2002) employ a three-variable VAR model to identify the impact of government spending and tax policy on output. Following positive spending shocks, output and consumption increase and investment fall. This approach is extended in Perotti (2005) to study the

effect of fiscal policy in five OECD countries. Mountford and Uhlig (2002) propose and adopt a different approach to achieve identification of fiscal shocks from VAR residuals by imposing sign restrictions on the impulse responses instead of contemporaneous restrictions. However, they find a small response of consumption, significant only on impact. Investment falls to positive spending and tax shocks. Yet by imposing restrictions on the impulse response, this approach finds a positive relationship between output and revenue shocks as opposed to business cycle shocks and by implication rules out the non-Keynesian effects of fiscal policy. That is, it rules out that output may respond positively to tax shocks for a few quarters after the shocks (Caldara and Kamps, 2008). The disagreements in the empirical literature on SVAR stems from the differences in specification of the VAR model, methods of identifications and the policy experiments conducted (Caldara and Kamps, 2008).

Many studies have adopted the SVAR to estimate the dynamic effects of exogenous fiscal policy shocks. For example, De Castro and De Cos (2008) estimate the effects of fiscal policy shocks in Spain and find positive response in output and consumption to positive government spending shocks. Giordano et al. (2007) estimate the impact of fiscal policy in Italy and find small positive response of output to government spending shocks; however, the shocks are temporary and fade out in the short run. Tenhofen, Wolff and Heppke-Falk (2010) find government spending to be significant in stimulating growth but output fails to respond to revenue shocks in Germany.

Afonso and Sousa (2009) investigate the macroeconomic effects of fiscal policy shocks in the United States, United Kingdom, Germany and Italy. Their results reveal that the impact of spending shocks on output is relatively small while the exchange rate depreciates, with varied impacts on housing prices.

The empirical literature presented so far essentially focussed on studies relating to developed countries. The literature on fiscal policy shocks in developing countries, specifically in sub-Saharan Africa, is very thin. This paucity in research could be due to the fact that most studies on fiscal policy surprises are conducted using higher frequency data, which is absent in most developing countries. The few studies that have emerged so far essentially rely on recursive ordering to achieve identification because the restrictions imposed on Blanchard and Perotti's (2002) approach to achieve identification is limited to quarterly frequency data. In studying the impacts of discretionary fiscal policy change in Egypt and Tunisia, Slimane and Tahar (2013) find significant and positive effects of output to spending expansion. A similar conclusion was reached by Mutuku and Elias (2014) for Kenya. Driss, Bettahar and Benbouziane (2014) examine the impacts of fiscal policy shocks and exchange rate dynamics in Algeria. They find that both government spending and revenues expansion significantly increase output. The latter is, however, counterintuitive, as conventional wisdom predictions expect tax shocks to lower output. Akpan and Atan (2015) investigate the macroeconomic effects of fiscal policy shocks in Nigeria using the recursive ordering and find that output significantly rises to spending expansion while private investment is insignificantly crowded-in by government spending. Millo and Kollamparambi (2016) investigate how government spending and tax policy affects output and employment in South Africa using the recursive approach.

They surprisingly find that output does not respond to spending expansion in the short run while positive revenue shocks increase output. They conclude that the transmission mechanism from government spending to output is not direct as predicted by the Keynesian doctrine, but is rather seen indirectly through employment, conforming to supply-side economics.

Even the size of the fiscal multiplier remains contentious in the empirical literature. There is an existing disagreement empirically on the impact of government spending and the tax multiplier. Researchers are yet to agree on which has stronger impacts or works faster in stimulating growth, probably owing to the different factors that have been empirically proven to influence the size of the fiscal multiplier. For example, Christiano, Eichenbaum and Rebelo (2011) and Monacelli, Perotti and Trigari (2010) use the reaction of interest rate to discretionary fiscal policy, while the extent of openness to trade is found in Ilzetzki, Mendoza and Végh (2013) and Faia, Lechthaler and Merkl, (2010). Furthermore, Leeper, Walker and Yang (2010) and Cogan et al. (2010) among others argue that the size of the fiscal multiplier is influenced by the models' properties.

Before proceeding to the next section, it is important to close the present section by summarising some empirical findings of previous studies. Table 3.1 shows clearly shows that the empirical findings on the effects of fiscal policy shocks are heterogenous. Specifically, the impact of government spending on private investment and private consumption is still debateable on both theory and empirics. Sierra Leone is a small open economy with large public sector employment. It is therefore necessary to empirically investigate the effects of fiscal policy surprises.

Table 3.1 Some Empirical Evidence on Fiscal Policy Shocks

Authors	Country	Year	Spending Shocks			Revenue Shocks		
			GDP	I	C	GDP	I	C
Fatás and Mihov	US	2001	+	+	+	NA	NA	NA
Blanchard and Perotti	US	2002	+	-	+	-	+	-
Mountford and Uhlig	US	2009	+	-	-	-	+	-
Perotti	OECD	2004	+	+	-	-	Mixed	Mixed
Galí, LópezSalido and Vallés	US	2007	+	-	+	NA	NA	NA
De Castro	Spain	2006	+	Mixed	+	Mixed	-	+
Giordano et al.	Italy	2007	+	+	+	+	0	0
Heppke-Falk et al.	Germany	2010	+	-	+	0	+	0
Lozano and Rodriguez	Colombia	2009	+	+	+	+	-	-
Akpan and Atan	Nigeria	2015	+	+	+	-	-	NA

(+) = Positive response, (-) = Negative response, I = Investment and C= Consumption

NA = Not Applicable

3.3 Methodology

This section describes the econometric model used to investigate the impact of surprise fiscal policy shocks on real output in Sierra Leone. Sims (1980) criticises the specification methodology of large-scale macro-econometric models, citing two different methodological short-comings. First, the simultaneous equations systems are specified based on the aggregation of partial equilibrium models, neglecting any concern for the subsequently omitted interrelations. Second, the dynamic structure of the model was often specified to provide restrictions that were essential to achieve identification or over-identification of the structural form (Amisano and Giannini, 2012). As such, Sims (1980) recommends the use VAR as an alternative to simultaneous equation systems for forecasting with macro-econometric models, which has given rise to the use of VAR in empirical research in macroeconomics. This chapter adopts the SVAR model as a framework for forecasting. The model is estimated using quarterly data for Sierra Leone from 1980q1-2014q4, providing us with a sample size of 140 observations. Following Perotti (2005), our benchmark model is a five-variable VAR model comprising output Y_t , government spending G_t , government revenue τ_t , inflation rate π_t and interest rate r_t . In addition, we specify a six-variable VAR model incorporating per capita private consumption c_t and per capita private investment i_t . All variables are real in log and per capita terms, except for the interest rate.

Denoting the vector of endogenous variables by X_t and the vector of reduced form residual as U_t , the reduced form VAR can be written as:

$$X_t = A(L)X_{t-1} + U_t \quad (3.1)$$

where A is $(K \times K)$ VAR coefficient matrices, L is a polynomial shift operator or lag length and U_t is a white noise error term with zero-mean and non-singular variance-covariance

matrix Σu , such that, $U_t \sim (0, \Sigma u)$. $X_t \equiv [g_t, y_t, \pi_t, \tau_t, r_t]'$, $U_t \equiv [u_t^g, u_t^y, u_t^\pi, u_t^\tau, u_t^r]'$ with $E[u_t] = 0$ and $E[u_t u_t'] = \Sigma u$ and $E[u_t u_s'] = 0$ for $s \neq t$. The reduced-form disturbances are usually correlated, which requires us to transform the reduced-form model into a structural model. Multiplying equation (1) by $(K \times K)$ matrix A_0 gives the structural form of the model:

$$A_0 X_t = A_0 A(L) X_{t-1} + B e_t \quad (3.2)$$

where $B e_t = A_0 U_t$, defines the relation between the structural residuals e_t and the reduced-form residuals u_t . Matrix A_0 defines the contemporaneous relation among the variables in the vector X_t . Knowing that $B e_t = A_0 U_t$, the relation between the reduced form of residuals and the structural residuals, matrix B needs to satisfy the condition $\Sigma u = B \Sigma_e B'$. The relation $\Sigma u = B B'$ does not however uniquely determine matrix B, because Σu is symmetric and contain at most $K(K + 1)/2$ different elements, while B has K^2 elements (Lütkepohl, 2005). Therefore, the structural shocks will not be uniquely determined without additional restrictions. Conversely, at least $K(K - 1)/2$ additional restrictions are required for unique specification of matrix B transformation in characterising the shocks.

This model is known as the B model. In the SVAR literature, the restrictions in both matrices A and B are combined, such that $B e_t = A U_t$ with $e_t \sim (0, I_K)$ follows $U_t = A^{-1} B e_t$, therefore $\Sigma_u = A^{-1} B B' A^{-1}$. This model gives us $K(K + 1)/2$ elements, where matrices A and B each comprise K^2 elements. To just identify the $2K^2$ elements in both matrices A and B, we require extra $2K^2 - \frac{1}{2}K(K + 1)$ restrictions (Lütkepohl, 2005), known as the AB model in SVAR literature. Without imposing restriction on the parameters in A and B based on economic justifications, the structural model will not be identified. We present below the identification approaches used in our empirical application.

3.3.1 VAR Identification

To study the effect of fiscal policy shocks in Sierra Leone, we apply a SVAR technique. In doing so, we adopt two identification techniques in our empirical analysis: the recursive approach proposed by Sims (1980) as applied in the study of fiscal policy shocks in the United States by Fatás and Mihov (2001) and the identification approach proposed and applied by Blanchard and Perotti (2002) to study the effects of government spending and taxes on output in the United States and applied to the study of fiscal policy shocks in OECD countries by Perotti (2005). We summarise the two identification approaches used in this study.

3.3.1.1. Recursive Approach

The first identification approach considered in this chapter is the recursive identification approach, sometimes referred to as the Cholesky decomposition, which restricts matrix B to an identity matrix and A_0 to a lower triangular matrix with all diagonal elements equal to one and all elements above the diagonal equal to zero. Let P be a $K \times K$ lower-triangular matrix with all positive main diagonal elements such that $\Sigma_u = PP'$, which gives the decomposed covariance matrix $\Sigma_u = A_0^{-1}\Sigma_e(A_0^{-1})'$. Let D be a diagonal matrix such that D and P have the same main diagonal elements and by specifying $A_0^{-1} = PD^{-1}$ and $\Sigma_e = DD'$ (Lütkepohl, 2005). This tells us that the Cholesky decomposition of the covariance matrix (that is the main diagonal elements) of matrices D and P is equal to the square root of the scalar variances (Kilian, 2011). The idea here is to separate the structural innovations u_t from the reduced-form innovations e_t , such that the errors are uncorrelated with each other. In our VAR system, the recursive approach suggests a causal ordering of the model variables. We order the variables as follows: government spending enters the model first, output is ordered second, inflation is ordered third, government revenue is ordered

fourth and interest rate last. The relation between the reduced-form disturbances u_t and the structural disturbance e_t takes the following form:

$$\begin{bmatrix} 1 & 0 & 0 & 0 & 0 \\ -\alpha_{yg} & 1 & 0 & 0 & 0 \\ -\alpha_{\pi g} & -\alpha_{\pi y} & 1 & 0 & 0 \\ -\alpha_{\tau g} & -\alpha_{\tau y} & -\alpha_{\tau \pi} & 1 & 0 \\ -\alpha_{rg} & -\alpha_{ry} & -\alpha_{r\pi} & -\alpha_{r\tau} & 1 \end{bmatrix} \begin{bmatrix} u_t^g \\ u_t^y \\ u_t^\pi \\ u_t^\tau \\ u_t^r \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} e_t^g \\ e_t^y \\ e_t^\pi \\ e_t^\tau \\ e_t^r \end{bmatrix} \quad (3.3)$$

We order our variables following Perotti (2005), Favero (2002) and Fatás and Mihov (2001). The ordering of the variables implies that: (i) government spending does not respond contemporaneously to shocks to other variables in the system; (ii) output does not react contemporaneously to shocks to inflation, government revenue and interest rate, but is affected contemporaneously by spending shocks; (iii) inflation does not react contemporaneously to government revenue and interest rate shocks, but is affected contemporaneously by government spending and output shocks; (iv) government revenue does not react contemporaneously to interest rate shocks but is affected by government spending, output and inflation shocks; and (v) interest rate is affected by all shocks in the system. It is worth noting that after the early period, the variables in the system can interact freely – for example, inflation shocks can affect output in all periods after the period in which the shock occurred.

According to Caldara and Kamps (2008), the underlying assumptions for ordering the variables are justified as follows: changes in government spending in contrast with changes government revenue are often unconnected to business cycles. In this regard, it is reasonable to assume that government spending is not affected contemporaneously by shocks emanating from the private sector. Ordering output and inflation before government revenue is justified based on the grounds

that shocks to these variables have an instantaneous impact on the tax base and, therefore, a contemporaneously effect on government revenue. This specific ordering of variables thus captures the effects of the automatic stabiliser on government revenue, while it rules out (possible important) concurrent effects of discretionary changes in taxes on output and inflation. Interest rate is ordered last, which is justified on the premise that given government spending and revenue as defined here (net of interest payment) are not sensitive to changes to interest rate.

3.3.1.2. Blanchard-Perotti Approach

Next, we consider the identification strategy proposed by Blanchard and Perotti (2002). This technique relies on institutional information about taxes and transfer and their collection period. This approach helps us to identify the automatic feedback of taxes and government spending on economic activity. This approach is of two-fold. First, the institutional information is used to estimate cyclically adjusted taxes and government spending. In the second step, estimates of the fiscal policy shocks are obtained. Blanchard and Perotti (2002) used a three-variable VAR model to estimate the effects of government spending and taxes on output in the United States. Perotti (2005) extends this approach to study the effect of fiscal policy shocks in OECD countries using a five-variable VAR model. In this subsection, we adopt the approach used in Perotti (2005), i.e. a five-variable VAR model.

Adopting this approach, the relationship between the reduced-form innovations u_t and the structural innovations e_t is written as follows:

$$u_t^g = \alpha_{gy}u_t^y + \alpha_{g\pi}u_t^\pi + \alpha_{gr}u_t^r + \beta_{g\tau}e_t^\tau + e_t^g \quad (3.4)$$

$$u_t^\tau = \alpha_{\tau y}u_t^y + \alpha_{\tau\pi}u_t^\pi + \alpha_{\tau r}u_t^r + \beta_{\tau g}e_t^g + e_t^\tau \quad (3.5)$$

$$u_t^y = \alpha_{yg}u_t^g + \alpha_{y\tau}e_t^g + e_t^y \quad (3.6)$$

$$u_t^\pi = \alpha_{\pi g}u_t^g + \alpha_{\pi y}u_t^y + \alpha_{\pi r}u_t^r + e_t^\pi \quad (3.7)$$

$$u_t^r = \alpha_{rg}u_t^g + \alpha_{ry}u_t^y + \alpha_{r\pi}u_t^\pi + \alpha_{rr}u_t^r + e_t^r \quad (3.8)$$

The above system of equations is not identified. The variance-covariance matrix of the reduced-form disturbances has 10 distinct elements, whereas the above system of equations comprises 17 free parameters.

The Blanchard and Perotti (2002) approach is quite different from the recursive approach. In the recursive approach, all seven parameters are restricted to zeros, whereas Blanchard and Perotti (2002) estimate some of the parameters. The first step of the estimation procedure involves an adjustment of government spending and revenues for the contemporaneous response to these variables to the business cycle and inflation.

As in Perotti (2005), the aggregate output elasticity of government revenue $\alpha_{\tau y}$ and the aggregate value of the inflation elasticity of government revenue are estimated outside the model and these estimates are used in the VAR in order to identify the fiscal shocks. Since government spending is excluded from transfer, output elasticity of government spending (α_{gy}) is set to zero. Inflation elasticity of government revenue is set to -0.5, as in Perotti (2005). This figure is argued on the premise that nominal wages of government employees, which account for a large portion of

government consumption, do not contemporaneously respond to changes in inflation, implying that government wage bill declines in real terms if there is an unanticipated inflation. Moreover, interest rate elasticities on government spending (α_{gi}) and government revenue ($\alpha_{\tau i}$) are set to zero, because interest paid, and interest received by government are omitted from the definition of government spending and revenue respectively.

From the reduced form residuals in equations (3.4) and (3.5), the structural innovations e_t^g and e_t^τ are linear combinations of three components. The first component is the systematic response of taxes and government spending to shocks in output, inflation and interest rate under an existing fiscal policy regulation – such as an unanticipated change in taxes in reaction to output shock, for a particular tax rate.

The second is the systematic discretionary reaction of policymakers to shocks in output, inflation and interest rate – for example, decrease in tax rates applied contemporaneously in response to recession – while the final component comprises random discretionary shocks to fiscal policies, referred to as ‘structural’ fiscal shocks, which unlike the reduced-form residuals are uncorrelated with all other structural shocks. This is the component that is of interest when estimating the impulse responses of fiscal policy shocks.

Formally, we can write:

$$u_t^g = \alpha_{gy}u_t^y + \alpha_{g\pi}u_t^\pi + \alpha_{gr}u_t^r + \beta_{g\tau}e_t^\tau + e_t^g \quad (3.9)$$

$$u_t^\tau = \alpha_{\tau y}u_t^y + \alpha_{\tau\pi}u_t^\pi + \alpha_{\tau r}u_t^r + \beta_{\tau g}e_t^g + e_t^\tau \quad (3.10)$$

where the coefficients α_{jk} capture the remaining two components and e_t^g and e_t^τ are the ‘structural’ fiscal shocks, i.e. $cov(e_t^g, e_t^\tau) = 0$. We can see that e_t^g and e_t^τ are correlated with the reduced form

residuals, making it impossible to obtain estimates using OLS regression of equations (3.9) and (3.10) above.

To achieve identification here, it is argued that because fiscal policy has long inside lags, the systematic discretionary fiscal response to any unanticipated event is absent within a quarter, because policymakers require more than a quarter to respond to the given shock, such as shocks to output. Perotti (2005) argues that government spending does not systematically respond to surprise changes in output within a quarter, therefore α_{gy} is set equal to zero. As such, the coefficients α_{jk} in equations (3.9) and (3.10) capture only the automatic response of fiscal variables to economic activity.

With available external information on the elasticity of government revenue and spending to output, inflation and interest rate, we can compute the fitting values of the coefficients α_{jk} . Then, we can further construct the cyclically adjusted fiscal shocks, which are linear combinations of two structural shocks, as follows:

$$u_t^{g,CA} \equiv u_t^g - (\alpha_{gy}u_t^y + \alpha_{g\pi}u_t^\pi + \alpha_{gr}u_t^r) = \beta_{gt}e_t^t + e_t^g \quad (3.11)$$

$$u_t^{\tau,CA} \equiv u_t^\tau - (\alpha_{\tau y}u_t^y + \alpha_{\tau\pi}u_t^\pi + \alpha_{\tau r}u_t^r) = \beta_{tg}e_t^g + e_t^\tau \quad (3.12)$$

The potential endogeneity between taxes and spending is corrected for by assuming either taxes come first, or spending is ordered first. If government spending is ordered before taxes, $\beta_{\tau g}$ is set to zero, and if tax is ordered before spending, $\beta_{g\tau}$ is set to zero. By placing such a restriction, we can estimate the above equation by OLS. The ordering does not really matter, as noted in Blanchard and Perotti (2002) and Perotti (2005). We assume government spending is ordered first to conform to our assumption of ordering in the recursive approach. This gives us:

$$u_t^{g,CA} = e_t^g \quad (3.13)$$

$$u_t^{\tau,CA} = \beta_{tg} e_t^g + e_t^t \quad (3.14)$$

Kargbo and Egwaikhinde (2012) provide estimates of output elasticities of government revenue for Sierra Leone.⁸ These authors estimate the total tax output elasticity $\alpha_{\tau y}$ to be 0.89. We estimate the aggregate value of inflation elasticity on government revenue ($\alpha_{r\pi}$) as 0.44. The reduced-form residuals and the structural residuals take the AB matrices form as follow:

$$\begin{bmatrix} 1 & 0 & 0.5 & 0 & 0 \\ -\alpha_{yg} & 1 & 0 & -\alpha_{y\tau} & 0 \\ -\alpha_{\pi g} & -\alpha_{\pi y} & 1 & -\alpha_{\pi\tau} & 0 \\ 0 & -0.81 & -0.44 & 1 & 0 \\ -\alpha_{rg} & -\alpha_{ry} & -\alpha_{r\pi} & -\alpha_{r\tau} & 1 \end{bmatrix} \begin{bmatrix} u_t^g \\ u_t^y \\ u_t^\pi \\ u_t^\tau \\ u_t^r \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 \\ \beta_{tg} & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} e_t^g \\ e_t^y \\ e_t^\pi \\ e_t^\tau \\ e_t^r \end{bmatrix} \quad (3.15)$$

When we compare the Perotti (2005) approach to the recursive approach, differences are evident. In the recursive approach, all elements of A_0 above the principal diagonal are restricted to zero, yet there are three exceptions in Perotti's (2005) identification approach. Estimating the output elasticity of government revenue in Perotti's approach and using this value as an instrument in estimating the fiscal shocks implies fixing the size of the automatic stabiliser. Therefore, Perotti (2005) estimates the contemporaneous effect of government revenue on output and inflation. In the recursive approach, the size automatic stabiliser is freely estimated while imposing zero restrictions on the contemporaneous effect of government revenue on output and inflation. Surprisingly, the empirical analyses reveal that the conceptual differences between the recursive approach and the Blanchard and Perotti (2002) approach have little effect on the results for the

⁸ See Kargbo and Egwaikhinde (2012).

benchmark value of output elasticity of government revenue imposed in the Blanchard and Perotti (2002) approach.

3.4 Data, Sources and Description of Data

GDP, private consumption, private investment and GDP deflator (inflation rate) are obtained from the world development indicators (World Bank), treasury bill rate is obtained from the International Financial Statistics (IFS) and tax revenue is obtained from two different sources; National Revenue Authority, Sierra Leone and the International Financial Statistics (IFS).

Following Blanchard and Perotti (2002) and Perotti (2005), the empirical literature on fiscal policy shocks are conducted using five standard variables; government spending, government revenue, GDP, inflation and interest rate. See for example Giordano et al (2007) for Italy, de Castro (2006) for Spain, Lozano and Rodriguez (2011) for Columbia, Parkyn and Vehbi (2014) for New Zealand, Shaheen and Turner (2010) for Pakistan, and Tenhofen, Wolff and Heppke-Falk (2010) for Germany among other studies. In structural VAR, ordering of the variable matters as it affect the impulse response, also, using different variable will make comparability with the existing literature on fiscal policy shock very unlikely. The key aim of estimating the effects of fiscal policy shocks is to examine fiscal variables respond to changes in government spending and taxes. Commodity price and foreign income don't constitute fiscal variables. With this in mind, I estimate the effects of fiscal policy shocks for Sierra Leone using the standard variables as in the empirical literature on fiscal policy shocks.

Most studies on fiscal VARs are carried out using quarterly data owing to various assumptions. For example, Blanchard and Perotti (2002) approach assume that it takes at least a quarter for fiscal authorities to intervene during economic downturns. However, most economies do not have quarterly data on fiscal variables. This problem of unavailability of higher frequency data have led

researcher to rely on interpolation of time series. For example, Favero (2002) and Marcellino (2006) estimate fiscal VAR using half-yearly data in four European countries: France, Italy, Spain and Germany. In the first three countries, the budget data was interpolated from annual series (Perotti, 2005). Because of the unavailability of quarterly data, which is a common feature of developing and emerging countries, we interpolate the available annual data to quarterly data. A similar approach can be found in the works of Lisman and Sandee (1964), Goldstein and Khan (1976), Wymer (1979), Bernanke and Mihov (1995), Al-Turki (1995) and Moosa (1995) among others. Parkyn and Vehbi (2014) and Shaheen and Turner (2010) apply the Chow and Lin (1971) approach to interpolate the series used in estimating their fiscal VAR for New Zealand and Pakistan respectively.⁹ The same approach is adopted here given the unavailability of quarterly data. The data used in this study was interpolated from the annual series using the method proposed by Chow and Lin (1971), available in EVIEWS.

The issues of temporary disaggregating time series data are well known. Problems in disaggregation can arise from either distribution. That is when the observed values of a flow low-frequency series of a particular length must be distributed across sub-period values. Alternatively, interpolation problem could arise due to generating a high-frequency series with the values of the new series being the same as the ones of the low-frequency series for those temporal moments where the latter is observed. Sometimes, the issues encountered with temporal disaggregated series includes residual autocorrelation in the disaggregated series, missing values at the end of the series etc. However, several approaches have been proposed by different authors to overcome the pitfall of disaggregating time series. For example, Boot, Feibes and Lisman (1967), Cohen, Muller and

⁹ Cavallo (2005) employs the same method to construct a quarterly series for hours worked in estimating the impact of fiscal shocks on government employment expenditure in the United States.

Padberg (1971), Denton (1971) and Chow and Lin (1971) etc. Applied macroeconometric research essentially rely on temporary interpolation in an even the choice of data frequency in unavailable. The data was transformed to real from their nominal values using the GDP deflator.

It is worth noting that the use of annual data does not change the result, as has been shown by Born and Müller (2012). These authors estimate the effect of government spending shocks using both annual and quarterly data for Australia, Canada, the United Kingdom and the United States, and find identical effects on the impulse response function.

3.4.1 Data Definitions

As in Blanchard and Perotti (2002) as well as other studies in the literature, we define government spending as the sum of general government final consumption expenditure (government consumption) and gross capital formation (government investment). Net taxes are defined as the sum of all total tax revenues less transfers (subsidies, grants, and other social benefits include all unrequited, non-repayable transfers on current accounts to private and public enterprises; grants to foreign governments, international organisations, and other government units; and social security, social assistance benefits and employer social benefits in cash and in kind). Inflation rate is the GDP deflator annual percentage, while interest rate is the treasury bill rate.

3.4.2 Time Series Properties of the Data

This section discusses the time series properties of the data used in this study. We proceed to test for unit roots in the series using the conventional ADF and PP unit root tests. The ADF and PP reject the hypothesis of no unit root in levels for the series at the conventional 5% level of significance. However, both tests confirm that the series are stationary at first difference. As the test for stationarity indicates the existence of unit root in all the series, the Johansen cointegration

test is carried out. The Johansen cointegration test shows there exist a cointegration relationship between the fiscal variables for the benchmark model.

To obtain more efficient estimates when there exists a cointegration relationship, we should specify a vector error correction model (VECM). However, we specify a VAR in levels,¹⁰ since it offers also a consistent estimate of the VAR coefficients and the impulse response function. Sims, Stock and Watson (1990), among others, argue against differencing a series, claiming that the aim of a VAR analysis is to determine the interrelationships among the variables (impulse response) rather than determining the parameter estimates. Using first differencing when the variables are cointegrated throws away the information inherent in the cointegration relationship. This, in turn, leads to a misspecification error, making inferences invalid (Enders, 2008). With these arguments in mind, and for our results to be comparable to the existing literature, we follow Mountford and Uhlig (2009), Christiano, Eichenbaum and Evans (1999) Blanchard and Perotti (2002) and Tenhofen, Wolff and Heppke-Falk (2010) among others and specify the VAR in levels, ignoring unit root since our goal is to determine the relationships among variables and not parameter estimates.

3.4.3 VAR Diagnostic Tests

In the VAR specification, it is important to obtain the optimal lag length to have a true forecast. Braun and Mittnik (1993) show that if the true lag from the VAR estimate is not selected, the output gives poor estimates and misleading inferences as the impulse response and variance decomposition result are unreliable. Lütkepohl (2005) indicates that overfitting (selecting a higher order lag length than the true lag length) causes an increase in the mean-square forecast errors of

¹⁰ See Enders (2008) for detail on this argument.

the VAR and that underfitting the lag length often generates autocorrelated errors. Hafer and Sheehan (1989) find that the accuracy of forecasts from VAR models varies substantially for alternative lag lengths. Table 3.2 below shows the optimal lag selected by the different criteria.

Table 3.2. Lag Order Selection Criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-289.4441	NA	6.38e-05	4.529910	4.640200	4.574724
1	599.8719	1696.541	1.07e-10	-8.767260	-8.105521	-8.498373
2	853.5483	464.4231	3.18e-12	-12.28536	-11.07217	-11.79240
3	1041.061	328.8690	2.62e-13	-14.78556	-13.02092	-14.06853
4	1132.771	153.7902	9.48e-14	-15.81186	-13.49578	-14.87076
5	1169.219	58.31592	8.05e-14	-15.98798	-13.12044*	-14.82280
6	1210.181	62.38972	6.42e-14	-16.23356*	-12.81458	-14.84431
7	1253.291	62.34258	5.00e-14	-16.51216	-12.54173	-14.89884
8	1302.459	67.32330	3.58e-14*	-16.88399	-12.36211	-15.04660
9	1353.150	65.50836	2.53e-14	-17.27924	-12.20591	-15.21777
10	1414.956*	75.11818*	1.53e-14	-17.84548	-12.22071	-15.55995*

* 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

The criteria often selected as the optimal lag length in VAR are the Akaike information criterion (AIC) and the Schwarz information criterion (SC). However, Ozcicek and Mcmillin (1999) have shown that for the short-lag models, the SIC slightly outperform the AIC, but the difference is small. For the longer-lag models, the AIC-specified lag length almost always forecasts better than the other criteria, especially the SC. When the sample size is small (60 observations and below), AIC and FPE perform better and should be chosen over the other criteria.

However, in larger sample sizes (above 60 observation), AIC and FPE perform poorly compared to SC (Liew, 2004). As shown in Table 3.2, the SC suggests five lags, while the AIC suggests six. I choose five lags as the optimal lag length.

I proceed next to test for the stability of the VAR model. If a VAR model is unstable, the results from forecasting with will unreliable. Also, the shocks to variable in the system will explode and will not die out.

Figure 3.1 VAR Stability Graph

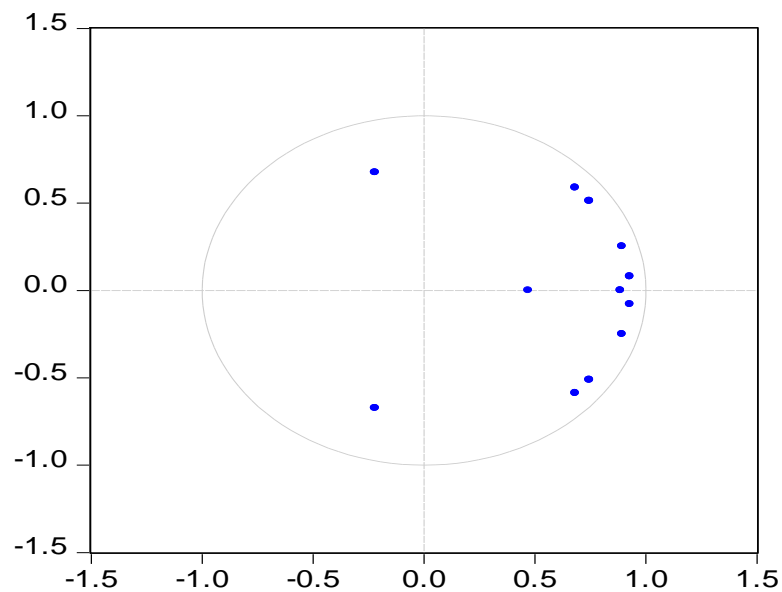


Figure 3.1 above shows the results of the root polynomial graph for the VAR model. The model is stable if no root lies outside or on the circle. As shown in Figure 3.1, no roots lie outside or on the circle. This means that the VAR model satisfy the stability condition. Next, I test for autocorrelation in the VAR residual and the result is presented in Table 3.3

Table 3.3 VAR Residual Serial Correlation LM Test

Lag	LM statistic	df	Prob.
1	53.46008	25	0.0008
2	47.52267	25	0.0043
3	53.33356	25	0.0008
4	110.5833	25	0.0000
5	29.00364	25	0.2638
6	32.47384	25	0.1448

Null hypothesis: No serial correlation at lag h

The Langrange Multiplier (LM) test statistic shows that the model suffers from autorrelation from lag 1 to lag 4. At lag 1, 2, 3 and 4, the LM test statistics are 53.46, 47.52, 53.33 and 110.58 with corresponding probability values of 0.008, 0.043, 0.008 and 0.000. I can reject the null hypothesis of no autocorrelation. However, at lag 5 and 6 the LM test statistic are 29.00 and 32.47 with corresponding probability values of 0.263 and 0.145. I therefore fail to reject the null hypothesis of no autocorrelation at both lag 5 and 6. The autocorrelation test give credence to the optimal lag length criterion test obtained earlier. The optimal lag length chosen was 5 and the autocorrelation test shows that at lag 5, I cannot reject the null hypothesis of no autocorrelation.

3.5 Empirical Results

This section presents the forecast error of variance decomposition, impulse response functions and the output multiplier to the respective fiscal shocks. The impulse responses are reported for 16 quarters which gives a forecast for four years and one standard deviation confidence bands attained by Monte Carlo integration approach with replications set at 100.

3.5.1 Variance Decomposition of Forecast Errors

Table 3.4 shows the results of the forecast errors and variance decomposition for the benchmark model. In both approaches, after 16 quarters the forecast error of government spending G_t is explained by itself above 65%, inflation π_t is 19% and 22% for each approach respectively, and taxes are at least 6%. Output and interest rate do not explain significant shares. More than 40% of the forecast error in net taxes, τ_t is explained by itself under both identification strategies (42.23% and 41.14% respectively). Government spending explains 37.68% and 30.03%, inflation explains 10.39% and 11.91%, output explains 9.34% and 8.22%, and interest rates explain 0.34% and 8.70% respectively. The moderate inflation and interest rates could be due to the fact that an increase in taxes reduces inflationary pressure because an increase in tax reduces output, leading to downward pressure on inflation and interest rate.

Above 40% of the variations in output Y_t is explained by shock to government spending (45.52% and 44.18% respectively) whereas shock to output itself explains 34.96% and 33.40% in each approach.

Table 3.4. Variance Decomposition in the Baseline VAR: Recursive Approach (RA) and Blanchard-Perotti Approach (BP)

		G_t		Y_t		π_t		τ_t		r_t	
		RA	BP	RA	BP	RA	BP	RA	BP	RA	BP
G_t	4	93.58	92.62	2.18	1.82	0.36	0.31	3.24	3.34	0.64	1.91
	8	83.44	83.02	3.07	2.19	5.57	6.01	7.17	7.06	0.75	1.92
	12	75.27	73.54	2.48	2.20	12.76	16.04	6.93	6.81	2.56	1.41
	16	68.89	67.28	3.25	2.27	19.01	22.77	6.07	6.22	2.78	1.48
Y_t	4	0.78	0.40	96.71	95.89	0.07	0.22	2.36	1.96	0.08	1.53
	8	7.13	6.26	85.23	85.89	0.79	0.80	6.71	5.24	0.14	1.81
	12	36.55	36.62	52.76	52.73	1.34	4.14	4.61	3.70	4.74	2.81
	16	45.52	44.18	34.96	33.40	6.33	12.25	5.03	5.62	8.16	4.55
π_t	4	14.14	15.40	0.94	0.77	74.56	77.21	5.40	5.68	4.96	0.94
	8	14.53	16.93	9.24	6.90	66.38	69.72	4.98	5.50	4.87	0.94
	12	21.66	21.14	9.68	8.60	59.77	63.79	4.74	4.71	4.15	1.76
	16	22.12	20.51	11.99	12.57	57.06	59.55	5.12	5.64	3.71	1.71
τ_t	4	39.97	37.49	3.61	4.16	2.58	3.32	53.79	53.43	0.05	1.60
	8	29.78	28.48	8.06	11.86	5.94	6.92	55.98	51.29	0.24	1.45
	12	37.97	35.41	8.59	9.52	7.92	10.62	45.21	37.58	0.31	6.87
	16	37.68	30.03	9.34	8.22	10.39	11.91	42.23	41.14	0.34	8.70
r_t	4	0.63	4.77	0.07	9.80	4.37	1.26	1.41	0.68	93.51	83.49
	8	0.42	5.06	0.37	9.82	12.15	9.86	4.79	1.37	82.27	73.89
	12	1.94	6.66	0.40	7.82	20.10	12.66	8.50	9.68	69.06	63.18
	16	10.97	10.92	0.41	6.64	21.17	15.97	11.22	12.13	56.23	54.33

Inflation explains about 12% and net taxes about 5% respectively. The high variation of output explained by government spending shock could be due to the rising spending-to-GDP ratio until 2011 linked to the post-war reconstruction period¹¹ and the increase in public investment in roads, education and telecommunication infrastructure. More than 55% of the variations in inflation (57.06% and 59.55% respectively) is explained by shock to inflation itself. Government spending accounts for more than 20% (22.12% and 20.51% respectively), showing that government

¹¹ The eleven-year civil war officially ended in January 2002.

spending stimulates the economy by increasing output but at the cost of higher inflation. Above 50% of the variation in interest rate r_t is self-explanatory (56.23% and 54.33% respectively). Inflation accounts for more than 15% (21.17% and 15.97% respectively), whereas government spending accounts for about 10 % (10.97% and 10.92% respectively) of the variation in interest rate. The high share of inflation followed by an increase in interest rate could be owing to an increase in interest rate increasing the demand for government securities, which in turn increases government spending, putting an upward pressure on inflation.

3.5.2 The Fiscal Policy Shocks

In the recursive approach, since all elements of matrix A above the principal diagonal are restricted to zero, which means imposing zero restrictions on the contemporaneous effect of taxes on output and inflation, the size of the automatic stabiliser is freely estimated. In the Blanchard-Perotti approach, the size of the automatic stabiliser is predetermined since the elasticity of government revenue on output is estimated outside the VAR model and is used as an instrument in the VAR in estimating the fiscal shocks. Thus, this approach easily estimates the contemporaneous effect of revenue on output and inflation. The two approaches yield identical findings with respect to the impulse response functions. Similar conclusions were reached by Caldara and Kamps (2008) and Lozano and Rodríguez (2011), among other studies.

The results presented show the impulse response function for government spending and government revenue shocks in the baseline model $(g_t, y_t, \pi_t, \tau_t, r_t)$. To account for the effect of fiscal policy shocks on private consumption and private investment, as these variables constitute major disagreements in both theoretical and empirical literature, we estimate a six-variable VAR model $(g_t, z_t, y_t, \pi_t, \tau_t, r_t)$, where z_t is components of output – that is, private consumption or investment. z_t (private consumption or private investment) is ordered before output y_t on

justification that private consumption or investment contemporaneously react to government spending shocks. Since they are components of output, structural consumption and investment shocks are deemed to affect output within the quarter. Because of the identical impulse response in identification approaches, the results presented below for government spending and revenue shocks equivalently hold for both.

3.5.2.1 Government Spending Shocks

Figures 3.2 (recursive approach) and 3.3 (Blanchard-Perotti approach) show effect of one standard deviation shock to government spending on the endogenous variables in the system.

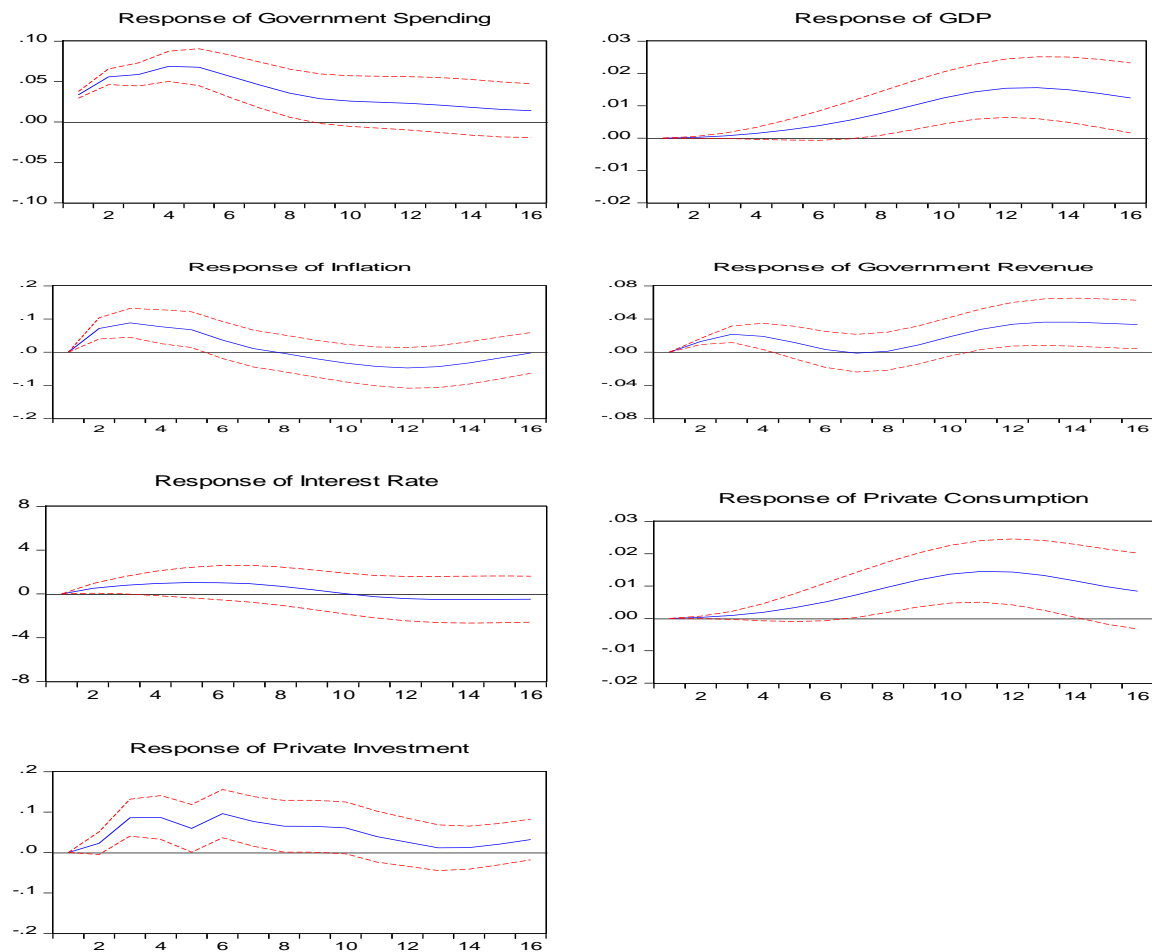


Figure 3.2. Responses to Government Spending Shocks – Recursive Approach

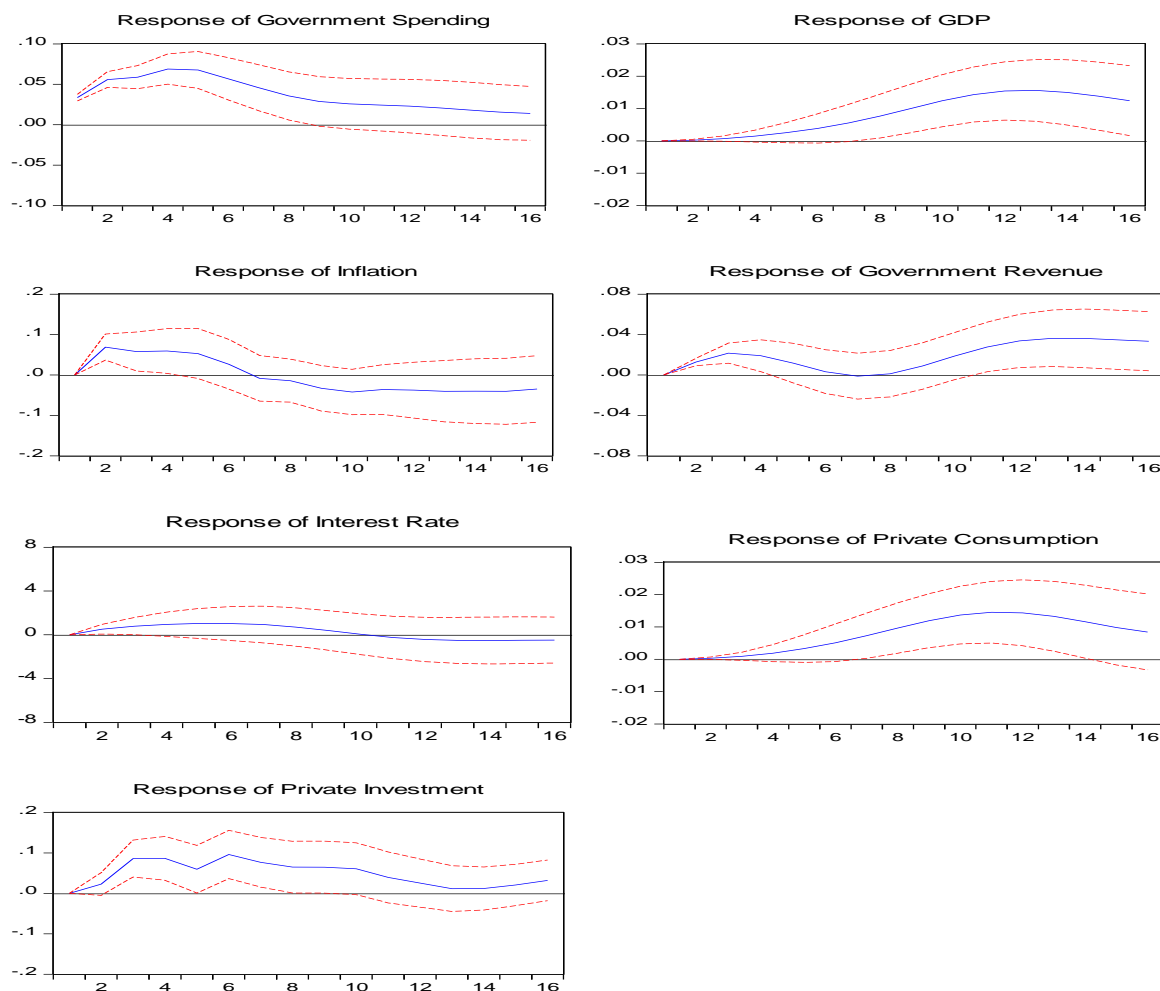


Figure 3.3. Responses to Government Spending Shocks – Blanchard-Perotti Approach

Output increased with a hump shape, attaining its peak at the end of the third year, with the shock on impact at about 0.07%. The effect became significant at the start of the second year and lasted throughout the horizon. Private consumption displays similar response as output, with a similar hump shape. The effect became significant at the start of the second year, reaching its peak at the end of the third year, after the shock on impact being at about 0.015%. The shock lasted throughout the horizon but became insignificant in the first half of the fourth year after the shock. These findings are in line with those reported by Blanchard and Perotti (2002), Fatás and Mihov (2001) and Galí, LópezSalido and Vallés (2007) among other studies.

Private investment rose with respect to government spending expansion, attaining its peak effect in the first year after the shock, which on impact was about 0.08%. The shock lasted throughout the period but fades out after the third year. The response of private investment to government spending expansion is in line with findings reported by Tenhofen, Wolff and Heppke-Falk (2010) and de Castro (2006). In the short-run, shocks to government spending had significant positive impact on output and its components (private investment and private consumption). More importantly, expansionary government spending significantly increases output and private consumption and the shock lasted throughout the horizon. These findings conform to the Keynesian prediction of expansionary government spending. These results are not surprising due to the fact that Sierra Leone has a large public sector in terms of job creation, investment and the provision of services. Households essentially rely more on government for jobs and the private sectors also depend on government for the award of contracts and the provision of essential services to boost the investment climate for example roads, electricity etc. The significant impacts of government spending on output and private consumption could be due to the spending plan of 2002 initiated by the government of Sierra Leone. The plan includes but not limited to increase government investment spending on infrastructure- a post-war development drive, increase job creation for ex-war combatants, building of technical and vocational institutions to train former child soldiers to acquire technical skills.

Government revenue increased in response to spending shock and attained its peak in the third year after the shock, which on impact was 0.035%. Similar findings were reported by Mountford and Uhlig (2009), De Castro (2006) etc. This short-run response of taxes to spending expansion could be due to the positive reaction of output to government spending shock as shown in the impulse response graph and/or the authorities' willingness to finance the increased spending needs by the

government- more specifically the increase in government spending in 2002 following the end of the eleven-year civil war. Inflation increased for the first two years after the spending shock. The peak effect was attained in the second quarter after the shock on impact was 0.07%. However, it fell after the seventh quarter and remained insignificant throughout the horizon while the shock lasted. Similar result was reported by De Castro (2006) for Spain. The effect of government spending on inflation is not surprising. This is due to the fact that Sierra Leone don't have an independent Central Bank neither and inflation targeting objective by the monetary authorities. Finally, interest rate rose for the first two years after the shock on impact was 1.2% and the peak effect was attained in the sixth quarter, a result similar to those reported by De Castro (2006) and Tenhofen, Wolff and Heppke-Falk (2010). It is worth noting that the identical impulses between these two approaches are of no surprise. In response to government spending shocks, the assumptions in both identification approaches are almost the same (compare the first row of matrix A in equations (3.3) and (3.15))

3.5.2.2 Government Revenue Shocks

Figures 3.4 (Recursive approach) and 3.5 (Blanchard-Perotti approach) show the impulse response for government revenue shock. Government spending fell in response to government revenue shock and the effect was only significant for one year. The peak effect was attained in the third quarter after the shock on impact was about 0.016%. The fall in government spending when revenue increased could be interpreted as 'deficit-reducing tax increase'. This finding could be due to the spending cut conditionality recommended by the IMF to the government of Sierra Leone. In 1984, the government of Sierra Leone, based on policy advice by the IMF, reduces its spending by cutting subsidies to rice importers, reducing the size of the public workforce especially in the civil service due to the rising deficits and deterioration in revenue collections. Output and Private

investment fell for two years in response to government revenue shocks, but the effect was only significant for the sixth quarter and died out after the second year. These findings are in line with results reported by Blanchard and Perotti (2002) and Mountford and Uhlig (2009). Private consumption and interest rate fell on impact but were not statistically significant.

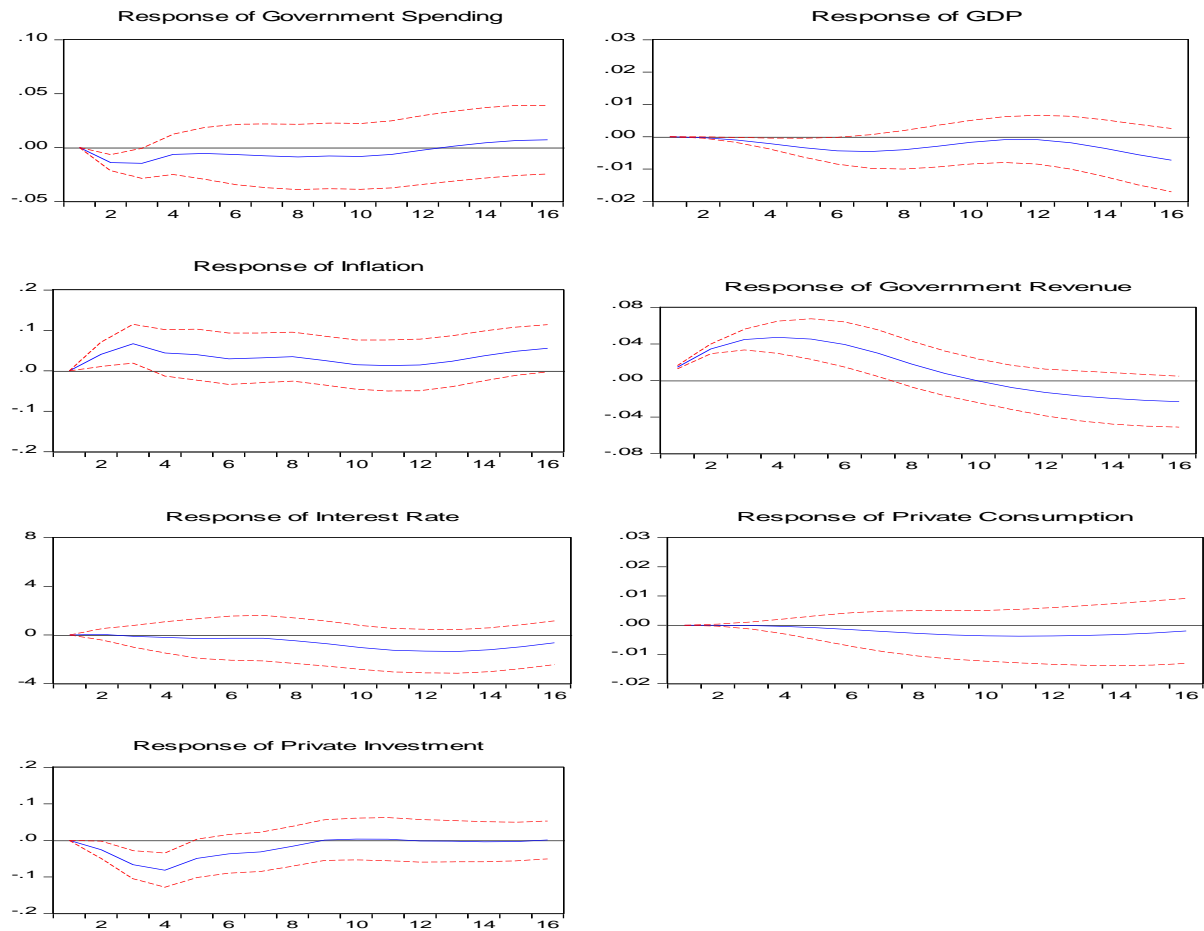


Figure 3.4. Responses to Government Revenue Shocks – Recursive Approach

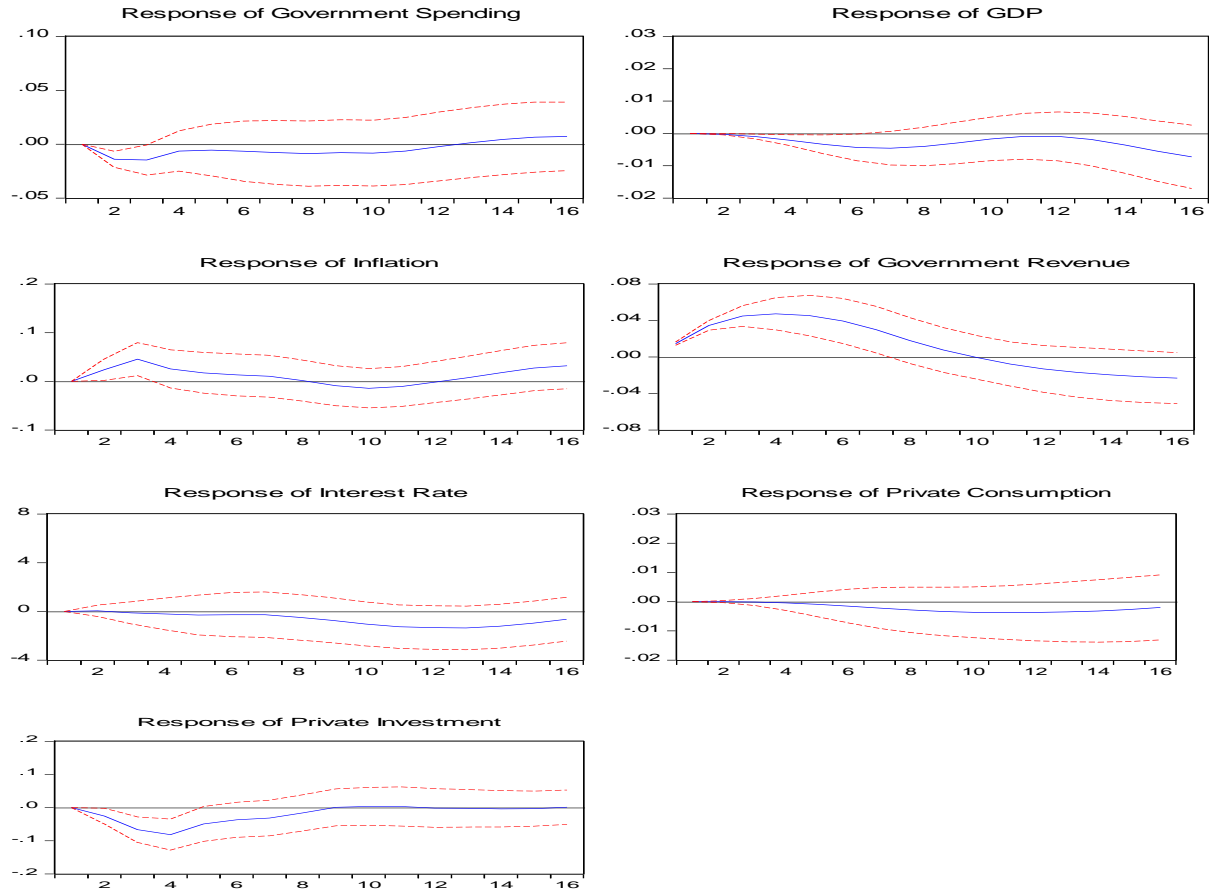


Figure 3.5. Responses to Government Revenue Shocks – Blanchard-Perotti Approach

Inflation rose to tax shocks and the peak effect of 0.06% was attained in the third quarter, while the shock lasted throughout the horizon. The response of inflation to tax shocks seems puzzling. A similar result is reported by Ravnik and Žilić (2011). Some plausible argument for this finding could be found in the supply-side perspective. An increase in taxes increases a firm's cost of production. The ultimate tax burden will then be transferred from firms to consumers in the form of indirect taxes. The end impact is higher prices of goods and services, hence higher inflation. Another argument could be that inflation is caused by other factors outside fiscal policy, such as imported inflation, output gap and monetary policy.

3.5.2.3. Responses to Shocks in Government Spending Components

We test for the response of output and its components to shock in government spending components – that is, government consumption and investment. The aim of the approach is two-fold. First, the disaggregation of government spending into components clearly depicts a broader picture on how the economy responds to the different categories of government spending at large. Second, it guides policymakers how to respond with the appropriate spending tool to smooth business cycle fluctuations, stimulus packages and economic recovery. We augment our baseline VAR here by replacing government spending with government consumption and government investment sequentially. The augmented VAR becomes $(k_t, z_t, y_t, \pi_t, \tau_t, r_t)$, where K_t is either government consumption or investment and Z_t is a component of output, i.e. private consumption or private investment.

3.5.2.4 Responses to Government Consumption Shock

Figure 3.6 shows the impulse responses of output and its components to shock in government consumption expenditure.

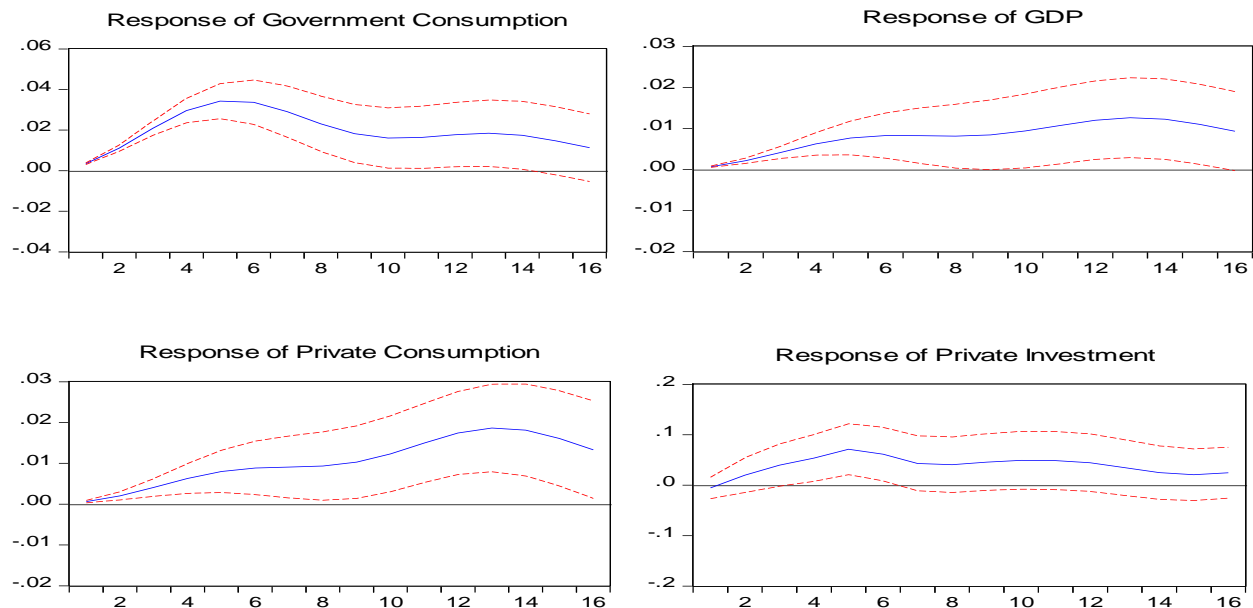


Figure 3.6. Responses to Government Consumption Shocks

Private consumption strongly increased with a hump shape and the shock was persistent throughout the horizon. The peak effect of 0.018 was attained in the fourteenth quarter and the effect was statistically significant while the shock lasted. Private investment moderately increased after the shock and fell gradually while the shock lasted throughout the period. The peak effect of 0.08% was reached in the sixth quarter and became insignificant after the second year. Output increased following the increase in its components. The shock was persistent, and it lasted throughout the horizons. The peak effect 0.008% was attained in the fourteenth quarter after the shock.

3.5.2.5 Responses to Government Investment Shock

Figure 3.7 presents the response of output and its components to shocks in government investment.

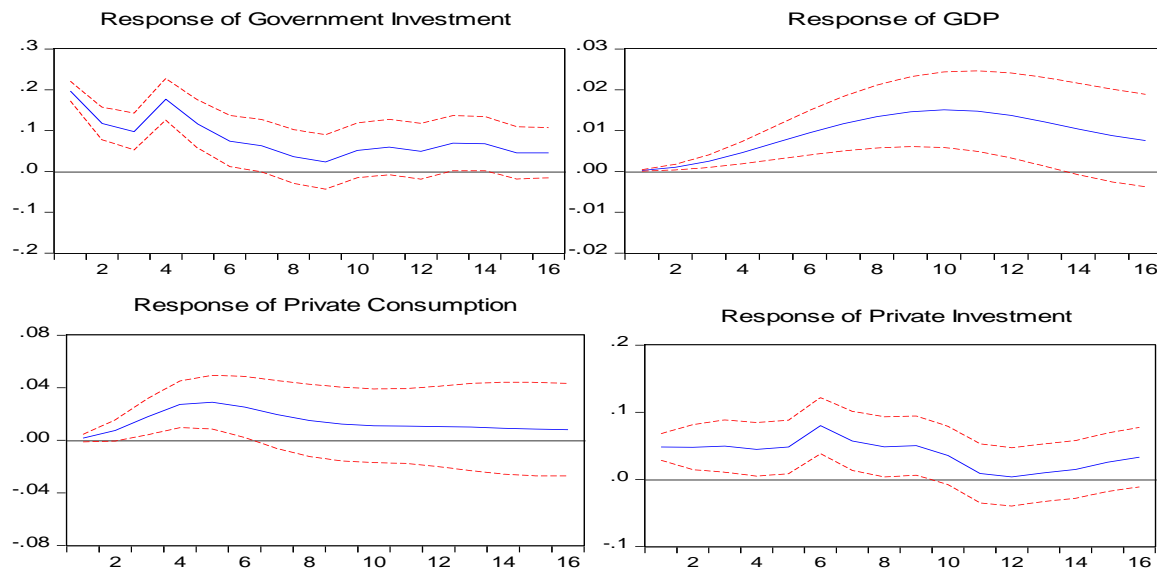


Figure 3.7. Responses to Government Investment Shocks

Private consumption strongly increased for the first two years and faded thereafter. The peak effect of 0.033% was attained in fourth quarter. Private investment also rose following the shock for three years, but the effect was significant only for ten quarters. The peak effect of 0.08% was reached in the seventh quarter. Output rose with a hump shape and the shock lasted throughout the periods but was significant for the first three years. The peak effect of 0.018% was reached in the tenth quarter. Though both spending components increased output and its components positively, the effect of government investment strongly stimulated output compared to government consumption. Thus, our results are in line with those reported by Baxter and King (1993), de Castro (2006), Giordano et al. (2007), Perotti (2005), Marcellino (2002) and Tenhofen, Wolff and Heppke-Falk (2010). The response of private investment to government investment could be based

on grounds that public investment in Sierra Leone comprises roads infrastructure, electricity and telecommunication engineering. Such investment attracts both domestic and foreign companies, which greatly impact output. Government investment strongly stimulated the economy in contrast with government consumption expenditures, shown by the size of the shocks on output. The above finding seems plausible for a small open economy characterised by large public-sector employment, small private sector and low savings.

3.5.2.6 Shocks to Government Revenue Components

This sub-heading displays how outputs and its components responded to the disaggregated components of government revenue. By doing so, it helps us to have a broader picture of how the economy responded to different tax policies. Indeed, the results indicate output and its components responded differently to direct and indirect taxes. Such analyses are useful for policy design and implementation and can guide policymakers as to which kind of tax policy is effective in stimulating growth. Output and its component responded to indirect and direct tax in the following manner.

3.5.2.7 Responses to Shocks in Direct Taxes

Figure 3.8 shows the response of output and its components to direct tax shocks. Output declined in response to shock in direct taxes for two and half years and the shock faded out thereafter. The peak effect of 0.003% was attained in the sixth quarter following the shock. Private investment fell throughout the period, but the effect was significant for only one year. Surprisingly, private consumption gradually increased after the first year following the shock, but the effect was not significant throughout. This finding is counter-intuitive as we expect private consumption to fall in response to an increase in direct taxes.

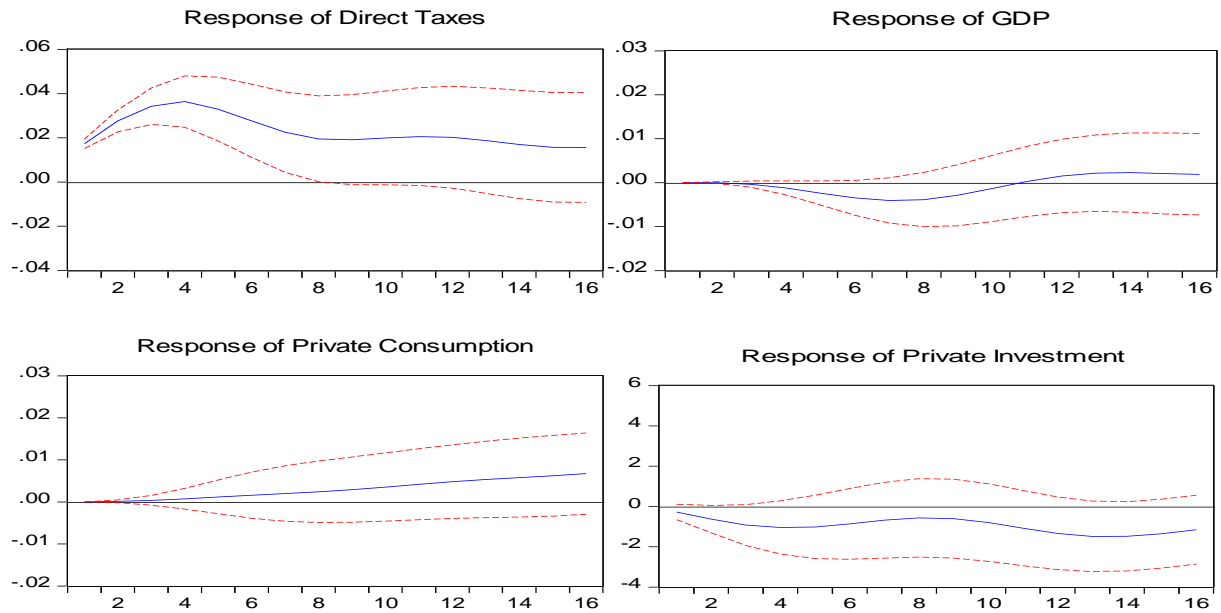


Figure 3.8. Responses to Direct Tax Shocks

3.5.2.8 Responses to Indirect Tax Shock

In Figure 3.9 we present the result of output and its components to shocks in indirect taxes. Private investment gradually increased to shock in indirect taxes while the shock lasted throughout the horizon. It was significant between the second and third year following the shock. The peak effect of 0.04% was attained in the second year. In the short run, private consumption did not respond to indirect tax shock, which could have been due to the delay of increased taxes to result in increased prices. In the second year and thereafter, private consumption increased to indirect tax shocks.

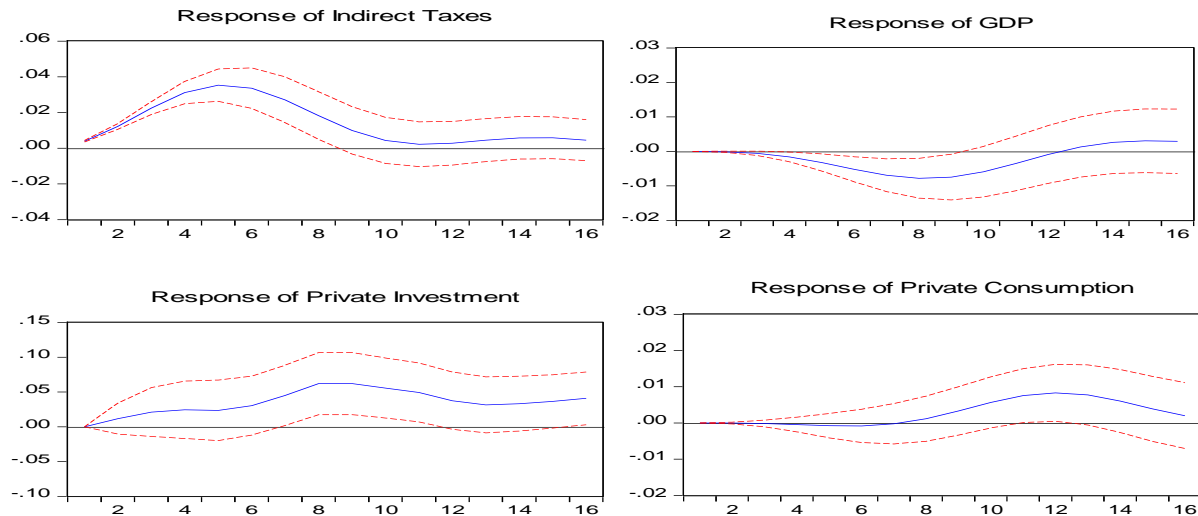


Figure 3.9. Responses to Indirect Tax Shocks

This result is also surprising. Output strongly fell in the first two-and-a-half years after the shock. The peak effect of 0.008% was attained in the second following the shocks while the shock gradually died out in the last year of the horizon. Comparing the two tax components, shock to direct taxes was less distortionary and the effect on output was much less compared to indirect taxes. Our results are similar to de Castro (2006) but contrast with Tenhofen, Wolff and Heppke-Falk (2010) and Lozano and Rodríguez (2011), among other studies.

3.5.2.9 Further Discussions of Results

In the short-run, shocks to government spending had significant impact on output and its components. Output and private consumption rose with a hump shape and in line with the Keynesian prediction of expansionary government spending. These results are not surprising due to the fact that Sierra Leone have large public sector in terms of job creation. The significant impacts of government spending on output and private consumption could be due to the increased spending plan of 2002 initiated by the government of Sierra Leone. The plan includes but not limited to increase government investment spending on infrastructure- a post-war development drive, increase job creation for ex-war combatant, building of technical and vocation institution to train former child soldiers to acquire technical skills, building and rehabilitations of schools in the war affected areas, recruit more teachers for primary and secondary schools etc. Again, private investment increase in response to expansionary government spending. This result is also in line with Keynesian wisdom. The economy of Sierra Leone is characterised by thin private sector constrained by credits and/or capital to undertake huge investments. Private sectors also depend on government for the award for contracts and the provision of essential services to boost the investment climate for example roads, electricity etc. Expansionary government spending produces an inflationary effect. This can be due to the fact that Sierra Leone don't have an independent, inflation-targeting central bank. Moreover, the monetary authorities are willing to accommodate the spending drive by the government such debt monetisation. Government revenue increases to spending expansion. This short-run response of taxes to spending expansion could be due to positive reaction of output to government spending shock and/or the authorities' willingness to finance the increased spending needs by the government.

Tax shocks reduced output and private investment significantly. However, the shocks to output were persistent and significant for only two years, whereas the shocks to private investment were temporary. Inflation increased due to an increase in taxes. Some plausible argument for this finding could be found in the supply-side perspective. An increase in taxes increases a firm's cost of production. The ultimate tax burden will then be transferred from firms to consumers in the form of indirect taxes. The end impact is higher prices of goods and services, hence higher inflation. Another argument could be that inflation is caused by other factors outside fiscal policy, such as imported inflation, output gap and monetary policy. With regards to the components of government spending (government consumption and government investment), both spending components increased output and its components significantly. However, the effect of government investment strongly stimulated output compared to government consumption as shown by the size of the shocks on output. Comparing the two tax components, shock to direct taxes was less distortionary and the effect on output was much less compared to indirect taxes. The above findings seem plausible for a small open economy characterised by large public-sector employment, small private sector and low savings.

3.5.2.10 Comparing the Results to the Existing Literature

The result presented in this paper are in line with studies in the existing literature that provide evidence of short-run effects of fiscal policy surprises. Expansionary government spending persistently increased output and private consumption with strong significant effects, as reported by Blanchard and Perotti (2002), Fatás and Mihov (2001) and Galí, LópezSalido and Vallés (2007) among others. Government spending expansion persistently crowded-in private investment in line with findings by Tenhofen, Wolff and Heppke-Falk (2010) and de Castro (2006). Government

spending shock increased government revenue, which is in line with Blanchard and Perotti (2002) but in contrast with Mountford and Uhlig (2009).

Also, government spending expansion is inflationary, and this finding is in line with De Castro (2006) for Spain. Finally, interest rate rises to shock in government spending, a result similar to those reported by De Castro (2006) and Tenhofen, Wolff and Heppke-Falk (2010). Shocks to government revenue temporarily reduced output and investment in line with results reported by Blanchard and Perotti (2002) and Mountford and Uhlig (2009). Inflation rose to tax shocks and in line with by Ravnik and Žilić (2011). Government investment expenditure strongly stimulated the economy when compared to government consumption expenditures. Thus, our results are in line with those reported by Baxter and King (1993), de Castro (2006), Giordano et al. (2007), Perotti (2005) and Tenhofen, Wolff and Heppke-Falk (2010). Shocks to indirect taxes are be more distortionary than direct taxes. Our results are similar to de Castro (2006) but contrast with Tenhofen, Wolff and Heppke-Falk (2010) and Lozano and Rodríguez (2011), among other studies.

3.6 Conclusion

This chapter presents an empirical evidence on the effects of surprise fiscal policy shocks on the Sierra Leone economy in the context of VAR. Short-run government spending expansion persistently increases private consumption and output. Private investment consistently crowds-in spending expansion, exhibiting a link between investment and economic activity and thus suggesting the existence of the acceleration hypothesis of investment in Sierra Leone. The empirics of this paper will serve as a useful benchmark reference for policy and academic discussions in the context of analysing the short-run impacts of discretionary fiscal policy surprises in Sierra Leone. Based on the findings, it can be concluded for policy recommendations that fiscal policy has proven to be a potent tool for smoothing fluctuations in economic activity in Sierra Leone. Two implications are inferred from this conclusion: (i) government spending expansion persistently increases output and its component, (ii) while tax increase significantly affects output and private investment – however, it fails to significantly affect private consumption, which is the largest components of aggregate demand. Spending cuts seem plausible in achieving fiscal consolidation compared with tax increase. The results indicate fiscal policy can indeed stabilise short-run fluctuations and further characterises the dynamic response of macroeconomic variables fiscal shocks.

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CHAPTER FOUR

Fiscal Policy and Optimal Taxation: Tests for Tax Smoothing Hypothesis in Sierra Leone

4.1 Introduction

Is the budget imbalance in Sierra Leone consistent with optimal tax policy? Following the 2008 global financial crises, many developed and developing countries experienced a deterioration in their budgetary positions. Sierra Leone, like many developing countries, has a long history of running budget deficits and budget imbalance is a common phenomenon. However, no known studies have asked whether this situation is consistent with optimal tax policy. The purpose of this chapter is therefore to empirically test whether the fiscal behaviour in Sierra Leone is consistent with optimal tax policy theory in the context of Barro's (1979) tax smoothing model.

The tax smoothing hypothesis formulated by Barro (1979) proposes that for tax policy to be optimal, the average tax rate should be smooth over time. The idea stems from the fact that tax collections are distortionary and to minimise the welfare cost (excess burden) of tax, collection should be spread over time. This optimal tax policy has the following implications: i) the issuance of public debt should respond positively to temporary increases in government spending and negatively to temporary increases in output; and ii) temporary changes in government spending and output should have no effect on tax rate. This last implication means that the tax rate should be unpredictable.

Following Barro's (1979) seminal work, many studies have examined the existence of the tax smoothing hypothesis both in developed and developing countries or groups of countries. The empirical literature can be broadly categorised into two strands. The first group examines the random walk behaviour and whether tax rate is unpredictable by its own lagged value or lagged

values of other variables, for example as demonstrated in Barro (1981), Kingston (1984), Kingston and Layton (1986), Kingston (1991) and Strazicich (1996, 1997, 2002) among others. The second category examines the relationship between budget balance and government expenditure. The idea here is that during bad times, the government is expected to run a deficit either through an increase in spending or a cut in tax, and in a period of good times, the government should run a surplus. According to this approach, tax smoothing should be counter-cyclical in nature. Studies that adopt this approach included Huang and Lin (1993), Olekalns (1997) and Cashin, Haque and Olekalns (1999), among others.

Despite the large volume of literature, to the best of our knowledge no studies have examined whether Sierra Leone's fiscal policy is consistent with the tax smoothing hypothesis. Using the methodology in Barro (1979), this chapter contributes to the literature by providing recent empirical evidence on tax smoothing in Sierra Leone.

Using annual time series data for Sierra Leone from 1980-2016, three different empirical approaches are performed. First, we utilise a battery of unit root tests to examine the random walk property of the tax rate. The null hypothesis of non-stationarity of the tax rate cannot be rejected, which implies that the tax rate follows random walk and hence is consistent with the tax smoothing hypothesis.

Second, we examine whether changes in tax rate are predictable by its own lagged values by running a univariate regression. The result shows that tax rate is unpredictable as changes in tax rate cannot be determined by its lagged values. This finding also supports the existence of the tax smoothing hypothesis. Finally, a VAR model is employed to examine whether the tax rate can be predicted by its own lagged values together with changes in government spending rate and growth

rate of real GDP. Our results indicate that all the variables employed are found not to be significant in predicating the tax rate. Overall, the empirical estimation supports the existence of optimal tax policy in Sierra Leone over the sample period.

4.2 Theoretical Framework and Review of Previous Studies

The tax smoothing hypothesis formulated by Barro (1979) assumes that the present value borrowing constraint of the government, exogenously given non-interest government spending and the initial debt determine the time path of government tax revenue. According to the Ricardian equivalence hypothesis, for a given amount of government spending, if taxes were lump sum, then the alteration to taxes and public debt to balance the budget would create no significant effect on the economy. However, in the absence of lump-sum taxation, approximation of non-lump-sum tax is as economically effective in the context of this hypothesis. Nevertheless, the absence of non-lump-sum taxes comes with the effect of excess burden, also known as the welfare cost of taxation. This deadweight loss of taxation (Z) is positively related to tax receipt (T) and negatively to tax base (Y). Barro (1981) specifies the welfare cost of taxation Z as follows:

$$Z_t = F(T_t, Y_t) = T_t f(\tau_t) \quad (4.1)$$

where τ is the average tax rate $\left(\frac{T_t}{Y_t}\right)$.

According to Barro (1981), the government objective is to minimise the present value the welfare cost of taxation Z :

$$\sum_{t=1}^{\infty} (1+r)^{-t} f(\tau_t) T_t \quad (4.2)$$

subject to the government present value borrowing constraint:

$$\sum_{t=1}^{\infty} (1+r)^{-1}G_0^t + D_0 = \sum_{t=1}^{\infty} (1+r)^{-1}f(\tau_t)T_t \quad (4.3)$$

where G_0 is the non-interest government spending, D_0 is the initial public debt and r is the real interest rate paid on public debt.

The constrained optimisation problem in equations (4.2) and (4.3) requires the government to choose a tax rate at each period such that the present value of welfare cost of taxation is minimised with a given present value borrowing constraint. The necessary condition for the above optimisation problem requires that the marginal welfare loss of taxation should be the same for all periods due to simultaneity in revenues from taxation and welfare loss. In other words, the planned tax rate should be constant over time. However, in the presence of uncertainty, the expectation of the current tax rate should be equal to the observed tax rate in the previous period, which means that the tax rate should follow martingale or random walk (Barro, 1981).

If the expected tax rate is constant, it implies that the level of taxes in each period is determined by Y and G_0 to maintain the present value borrowing constraint. However, if Y is constant over time, the constancy in τ means a constant T also. In case G_0 is constant, we have a balanced budget from the intertemporal budget constraint $T_t = G_0^0 + rD_0$.¹² As such, the revenues from taxation are sufficient to meet interest payments on previous public debt and non-interest spending.

If Y and G_0 are growing at a constant rate such that $Y_t = Y_0(1 + \mu)$ and $G_0^t = G_0^0(1 + \gamma)$, a constant τ means that T is also growing at the same rate as Y . Given that μ and γ are the conditional

¹² In such scenario, the initial debt is not amortised.

expectations of growth rate of Y and G_0^0 , setting $\boldsymbol{\nu} < \boldsymbol{\mu} < r$, Barro (1981) derives the expected tax revenue at time zero as:

$$T_0 = \left(\frac{r - \mu}{1 + \mu} \right) \left[\frac{G_0^0(1 + \gamma)}{(r - \gamma)} D_0 \right] \quad (4.4)$$

Equation (4.4) implies that tax revenue is related positively to the growth rate of permanent non-interest spending and negatively related to the growth rate of permanent income.

In a situation where the time path of G^0 and Y temporarily depart from their trend growth by irregular (+ or -) factors ν and ζ respectively, one period ahead G^0 and Y are given by $G_t^0 = (1 + \nu)G_0^0(1 + \gamma)$ and $Y_t = (1 + \zeta)Y_t(1 + \mu)$. Equating $\boldsymbol{\nu} = \boldsymbol{\mu}$, implying that T and G^0 are growing at the same trend growth of Y and assuming two period cases, Barro (1981) arrives at:

$$T_1 = \alpha [(G_0^0(1 + \mu) + (r - \mu)D_0 + \nu G_0^0(1 + \mu) \beta +] \quad (4.5)$$

where

$$\alpha = \left[\frac{(1 + \zeta)}{(1 + \zeta) - \zeta((1 + \mu)/(1 + r))^n} \right]$$

$$\beta = 1 - [(1 + \mu)/(1 + r)]^k$$

Equation (4.5) $(G_0^0(1 + \mu))$ represents the permanent component of non-interest government spending, $(r - \mu)D_0$ is the interest payment net of output growth, $\nu G_0^0(1 + \mu)$ is the temporary non-interest government spending, α is the factor that accounts for the influence of transitory income, n gives the duration of transitory departure of Y and k represents the duration of the transitory departure of G^0 . From equation (4.5) the following implications emerge:

(i) There are no effects of purely transitory expenditure on current taxation (if $k \rightarrow 0$, $\beta=0$).

If actual government spending deviates from its trend for a long period (if $k \rightarrow \infty$, $\beta=1$ when $\mu < r$), it implies the transitory expenditure has a positive impact on current taxation.

(ii) If changes in income are purely transitory (if $n \rightarrow 0$), their effect on taxes is specified as $\alpha = (1+\zeta)$. If the transitory deviation has a long-lasting effect, (if $n \rightarrow \infty$), α approaches infinity. Current taxes are thus a decreasing function of the anticipated duration of transitory income.

According to Barro (1981), one way to test the above theoretical implications is to examine the constancy in the planned tax rate over time, in that the tax rate should be unpredictable as it reflects only new information on the time path of government spending, output and other variables. This observation led to the random walk tests on tax rate to investigate the tax smoothing hypothesis. Barro (1981) examines whether the United States government was carrying out an optimal tax policy by smoothing the distortionary effects of taxes. Barro (1981) uses average tax rate (tax revenue to GNP) as a proxy for marginal tax rate and finds that the tax rate follows a random walk. Additionally, he finds no predictive power for tax-rate changes from changes in government expenditure and growth of real output. As such, changes in tax rates were unpredictable upon arrival of new information. His findings are consistent with optimal tax smoothing hence an optimal tax policy.

Kingston (1984) tests for tax smoothing hypothesis in the United States using actual marginal tax rate from 1913-1975. He complements Barro's theory of tax smoothing by incorporating microeconomic foundations. His empirical results accept the hypothesis of random walk in tax collection costs, and the parallel hypothesis of tax rate is rejected. Trehan and Walsh (1990) adopt

a similar approach and test for evidence of tax smoothing in United States using annual data from 1890-1982. Their results provide evidence of tax smoothing. Strazicich (1997) examines tax smoothing behaviour by the sub-national governments of Canada and the United States. He finds that tax smoothing hypothesis is rejected for state government but cannot be rejected for provincial government. Horrigan (1986) uses annual United States data spanning from 1953-1978 and finds that the tax smoothing hypothesis is rejected.

Sahasakul (1986) uses the random walk hypothesis of tax rate τ to arrive at a relationship between the optimal tax rate and the permanent component of government expenditure rate. Sahasakul (1986) expresses the government budget constraint as:

$$D_t = (1 + r_t)D_{t-1} + G_t^0 - T_t \quad (4.6)$$

Dividing throughout by Y_t , Sahasakul (1986) arrives at:

$$d_t = (1 + r_t - \mu'_t)d_{t-1} + g_t^0 - \tau_t \quad (4.7)$$

where $d_t = D_t/Y_t$ is the debt income ratio, $g_t^0 = G_t^0/Y_t$ and μ'_t is the growth rate of output. Using the assumption of martingale together with the assumption of constant r and μ , Sahasakul arrives at the following equation for optimal tax rate τ at time t :

$$\tau_t = (r_t - \mu'_t)d_{t-1} + [(r_t - \mu'_t)/(1 + r_t - \mu'_t)] \sum_{i=0}^{\infty} E_t (1 + r_t - \mu'_t)^{-1} g_{t+i}^0 \quad (4.8)$$

Sahasakul (1986) defines the first term on the right-hand-side as the interest payment on public debt net of output growth and the second part as the future expectation or the permanent component of government expenditure. Sahasakul (1986) uses annual United States data to test for the tax

smoothing hypothesis by regressing marginal tax rate τ_t on permanent expenditure rate. In contrast to Barro (1981), he finds a significant response of tax rate to changes in permanent expenditure rate, which implies that tax rate is predictable, and that tax smoothing is rejected. In a similar vein, Jayawickrama and Abeysinghe (2013) test for tax smoothing behaviour by regressing tax rate on permanent expenditure rate.

They argue that for tax smoothing to hold, future tax rates should cointegrate with permanent expenditure rate even when tax rate and expenditure rate follow random walk. Jayawickrama and Abeysinghe (2013) propose the concept of weak and strong evidence of tax smoothing hypothesis depending on the degree of cointegration between tax rate and permanent expenditure rate. Using annual data spanning from 1954-2004 for Australia, Canada, Italy, Holland, the United Kingdom and the United States, they find evidence that tax smoothing holds for all these countries.

Recent studies have concentrated on alternative features of the tax smoothing hypothesis. Instead of testing for evidence of random walk in tax rate, some studies have tested for tax smoothing behaviour by investigating whether the budget balance (deficits/surplus) is informative about future changes in government spending. The government sets the budget balance for any period, equal to the presented discounted value of expected changes in government expenditure. The implication is that when expenditure is expected to rise, the government should run a surplus. Conversely, when expenditure is expected to fall, the government should borrow and run a deficit budget. Huang and Lin (1993), Ghosh (1995), Olekalns (1997) among others adopt Campbell's (1987) and Campbell and Shiller's (1987) VAR approach to explore and test all time-series implications of the tax smoothing hypothesis.

These authors start with one period, where the government budget constraint specified as:

$$D_{t+1} = (1 + r)D_t + G_t + \tau_t Y_t, \quad (4.9)$$

where D_t is the stock of real government debt, G_t is real government expenditure, τ_t is the average tax rate, Y_t is real output and r is the fixed real interest rate.

If output grows at a fixed rate equal n , equation (4.1) can be expressed as:

$$(1 + n) d_{t+1} = (1 + r) d_t + g_t + \tau_t \quad (4.10)$$

with the lowercase letters denoting the ratio of the respective variable to output. Since equation (4.10) holds for every period, taking expectation of it, solving for τ_t by recursive forward substitution gives the standard intertemporal budget constraint in expected terms:

$$\sum_{j=t}^{\infty} \left(\frac{1}{1+R}\right)^{j-t} E_t \tau_j = \sum_{j=t}^{\infty} \left(\frac{1}{1+R}\right)^{j-t} E_t g_j + (1+r)d_t + \lim_{j \rightarrow \infty} \left(\frac{1}{1+R}\right)^j E_t (1+n)d_{t+j} \quad (4.11)$$

If the transversality condition on debt is imposed, i.e., the government cannot ignore a debt which has a positive expected present value:

$$\lim_{j \rightarrow \infty} \left(\frac{1}{1+R}\right)^j E_t (1+n)d_{t+j} \quad (4.12)$$

gives

$$\sum_{j=t}^{\infty} \left(\frac{1}{1+R}\right)^{j-t} E_t \tau_j = \sum_{j=t}^{\infty} \left(\frac{1}{1+R}\right)^{j-t} E_t g_j + (1+r)d_t \quad (4.13)$$

where j is the index variable for time, $R = (r - n)/(1+n)$ is the effective net interest rate faced by government, and $E_t = E(\cdot | I_t)$ is the expectation operator, conditional on the government's

information set at time t , I_t . Equation (4.13) implies that the net present value of expected tax rate must be equal to the sum of the net presented value of expected government expenditure plus the initial debt.

When the government levies taxes, it is assumed that distortionary cost is imposed, such as collection cost and deadweight loss, which are incurred when individuals substitute market work. The government's aim is to minimise the welfare losses that occur due to the choice of the tax rate. These costs are assumed to be proportional to the square root of tax rate. Following Barro (1979) and Ghosh (1995), the government's objective function is to maximise:

$$V = -\left(\frac{1}{2}\right) \sum_{j=t}^{\infty} \beta^{j-t} E_t \tau_j^2, \quad 0 < \beta < 1 \quad (4.14)$$

where β is the government's subjective discount rate. The objective here is to maximise equation (4.14) subject to equations (4.10) and (4.12). Assuming $\beta = 1/(1+R)$, the Euler equation implies that for any $j > t$:

$$E_t \tau_t = \tau_t \quad (4.15)$$

Equation (4.5) implies that the tax rate follows a random walk. This is the first basic implication of the tax smoothing hypothesis, which has been tested in several empirical studies, for example Barro (1981) and Sahasakul (1986). Substituting equation (4.15) into (4.12), the tax smoothing hypothesis can be written as:

$$\tau_t = (r - n)d_t + \frac{R}{1 + R} \sum_{j=t}^{\infty} \left(\frac{1}{1 + R}\right)^{j-t} E_t g_j \quad (4.16)$$

Equation (4.16) means optimal fiscal policy implies that the tax rate should constantly be set equal to the annuity value of the sum of government debt and the present discounted value of expected government expenditure.

Thus, the right-hand side of equation (4.16) is the constant flow of government expenditure that is anticipated to be sustained for the rest of the government's time horizon – that is, it is the permanent government expenditure. Optimal fiscal policy would mean that the tax rate should always be set equal the permanent government expenditure.

If we define budget balance as:

$$bal_t = (1 + n)(d_t - d_{t-1}) \quad (4.17)$$

the dynamic government budget constraint can be written as:

$$bal_t = \tau_t - (g_t + (r - n)d_t) = \tau_t + g_t^{TOT}, \quad (4.18)$$

where g_t^{TOT} is the total government expenditure, i.e., the sum of current expenditure g_t , and the effective interest payment on government debt $(r - n)d_t$.

After substituting equation (4.16) into (4.18), the tax smoothing hypothesis can be restated as:

$$bal_t = \sum_{j=t+1}^{\infty} \left(\frac{1}{1 + R} \right)^{j-t} E_t \Delta g_t^{TOT} \quad (4.19)$$

Equation (4.19) implies that for the tax smoothing hypothesis to hold, optimal fiscal policy requires that the budget balance for any period always be set equal to the presented discounted value of expected changes in government expenditure. In effect, when expenditure is expected to rise, the government should run a surplus. Conversely, when expenditure is expected to fall, the government should borrow and run a deficit budget.

Thus, a temporary positive shock to expenditure means a deficit budget, whereas a permanent shock to expenditure means no change in the budget balance as the tax rate is fully adjusted to the permanent shock. The behaviour of a tax smoothing government facing an exogenous expenditure is equivalent to the actions of a consumer who desires to smooth consumption over time when labour income is stochastic (Hall, 1978).

Huang and Lin (1993) test for optimal tax policy in the United States between 1929-1988. They find no evidence of tax smoothing behaviour. In accounting for structural breaks, evidence of tax smoothing is not rejected for post 1947. Ghosh (1995) tests for tax smoothing in the United States and Canada in the context of VAR. By using annual data from 1961-1988, he finds that the tax smoothing model is successful in explaining the behaviour of the federal government deficits for both countries. Olekalns (1997) finds the Australia budget surplus to be too volatile to be fully consistent with optimal tax behaviour during the sample period of 1964-1995.

Crosby and Olekalns (1998) test for tax smoothing behaviour in Australia, the United Kingdom and the United States and find that tax smoothing behaviour exists only for the United States. Serletis and Schorn (1999) test for tax and revenue smoothing for the United States, United Kingdom, Canada and France. They employ a tri-variate VAR and their results shows that tax and inflation smoothing hold, but revenue smoothing is rejected.

The literature on developing countries is relatively thin compared to that on developed countries. Only a few studies have investigated tax smoothing hypothesis in developing countries. For example, Cashin, Olekalns and Sahay (1998) apply Barro's tax smoothing model to India data spanning from 1951-1997. They find evidence of tax smoothing behaviour in the central

government, but the tax behaviour of state government is inconsistent with the tax smoothing hypothesis.

Cashin, Haque and Olekalns (1999) test for tax smoothing in Pakistan and Sri Lanka from 1956-1997 respectively. They find that tax smoothing hypothesis holds for Pakistan but does not hold for Sri Lanka. As such, the deficit behaviour of Pakistan is consistent with the tax smoothing hypothesis while Sri Lanka deficit behaviour is inconsistent with the hypothesis. Cashin, Haque and Olekalns (2003) then test for optimal taxation in Pakistan for the period 1956-1995. Their results suggest that Pakistan's fiscal policy is optimal and consistent with tax smoothing behaviour, but the stock of public liabilities is on an unsustainable trajectory. Rocha (2001) investigates whether Brazil smoothed tax for the period 1970-1994. The results reject the tax smoothing hypothesis. Rocha (2001) suggests that the performance of public debt may be explained from the standpoint of political economy rather than the idea of tax smoothing.

Using Chilean data spanning from 1972-2003, Pasten and Cover (2011) find strong evidence for the tax smoothing hypothesis when royalties from the copper industry were not under government regulations. On the other hand, weak evidence of tax smoothing hypothesis exists when royalties from the copper industry were regulated by government. Kurniawan (2011) uses Indonesia data spanning from 1970-2010. He tests for tax smoothing behaviour in the context of Barro's (1981) model and finds evidence of optimal fiscal policy, which means that Indonesia fiscal policy is consistent with tax smoothing hypothesis. Ashworth and Evans (1998) examine the existence of seigniorage and tax smoothing in a sample of 32 developing countries. They find that tax smoothing has not been significant elements in determining the behaviour of seigniorage. Talvi and Vegh (2000) examine the fiscal behaviour of 56 countries using annual data spanning from

1970-1994. They find that the fiscal policies in G-7 follow tax smoothing behaviour while developing countries are highly pro-cyclical.

The empirical literature on tax smoothing theory has been characterised with mixed findings. These differences could be due to the methodology applied, theoretical predictions and the choice of variables. I conclude this section by providing a brief summary on the empirical literature on tax smoothing theory in Table 4.1.

Table 4.1. Some Empirical Evidence on the Tax Smoothing Hypothesis

Author(s) and Date	Data Frequency	Period and Country	Major Variables	Tests	Does Tax Smoothing Hypothesis Hold?
Barro (1979)	Annual	1922-1976 US	Debt to Income Ratio, Inflation, Government Expenditure	OLS	Yes
Barro (1981)	Annual	1879-1979 US	Government expenditure, Aggregate output (GNP), Total Taxes	OLS	Yes
Barro (1986)	Annual	1916-1982 US	GNP, CPI and Government Spending	Maximum Likelihood, Unit root tests	Yes
Sahasakul (1986)	Annual	1837-1982 US	Permanent government spending, Initial	OLS	No

			public debt, Defence purchase, Marginal tax rate		
Horrigan (1986)	Quarterly	1953:2- 1978:4 US	Inflation, GNP, Federal expenditures, Public debt	OLS	Yes
Trehan and Walsh (1988)	Annual	1890-1982 US	Government expenditures, Total taxes	Unit root tests	No
Bohn (1990)	Quarterly	1954-1987 US	GNP, Inflation, M1, Military spending, Stock returns	Bivariate Vector Autoregression	Yes
Haung and Lin (1993)	Annual	1929-1988 1947:1988 US	Tax rate, Government expenditure rate, Budget balance, Aggregate output	Unit root tests, Vector autoregression	Yes after 1947 and No for full sample
Ghosh (1995)	Annual	1961-1988 US and Canada	Tax rate, Government expenditure rate, Budget balance	Unit root tests, VAR	Yes, for both countries
Strazicich (1996)	Annual	1963-1989	Tax rate, Government	Panel Unit root tests	No for state government and Yes for

		1961-1989 Canadian Provinces	spending rate, output		provincial government
Olekalns (1997)	Annual	1964-1995 Australia	Tax rate, Government expenditure rate, Budget balance, Interest rate	Unit root tests, VAR	No
Ashworth and Evans (1998)	Annual	1951-1994 32 Developing Countries	Tax rate, Inflation rate, Velocity of money	Unit root tests, Cointegration	No
Roubuni (1998)	Annual	1960-1985 18 OECD countries	Net debt, Investment rate, Budget deficits, Current account-GDP ratio, Saving- GDP ratio	OLS	No for tax and revenue- smoothing
Cashin, Olekalns and Sahay (1998)	Annual	1951-1997 India Central and state government	Tax rate, Government expenditure rate, Budget balance	Unit root tests, VAR	Yes, for central government and No, for state government
Scott (1999)	Annual	1913-1989 US	Marginal tax rate, Average hours worked	Unit root tests	No

Serletis and Schorn (1999)	Quarterly	1950-1994 Canada, France, U.K, US	Tax rate, Inflation rate	Unit root tests, VAR, Cointegration	Yes
Cashin, Haque and Olekalns (1999)	Annual	1956-1995 1964-1997 Pakistan and Sri Lanka	Tax rate, Government expenditure rate, Budget balance	Unit root tests, VAR	Yes, for Pakistan and No, for Sri Lanka
Talvi and Vegh (2000)	Annual	1970-1994 56 countries	Real output, Real private and government consumption, Real total revenue	Correlation, OLS	Yes, for G- 7 and No, for developing countries
Malley and Philippopoulos (2000)	Annual	1960-1996 U.S, West Germany, Japan, U. K	Private and Government consumption, Private capital and Expenditure-to- output ratio	FIML estimator, Wald test	No for all countries
Rocha (2001)	Annual	1970-1994 Brazil	Tax rate, Government expenditure rate, Budget balance	Unit root tests, VAR	No
Ricciuti (2001)	Annual	1861-1998 1950-1998 Italy	Government revenue-to-GDP ratio, Total	Unit root tests, Granger- Causality	Yes

			budget outlay- to-GDP ratio, Seigniorage		
Alder (2002)	Annual	1952-1999 1970-1996 Sweden	Tax rate, Government expenditure rate, Budget balance	Unit root tests, VAR	Yes
Fisher and Kingston (2002)	Quarterly	1953-2001 U. S	Permanent income, Total revenues, Government Outlays	VAR, Granger- causality, Wald test	Yes
Strazicich (2002)	Annual	1955-1998 19 Industrial countries	Tax rate, Government Expenditure- Output ratio, Growth rate of real GDP, Political variable	Panel Unit root tests	Yes, for National government
Cashin, Haque and Olekalns (2003)	Annual	1956-1995 Pakistan	Tax rate, Government expenditure rate and Budget balance	Unit root tests, VAR	Yes
Chen (2003)	Annual	1972-1992 Panel of 87 countries	Per capita real GDP, Per capita government expenditure,	Fixed effects panel regression	Yes for developed countries and No,

			Debt-to-GDP ratio		developing countries
Ricciuti (2003)	Annual	1861-1998 Italy	Government revenue-to-GDP ratio, Total budget outlay-to-GDP ratio	Unit root tests, Granger-causality	Yes
Alder (2006)	Annual	1952-199 1970-1996 Sweden	Tax rate, Government expenditure rate, Budget balance	Unit root tests, VAR	Yes, from 1952-1999 and No, for 1970-1996
Kurniawan (2011)	Annual	1970-2010 Indonesia	Tax rate, Government expenditure rate, Growth rate of real GDP	Unit root tests, VAR	Yes
Abeyasinghe and Jayawickrama (2013)	Annual	1954-2004 Australia, Canada, Italy, Holland, U.K, U.S	Tax rate, Government expenditure rate, M1, CPI, unemployment rate	Unit root tests, Error correction	Yes, for all countries

4.3 Data and Methodology

4.3.1 Data

Data on tax revenue is sourced from the IMF's International Financial Statistics and the National Revenue Authority, Sierra Leone. Total government spending is the sum of government consumption expenditure and government investment, transfers and interest on public debt. This data was sourced from the World Development Indicators of World Bank together with growth rate of real GDP. Tax rate and government spending rate are arrived at dividing tax revenue and government spending by GDP. All variables are converted to real from their nominal values by using the GDP deflator.

4.3.2 Methodology

The methodology employed in this study to examine whether the tax smoothing hypothesis holds for Sierra Leone is the Barro's (1979) tax smoothing approach. The first empirical procedure tests whether tax rate follows a random walk as this is the necessary condition for tax smoothing. Second, we examine whether tax rate changes are unpredictable, i.e. if changes in tax rate can be predicted by its own lagged values or lagged values of other variables. This approach is better suited to test for the tax smoothing hypothesis in developing countries like Sierra Leone for two main reasons. First, unlike the methodology in Ghosh (1995) and others that require interest rate on government debt that is unavailable for Sierra Leone and many other countries, this approach utilises the total government spending for which data is available for longer period. Second, the empirical procedure that is used in construction of the interest rate on government borrowing in Olekalns (1997) as well as other studies may not give the true value of the interest rate on government debt, which is likely to affect the empirical results.

To carry out the empirical analyses on tax smoothing theory, I test for both random walk in tax rate and the predictability of changes in Tax rate. To examine the random walk implication of tax smoothing this chapter employ battery of tests to the tax rate τ_t . If the null hypothesis of random walk is rejected, then tax smoothing is rejected.

Second, a univariate autoregression is adapted to test whether changes in tax rate can be predicted by its own lagged values. Tax smoothing theory suggest that changes in tax rate should be unpredictable by its past value. This hypothesis is tested by regressing tax rate by its own lagged and if the coefficients of the lagged values of tax rate are significant it implies that changes in tax rate is predictable which implies tax smoothing theory is not observed.

Finally, a tri-variate VAR model is employed to examine if changes in tax rate can be predicted by changes in government spending rate and growth rate of real GDP. Tax smoothing theory also suggest that changes in tax rate should be unpredictable even upon the arrival of new information. This means that tax rates should be unpredictable by its own lagged values, lagged values of government spending, and lagged values of growth rate of GDP.

In a system of equations to test whether lagged values of a particular variables together with lagged values of other variables are better conducted in the context of VAR framework. The empirical literature has tested this hypothesis differently. While earlier studies employ OLS such as Barro (1981), Sahasakul (1986), Horrigan (1986) etc, more recent studies have tested this hypothesis in the context of VAR for example Olekalns (1997), Kurniawan (2011) and Karakas, Taner and Yanikkaya (2014) etc. I adopted the VAR framework to examine the tax smoothing theory in Sierra Leone as it is better suited for such an analysis.

I test for tax smoothing theory by first examining the random walk behaviour of tax rate. Battery of unit root tests are employed and are summarised as follows:

4.3.2.1 The Augmented Dickey-Fuller Test

Following the pioneering work by Dickey and Fuller (1979) many studies have employed these tools in empirical macroeconomics after it was popularised by Nelson and Plosser (1982). The standard ADF test is specified as:

$$\Delta Y_t = \alpha_0 + \alpha_1 t + \delta Y_{t-1} + \sum_{j=1}^L \beta_j \Delta Y_{t-j} + \epsilon_t \quad (4.20)$$

Where α_0 is the constant, α_1 is the coefficient on the trend term t , ΔY_{t-1} is the first difference operator to control for serial correlation in the error term, and from the estimation of δ the ‘tau’ statistic is obtained and compared to relevant critical values. The null hypothesis is that δ is zero, i.e. there is a unit root. We reject this hypothesis when the computed statistic is more than the conventional critical values. The assumption for the validity of the original Dickey-Fuller test is that the residuals in the regression are not serially correlated. If they are, the aim of the ADF is to add lags to the dependent variable in the above equation until the serial correlation is overcome.

4.3.2.2 Dickey-Fuller Generalised Least Square Test

DF-GLS proposed by Elliot, Rothenberg, and Stock (1996) is akin to the ADF test, except that the series is transformed via a GLS detrending regression before performing the test. The detrended data is defined as:

$$\Delta Y_t^d = Y_t - \hat{\beta}'_{\hat{\varphi}} D_t \quad (4.21)$$

where $\hat{\beta}'_{\hat{\varphi}} = (D'_{\hat{\varphi}} D_{\hat{\varphi}})^{-1} D'_{\hat{\varphi}} y_{\varphi}$.

Using the GLS detrended data, estimates by least square for the ADF test regression without the deterministic term is given by:

$$\Delta Y_t^d = \pi Y_{t-1}^d + \sum_{j=1}^L \varphi_j \Delta Y_{t-j}^d + \epsilon_t \quad (4.22)$$

The null hypothesis is that π is zero. Elliot, Rothenberg and Stock (1996) have shown that this test has significantly greater ability than the previous versions of the ADF test. Just as the standard Dickey-Fuller test may be run with or without a trend term, there are two forms of DF-GLS: GLS detrending and GLS demeaning. With GLS detrending, the series is regressed on a constant and linear trend, and the residual series is used in a standard Dickey-Fuller regression. With GLS demeaning, only a constant appears in the first stage regression; the residual series is then used as the regressand in a Dickey-Fuller regression.

4.3.2.3 Phillips and Perron Test

To correct for the possible serial correlation and heteroscedasticity in the residuals of the Dickey-Fuller test, Phillips and Peron (1998) proposed an alternative unit root test. These authors use the Newey-West (Newey and West, 1987) heteroscedasticity and autocorrelation consistent covariance matrix estimator, a non-parametric correction of the Dickey-Fuller test in which allowance is made for possible heteroscedasticity and serial correlation in the residuals. The asymptotic distribution and the critical values for the PP test statistic are the same as in the ADF test. The PP test has a null hypothesis that the series is $I(1)$. However, the PP test was shown to exhibit an inferior small sample performance relative to the ADF test, and therefore should be used only as a complement to other approaches (see, for example, Schwert (1989), Campbell and Perron (1991), Agiakloglou and Newbold (1992), DeJong et al. (1992) and Liu and Praschnik (1993).

The test equation is specified as:

$$\Delta Y_t = \beta_0 + \beta_1 t + \rho Y_{t-1} + \epsilon_t \quad (4.23)$$

where β_0 is the constant, β_1 is the coefficient on the trend term t , and from the estimation of ρ the ‘tau’ statistic is obtained and compared to relevant critical values. The null hypothesis is that ρ is zero, i.e. there is a unit root. The rejection criteria of the PP test are the same as the ADF and DF-GLS.

4.3.2.4 Kwiatkowski, Phillips, Schmidt and Shin Test

In small samples, both ADF and PP tests suffer from low power when the coefficient of the trend term β is close to one. Moreover, misspecification vis-à-vis a trend or the numbers of lags that ensure that the test captures any short-term dynamics may affect the size of the test, which may result in the through null being rejected. As an alternative test, we perform the KPSS test to the fiscal series for robustness check. Unlike the ADF, DF-GLS and PP, this test has the opposite null hypothesis: that the series being tested have no unit root (stationary). Doing both ADF, DF-GLS and PP and KPSS tests guarantee robustness when the findings are not inconsistent at a given level of significance. The KPSS uses a similar autocorrelation correction to the PP test but in a parametric sense. The KPSS assumes that the observed time series is disintegrated into a deterministic trend, random walk and stationary error term.

The KPSS statistic is a LM statistic and is based on the residuals from the OLS regression of a time series in question on exogenous variable y_t :

$$\tau_t = \hat{y}'_{\hat{\tau}} \boldsymbol{\delta} + \epsilon_t$$

The associated KPSS LM test statistic is specified thus:

$$\text{KPSS} = \sum_{t=1}^T \frac{S_t^2}{T^2 f_0} \quad (4.24)$$

where

$$S_t = \sum_{s=1}^T \hat{\epsilon}_s$$

is a cumulative function based on the residuals, f_0 is an estimator of the residual spectrum at frequency zero, and T is the sample size.

4.3.2.5 Zivot-Andrews unit root test

As noted by Perron (1989, 1990), the standard unit root tests such as the ADF, DF-GSL, PP and KPSS tests fail to account for any possibility of structural breaks in time series data. Perron (1989, 1990) argues that the standard unit root tests could fail to reject the null hypothesis of non-stationarity because the power to reject non-stationarity decreases when the stationary alternative is true, and a structural break is ignored. To overcome such problem, Perron (1990) recommends allowing for structural breaks at a known date based on knowledge of the data.

However, it has been argued by Zivot and Andrews (1992) that by exogenously determining the break date could lead to an over rejection of the hypothesis of unit root in the series. Zivot and Andrews (1992) develop an alternative model that allows for an endogenous break in time series data, known as the Zivot-Andrews (ZA) unit root test.

There are at least two advantages when a researcher accounts for structural breaks in testing for unit root in the data (Glynn et al., 2007). First, it prevents obtaining results that are biased towards non-rejection of the hypothesis of unit root. Second, by endogenously determining when the break occurred, useful information may be obtained for analysing whether the break in the data corresponds to a government policy, political events, regime shifts, wars etc.

The conventional form of the ZA unit root test is called the model C, which accounts for a one-time change in both intercept and slope of a series. The model C of the ZA unit root test is given as:

$$\Delta\tau_t = c + \alpha\tau_{t-1} + \beta t + \gamma DU_t + \theta DT_t + \sum_{j=1}^k d_j \Delta\tau_{t-j} + \epsilon_t \quad (4.25)$$

where $DU=1$ and $DT=t-TB$ if $t > TB$ and zero otherwise.

This model tests the null hypothesis of unit root against the alternative hypothesis of trend stationary with a one-time break in both the intercept and slope of the trend function at an unknown date. Models A and B of the ZA unit root test allow for break in intercept only and slope only respectively.

Following Perron (1997), many studies in the literature have reported estimates for either model A or C, or both. However, Sen (2003) argues that the loss in test power is substantial when only model A is estimated in a situation where model C is correct. Similarly, the loss of power is minimal when model C is estimated in a scenario in which model A should have been the correct one. This study therefore reports estimates from both models.

4.3.3 Predictability of Tax Rate Changes

Another predictor for tax smoothing hypothesis to be valid is that tax rate τ_t is unpredictable. In other words, changes in the tax rate τ_t cannot be explained by its own lagged values or by lagged values of any other variable in the model. As in the empirical literature, we check for unpredictability of tax rate in a three-variable VAR model by incorporating government spending rate g_t and real output growth rate θ_t (as a proxy for productivity). Government expenditure and productivity are key determinant variables that influence the tax rate. We can also predictability of changes in government spending rate Δg_t and changes in output Δy_t in the VAR model.

4.3.3.1 Univariate Autoregression

We start with the tests for whether changes in the tax $\Delta\tau_t$, is predictable by its own lagged values by estimating the following autoregression (AR) model:

$$\Delta\tau_t = \beta_0 + \sum_{j=1}^k \beta_j \Delta\tau_{t-j} + \epsilon_t \quad (4.26)$$

Based on the results from equation (4.22), we employ the F test under the null hypothesis that $\beta_1 = \beta_2 = \dots = \beta_k = 0$. This means that $\Delta\tau_t$ is unpredictable by its own lagged values. We reject the null hypothesis if the F-statistic is less than the critical values and conclude that changes in tax rate are not influence by its own lagged value and hence tax rate is unpredictable.

4.3.3.2 Vector Autoregression

We proceed further to test for whether changes in the tax rate τ_t can be explained not only by its own lagged values but by lagged values of changes in government spending rate and output growth rate. As argued by Barro (1981), tests for the unpredictability of changes in tax rate are most thought-provoking in situation where some future changes in relevant variables are predictable. In

this regard, we perform a VAR and check for the predictability of all the variables in the tri-variate VAR by employing the F-test and block exogeneity Wald test.

Consider a VAR model with lag order ρ as follows:

$$Z_t = \alpha + \phi_1 z_{t-1} + \phi_2 z_{t-2} + \dots + \phi_p z_{t-p} + \epsilon_t \quad (4.27)$$

where $Z_t = [\Delta \tau_t, \Delta g_t, \Delta y_t]'$ is a vector of endogenous variables in the system, α is a vector of constants, ϕ_t ($i=1, 2, \dots, p$) are k-dimensional coefficients matrices, and ϵ_t is the k - dimensional vector of residuals.

If the lag length is 2, the VAR model in equation 4.24 can be written as:

$$\begin{bmatrix} \Delta \tau_t \\ \Delta g_t \\ \Delta y_t \end{bmatrix} = \begin{bmatrix} \alpha_{10} \\ \alpha_{20} \\ \alpha_{30} \end{bmatrix} + \begin{bmatrix} \beta_{11} & \beta_{12} & \beta_{13} \\ \beta_{21} & \beta_{22} & \beta_{23} \\ \beta_{31} & \beta_{32} & \beta_{33} \end{bmatrix} \begin{bmatrix} \Delta \tau_{t-1} \\ \Delta g_{t-1} \\ \Delta y_{t-1} \end{bmatrix} + \begin{bmatrix} c_{11} & c_{12} & c_{13} \\ c_{21} & c_{22} & c_{23} \\ c_{31} & c_{32} & c_{33} \end{bmatrix} \begin{bmatrix} \Delta \tau_{t-2} \\ \Delta g_{t-2} \\ \Delta y_{t-2} \end{bmatrix} + \begin{bmatrix} \epsilon_1 \\ \epsilon_2 \\ \epsilon_3 \end{bmatrix} \quad (4.28)$$

The tax rate changes, $\Delta \tau_t$ equation can be written as:

$$\Delta \tau_t = \alpha_{10} + \alpha_1 \Delta \tau_{t-1} + \alpha_2 \Delta \tau_{t-2} + \beta_1 \Delta g_{t-1} + \beta_2 \Delta g_{t-2} + \phi_1 \Delta y_{t-1} + \phi_2 \Delta y_{t-2} + \epsilon_t \quad (4.29)$$

For simplicity, the coefficients of lags of $\Delta \tau_t$, Δg_t , and Δy_t have been represented as α , β and φ respectively.

After estimating the VAR model, we apply the F-test and block exogeneity Wald test to examine the predictability of the variables in the system. The F-test, otherwise known as the joint significance test, is used to test the null hypothesis that in a VAR model the lagged explanatory variables have no significant influence on the dependent variable, meaning that all the coefficients are instantaneously zero (Greene, 2011; Wooldridge, 2008).

Consider the following tax rate changes $\Delta \tau_t$, equation with lag order ρ :

$$\Delta\tau_t = \boldsymbol{\delta} + \sum_{j=1}^{\rho} \alpha_j \Delta\tau_{t-j} + \sum_{j=1}^{\rho} \beta_j \Delta g_{t-j} + \sum_{j=1}^{\rho} \varphi_j \Delta y_{t-j} + \epsilon_t \quad (4.30)$$

The null hypothesis to be tested is:

$$H_0: \sum_{j=1}^{\rho} \alpha_j = \sum_{j=1}^{\rho} \beta_j = \sum_{j=1}^{\rho} \varphi_j = 0 \quad (4.31)$$

If we fail to reject the null hypothesis, we conclude that there is no evidence that the lagged explanatory variables have significant influence on $\Delta\tau_t$ which means that tax rate change is unpredictable.

Additionally, the block exogeneity Wald test is employed with the aim to ascertain whether each block of lagged variables in each equation in the VAR model can, either individually or jointly, significantly influence each of the dependent variables. To do so, we restrict all coefficients in each block of lagged variables to zero. For example, the null hypothesis for individual block exogeneity test in $\Delta\tau_t$ equation can be written as:

$$H_0: \sum_{j=1}^{\rho} \beta_j = 0 \text{ or } \sum_{j=1}^{\rho} \varphi_j = 0 \quad (4.32)$$

The block coefficients of lagged Δg_t and the block coefficients of lagged Δy_t are respectively:

$$\sum_{j=1}^{\rho} \beta_j \quad \text{and} \quad \sum_{j=1}^{\rho} \varphi_j .$$

Meanwhile, the joint block exogeneity test is expressed as:

$$H_0: \sum_{j=1}^{\rho} \beta_j = \sum_{j=1}^{\rho} \varphi_j = 0 \quad (4.33)$$

We use the Wald test of coefficient restriction to test the joint significance of each block of the lagged endogenous variable in each equation in the VAR system and similarly for joint significance of all blocks of lagged endogenous variables in each equation of the model. The Wald test, which is based on the likelihood test statistic, is:

$$(T - c)(\log |\Sigma_r| - \log |\Sigma_u|) \quad (4.34)$$

where T is the number of observations and c is the number of parameters estimated in each equation of the unrestricted VAR model. Σ_r and Σ_u are the variance/covariance matrices of the restricted and unrestricted VAR system.

4.4 Empirical Results

This section presents the empirical results regarding whether the tax smoothing hypothesis holds in Sierra Leone. Both random walk and predictability test are applied, and the results are presented below.

4.4.1 Unit Root Tests

We start with examining the existence of unit root in tax rate, a necessary condition for the tax smoothing hypothesis. To do so, we employ a battery of unit root tests. The results are presented in Table 4.2.

Table 4.2. Results of Unit Root Tests for Tax Rate

	ADF	Test	PP Test		DF-GLS	Test	KPSS	Test
	With Trend	No Trend	With Trend	No Trend	With Trend	No Trend	With Trend	No Trend
Test Stats.	-3.402	-2.793	-3.587	-2.817	-2.597	-2.022	0.102	0.284
Critical Values								
1%	-4.235	-3.627	-4.235	-3.627	-3.770	-2.631	0.216	0.739
5%	-3.640	-2.946	-3.640	-2.946	-3.190	-2.150	0.146	0.463
10%	-3.502	-2.612	-3.502*	-2.612*	-2.890	-1.950*	0.119	0.347

ADF and DF-GLS-Lags selections were based on the Schwarz Information Criterion, where * represent statistical significance of 10%.

PP and KPSS Lag selections were based on the Newey-West Bandwidth using Bartlett Kernel Criterion, where ***, ** and * represent statistical significance of 1%, 5% and 10% respectively.

ADF, DF-GLS and PP has the null hypothesis that there is unit root

KPSS has the null hypothesis that the series is stationary

The unit root tests are performed for both the inclusion of the trend term and without trend. The null hypothesis of unit root in tax rate τ_t is not rejected at 5% significance level for the ADF, DF-GLS and PP tests. For the ADF test, the test statistics with and without trend are -3.402 and -2.973 respectively, which are less than the 5% critical values of -3.640 and -2.946 in absolute term. With regards to the PP test, the test statistics with and without trend are -3.587 and -2.817 respectively, which are less than the 5% critical values of -3.640 and -2.946 in absolute term. The test statistics with and without trend for the DF-GLS are -2.597 and -2.022 respectively, which are less than the 5% critical values of -3.190 and -2.150. The results for the ADF, DF-GLS and PP indicate that the null hypothesis of unit root in tax rate cannot be rejected at the 5% conventional level. Finally, for robustness, we perform the KPSS test on tax rate with the null hypothesis that the tax rate is stationary. The test statistics with and without trend for the KPSS test are 0.102 and 0.284 respectively, which are less than the 5% critical values of 0.146 and 0.463 respectively. As such, the null hypothesis of stationarity in tax rate is rejected. The KPSS results support the findings from previous unit root tests that tax rate is non-stationary. As in Barro (1986), Trehan and Walsh (1988), Ashworth and Evans (1998) etc, these findings support the random walk behaviour of tax rate which is consistent with tax smoothing theory.

To complement the standard unit root tests discussed above, we perform ZA unit root test for tax rate. The results are reported in Table 4.3.

Table 4.3. Results of ZA Unit Root Tests

Test Model	Lags	Test Statistic	Break Year	Critical 1%	Values 5%	10%
Model A	2	-3.78	2000	-5.45	-4.93	-4.58
Model C	2	-4.46	2000	-5.57	-5.08	-4.82

The null hypothesis of unit root in tax rate series cannot be rejected even in the presence of structural breaks. Both model A and model C fail to reject the null hypothesis of unit root at 5% significance levels. Moreover, the ZA endogenously identifies a significant break in tax rate series. Both models show that the break occurs in the year 2000, which is close to the year 2002 when the tax systems in Sierra Leone was reformed, resulting in the establishment of the National Revenue Authority as the body responsible for administering tax laws and collection of central government revenues.

In summary, based on results obtained from the various unit root tests, we find evidence that tax rate is non-stationary. Tax rate thus follows a random walk – a result that is consistent with the tax smoothing hypothesis.

4.4.2 Predictability of Changes in Tax Rate

This section presents whether tax rate changes are predictable by either its own lag or lag values of another variables. We employ both the univariate and vector autoregression and the results are presented below.

4.4.2.1 Results of Univariate Autoregression

Another requirement for tax smoothing to hold is that tax rate should be unpredictable, i.e. the tax rate should not be predicted by its own lagged values. Based on the lag selection criteria, the AIC suggest that the model should be estimated with two lags. However, to have richer information on the predictability of changes in the tax rate, the model is estimated with the lag order of 1, 2, 3 and 4. The results are presented in Table 4.4

Table 4.4. Univariate Autoregression Results

	Number of of Lags in Autoregression			
Coefficients	Lag 4	Lag 3	Lag 2	Lag 1
Constant α_0	0.078 (0.268)	0.080 (0.254)	0.007 (0.021)	-0.133 (-0.392)
α_1	-0.183 (-0.976)	-0.104 (-0.609)	-0.010 (-0.056)	-0.044 (-0.245)
α_2	0.101 (0.581)	0.116 (0.733)	0.102 (0.614)	
α_3	-0.212 (-1.320)	-0.220 (-1.388)		
α_4	-0.189 (-1.146)			
F-stat	1.059	1.048	0.192	0.064
Prob. (F-stat)	(0.396)	(0.386)	(0.827)	(0.802)

Note: Numbers in parentheses are t-statistics.

From Table 4.4, the coefficient for tax rate at lag 1 is -0.044. The F-stat is 0.064 with corresponding probability value of 0.802. One lag value of tax rate cannot predict changes in tax rate as the probability value is insignificant. At lag 2, the coefficient for tax rate is 0.102. The F-stat is 0.192 with corresponding probability value of 0.827. At lag 2, the value of tax rate cannot predict changes in tax rate as the probability value is insignificant. For lag 3, the coefficient for tax rate is -0.220. The F-stat is 1.048 with corresponding probability value of 0.386. At lag 3, the value of tax rate cannot predict changes in tax rate as the probability value is insignificant. At lag 4, the coefficient for tax rate is -0.189. The F-stat is 1.059 with corresponding probability value of 0.396. At lag 4, the value of tax rate cannot predict changes in tax rate as the probability value is insignificant. The F-tests obtained from the different lag lengths from the univariate autoregression are not significant at the 5% level. These results imply that the null hypothesis of zero coefficients for the lagged values of changes in the tax rate cannot be rejected. Therefore, we conclude that during the sample period under investigation, tax rate changes cannot be predicted by its own lagged values, suggesting evidence of tax smoothing theory hold in Sierra Leone. Similar conclusions were reached by Kurniawan (2011) for Indonesia, Karakas, Taner and Yanikkaya (2014) for Turkey etc.

4.4.2.2 VAR Results

We proceed to test for whether tax rate changes $\Delta\tau_t$, can be predicted not only by its own lagged values, but also by the lagged values of changes in government spending rate Δg_t and GDP growth rate Δy_t . Additionally, we provide evidence of the predictability of changes in government spending rate Δg_t and growth rate of output Δy_t . To do this, we estimate a tri-variate VAR and start with by determining the optimal lag length. We estimate a VAR with lag length of 4. The result of lag selection is presented in Table 4.5.

Table 4.5 VAR Lag Order Selection Criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-302.1122	NA*	38404.92	19.06951	19.20692	19.11506
1	-292.9614	16.01378	38192.80	19.06009	19.60974	19.24228
2	-283.4360	14.88356	37615.61*	19.02725*	19.98914*	19.34609
3	-277.4610	8.215539	47456.31	19.21631	20.59044	19.67180*
4	-272.6601	5.701109	67123.90	19.47876	21.26512	20.07089

* 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

The results from the lag length criteria show that optimal lag chosen by FPE, SC and AIC are 2 lags and, as such, the model should be estimated with 2 lags.

Having established the optimal lag length, I proceed next to test for the stability of the VAR model.

If a VAR model is unstable, the results from forecasting with will unreliable. Also, the shocks to variable in the system will explode and will not die out.

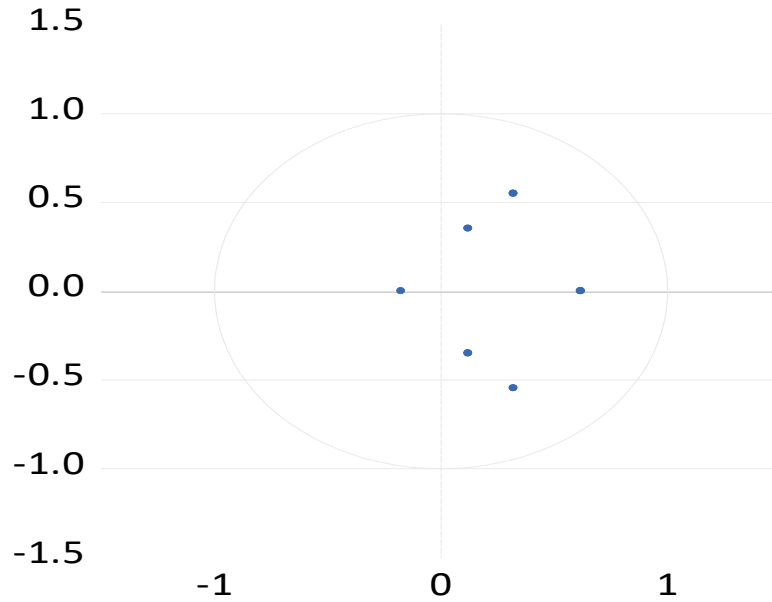


Figure 4.1 VAR Stability Graph

Figure 3.1 above shows the results of the root polynomial graph for the VAR model. The model is stable if no root lies outside or on the circle. As shown in Figure 3.1, no roots lie outside or on the circle. This means that the VAR model satisfy the stability condition. Next, I test for autocorrelation in the VAR residual and the result is presented in Table 4.6

Table 4.6 VAR Residual Serial Correlation LM Test

Lag	LM stat	df	Prob.
1	4.19	9	0.898
2	7.35	9	0.600
3	4.01	9	0.910
4	3.18	9	0.956

Null hypothesis: No serial correlation at lag 1-4

The Lagrange Multiplier (LM) test statistic shows that the model does not suffer from autocorrelation from lag 1 to lag 4. At lag 1, the LM test statistic is 4.19 with corresponding p-value of 0.898. I fail to reject the null hypothesis of no autocorrelation. Similarly, for lag 2, 3, and 4, the LM statistics are 7.35, 4.01 and 3.18 with corresponding p-values of 0.600, 0.910 and 0.956. Also, I fail to reject the null hypothesis of no autocorrelation in the residual. The VAR model does not suffer from serial correlation. The autocorrelation test gives credence to the optimal lag length criterion test obtained earlier. The optimal lag length chosen was 2 and the autocorrelation test shows that at lag 2, I cannot reject the null hypothesis of no autocorrelation.

Finally, I test for heteroscedasticity in the VAR residual and the results are presented in Table 4.7

Table 4.7 VAR Residual Heteroskedasticity Tests (Levels and Squares) Joint Test

Chi-sq	df	Prob.
59.24	72	0.86

Null hypothesis: No heteroscedasticity in the residual

Under the null hypothesis of no heteroscedasticity, or (no misspecification), the non-constant regressor should not be jointly significant. From Table 4.7, the Chi-sq is 59.24 with probability value of 0.86. I therefore fail to reject the null hypothesis of heteroscedasticity in the residual. VAR satisfy the heteroscedasticity condition. I proceed to show the estimates from the VAR results for tax rate, government spending rate and growth rate of output. This is shown in Table 4.8. However, for consistency with the autoregression results of tax rate changes and to have more insight and richer results about the predictability of the variables, we present the estimates from lag 1 to 4. The result from the VAR with four lags is presented in in Table 4.8

Table 4.8. VAR Results

Dependent Variables	Lag order in VAR	R^2	F-stat	Prob. (F-stat)	DW
$\Delta\tau_t$	1	0.062	0.680	0.571	1.787
	2	0.092	0.456	0.834	2.125
	3	0.227	0.751	0.660	2.105
	4	0.250	0.528	0.871	2.079
Δg_t	1	0.085	0.962	0.423	2.015
	2	0.256	1.551	0.199	2.244
	3	0.461	2.189*	0.063	1.901
	4	0.494	1.546	0.190	1.795
Δy_t	1	0.015	0.512	0.928	1.997
	2	0.136	0.709	0.644	2.111
	3	0.241	0.812	0.610	2.160
	4	0.437	1.227	0.334	1.675

Note * indicate significance at 10% level

The VAR results above show that for the tax rate changes $\Delta\tau_t$ equation, that is where $\Delta\tau_t$ is the dependent variable, we cannot reject the null hypothesis of zero coefficient restriction for all lagged variables in the equation. The F-statistics of 0.680, 0.456, 0.751 and 0.528 for the VAR with lag orders 1, 2, 3 and 4 respectively are not significant at any conventional significance level. We conclude that tax rate changes are not predictable by all the lagged variables during the period under review.

When change in government spending Δg_t is the dependent variable, the result shows that changes in government spending can be predicted by its own lag but only in the third year. The F-statistics of 0.962 and 1.551 for lag order 1 and 2 respectively are not significant. However, the F-statistic of 2.189 is significant at 10% level. For growth rate of real GDP equation, the results indicate that for a period up to four lags, real GDP growth rate is not predictable by its own lagged values. The F-statistics of 0.512, 0.709, 0.812 and 1.227 for lag orders 1, 2, 3, and 4 are all insignificant at each of the conventional levels.

4.4.2.3 Block Exogeneity Test

In Table 4.9 below, we present the block exogeneity Wald test of coefficient restriction based on the VAR with two lags are chosen by the AIC to be optimal. The results are presented in three categories: the first part shows whether we can exclude separately or jointly the blocks of lags of changes in government spending rate Δg_t and changes in growth rate of real GDP y_t from changes in tax rate $\Delta \tau_t$ equation. In the same vein, the next rows test for the same hypotheses.

Table 4.9. Block Exogeneity Wald Test Results

Dependent Variable	Excluded Variables	Chi-sq	df	P-value
$\Delta \tau_t$	Δg_t	1.090	2	0.580
	Δy_t	1.617	2	0.445
	All	2.374	4	0.667
Δg_t	$\Delta \tau_t$	5.586*	2	0.061
	Δy_t	1.797	2	0.407
	All	7.137	4	0.129
Δy_t	$\Delta \tau_t$	0.435	2	0.805
	Δg_t	2.414	2	0.299
	All	4.046	4	0.399

Note * indicate significance at 10% level. The term ‘All’ refers to the exclusion of lags of all variables other than the lags of the dependent variables.

The results above show that when tax rate changes $\Delta \tau_t$ is the dependent variable, the null hypothesis of excluding lags of changes in government spending rate Δg_t and changes in growth rate of real GDP Δy_t cannot be separately or jointly rejected. The chi-square value of 1.090 (with p-value = 0.580) and 1.617 (with p-value = 0.445) for Δg_t and Δy_t are insignificant, implying that the block of lags of the two variables can be excluded from the tax rate changes $\Delta \tau_t$ equation separately. Moreover, the chi-square value of 2.374 (with p-value = 0.667) for the exclusion of all variables is also insignificant. This implies that tax rate changes are unpredictable by the arrival

of new information which is consistent with tax smoothing theory. Our result is in line with Kurniawan (2011) and Karakas, Taner and Yanikkaya (2014) among other studies.

The blocks lags of changes in government spending rate Δg_t and changes in growth rate of real GDP Δy_t can thus be jointly excluded from changes in tax rate $\Delta \tau_t$ equation. Based on these results, we can therefore conclude that tax rate changes $\Delta \tau_t$ are not predicted by changes in government spending Δg_t and changes in growth rate of real GDP Δy_t , either individually or jointly. When changes in government spending rate Δg_t is the dependent variable, the results show that the blocks of lags of tax rate changes $\Delta \tau_t$ and growth rate of real GDP Δy_t can jointly be excluded from changes in the government spending rate Δg_t equation. The chi-square value of 7.137 (with p-value = 0.129) is insignificant at 5% or lower. Δg_t thus cannot be jointly predicted by $\Delta \tau_t$ and Δy_t . However, separately, the result shows that the blocks of lags of tax rate changes $\Delta \tau_t$ have significant power in predicting Δg_t . The chi-square of 5.586 (with p-value = 0.061) is significant at the 10% level.

Finally, the results show that when changes in GDP growth rate Δy_t is the dependent variable, the null hypothesis of excluding lags of changes in government spending rate Δg_t and changes in tax rate $\Delta \tau_t$ cannot be separately or jointly rejected. The chi-square value of 0.435 (with p-value = 0.805) and 2.414 (with p-value = 0.299) for $\Delta \tau_t$ and Δg_t are insignificant, which implies that the block of lags of the two variables can be excluded from changes in real GDP growth Δy_t equation separately. Moreover, the chi-square value of 4.046 (with p-value = 0.399) for the exclusion of all variables is also insignificant. Thus, the block lags of changes in government spending rate Δg_t and changes in tax rate $\Delta \tau_t$ can be jointly excluded from the changes growth rate Δy_t equation.

4.5 Conclusion

In this chapter, we empirically investigated whether the tax policies that has been carried out between 1980-2016 are consistent with tax smoothing hypothesis. To achieve this aim, three different empirical approaches were performed. First, we utilised four different unit root tests to examine the random walk property of tax rate. The null hypothesis of non-stationarity of tax rate could not be rejected, which implies tax rate follows random walk and hence is consistent with the tax smoothing hypothesis. Second, we examined whether changes in tax rate is predictable by regressing changes in tax rate by its own lagged values. The result shows that tax rate is unpredictable as changes in tax cannot be determined by its lagged values. This finding also supports the existence of the tax smoothing hypothesis. Finally, a VAR model was employed to examine whether tax rate can be predicted by its own lagged values together with changes in government spending rate and growth rate of real GDP. Our results indicate that all the variables employed were found not be significant is predicating tax rate. Overall, the empirical estimation supports the existence of tax smoothing over the sample period.

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CHAPTER FIVE

Conclusions and Policy Recommendations

5.1 Introduction

As noted in Chapter One, the use of fiscal policy as a stabilisation tool has been a subject of great controversy among macroeconomists and policy makers. Prior to the great recession of 2008, economists and creditors were more concerned about the sustainability of fiscal policy in developing and emerging countries. In both developing and emerging economies, the reduction of fiscal deficits is one key short-term macro-stabilisation goal.

The sharp deterioration in primary balance following the 2008 financial crises in advanced economies, particularly the United States and European Union, has led to macroeconomists and fiscal policy makers reassessing the impacts of fiscal policy on economic activity. The IMF for the first time have become advocates for fiscal expansion, an apparent departure from the long-held agreement among economists that monetary policy rather than fiscal policy was the appropriate response to fluctuation in economic activity.

Recently, economists and policy makers have become interested in how the economy responds to fiscal surprises – particularly the macroeconomic effects of fiscal policy shocks. In most developing countries, revenue from taxation as a share of GDP is less than twenty percent. Various tax tools have been designed by fiscal policy makers to raise tax revenue to reduce fiscal deficits. However, raising taxes comes with a distortionary cost. Optimal tax policy requires that the government smooths tax to reduce the welfare cost. Based on these observations, the aim of this thesis was to assess these three key areas of fiscal policy; fiscal sustainability, fiscal policy shocks and the tax smoothing hypothesis in Sierra Leone. The summary and major conclusions are

presented in section 5.2, which also outlines the original contribution to the literature made by this study. Section 5.3 focusses on policy implications and 5.4 offers suggestions for future studies.

5.2 Summary and Conclusions

This thesis comprised three empirical chapters of related themes on fiscal policy in Sierra Leone. In Chapter Two, we performed three different analyses to examine the sustainability of fiscal policy. The first analysis was based on the government's IBC. This approach implies that an existing fiscal policy is sustainable if the primary deficits ratio (primary deficits-to-GDP ratio) is stationary, or alternatively, if there exist a cointegration relationship between government revenues and expenditures. After performing battery of tests, the results show that primary deficit ratio is stationary, a necessary condition for sustainable fiscal policy. Moreover, the unit root tests show that both government revenue and expenditure are non-stationary in levels but are stationary at first difference. We proceeded to test for cointegration between these fiscal variables by employing both the DOLS and the Johansen system approach. Both approaches confirmed the existence of cointegration relationship between government revenue and expenditure. The estimated cointegration coefficients show that fiscal policy during the sample period was weakly sustainable. We further proceeded to endogenously account for structural breaks in the cointegration relationship, which is relevant for Sierra Leone, a country that has witnessed significant changes over the years, including SAP in the 1980s, tax reforms in the 1990s and 2000s etc. We found evidence of structural break occurring in 1984 and the sustainability became weaker after the break date. There also exists uni-directional causality running from government revenue to expenditure. This causality result is in line with the tax-and-spend hypothesis as proposed by Friedman (1978). Finally, we further examined sustainability of fiscal policy by estimating an augmented Bohn (1998) fiscal reaction function for Sierra Leone. The results show a significant positive reaction of

primary balance ratio to variation in debt ratio, again leading to the conclusions that fiscal policy during the review period was sustainable. The results also revealed that the fiscal policy in Sierra Leone during the review period was procyclical. In other words, during the period of bad times the government found it difficult to borrow and therefore reduced spending and increased taxes and did the opposite during boom or good times – a behaviour that is counter intuitive to some macroeconomists.

In Chapter Three, we examined how the economy responds to macroeconomic fiscal shocks within the framework of SVAR. Two different approaches were used to identify the fiscal shocks. First, the recursive approach was used, and the variables were ordered in line with Fatás and Mihov (2001), Favero (2002) and Perotti (2005). The second identification strategy was adopted from Blanchard and Perotti (2002). The empirical results from the two approaches yielded identical impulse response function with respect to the fiscal shocks. Overall, the results show that government spending shocks strongly stimulate the economy by increasing output and its components (private consumption and investment). Both government spending and tax shocks are inflationary.

Chapter Four investigated whether fiscal policy in Sierra Leone has been optimal based on Barro's (1979) tax smoothing framework. First, after performing battery of unit root tests, we found that tax rate followed a random walk during the sample period. Additionally, both AR and VAR confirmed that changes in tax rate cannot be predicted by its own lagged values or lagged values of other variables in the model. These findings led us to conclude that during the sample period, the fiscal policy in Sierra Leone was optimal.

5.2.1 Contributions to the Literature

The results of this study have shown that fiscal policy in Sierra Leone has been sustainable and there is evidence that the tax smoothing hypothesis holds. The contribution of this thesis to the literature are as follows:

- Provides recent analysis on fiscal sustainability, fiscal policy shocks and the tax smoothing hypothesis;
- Accounts for structural shift in the deficits process using endogenous structural breaks test;
- Estimates the relationship between primary deficit ratio and debt ratio (fiscal reaction function); and
- Estimates the dynamic response of fiscal policy shocks on key macroeconomic variables using SVAR.

The second chapter highlighted that little work has been done in Sierra Leone on fiscal sustainability. Compared to the existing literature on Sierra Leone, this chapter made three distinct contributions: (i) the analysis uses the most recent data set available; (ii) we estimated a policy rule also known as a fiscal reaction function for Sierra Leone; and (iii) we accounted for endogenous structural breaks in the cointegration relationship between government revenue and expenditure.

Chapter Three examined the impact of exogenous fiscal policy shocks on output, private consumption, private investment, inflation and interest rate using the SVAR. To the best of our knowledge, we are not aware of no other work that does so on Sierra Leone.

Chapter Four investigated whether the tax soothing hypothesis holds for Sierra Leone. Two different approaches were used. To the best of our knowledge, we are not aware of no other similar work on Sierra Leone.

5.3 Policy Recommendations

The empirical results from this research have significant policy implications in terms of dealing with the fiscal problems effectively. First, it was observed in Chapter Two that the fiscal policy in Sierra Leone during the sample period is weakly sustainable and, government expenditure as a percentage of GDP is growing faster than government revenue as a percentage of GDP. Also, it was observed in Chapter Two that expenditure adjustments tend to work faster compared to revenue adjustments is reducing the size of the deficits. It is therefore recommended that the government of Sierra Leone should introduce the following measures:

- (i) enhance tax collection
- (ii) (ii) introduce reforms aimed at widening the tax base;
- (iii) (iii) reduce tax loopholes, tax avoidance and evasion.
- (iv) cut down expenditures not geared towards achieving economic growth

These measures will go a long way towards increasing the amount of revenue received from taxes, reducing the size of the deficits, and achieving strong form of fiscal sustainability.

It was also observed in Chapter Three that government spending strongly stimulates the economy by increasing output and its components (private consumption and investment). However, when we disaggregate government spending into its components- government consumption and government investment, the empirical results show that government investment is more effective in increasing output compared to government consumption expenditure. Therefore, it is recommended the government of Sierra Leone should concentrate its spending on investments. Such investment includes but not limited to infrastructural development such as electricity, roads, hospitals, information, communication and technology and so forth, and irrelevant spending such as those white elephant projects should be abandoned.

The findings from Chapter Four indicates that the fiscal policy in Sierra Leone over the sample period has been consistent with optimal tax theory. It is therefore recommended that the government of Sierra Leone should continue to smooth taxes to minimise the distortionary effects as tax smoothing is a precondition for sustainable fiscal policy.

5.4 Suggestion for Further Studies

Owing to the data span, Chapter Two included only a single structural break. It is thus recommended that future studies with extended data set should test for multiple break dates. Because of the non-existence of interest rate on public debt data, this thesis ignores testing for fiscal sustainability by using the debt sustainability approach. Future studies can test for fiscal sustainability using this approach when data is available. Also, due to the unavailability of interest rates on public debt data, this thesis does not take into account testing for tax smoothing by using the relationship between primary balance and government expenditure.

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