

The Inflationary Effects of Fiscal Deficit in Sierra Leone: A Simulation Approach

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Contents

List of tables

List of figures

Abstract

1.	Introduction	1
2.	Historical evolution of fiscal deficit and its financing in Sierra Leone	4
3.	Literature review	8
4.	Methodology	11
5.	Empirical results and analysis	16
6.	Conclusion, policy implication and recommendations	25
	Notes	28
	References	29
	Appendix	31

List of tables

1.	Fiscal performance of Sierra Leone, period average	4
2.	Results of the unit root tests using Dickey-Fuller class of test	16
3.	Results of the unit root tests using the Phillips-Perron test	17
4.	Result of the autoregressive model of inflation	18
5.	Correlation matrix of variables in the inflation model	19
6.	Summary statistics of the inflation model validation	22
7.	Budget deficit and growth of money supply required to meet the medium-term inflation target for Sierra Leone	24
A1.	Data sources and description	31
A2.	Descriptive statistics of model variables	32
A3.	The initial (Over-parametized) general ARDL model of inflation	32

List of figures

1.	Budget deficit (% of GDP), money growth (M2G) and inflation (INF) in Sierra Leone	5
2.	Fiscal deficit and its financing method in Sierra Leone	6
3.	Seigniorage revenue (% of GDP) and inflation rate in Sierra Leone	7
4.	Model stability test with CUSUM test	19
5.	Model stability test with CUSUM square test	20
6.	Graphs of actual and simulated values of inflation	21

Abstract

The objective of the study is to identify rules for the conduct of fiscal and monetary policies for low inflation in Sierra Leone. Policy simulations are carried out following the estimation of an inflation model with annual data from 1971 to 2012. The results reveal that, achieving Sierra Leone's medium-term inflation targets of 6.0%, 5.4% and 5.4% for 2015, 2016, and 2017, respectively, requires budget deficit, excluding grants, to be 6.0 %, 5.6%, and 4.9% of GDP, respectively, with corresponding money supply growth targets of 10.4%, 9.7% and 8.6%, respectively.

1. Introduction

Background

Growing fiscal deficits, escalating government debts, and monetization of fiscal deficit have become major concerns of policy makers and academics. Thus, the relationship between fiscal deficit and key macroeconomic variables, in both developed and developing countries, has attracted interest in theoretical debates and empirical research.

Fiscal management has resulted in persistent budget deficit in Sierra Leone since the early 1970s and monetary policy has more often than not accommodated fiscal expansion, with monetary policy being more of expansionary than contractionary. Despite the fact that monetary policy has price stability as an objective while growth is the main objective of fiscal policy, the performance of the economy on these indicators is unsatisfactory, with the exception of the 15.2% and 20.1% growth of 2012 and 2013, respectively, driven by the iron ore production which started in 2012. As in the case of most sub-Saharan African economies, Sierra Leone experienced moderate growth in the 1970s, and the growth performance of the 1980s was poor. It was worse in the 1990s (the war period) while the 2000s, which is the post-war period, experienced a higher growth rate than the 1970s, 1980s, and 1990s. Net foreign asset, which was positive in the early 1970s, has consistently been negative since the mid 1970s and the size of the deficit on the trade balance and the current account was on the increase in the 1990s. The end of the war could not divert this trend though there was large flow of foreign aid (mostly for post-war reconstruction), which increased foreign reserve in the early to late 2000s. In all the years from 2000 to 2012, gross external reserve of Sierra Leone could not finance up to six months of imports, in spite of the increased export in 2012 and 2013 due to iron ore export boom which started in 2012 following the discovery of iron ore. Thus, Sierra Leone still experiences deterioration in the external sector. The rate of inflation was low in the early 1970s while the mid 1970s to the end of the 1990s experienced double digit inflation rate (triple digit inflation was the case in some years). Single digit inflation was observed in the early 2000s and double digit inflation re-emerged in the late 2000s. Over the period 2005-2009 average inflation rate was 11.8%, and during the period 2010-2012 it was 15.2%.

Statement of the problem

In Sierra Leone, budget deficit (excluding grants) increased from 3.5% of GDP during the period 1970-1975 to 11.5% during the period 1980-1985, and increased further to 13.4% during the period 2001-2005. From 2006 to 2009, it stood at 8.0% and during the period 2010-2012 it stood at 11.4% of GDP. The consistent deficit in the fiscal balance of Sierra Leone emanates from low tax revenue and growing government expenditure. The poor fiscal performance coexists with slow growth of real GDP, with the exception of the 15.2% and 20.1% growth of real GDP in 2012 and 2013, respectively. These growths were, however, driven by the iron ore production, which started in 2012. High inflation rates and deficit in the trade balance are also in coexistence with the poor fiscal performance in spite of the high growth of 2012 and 2013.

Since fiscal deficit coexists with poor macroeconomic performance in Sierra Leone, including high and unstable price level, the questions of relevance then are: (i) what is the quantitative effect of fiscal deficit on inflation in Sierra Leone? (ii) what is the level of fiscal adjustment needed to bring down the rate of inflation to specific desirable levels? An understanding of these issues can help policy makers in the drive towards achieving the objective of low and stable prices in the economy, an issue of strong relevance to the central bank.

Objectives of the study

The overall objective of the study is to investigate the quantitative impact of fiscal deficit on inflation and identify monetary and fiscal policy rules for the conduct of monetary policy aimed at low and stable price level in Sierra Leone.

The specific objectives of the study are to investigate:

- i) the degree of responsiveness of money supply to budget deficit and the response of inflation to money supply in Sierra Leone;
- ii) the growth of money supply necessary to achieve the medium-term target for inflation rates of 6.0%, 5.4%, and 5.4% in 2015, 2016, and 2017, respectively; and
- iii) the amount of fiscal adjustment needed to bring inflation to the medium-term targets for 2015, 2016, and 2017.

Justification for the study

There are two justifications for the study. First, Sierra Leone has been recording budget deficit for over three decades, and this coexists with poor macroeconomic performance, including high rates of inflation. It is, therefore, imperative to determine whether the poor performance on the control of inflation in Sierra Leone is predicated on the fact that deficit in the budget balance has been consistent. This is important given the fact that the major objective of monetary policy in Sierra Leone is to maintain low and stable price level. A study on this issue would provide guiding principles to policy

makers in coordinating the activities of the fiscal sector in an effort to meet the inflation objective under the conduct of monetary policy in the economy.

Second, there have been studies on the effects of fiscal deficit on inflation in many developing economies as well as the developed economies. However, the empirical results are not necessarily the same across countries. This mixed result in the empirical world is consistent with the theoretical exposition. It is, therefore, important to investigate this issue on a country-specific basis. This is important for Sierra Leone since, to the best knowledge of the author, there is no study on Sierra Leone with respect to the quantitative inflationary effects of fiscal deficit.

The study extends the existing literature in two ways. It investigates, not only the qualitative impact of fiscal deficit on inflation, but also the levels of fiscal deficit (as a percentage of the economy) required to achieve specific rates of inflation and the money supply consistent with these specific rates of inflation. Moreover, it estimates the elasticity of money supply with respect to budget deficit.

Scope of the study

The study is on Sierra Leone, a small open-economy that has recorded deficit in the budget balance, slow growth of real GDP, high rates of inflation and deficit in the trade balance for more than three decades. The period of study is from 1971 to 2012. The period is chosen on the basis of data availability for all the variables and the fact that it is long enough to capture the periods of interest rate regulation¹, fixed exchange rate regime and monetary expansion in Sierra Leone. The study focuses on the quantitative effects of overall fiscal deficit on inflation.

2. Historical evolution of fiscal deficit and its financing in Sierra Leone

Historical evolution of fiscal deficit in Sierra Leone

The fiscal performance of Sierra Leone has been weak in the last four decades. Since 1971, the budget balance of Sierra Leone has been in deficit, emanating mainly from low tax revenue, given the increasing government expenditure.

In the early 1970s, budget deficit (excluding grants) as a ratio of GDP was less than 5%. It increased from an average of 3.47% over the period 1970-1975 to 8.51% over the period 1976-1979, and increased further to 11.46% over the period 1980-1985 (see Table 1).

In 1987, fiscal deficit (excluding grants) as a percentage of GDP stood at 18.58%, which is the highest in the history of Sierra Leone. Financing of this deficit was done mainly by borrowing from the domestic banking system. Thus, growth of money supply was high and the consequence in terms of rate of inflation was experienced. Inflation rate was 179% in this year; this is the highest value of inflation rate in Sierra Leone history (see Figure 1).

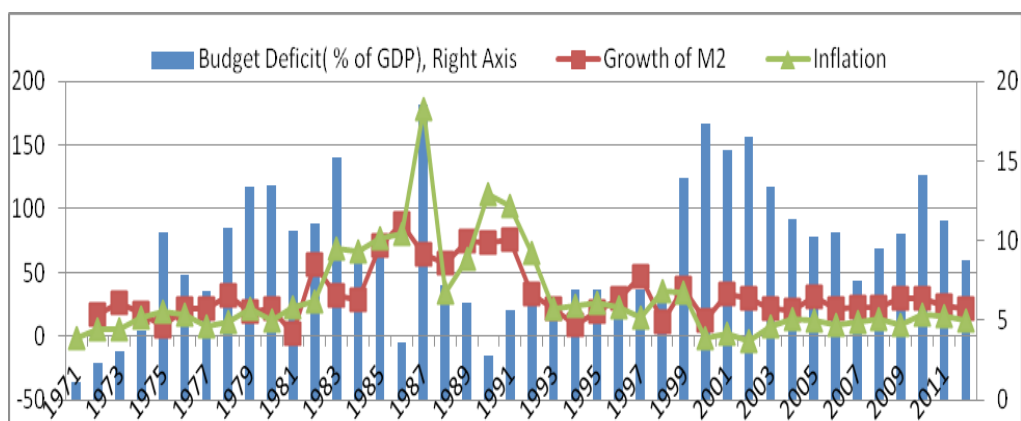
Government expenditure as a percentage of GDP reduced from an average of about 21.74% over the period 1980-1985 to 13.71% over the period 1986-1990, while government revenue as a percentage of GDP reduced from an average of 11.34% over the period 1980-1985 to an average of 6.17% over the period 1986-1990. Though government revenue and expenditure reduced over the period 1986-1990, compared to the period 1980-1985, the reduction in government expenditure was not enough to turn the fiscal balance into surplus. Budget deficit as a ratio of GDP (excluding grants) fell from 11.46% over the period 1980-1985 to 7.66% over the period 1986-1990.

Table 1: Fiscal performance of Sierra Leone, period average

Period	Government Expenditure (% of GDP)	Government Revenue (% of GDP)	Budget Deficit, Excluding Grants (% of GDP)
1970-1975	20.04	16.57	3.47
1976-1979	26.46	16.75	8.51
1980-1985	21.80	11.34	11.46
1986-1990	13.83	6.17	7.66
1991-1995	16.95	10.81	6.14
1996-2000	18.67	8.93	9.74
2001-2005	26.84	13.40	13.44
2006-2010	16.33	8.28	8.05
2011-2012	23.00	11.60	11.40

Source: Calculated by author from International Financial Statistics and Government Financial Statistics.

Figure 1: Budget deficit (% of GDP), money growth (M2G) and inflation (INF) in Sierra Leone



Source: Calculated by author from International Financial Statistics and Government Financial Statistics.

Government revenue, as a percentage of GDP, was higher in the period 1991-1995 (the early years of the rebel war) than the period 1986-1990, and government expenditure as a percentage of GDP was also higher in the period 1991-1995 than the period 1986-1990. Relative to the period 1986-1990, the period 1991-1995 recorded low budget deficit. The low budget deficit recorded in the period 1991-1995, relative to 1986-1990, was mainly as a result of the fiscal discipline that was emphasized in the Structural Adjustment Programmes that was initiated in 1992. Under this programme, public sector employees, with the exclusion of the military and police, were reduced by more than 50% over the period 1991-1995. This was done through the removal of ghost workers from the payroll and the retrenchment of redundant daily workers.

Budget deficit as a percentage of GDP (excluding grants) increased from 6.14% over the period 1991-1995 to 9.74% over the period 1996-2000. This was mainly as a result of the escalation of the rebel war, which reduced government revenue and increased government expenditure. Government revenue as a percentage of GDP fell from 10.81% over the period 1991-1995 to 8.93% over the period 1996-2000, while government expenditure as a percentage of GDP increased from an average of 16.95% over the period 1991-1995 to 18.51% over the period 1996-2000.

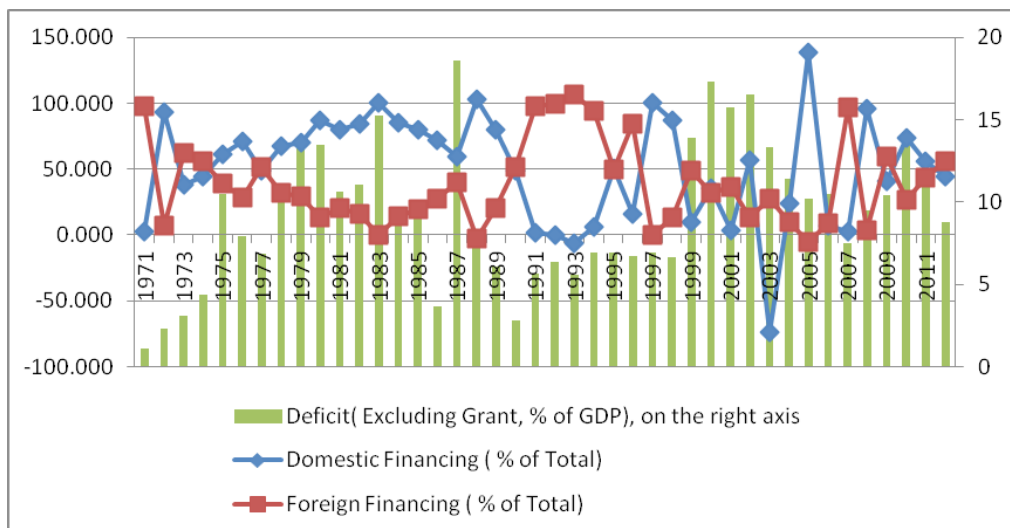
Despite the fact that the war ended in 2000, the years 2001 to 2005 (post-war period) also recorded budget deficits. Budget deficit as a ratio of GDP was higher in all the years from 2000 to 2005 than all the years from 1988 to 1998. Moreover, fiscal deficit (excluding grants) as a ratio of GDP was about 13.4% over the period 2001-2005. This implies that fiscal performance in the early years of the post-war period was worse than the war period (1991-2000) and the pre-war period (1970-1990). This was basically because of the increase in government expenditure in the post-war period for reconstruction and rehabilitation. Government expenditure as a percentage of GDP increased from an average of 18.67% over the period 1996-2000 to 26.84% over the period 2001-2005, and it reduced to 16.33% over the period 2006-2009, while revenue reduced from 13.40% over the period 2001-2005 to 8.28% over the period 2006-

2009, fiscal deficit as a percentage of GDP (excluding grants) stood at about 8.05%. It stood at 11.4% during the period 2010-2012.

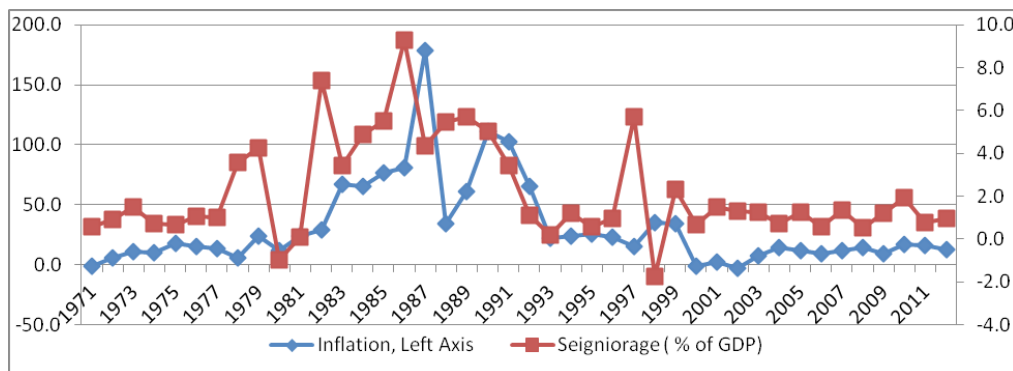
Fiscal deficit financing and seigniorage revenue in Sierra Leone

The financing of fiscal deficit in Sierra Leone during the period 1971-1974 was more from foreign sources than domestic sources, with foreign sources accounting for 55.5%. During this period, fiscal deficit was low, averaging 2.7% of GDP per year, seigniorage revenue was 0.9% of GDP per year and average inflation rate was 6.3%. Unlike the early 1970s, from 1975 through the 1980s, domestic financing of fiscal deficit dominated foreign financing, with domestic financing increasing from 61.2% of total financing in 1975 to 87% in 1980, 85.6% in 1984 and 79.9% in 1989. Seigniorage revenue, which was 0.7% of GDP in 1975, picked up to 3.6% in 1978 and 4.3% in 1979 and further to 7.4% in 1982, while inflation rate surged from 10.0% in 1974 to 24.2% in 1979 and 29% in 1982. Seigniorage revenue remained high during the period 1983-1989, being between 3.4% of GDP and 9.3%. This suggests that during the period 1971-1989, seigniorage was high during the period when domestic financing dominated foreign financing of the deficit (that is, 1975-1989). The rate of inflation was also high during the period when domestic financing dominated the financing of the deficit. Inflation rate, which was 10.0% in 1974, had risen to 29.0% in 1982, 80.6% in 1986, 178.8% in 1987, and 60.8% in 1989, compared to an average of 6.3% during the period 1971-1974. Figure 2 shows fiscal deficit (overall, excluding grants) and its financing method; and Figure 3 shows seigniorage revenue and inflation.

Figure 2: Fiscal deficit and its financing method in Sierra Leone



Source: Calculated by author from International Financial Statistics and Government Financial Statistics.

Figure 3: Seigniorage revenue (% of GDP) and inflation rate in Sierra Leone

Source: Calculated by author from International Financial Statistics and Government Financial Statistics.

Owing to the economic crisis of the 1980s, including high budget deficits and inflation rates, Sierra Leone adopted an economic adjustment programme in June 1986, though it was not sustainable. It was abandoned in October 1987 due to inability to meet the relevant macroeconomic targets. The programme was resumed in November 1989, though without an external financial support. The new phase included liberalization of the exchange rate in 1990, allowing for the operation of foreign exchange bureaus in 1992, deregulation of commercial bank's interest rates in 1992, abolishing directed credit in 1992, and operation of open market for treasury bill (also in 1992).

Fiscal deficit was relatively low during the reform period of 1989-1996, falling from an average of 10.0% of GDP during the period 1983-1989 to an average of 5.9% of GDP during the period 1990-1996. Foreign financing dominated domestic financing of the deficit during the period 1990-1996, with an average of 83.3% of total financing, compared to only 17% during the period 1983-1989. In addition, seigniorage² revenue was relatively low during this adjustment periods, falling from an average of 6.6% of GDP during the period 1983-1989 to an annual average of 1.8% during the period 1990-1996, reflecting the change in deficit financing behaviour with more weight on foreign financing than domestic money financing method.

During the war period, 1991-2001³, Sierra Leone's fiscal deficit financing was dominated by foreign financing, unlike the mid 1970s to the decade of the 1980s when it was dominated by domestic financing. Seigniorage revenue was also lower during the early years of the war, 1991-1996, than the period 1975-1989. In 1997 and 1998, domestic financing dominated the deficit financing. This is not unconnected to escalation of the war during which the democratically elected government of 1996 was overthrown in 1997 and the Military government, in collaboration with the rebels, ruled until early 1998 when the government was removed from power by a regional intervention force.⁴

Seigniorage revenue, which was 1.0% of GDP in 1996, rose to 5.7% of GDP in 1997. During the period 1999-2009, foreign financing dominated deficit financing as in the period 1992-1996, with the exception of 2002, 2005 and 2008. Seigniorage revenue remained lower during the period 1999-2009 than its levels before 1992. In 2010, 2011, and 2012, seigniorage revenue was only 1.9%, 0.8% and, 1.0% of GDP, respectively. However, inflation rates during this period were still on the higher side with 16.6%, 16.2%, and 12.9% in 2010, 2011, and 2012, respectively.

3. Literature review

Both the theoretical and empirical literature on the macroeconomic effects of budget deficit depends on the variable of interest; for example, private investment and income, interest rate, exchange rate, the trade balance or inflation. To the extent that our key macroeconomic variables of interest here is inflation, the review focuses on the literature on inflation.

Theoretical literature

The theoretical literature on the effect of budget deficit on inflation posits that the effect depends on the method of financing the deficit as well as the effect of the deficit on private investment and aggregate demand.

The fiscal theory of inflation predicts the link between fiscal deficit and inflation through changes in money supply, as well as an independent channel without affecting the supply of money. The channel through which changes in fiscal deficit affect inflation through its impact on the supply of money is the weak form, while the independent channel is the strong form fiscal theory of inflation. The weak form fiscal theory considers the fiscal authority and the monetary authority to be in a ‘game-of-chicken’ where the fiscal authority moves first by committing itself to a path for the budget deficit and the monetary authority is forced to move to generate the necessary seigniorage to maintain the solvency of the budget. Hence, there is fiscal dominance under this channel and monetary policy is said to be accommodative. The creation of seigniorage for fiscal deficit financing increases money supply and this leads to inflation. Thus, the idea of the weak form fiscal theory is that inflation is a monetary phenomenon influenced by fiscal behaviour.

The strong form fiscal theory posits that fiscal deficit can lead to inflation under a fixed money stock; in which case, prices are determined by the willingness of the public to hold money. Moreover, it maintains that, in the absence of the budget constraint of the government, prices are not uniquely determined. The theory, therefore, stresses the fact that in the long run, the government budget constraint is balanced and changes in fiscal policy affect the price level to the extent that the price level is the equilibrating factor to make the real value of government debts adjust to a level which makes it equal to the fiscal budget balance. The shift in price level occurs as a result of the perception of the market about the sustainability of government budget. An increase in price level is the case as long as individuals have the expectation that the deficit is unsustainable. The strong form fiscal theory, however, require very elastic interest elasticity of money demand since it is only under this situation that changes in fiscal policy can directly

affect price level (and hence, real money demand) with an unchanged money stock (Carlstrom and Fuerst, 1999).

Friedman (1968) argued that the monetary authorities can control the rate of inflation through the control of money supply. Moreover, fiscal deficit leads to inflation when it is monetized. He further argued that the effect of bond financing depends on whether interest rates are pegged or not. When interest rates are pegged, bond financing would require, at least in the long run, an increase in money supply, leading to inflation (Sergent and Wallace, 1981). He further argued that, bond-financed fiscal deficits causes interest rate to be so high that the financing method would eventually be monetization, thereby leading to inflation in the long run. Miller (1983) argued that whether deficit is monetized or not it leads to inflation. It leads to inflation through the crowding out effect of private investment once it is bond-financed (that is, bond financing increases interest rate and this crowds out private sector investment, thereby reducing output growth and hence causing rising price level.

While it is recognized that the effect of budget deficit on inflation depends, in part, on its effect on private investment, its effect on private investment depends on the relevance of the Neoclassical theory, the Keynesian school of thought or the Ricardian equivalence. According to the Neoclassical theory, individuals plan their consumption over their life cycle. Hence, budget deficit increases consumption while shifting taxes to future generations and the increase in consumption decreases saving (under the assumption of full employment). This leads to higher interest rate and decline in private investment and income. According to the Keynesian theory, budget deficit increases domestic production as there are unemployed resources and liquidity constraint. Thus, investors become more optimistic and increase private investment, which increases income. The Ricardian equivalence considers budget deficits and taxation to have equivalent effects on the economy (Barro, 1989). Hence national saving does not change since the increase in private saving is matched by an equivalent decline in public saving. To the extent that national saving, investment and aggregate demand do not change, budget deficit does not affect the price level.

The discussion reveals that, at the theoretical level, there is a link between deficit and monetary growth and deficit and inflation, with the strength of the relationship depending on the method of financing the deficit and the relevance of the crowding out effect.

Empirical literature

The empirical evidence on the effects of budget deficit on a particular variable is mixed and the approaches for investigation has been the use of Granger Causality test, Ordinary Least Squares, Vector Autoregression (VAR), Error Correction Models (ECM) and simultaneous equations model. Moreover, the empirical literature shows that both the method of financing and the components of government expenditure have different macroeconomic effects.

Darrat (1985) used the OLS to investigate the effects of fiscal deficit on inflation in the U.S. His result showed that fiscal deficit had a significant positive effect on inflation. This result is similar to the works of Metin (1995) who applied the error correction model to Turkey over the period 1950-1988 and Choudhary and Parai (1991) who applied the

rational expectation macro model of inflation, using quarterly data for Peru over the period 1973-1981. Other studies that have had similar results with Darrat (1985) are Dogas (1992) for Greece, Hondroyiannis and Papapetrou (1994) for Greece, Metin (1998) for Turkey, Egwakhide (1999) for Nigeria, Darrat (2000) for the U.S., and Tchokote (2005) for Cameroon. Studies that have found no relationship between fiscal deficit and inflation include Dwyer (1982) and Karras (1994). Most of the empirical studies on the effects of fiscal deficit on inflation revealed that, budget deficit that is financed by monetization leads to inflation and in general, the effect of budget deficit depends on the way the deficit is financed as well as the impact of the deficit on aggregate demand (Saleh, 2003).

Under the consideration that increased private investment and growth ameliorates inflation, other studies have investigated the effect of budget deficit on growth and private investment. Guess and Koford (1984) carried out Granger Causality test and showed that budget deficit did not cause economic growth in any of the OECD countries over the period 1949-1981. This is in contrast to the work of Landau (1983) who found, in a cross-sectional study, a negative relationship between budget deficit that arises from increase in public consumption and economic growth. The result of Guess and Koford (1984) is similar to that of Kormendi and Meguire (1985) for 47 countries over the period 1950-1977. Miller and Russek (1997) investigated the effects of budget deficit on private investment for a sample of developed and developing countries over the period 1975-1985. Their study revealed that both the method of financing and the component of government expenditure have different effects: while debt-financed increase in defence, health, social security and welfare has negative effect on economic growth in developing countries, debt-financed increase in education expenditure in developed countries has positive effect on economic growth, which is good for low inflation. Ghali (1997) investigated the relationship between government spending and economic growth in Saudi Arabia with the use of annual data over the period 1960-1996 and their study showed that government expenditure has no effect on economic growth, which implies that government spending has no effect on inflation through increased economic activities. This corroborates with the Ricardian equivalence hypothesis.

While some studies on the effects of budget deficit on macroeconomic performance used partial equilibrium approach, which adopts single equation technique (for example, Eisner, 1989) others have used a macroeconomic framework. Studies under this category include Aghveli and Sassanpour (1982) for Iran, Mansur (1989) for Philippines, Egwaikhide (1999) for Nigeria, Tchokote (2005) for Cameroon, Soludo (1997) for Nigeria, Olopoenia (1991) for Nigeria, and Bartoli (1989) for ten Latin American countries. However, none of these studies explicitly model the effects of fiscal deficit on the money supply to obtain the responsiveness of money supply to fiscal deficit. Egwakhide (1999), for example, handled the effect of fiscal deficit on the money supply through an identity.

The review of the empirical literature shows that, while much has been done on the inflationary effects of fiscal deficit in other developing countries, there is research vacuum in the case of Sierra Leone. Modelling the monetary response of fiscal deficit has not been considered in the literature, even for economies that often monetize their deficits. In other cases, the response has been treated as an identity where an increase in budget deficit increases the flow of money supply, as in Egwakhide (1999) and Tchokote (2005). This study, therefore, bridges these research gaps.

4. Methodology

The model

To the extent that the effects of fiscal deficit on inflation depends on how it is financed (though the composition of government expenditure also matters), the model takes into consideration the fact that fiscal deficit in Sierra Leone was financed mainly by domestic method, especially central bank lending to the government. This was the case especially before the adjustment policy that took off in 1992 while it was not zero in the post-1992 era. Thus, we obtained the elasticity of money supply with respect to budget deficit and estimated an inflation equation accounting for the role of monetary growth. We then traced the money supply growth necessary to achieve and maintain various rates of inflation in Sierra Leone, under various scenarios. The budget deficits consistent with these monetary growth rates were then obtained.

In what follows the model is discussed.

The inflation equation

The inflation equation rests on a simple model in which the price level is a weighted average of the price of tradeable goods (P^T) and non-tradeable goods (P^{NT}). That is:

$$\begin{aligned} \text{Ln}P_t &= \alpha(\text{Ln}P_t^T) + (1 - \alpha)(\text{Ln}P_t^{NT}) \\ 0 < \alpha < 1 \end{aligned} \tag{1}$$

The price of tradeable goods is determined in the world market and depends on foreign price (P^f) and the nominal exchange rate (e). Under the purchasing power parity (PPP):

$$\text{Ln}P_t^T = \text{Ln}e_t + \text{Ln}P_t^f \tag{2}$$

Equations 1 and 2 imply that nominal exchange rate depreciation or an increase in

foreign price level will increase the domestic price level through an increase in the price of tradeable goods.⁵

The price of non-tradeable goods is determined by the money market equilibrium condition (which posits that real money supply (M_s/P) is equal to real money demand (M_d/P). Hence:

$$\text{Ln}P_t^{NT} = \beta(\text{Ln}M_t^s - \text{Ln}M_t^d) \quad (3)$$

Where β is a scale factor representing the relationship between economy-wide demand and the demand for non-tradeable goods.

Standard theories of money demand function⁶ maintain that the demand for money is an increasing function of real income (RGDP) and a decreasing function of interest rate (i).

In Linear form, the demand for money function is given as:

$$\text{Ln}M_t^d = \gamma_0 + \gamma_1 \text{Ln}RGDP_t + \gamma_2 \text{Ln}i_t \quad (4)$$

$$\gamma_1 > 0, \gamma_2 < 0$$

Substituting (4) in (3) gives:

$$\text{Ln}P_t^{NT} = \beta(\text{Ln}M_t^s - \gamma_0 - \gamma_1 \text{Ln}RGDP_t - \gamma_2 \text{Ln}i_t) \quad (5)$$

Substituting (2) and (5) in (1) and holding foreign price level constant on the basis that it is out of the control of the domestic economy, the price equation is obtained as a function of domestic money supply, income, nominal exchange rate and interest rate. That is:

$$P = f(M^s, RGDP, e, i) \quad (6)$$

Given that inflation rate is the growth of price level (percentage change in the price level), the left hand-side and the right hand-side variables can be transformed into growth rates or changes; in which case, inflation would depend on the growth rates or changes in the variables on the right hand-side of Equation 6. In this model, change in interest rate and the percentage change in the levels of the other variables are used. Hence, the inflation equation can be written as follows:

$$INF = f(M^s g, RGDP g, EXR d, \Delta i) \quad (7)$$

Where INF is the rate of inflation, M2g is the growth of broad money supply, RGDPg is the growth of real GDP, EXRd is the depreciation of the nominal exchange rate and Δi is change in interest rate.

Since Sierra Leone had war over the period 1991-2001, Equation 7 is augmented by including a war dummy, DWAR, which takes a value of 0 in the war period and 1 otherwise. Given the importance of agricultural output in the economic activity of Sierra Leone, and the high dependence of the economy on import, both the growth of agricultural output (AGVg) and inflation in import price (Pmg), which is the percentage change in import price index, are included in the inflation equation. Thus, the inflation equation estimated is given as:

$$INF_t = \mu_0 + \mu_1 M2g_t + \mu_2 RGDP_{gt} + \mu_3 EXR_{dt} + \mu_4 \Delta i_t + \mu_5 AGV_g + \mu_6 Pm_g + \mu_7 DWAR + U_t$$

$$\mu_1, \mu_3, \mu_4, \mu_6, \mu_7 > 0 \text{ and } \mu_2, \mu_5 < 0 \quad (9)$$

Budget deficit elasticity of money supply

To the extent that budget deficit does not form part of the explanatory variables in Equation 9, and we are interested in the effect of budget deficit (BDEF) on inflation; the elasticity of money supply (M2) with respect to budget deficit is obtained. This procedure lies in the fact that, the effect of budget deficit on inflation works through its impact on money supply by the creation of seigniorage, though it can also operate through increase in interest rate where interest rates are not regulated. In addition, to the extent that budget deficit is a flow and money supply is a stock, the elasticity is obtained using the flow form of money supply, which stresses the idea that it is the growth of money supply but not its level that matters for inflation dynamics.

Hence, the elasticity of money supply (in flow form) with respect to budget deficit is given as in Equation 10. This linear trend approach is used for the elasticity estimation to account for outliers. Where, ' β ' is the elasticity of money supply with respect to budget deficit.

$$Ln(\Delta M2)_t = \alpha + \beta LnBDEF_t \quad (10)$$

To account for the change in fiscal behaviour where domestic financing, especially monetization, dominated deficit financing from 1975 to 1991 compared to 1992-2012 (the difference in behaviour was driven by the adjustment programmes that started in 1992) the elasticities are calculated for the periods 1975-1991, 1992-2012, and the whole period. The change in fiscal behaviour suggests that this elasticity is expected to be lower during the period 1992-2012 than during the period 1975-1991. The elasticity for the most recent period (1992-2012) is used in the simulation as it is the period with similar fiscal behaviour to what is expected to obtain during the simulation period (2015-2017).

Estimation technique and policy simulation calculations

Estimation technique

The model of inflation was estimated in the context of an autoregressive distributed lag (ARDL) by first testing the variables for stationarity. The importance of distributed lag model rests in the fact that it pays attention to the effect of delayed effect. Moreover, it tests the Olivera-Tanzi Effect, which states that high inflation leads to higher inflation through its negative impact on real value of revenue (caused by tax collection lags) and its positive impact on government expenditure and hence on budget deficit. This is the equivalence of a dynamic error correction model, but without an error correction term since the variables are stationary. Historical simulation by way of testing the forecasting ability of the inflation model is carried out and policy simulations are then carried out.

Required money supply, CPI, GDP deflator, nominal GDP and budget deficit (% of GDP)

From Equation 9, for a given target for inflation, the required money supply growth can be obtained for specific values of the significant right hand-side variables. This can be used to derive the required budget deficit in local currency, based on the elasticity consideration in Equation 10.

By plugging the required inflation rate, based on the medium-term targets from the *Agenda for Prosperity* document of the Government of Sierra Leone (2013), into the definition of inflation (Equation 11) the required price level is obtained for 2014 to 2017 since the data for 2013 is actual. Where P is the consumer price index and Inf is inflation rate.

$$Inf_t = \frac{P_t - P_{t-1}}{P_{t-1}} \times 100 \quad (11)$$

The required GDP deflator is then obtained by considering over the last five years of the estimation period (2008-2012) the proportionate relationship between change in the consumer price index and change in GDP deflator, as in Equation 12. Where GDPDEF is GDP deflator.

$$\frac{\Delta P_t}{\Delta GDPDEF_t} = \lambda_t \quad (12)$$

The mean and median value of λ over the period 2008-2012 is found to be 1.3. Hence, a value of 1.3 is used.

This relationship (Equation 12) was used to derive the corresponding GDP deflator for the period 2014-2017. Using the results from the elasticity estimation for flow of money supply with respect to budget deficit (Equation 10), the corresponding budget deficit is obtained. With the target for real GDP growth known from the country's *Agenda for Prosperity* document, the corresponding actual real GDP for 2014-2017 is obtained given that the real GDP for 2013 exists as actual series.

Given the derived values for GDP deflator and the derived real GDP, the required nominal GDP consistent with the real GDP growth target and target for inflation rates are obtained by multiplying the real GDP by the GDP deflator (and dividing by 100). The derived required budget deficit is then divided by the derived nominal GDP to have the budget deficit in percentage terms.

Data type and sources

The estimation was done with aggregate annual data from 1971 to 2012. The data was obtained from the International Financial Statistics (IFS), Government Financial Statistics, World Development Indicators and WAMA Data Base. The descriptions of the variables are given in Appendix Table A1. Appendix Table A2 shows the descriptive statistics of the variables.

5. Empirical results and analysis

Time series properties of the variables

To the extent that macroeconomic variables are often not stationary, and regression with non-stationary variables leads to misleading results, we tested the variables for unit root. The Dickey-Fuller and Phillip-Perron tests were used. A variable is considered stationary when at least one of the methods reveals stationarity. Tables 2 and 3 show the results of the unit root tests. The result shows that all the variables are stationary.

Table 2: Results of the unit root tests using Dickey-Fuller class of test

Variable		Dickey- Fuller (DF) Test		ADF Test (One Lag)		ADF Test (Two Lag)	
		Constant	Constant and Trend	Constant	Constant and Trend	Constant	Constant and Trend
Inflation	Level	-3.026*	-3.162	-2.189	-2.330	-1.640	-1.789
M2 Growth	Level	-3.007*	-3.018	-2.248	-2.266	-2.046	-2.057
Real GDP Growth	Level	-4.227**	-4.370**	-2.732	-2.868	-2.376	-2.522
Exchange Rate Depreciation	Level	-5.511**	-5.536**	-3.797**	-3.842*	-2.776	-2.825
Agricultural Output Growth	Level	-3.524*	-3.477	-2.983*	-2.944	-2.295	-2.264
Import Price Growth	Level	-5.622**	-5.836**	-4.684**	-4.995**	-3.663**	-4.059*
Change in Interest Rate	Level	-6.454**	-6.356**	-4.767**	-4.693**	-4.974**	-4.907**
Critical Values (DF and ADF Tests)							
Constant: 5% = -2.94 , 1% = -3.62				Constant and Trend: 5% = -3.53, 1% = -4.22			

Note: ** and * implies the variable is stationary at 1% and 5%, respectively.

Table 3: Results of the unit root tests using the Phillips-Perron test

VARIABLE		Phillips Perron Test Statistic	
		Constant	Constant and Trend
Inflation	Level	-2.964*	-2.980
M2 Growth	Level	-3.022*	-2.986
Real GDP Growth	Level	-4.449**	-4.536**
Exchange Rate Depreciation	Level	-5.723**	-5.672**
Agricultural Output Growth	Level	-3.67**	-3.62
Import Price Growth	Level	-5.74**	-6.05**
Change in Interest Rate	Level	-6.834**	-6.719**

Critical Values for the Phillips-Perron Tests

Constant: 5% = -2.93 , 1% = -3.61 Constant and Trend: 5% = -3.53, 1% = -4.21
Lag Truncation for Battlett Kernel: 3

Note: ** and * implies the variable is stationary at 1% and 5%, respectively.

The result of the inflation model

Having found that all the variables are stationary, there is no need for cointegration test as it is a test useful when the model contains non-stationary variables. An autoregressive distributed lag (ARDL) model of inflation was, therefore, estimated on the grounds that it reveals the dynamic nature of the process that explains inflation by attaching importance to, not only contemporaneous effects, but also lagged effects.

The autoregressive distributed lag (ARDL) model of inflation was estimated with an initial lag length of one in order to save the degrees of freedom. Appendix Table A3 shows the initial (over-parametized) general ARDL model of inflation. The over-parametized model was reduced to a parsimonious model by deleting insignificant variables one by one in order of high p-values. The parsimonious model that explains inflation in Sierra Leone is given in Table 4, together with the diagnostic tests (at the bottom of the table).

The general-to-specific arrival at the parsimonious model of inflation shows that, change in interest rate, growth of agricultural output, growth of import price and the war dummy are not significant in explaining inflation in Sierra Leone. The insignificance of interest rate suggests weak transmission of interest rate to domestic prices and hence weak transmission of the interest rate channel of monetary policy in Sierra Leone. The insignificance of agricultural output growth could reflect the fact that agricultural output and real GDP are strongly collinear, given a correlation coefficient of 0.55 (significant at 1%). The insignificance of import price growth could reflect the fact that the pass-through of international prices to domestic prices in Sierra Leone is more important when it works through the exchange rate but not through import price itself, as measured by import price index. Table 5 shows the correlation matrix of the variables, which further shows that money growth and exchange rate are the variables with significant correlations with inflation rate and real GDP growth has a negative, but insignificant correlation coefficient with inflation rate.

Table 4: Result of the autoregressive model of inflation

The estimation sample is: 1973 - 2012					
	Coefficient	Std.Error	t-value	t-prob	Part.R ²
M2g	0.528351	0.1396	3.78	0.0006	0.2904
M2g_1	0.396562	0.1660	2.39	0.0224	0.1402
RGDPg	-0.725562	0.3461	-2.10	0.0433	0.1116
EXRd_1	0.204745	0.03146	6.51	0.0000	0.5476
Constant	-4.05412	5.439	-0.745	0.4610	0.0156
sigma	14.565	RSS	7424.86921		
R ²	0.857935	F(4,35) =	52.84 [0.000]**		
log-likelihood	-161.232	DW	1.49		
AR 1-2 test:	F(2,33) =	1.8447	[0.1740]		
ARCH 1-1 test:	F(1,33) =	0.21752	[0.6440]		
Normality test:	Chi ² (2) =	4.8749	[0.0874]		
Hetero test:	F(8,26) =	1.0467	[0.4283]		
Hetero-X test:	F(14,20) =	1.6573	[0.1471]		
RESET test:	F(1,34) =	0.081076	[0.7776]		

The ARDL model of inflation shows that the growth of money supply, exchange rate depreciation and real GDP growth are the determinants of inflation in Sierra Leone. Money supply growth and exchange rate depreciation have positive effects on inflation while real GDP growth has a negative effect. This implies that inflation in Sierra Leone is explained by demand pressure, exchange rate pass-through and supply-side factors. Moreover, both contemporaneous and one-period lagged value of money supply growth are significant, only the contemporaneous value of real GDP growth is significant and it is the one-period lagged value of exchange rate depreciation that is significant. The R-squared show that, about 85.8% of the inflation variation in Sierra Leone is explained by the growth of money supply, exchange rate depreciation and real GDP growth. The F-Statistic shows that the variables are jointly significant at the 1% level.

The insignificance of the war dummy is attributed to the fact that, in Sierra Leone, the pre-war period (1971-1991) was a non-adjustment period and inflation rate was extremely high, especially after the mid- 1970s, under the existence of regulated interest rates, fixed exchange rate and high budget deficit. However, while the war started in 1991, adjustment started in 1992 with liberalized interest rate, collapse of fixed exchange rate regime in 1990 with foreign exchange rate bureau in operation in 1992 and improved fiscal behaviour in terms of degree of monetization of fiscal deficit followed. Hence, money growth was lower in the war period which coincided with the adjustment period, than the pre-war period. Thus, the inflation rate of the war-period was lower than the pre-war period though the growth of real GDP was lower in the war period than the pre-war period. Inflation rate of the post-war period is, however, lower than the case of the war period. This is because the post-war period has the characteristics of adjustment period and high growth of GDP relative to the war period. Thus, a dummy capturing war and non-war period where non-war period does not only include post-war period but also pre-

war period, can reveal an insignificant effect. This is because it tests essentially whether war period inflation is significantly higher than non-war period, which constitutes both the pre-war and the post-war periods.

The diagnostic tests (at the bottom of Table 4) show that the estimated model residuals are normally distributed with constant variance (no heteroscedasticity). Moreover, the model is free from autocorrelations, autoregressive conditional heteroscedasticity and functional form misspecification. Model stability tests were also carried out; figures 4 and 5 shows the results of the model stability tests. The figures show that the parameters of the inflation model are stable as the recursive estimates are within the 5% band over the estimation period.

Table 5: Correlation matrix of variables in the inflation model

Correlation (Probability)	INF	M2g	EXRd	RGDPg	Δi	AGVg	PMg
INF	1.000000 -						
M2g	0.689943 (0.0000)	1.000000 -					
EXRd	0.391265 (0.0114)	0.641734 (0.0000)	1.000000 -				
RGDPg	-0.180793 (0.2580)	-0.155986 (0.3301)	-0.164348 (0.3045)	1.000000 -			
Δi	0.295161 (0.0610)	0.208346 (0.1911)	0.138354 (0.3883)	-0.077258 (0.6311)	1.000000 -		
AGVg	0.073586 (0.6475)	0.091608 (0.5689)	0.031684 (0.8441)	0.545603 (0.0002)	0.074551 (0.6432)	1.000000 -	
Pmg	0.201130 (0.2073)	-0.261118 (0.0991)	-0.327053 (0.0369)	0.076402 (0.6349)	0.072588 (0.6520)	0.142583 (0.3738)	1.000000 -

Figure 4: Model stability test with CUSUM test

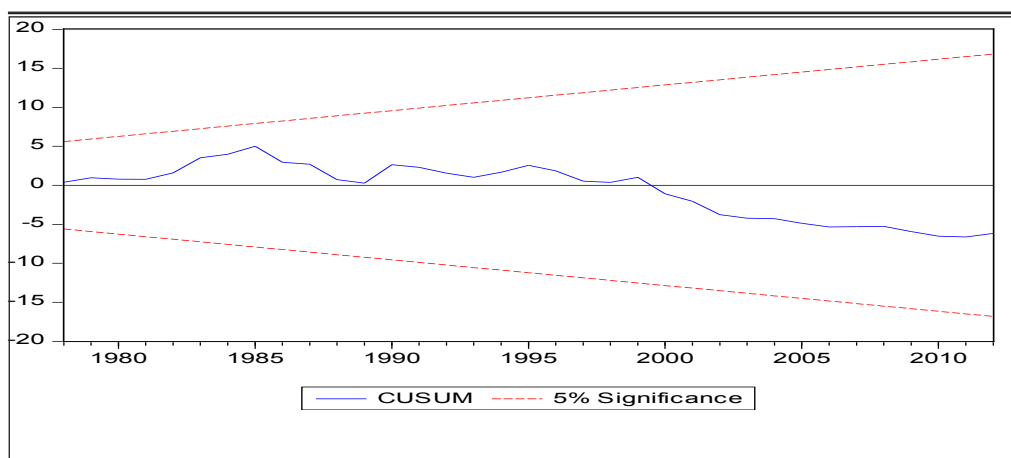
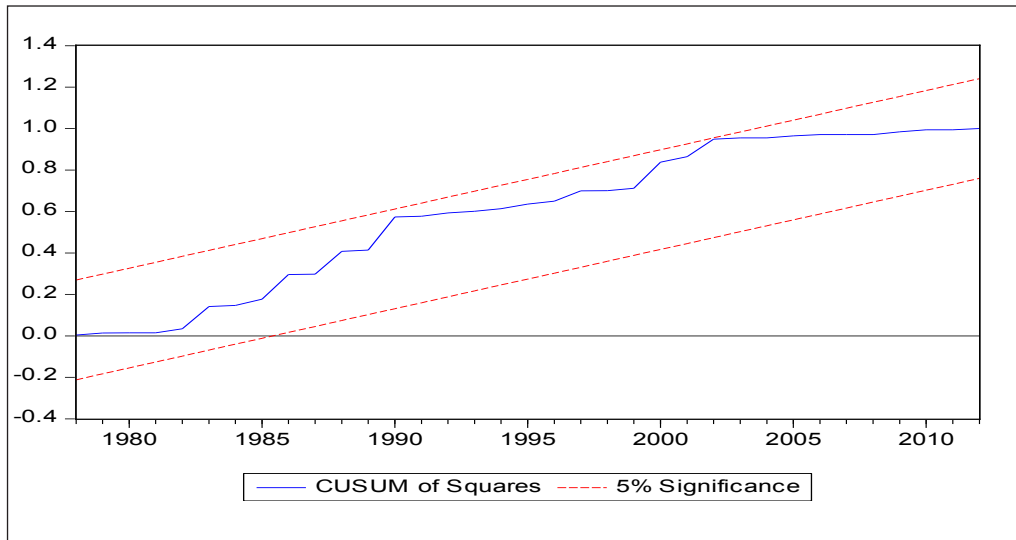


Figure 5: Model stability test with CUSUM square test



Budget deficit elasticity of money supply

The estimated version of Equation 10 to reveal the budget deficit elasticity of flow of money supply is given in (13) to (15). The result shows that the elasticity of flow of money supply with respect to budget deficit over the period 1992-2012 is 1.02, and it is 1.31 over the period 1975-1991, while it is 0.95 for the period 1975-2012. The period 1972-1974 was also a period with low seigniorage relative to 1975-1991; but given the size of the observations, this period was not used for the calculation of the elasticity. In addition, it is far from our policy simulation period (2015-2017).

$$\ln(\Delta M2) = -2.46 + 1.31 \ln BDEF, \quad \text{for 1975-1991} \tag{13}$$

$$\ln(\Delta M2) = -1.53 + 1.02 \ln BDEF, \quad \text{for 1992-2012} \tag{14}$$

$$\ln(\Delta M2) = -0.50 + 0.95 \ln BDEF, \quad \text{for 1975-2012} \tag{15}$$

Historical simulation

Historical simulation, which is the conventional approach to the evaluation of the forecasting performance of a model, was used to determine the forecasting performance of the inflation model. This includes an examination of the graphs of actual

and simulated values and the use of summary statistics such as: the Theil's inequality coefficient and its decomposition, and the correlation coefficient between the actual and simulated values of the series.

Figure 6 shows the graphs of actual and historically simulated values of inflation. The figure shows that, the time paths of the historical and simulated series are close and more importantly, turning points of the actual series are well tracked by the historically simulated series.

Figure 6: Graphs of actual and simulated values of inflation

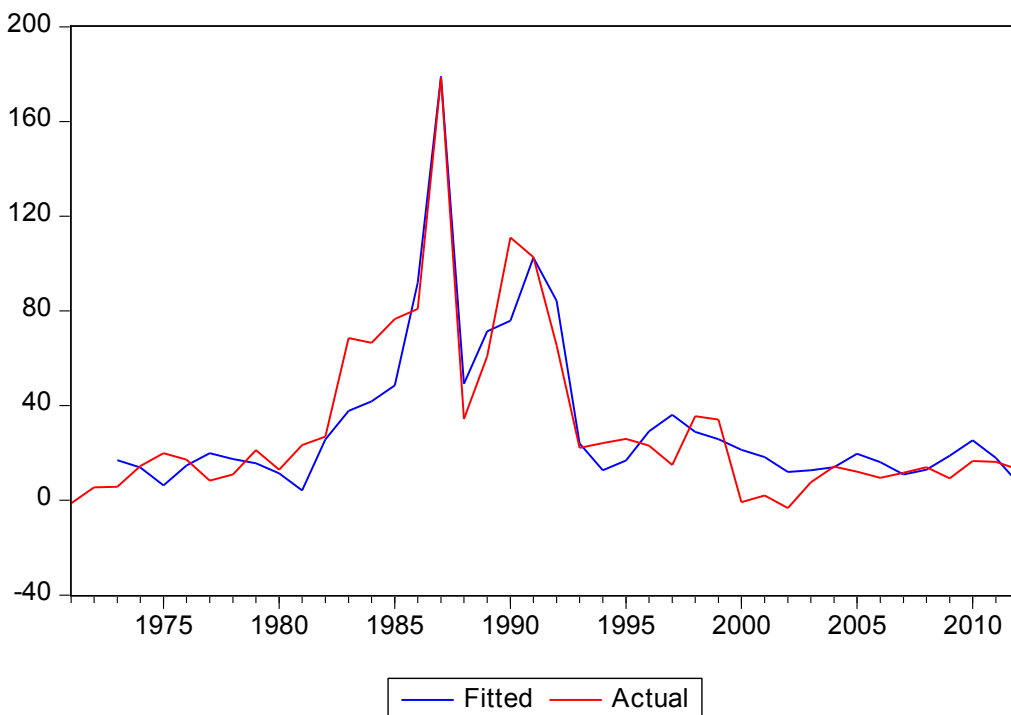


Table 6 shows the summary statistics of the model validation. The Theil's inequality coefficient is 0.14. A detailed analysis of the Theil's inequality coefficient requires knowledge of its decomposition. The bias proportion of the Theil's inequality coefficient is zero. This shows that the cause of the discrepancy between the actual and simulated values is not precipitated by the differences between their means. The variance proportion of the Theil's inequality coefficient is also low, a value of 0.04. This shows that the discrepancy between the simulated and actual series is not precipitated by differences between their variances. The covariance proportion is 0.96; it shows that the discrepancy between the actual and simulated series is due to their imperfect covariance. Nothing can be done about this, in order to improve forecasting ability. The correlation coefficient between the actual and fitted values is 0.93 and is significant at the 1% level, also suggesting the appropriateness of the model for policy simulation. These values are the expectations for a model with good forecasting performance.

To the extent that a model is a good predictor of the historical series, when both the bias and variance proportions are low, and the covariance proportion is high, the

estimated model is suitable for forecasting and policy simulation. This is also supported by the high correlation coefficients between actual and simulated series, which is 0.93.

Table 6: Summary statistics of the inflation model validation

Measure	Value	
Correlation Between Actual and Fitted*	0.93 (0.00)	
Root Mean Squared Error	13.62	
Mean Absolute Error	10.34	
Mean Absolute Percent Error	136.90	
Theil's Inequality	0.14	
Decomposition of Theil's Inequality		
	Bias Proportion	0.00
	Variance Proportion	0.04
	Covariance Proportion	0.96

* Figure in parenthesis is the p-value for the null hypothesis of insignificant coefficient.

Policy simulation

The *Agenda for Prosperity*, which is Sierra Leone's Third Generation Poverty Reduction Strategy Paper, has a section on medium-term macroeconomic objectives. Among the macroeconomic targets is that the inflation rates for 2015, 2016, and 2017 are 6.0%, 5.4% and 5.4%, respectively. Against this background, we carried out simulation experiments which asked the questions: (i) what should be the required budget deficit to achieve the rate of inflation in Sierra Leone at 6.0%, 5.4% and 5.4% for the periods 2015, 2016, and 2017, respectively? (ii) What should be the corresponding growth of money supply for these periods?

To answer these questions, the parameters of the estimated inflation equation under real GDP growth that is based on the medium-term macroeconomic target for real GDP growth and some assumptions about exchange rate depreciation were used. The growth of money supply and budget deficit (excluding grants) as a ratio of GDP that is required to achieve these inflation rates were obtained. To the extent that money growth, exchange rate depreciation and real GDP growth are found to be the determinants of inflation, the following four scenarios were considered in the simulation:

- I. Stable exchange rate and high real GDP growth.
- II. Stable exchange rate and low real GDP growth.
- III. Unstable exchange rate and high real GDP growth.
- IV. Unstable exchange rate and low real GDP growth.

The model, therefore, assumes that exogenous shocks affect the economy through exchange rate changes or changes in demand and supply conditions that affect output. Thus, scenario I above corresponds to the best case scenario for policy makers, while scenario IV corresponds to the worst case scenario.

In terms of characterizing stable exchange rate, we gave recourse to the depreciation rates of the Leone with respect to the US dollar during the post-war period, which is 2002- 2012. The data reveals that, with the exception of the depreciation rate of -1.0% in 2012, representing an appreciation of the Leone, the least depreciation was 0.1% (in

2007), while the highest was 26.7% (in 2009). Thus, a depreciation rate of 0.1% and 26.7% were used as the quantitative values defining strong stability and high instability of the exchange rate.

In the case of high real GDP growth, we used the medium-term target for real GDP growth, including iron ore. This is on the grounds that real GDP growth, which was 6.0% in 2011 and (averaged about 6.0% during the period 2003-2011), was 15.2% and 20.1% in 2012 and 2013, respectively, following the discovery and mining of iron ore⁷ in Sierra Leone in 2012. In the case of low real GDP growth, we used the medium-term target for real GDP growth that excludes iron ore.

The medium-term iron ore inclusive real GDP growth based on the *Agenda for Prosperity* of the Government of Sierra Leone are 12.4%, 7.7%, and 5.2%, respectively, for 2015, 2016, and 2017; while for the non-iron ore real GDP, the growth target is 6.6%, 6.6%, and 7.0%, respectively. However, since for 2017 the non-iron ore GDP growth target of 7.0% is higher than the iron ore inclusive growth target of 5.2%, 7.0% is used under high real GDP growth and 5.2% is used under low real GDP growth case for 2017. The results of the simulation experiments are given in Table 7.

The results of the simulation show that, to achieve the medium-term target for inflation rates of 6.0%, 5.4%, and 5.4% in 2015, 2016, and 2017, respectively, the required budget deficit, excluding grants, (% of GDP) should be between 6.0% and 11.1% in 2015. The exact numerical value depends on the stability of the exchange rate and the growth of real GDP. For 2015, an exchange rate depreciation of 26.7% combined with a real GDP growth of 6.6% is consistent with the least value of 6.0% of GDP while an exchange rate depreciation of 1.0% combined with a real GDP growth of 12.4% is consistent with the highest value of 11.1% of GDP. The corresponding budget deficits for achieving Sierra Leone's medium-term inflation rates of 5.4% for 2016 and 5.4% for 2017 are: 5.6% of GDP to 9.3% of GDP for 2016, and 4.9% of GDP to 9.3% of GDP for 2017. The exact numerical value also depends on the rate of depreciation of the exchange rate and the growth of real GDP, as in the case for 2015.

The results of the simulation also reveal that, to achieve the medium-term target for inflation rates of 6.0%, 5.4%, and 5.4% in 2015, 2016, and 2017, respectively, the underlying required money supply growth should be between 10.4% and 20.7% in 2015. The exact numerical value depends on the stability of the exchange rate and the growth of real GDP. An exchange rate depreciation of 26.7%, combined with a real GDP growth of 6.6%, is consistent with the least value of 10.4%; while an exchange rate depreciation of 1.0%, combined with a real GDP growth of 12.4%, is consistent with the highest value of 20.7%. The corresponding growth of money supply for achieving Sierra Leone's medium-term inflation rates of 5.4% for 2016 and 5.4% for 2017 are: 9.7% to 16.4% for 2016 and 8.6% to 15.8% for 2017. The exact numerical value also depends on the rate of depreciation of the exchange rate and the growth of real GDP.

In terms of procedure, the following was done: by plugging the required inflation rate based on the targets from the *Agenda for Prosperity* document into the definition of inflation, the required price level is obtained for 2014-2017 since the data for 2013 is actual. The required GDP deflator is then obtained by considering over the last five years of the estimation period (2008-2012) the proportionate relationship between change in the consumer price index and change in GDP deflator. This relationship was used to derive the corresponding GDP deflator for 2014-2017 (from Equation 12 and Equation 11).

Table 7: Budget deficit and growth of money supply required to meet the medium-term inflation target for Sierra Leone

ASSUMPTIONS→ ↓	Required Budget Deficit, excluding grants (% of GDP)							
	Suppose Real GDP grows at its Medium-Term Target for iron ore included GDP				Suppose Real GDP grows at its Medium-Term Target for non-iron ore GDP			
	2014	2015	2016	2017	2014	2015	2016	2017
Exchange Rate Depreciation at its Best Case (Stable Exchange Rate)	12.1	11.1	9.3	9.3	9.7	9.3	9.3	9.0
Exchange Rate Depreciation at its Worst Case (Unstable Exchange Rate)	12.1	8.1	5.8	5.4	9.7	6.0	5.6	4.9

ASSUMPTIONS→ ↓	Required Money Supply Growth							
	Suppose Real GDP grows at its Medium-Term Target for iron ore included GDP				Suppose Real GDP grows at its Medium-Term Target for non-iron ore GDP			
	2014	2015	2016	2017	2014	2015	2016	2017
Exchange Rate Depreciation at its best case (Stable Exchange Rate)	23.5	20.7	16.4	15.8	17.4	16.1	15.5	14.4
Exchange Rate Depreciation at its Worst Case (Unstable Exchange Rate)	23.5	15.0	10.6	10.0	17.4	10.4	9.7	8.6

Using the results from the elasticity estimation, for flow of money supply with respect to budget deficit, the corresponding budget deficit is obtained (from Equation 10). With the target for real GDP growth known from the country's *Agenda for Prosperity* document, the actual real GDP for 2014-2017 is obtained given the real GDP for 2013 to be actual. Given the values for GDP deflator and the derived real GDP, the required nominal GDP consistent with the real GDP growth target and target for inflation rates are obtained by multiplying the real GDP by the GDP deflator (and dividing by 100). The derived required budget deficit is then divided by the derived nominal GDP to have the derived budget deficit in percentage terms.

6. Conclusion, policy implication and recommendations

Conclusion

Given the growing inflationary pressure in Sierra Leone and persistent budget deficit, often financed largely by monetization though fiscal behaviour in terms of seigniorage creation reduced following the start of adjustment in 1992, the paper has sought to investigate the quantitative effects of budget deficit on inflation in Sierra Leone. Annual data from 1971 to 2012 was used to estimate a model of inflation under the autoregressive distributed lag (ARDL) model structure to account for the model dynamics (lag impact of variables) on inflation. Policy simulations were then carried out for the period 2015-2017.

Tests for unit root were carried out and the results reveal that all the variables are stationary. The estimated model of inflation shows that, inflation is determined negatively by real GDP growth and positively by money supply growth and exchange rate depreciation.

The simulation experiments carried out from the estimation results reveal that, to achieve Sierra Leone's medium-term target inflation rate of 6.0%, 5.4%, and 5.4% for 2015, 2016, and 2017, respectively, the required money supply and underlying budget deficit depends on the degree of exchange rate depreciation and real GDP growth. Specifically, money supply growth has to be between 10.4% and 20.7% in 2015. A value closer to the lower limit here is preferred when the depreciation of the exchange rate is closer to 26.7% and real GDP growth is closer to 6.6%, while a value closer to the upper limit is preferred when the depreciation of the exchange rate is closer to 0.1% and real GDP growth is closer to 12.4%. Money supply growth has to be between 9.7% and 16.4% in 2016 to achieve the inflation target for 2016 and a value closer to the lower limit here is preferred when the depreciation of the exchange rate is closer to 26.7% and real GDP growth is closer to 6.6%; while a value closer to the upper limit is preferred when the depreciation of the exchange rate is closer to 0.1% and real GDP growth is closer to 7.7%. It has to be between 8.6% and 15.8% in 2017 to achieve the 2017 target for inflation rate (5.4%), and a value closer to the lower limit is preferred when the depreciation of the exchange rate is closer to 26.7% and real GDP growth is closer to 5.2%; while a value closer to the upper limit is preferred when the depreciation of the exchange rate is closer to 0.1% and real GDP growth is closer to 7.0%.

With respect to the required budget deficit for the achievement of Sierra Leone's medium-term target inflation rate of 6.0%, 5.4%, and 5.4% for 2015, 2016, and 2017, respectively, budget deficit, excluding grants (% of GDP) has to be between 6.0% and

11.1% in 2015. A value closer to the lower limit is preferred when the depreciation of the exchange rate is closer to 26.7%, and real GDP growth is closer to 6.6%; while a value closer to the upper limit is preferred when the depreciation of the exchange rate is closer to 0.1%, and real GDP growth is closer to 12.4%. Budget deficit, excluding grants (% of GDP), has to be between 5.6% of GDP and 9.3% in 2016 to achieve the inflation target for 2016, and a value closer to the lower limit is preferred when the depreciation of the exchange rate is closer to 26.7%, and real GDP growth is closer to 6.6%; while a value closer to the upper limit is preferred when the depreciation of the exchange rate is closer to 0.1%, and real GDP growth is closer to 7.7%. Budget deficit, excluding grants (% of GDP), has to be between 8.6% and 15.8% in 2017 to achieve the 2017 target for inflation rate (5.4%), and a value closer to the lower limit is preferred when the depreciation of the exchange rate is closer to 26.7%, and real GDP growth is closer to 5.2%; while a value closer to the upper limit is preferred when the depreciation of the exchange rate is closer to 0.1% and real GDP growth is closer to 7.0%.

Policy implication and recommendations

Based on the results of the study, the following recommendations are useful to policy makers in Sierra Leone.

In the interest of low inflation rate, the conduct of monetary policy in Sierra Leone should be done by making forecast for the nominal exchange rate, growth of real GDP, and a target for inflation rate such that the required target for money supply (M2) is obtained from a simulation process from a structural model of inflation. The instruments of monetary policy can then be applied to hit the intermediate target, which is broad money (M2).

The liquidity management process, which maintains the growth of broad money supply between 10.4% and 20.7% in 2015, 9.7% and 16.4% in 2016, and 8.6% and 15.8% in 2017, is a good option to achieve the medium-term inflation rates of 6.0%, 5.4%, and 5.4% in 2015, 2016, and 2017, respectively. The actual growth rate of money supply from these ranges should depend on the expected growth of real GDP and exchange rate depreciation. In periods of high real GDP growth (about 12.4% for 2015, 7.7% for 2016, and 7.0% for 2017) and low exchange rate depreciation (about 0.1%) money supply growth that is closer to the upper limits are appropriate, while when real GDP growth is expected to be low (about 6.6% for 2015, 6.6% for 2016, and 5.2% for 2017) and expected exchange rate depreciation is high (about 26.7%) values closer to the lower limits are preferred.

A fiscal policy rule that keeps the budget deficit, excluding grants (% of GDP), at 6.0% in 2015, 5.6% in 2016, and 4.9% in 2017 is a good option to achieve the medium-term inflation targets of 6.0%, 5.4%, and 5.4% in 2015, 2016, and 2017, respectively. For exchange rate depreciation that is lower than 26.7% in 2015, 2016, and 2017 and an expected real GDP growth that is higher than 6.6% in 2015, 6.6% in 2016 and 5.2% in 2017, budget deficit (excluding grants) that is not as tight as these ones are appropriate, where the point where the upper limit for 2015 is 11.1%; for 2016 it is 9.3% and for 2017 it is also 9.3%. This is the case when the annual exchange rate depreciation is about 0.1% and GDP growth is about 12.4% in 2015, 7.7% in 2016 and 7.0% in 2017.

The conduct of monetary and fiscal policies in accordance with the observed limits for broad money growth and fiscal deficit, as a percentage of GDP, should be through a coordination between the monetary and fiscal authorities such that fiscal and monetary authorities play the ‘chicken game’ by these rules and the fiscal operations do not renege on the rules since such a default would make it incentive compatible for the monetary authorities to accommodate the fiscal authorities to a suboptimal degree. This is more important given the fact that there are other macroeconomic objectives of policy makers, including sustained and inclusive economic growth, while the central bank has low inflation objective among its primary goals.

To the extent that real GDP has negative impact on inflation in Sierra Leone, it is important that the authorities pay attention to supply-side policies that increase the output of the economy in an effort to reduce the rate of inflation, thus strengthening the credibility of the central bank. These include continued effort at building the health, education, transport, communication, electricity, water, and justice sectors of the economy, as well as private sector growth support policies.

As depreciation of the nominal exchange rate leads to higher inflation in Sierra Leone, it is important for the country to increase investment in the tradeable goods sector in order to increase export earnings of Sierra Leone, which has favourable impact on exchange rate stabilization. This also includes policies that enable Sierra Leone to have the maximum foreign exchange earnings from mining sector activities.

Notes

1. Governments of LDCs, including Sierra Leone, used to regulate their interest rates, particularly in the 1980s, in an effort to obtain cheap credit from the banking sector in order to finance their fiscal deficits.
2. Seigniorage is calculated as change in reserve money expressed as a percentage of GDP.
3. The war started about one and half years after the resumption of adjustment programmes in November 1989.
4. Sierra Leone had its first democratically elected government, since 1968, in March 1996 and was overthrown in May 1997 but reinstated in February 1998.
5. This is referred to as the exchange rate pass-through effect.
6. The standard money demand functions are the Quantity Theory of money, Keynes demand function, Friedman's restatement of the Quantity Theory of Money, and the Baumol-Tobin Model.
7. This mineral is mined and exported by the African Minerals, with the government getting royalty (and not tax) from production while a number of Sierra Leoneans have gained employment since its operation started.

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Appendix

Table A1: Data sources and description

Variable	Symbol	Description	Source
Inflation	INF	Percentage change in Consumer Price Index	Calculated by Author
Budget Deficit	BDEF	Overall fiscal deficit	Government Financial Statistics and WAMA Data Base
Money Supply	M 2	Broad money supply-that is, narrow money supply plus quasi money	International Financial Statistics
Nominal Exchange Rate	EXR	Period average of the price of one U.S dollar in Leones	International Financial Statistic
Nominal GDP	NGDP	Gross Domestic Product at current market price	International Financial Statistics
Nominal Interest Rate	i	Treasury Bill Rate	International Financial Statistics
Price Level	P	The Consumer Price Index with 2000 as the base year	International Financial Statistics
Real Gross Domestic Product	RGDP	Gross Domestic Product at constant prices (2005 prices)	World Development Indicators
Agricultural Output	AGV	Agricultural Value Added at Constant Prices (2005 prices)	World Development Indicators
Import Price	Pm	Import Price Index	African Development Indicators
GDP Deflator	GDPDEF	The deflator for the Nominal GDP	World Development Indicators

Table A2: Descriptive statistics of model variables

	Inflation Rate	Money Supply Growth	Exchange Rate Deprecia- tion	Real GDP Growth	Change in Interest Rate	Growth of Agricul- tural Value Added	Growth of Import Price
Mean	32.0	32.7	37.5	2.3	0.4	5.1	13.5
Median	17.2	26.1	9.0	2.4	0.6	4.6	9.1
Maximum	178.7	88.4	583.1	26.3	28.0	49.8	142.4
Minimum	-3.3	2.6	-35.3	-19.0	-50.0	-37.5	-52.4
Std. Dev.	36.4	20.8	97.4	6.9	11.6	14.0	35.5
Skewness	2.1	1.2	4.5	0.2	-1.6	0.0	2.0
Kurtosis	8.0	3.4	25.4	6.9	10.8	6.9	8.0
Jarque-Bera Probability	74.1 0.0	9.5 0.0	999.7 0.0	26.5 0.0	119.9 0.0	25.6 0.0	69.9 0.0
Observations	41	41	41	41	41	41	41

Table A3: The initial (Over-parametrized) general ARDL model of inflation**Modelling inf by OLS**

	Coefficient	Std.Error	t-value	t-prob	Part.R ²
inf_1	0.172348	0.1308	1.32	0.1996	0.0649
Constant	4.78972	7.995	0.599	0.5545	0.0142
M2g	0.437451	0.1991	2.20	0.0375	0.1619
M2g_1	0.0330987	0.2431	0.136	0.8928	0.0007
RGDPg	-0.989512	0.5256	-1.88	0.0714	0.1242
RGDPg_1	-0.358570	0.5008	-0.716	0.4806	0.0201
EXRd	0.0343949	0.03483	0.987	0.3329	0.0375
EXRd_1	0.201065	0.04062	4.95	0.0000	0.4950
	0.183895	0.2408	0.764	0.4523	0.0228
	-0.0891800	0.2224	-0.401	0.6918	0.0064
Pmg	0.108296	0.08839	1.23	0.2319	0.0566
Pmg_1	-0.127556	0.09275	-1.38	0.1813	0.0703
AGVg	0.304746	0.2162	1.41	0.1710	0.0736
AGVg_1	0.251687	0.2256	1.12	0.2751	0.0474
DWAR	-7.01280	6.923	-1.01	0.3208	0.0394
sigma	14.2811	RSS	5098.74097		
R ²	0.902442	F(14,25) =	16.52 [0.000]**		
log-likelihood	-153.715	DW	1.4		
AR 1-2 test:	F(2,23) =	4.3433	[0.0251]*		
ARCH 1-1 test:	F(1,23) =	0.00014321	[0.9906]		
Normality test:	Chi ² (2) =	5.3146	[0.0701]		
Hetero test:	Chi ² (27) =	34.114	[0.1628]		
Hetero-X test:	not enough observations				
RESET test:	F(1,24) =	0.010060	[0.9209]		

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