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Analysis of budget deficits and macroeconomic fundamentals: A VAR-VECM approach

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Abstract

Aim/purpose – This paper examines the relationship between budget deficits and selected macroeconomic variables in Tanzania for the period spanning from 1966 to 2015.

Design/methodology/approach – The paper uses Vector autoregression (VAR) – Vector Error Correction Model (VECM) and variance decomposition techniques. The Johansen's test is applied to examine the long run relationship among the variables under study.

Findings – The Johansen's test of cointegration indicates that the variables are cointegrated and thus have a long run relationship. The results based on the VAR-VECM estimation show that real GDP and exchange rate have a negative and significant relationship with budget deficit whereas inflation, money supply and lending interest rate have a positive one. Variance decomposition results show that variances in the budget deficits are mostly explained by the real GDP, followed by inflation and real exchange rate.

Research implications/limitations – Results are very indicative, but highlight the importance of containing inflation and money supply to check their effects on budget deficits over the short run and long-run periods. Also, policy recommendation calls for fiscal authorities in Tanzania to adopt efficient and effective methods of tax collection and public sector spending.

Originality/value/contribution – Tanzania has been experiencing budget deficit since the 1970s and that this budget deficit has been blamed for high indebtedness, inflation and poor investment and growth. The paper contributes to the empirical debate on the causal relationship between budget deficits and macroeconomic variables by employing VAR-VECM and variance decomposition approaches.

Keywords: budget deficit, macroeconomic variables, VAR-VECM.
JEL Classification: C22, E62, H62.

1. Introduction

The budget deficit occupies great attention to policy makers because its size and ways of financing it, determines the fiscal constraints that a country will be subject to in the long term. In recent times, the budget deficit position of many developing countries has worsened, drawing attention to its long term sustainability. As these low income countries consistently operate budget deficit, government debts tend to accumulate.

Budget deficit which arises from fiscal operations of the government whenever expenditure exceeds revenue, can be financed through a number of ways including government borrowing domestically and from international sources, printing money by the central bank and through foreign aid from donor governments and agencies. However, through borrowing, interest payments tend to grow higher as past deficit adds up to current borrowings. This calls for further borrowing to cover the interest payment and the increasing primary deficit, which in turn affects the rate of future borrowing. Indeed, if the budget deficit is financed by borrowing from the domestic banking system, there will be an increase in the domestic interest rates and the crowding out of private borrowers [Easterly & Schmidt-Hebbel 1993]. Moreover, monetization of the deficit results to an increase in the money supply and the rate of inflation [Friedman 1981; Ahking & Miller 1985; IMF 1995; Vuyyuri & Seshaiah 2004]. Also, exchange rate may appreciate due to budget deficit. The appreciation of the exchange rate may result from the inflow of foreign exchange, making the country's exports less competitive. This in turn, leads to the deterioration of the current account balance. Also, as Herr & Priewe [2005] and Brownbridge & Tumusiime-Mutebile [2007] point out, less competitive exports may lead to resources moving away from the production of tradables to the production of non-tradables.

In most low income countries persistent budget deficit is a result of ever expanding government expenditure, inadequate revenue generation capacity of government and increasing debt levels [Pomeyie 2001]. Because of narrow tax base, structural characteristics of the economies and unsophisticated nature of tax administration, low income countries lack the capacity to raise sufficient revenue from domestic and external sources. However, it is very important to note that excessive fiscal deficit may result into debt crisis because it leads to the growth of the country's external debt stock [Easterly & Schmidt-Hebbel 1993; IMF 1995]. Thus, budget deficit has huge impact on the financial, economic and political stability of the country. Notable, the extent of the impact of budget deficits on an economy is determined by macroeconomic factors such as inflation rate, real GDP, money supply, real interest rate, and exchange rate [see Ndanshau 2012; Lwanga & Mawejje 2014].

The objective of this paper is to examine the relationship between budget deficits and macroeconomic variables in Tanzania using an econometric approach. It is important to examine the determinants of budget deficits in Tanzania because, despite the growing literature on the relationship between budget deficits and macroeconomic variables, the country has been experiencing budget deficit since the 1970s and that this budget deficit has been blamed for high indebtedness, inflation and poor investment and growth. The paper contributes to the empirical debate on the causal relationship between budget deficits and macroeconomic variables by employing Vector Error Correction Model (VECM) and variance decomposition approaches.

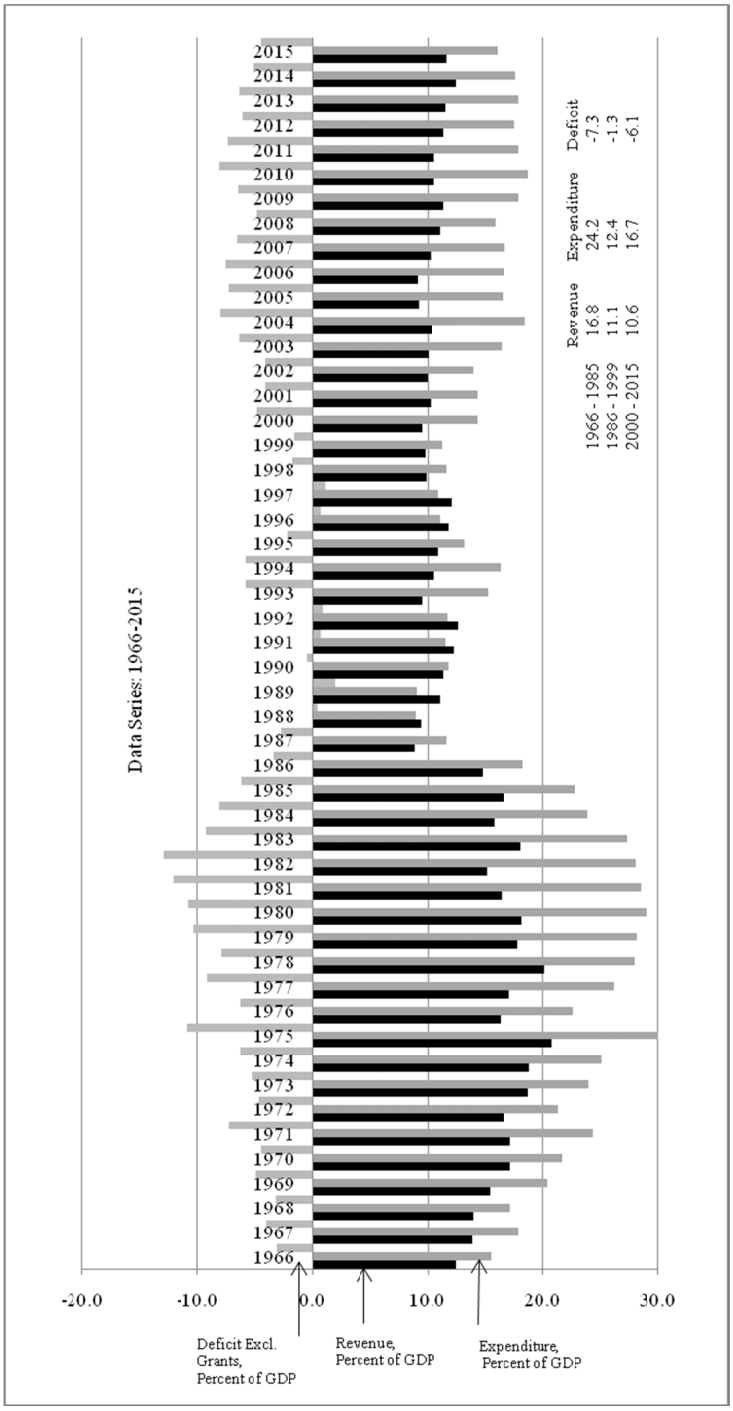
The rest of the paper is organized as follows: Section 2 provides a brief discussion on budget deficits and literature review. Section 3 describes the methodology, data and variables used for analysis. Section 4 discusses the empirical results. Section 5 concludes and provides the policy implication of the results of this paper.

2. Budget deficits in Tanzania and brief literature review

For most years, over the 1966-2015 period, government expenditure in Tanzania has exceeded government revenue leading to budget deficits. Expenditure has been rising steadily due to many reasons including an increase in demand for infrastructure and payment of interest on debt. Also, rising budget deficit in Tanzania over the 1966-2015 period was due to low collection of revenue mainly because of narrow tax base, tax evasion, tax avoidance, and corruption. During the 1966-1985 period, government revenue was, on average, 16.8 percent of GDP whereas government expenditure as a proportion of GDP averaged 24.2 percent, leading to a budget deficit of 7.3 percent of GDP (Figure 1). Budget deficit rose from 3.1 percent of GDP in 1966 to 12.9 percent of GDP in 1982.

The rise in budget deficits in Tanzania could be attributed to several factors that include internal and external shocks, which sometimes required government intervention through fiscal policy. In the 1970s, the deficit is explained mainly by the socialist ambition of providing universal social service on equal basis especially after the 1967 Arusha Declaration [Kapunda & Topera 2013]. This was justified with free provision of education up to university, health, and rural water supply by the government. Other factors for rising government expenditure include decentralization policy, the 1973-1974 oil price shock, severe, drought of 1974-75, collapse of the East African Community in 1977, war between Tanzania and Uganda of 1978-79. By and large, economic crisis of 1980s adversely affected revenue mobilization and contributed significantly to rising government expenditure.

Figure 1. Government revenue and expenditure (percent of GDP)



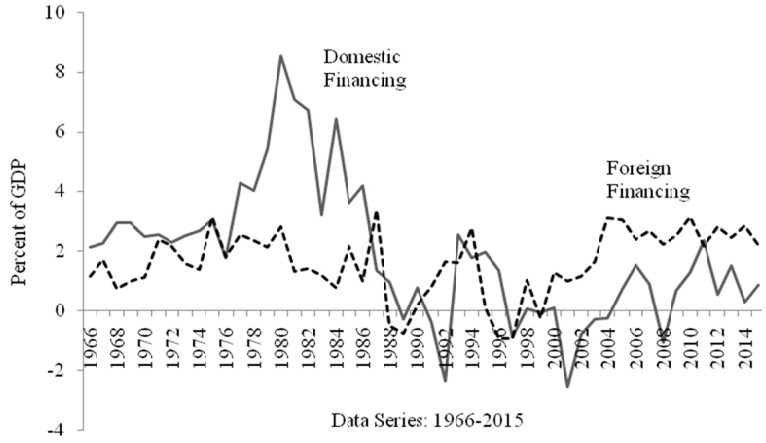
Source: Author's estimates using data from Bank of Tanzania [2011; 2016].

During the 1986-1999 period, budget deficit, on average, declined significantly to 1.3 percent of GDP. In fact, the economy experienced budget surplus in the 1988-1989, 1991-1992, and 1996-1997 periods. During these periods of economic liberalization, government expenditure declined to 12.4 percent of GDP from 24.2 percent in the 1966-1985 period. However, the share of government revenue to GDP declined to 11.1 percent during the 1986-1999 period, from 16.8 percent in the 1966-1985 period. This suggests that the decline of budget deficit during the early stages of economic liberalization was not due to increase in revenue collection but because of the decline in the ratio of expenditure to GDP.

In the recent years, both government expenditure and budget deficit as proportions of GDP have, on average, increased while revenue has, on average, declined. For example, during the 2000-2015 period, government expenditure and deficit, respectively, rose to 16.7 percent and 6.1 percent from 12.4 percent and 1.3 percent in the 1986-1999 period. By contrast, revenue as a percent of GDP declined to 10.6 percent in the 2000-2015 period, from 11.1 percent in the 1986-1999 period. This signifies a financing gap of about 6.1 percent of GDP over the 2000-2015 period had to be filled by other sources like borrowing and foreign aid. Notable, the increase in expenditure in the recent years mainly was to respond to the Millennium Development Goals and National Strategies for the Growth and Reduction of Poverty [Topera 2012].

The persistent increase in budget deficits in Tanzania means that the debt level and its servicing will continue to grow without limit unless constrained. This may lead to explosion of the ratio of debt to GDP due to higher interest payment. In fact, policy makers should be concerned with the extent to which the budget deficit is sustainable. Figure 2 reports the trend of domestic and external deficit financing as a percent of GDP over the 1966-2015 period. It should be noted, however, that domestic sources of deficit financing include mainly sale of government securities and bank financing whereas external source is largely in form of loans and grants. Like in many other low income countries, grants in Tanzania come in form of budget or project support from bilateral and multilateral donor governments and agencies. Figure 2 shows that, in the last 2 decades, the external financing of the budget deficit has generally been higher than domestic financing. However, when inefficiently allocated, the cost of borrowed external resources can contribute to high or even unsustainable levels of external debt servicing obligations. In fact, debt servicing consumes scarce resources that can be used for financing development. According to Thapa [2005], excessive deficits and heavy borrowing to finance that deficit drain out the resources of the developing countries.

Figure 2. Domestic and external deficit financing (percent of GDP)



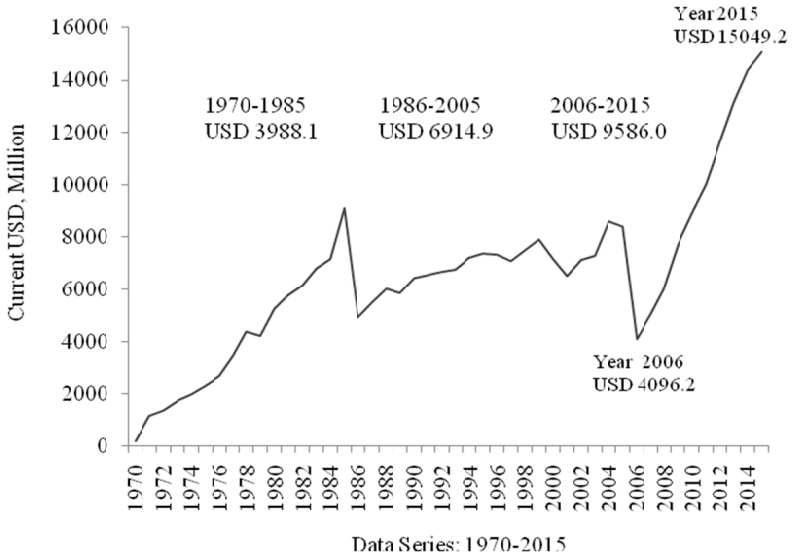
Source: Author's computations using data from Bank of Tanzania [2016].

The shift of budget deficit financing from domestic sources during the 1966-1990 period to external sources over the 1991-2015 period (Figure 2) and persistent high budget deficit as percent of GDP, suggest that attaining sustainable economic growth and changes in the budget deficit would have substantial impact on the whole economy. In fact, the search for ways to improve domestic revenue mobilization and control growth in recurrent expenditure while increasing development expenditure is a significant policy issue in Tanzania and other developing countries. This is very important because the recurrent expenditure and financing through grants reduce the ability of the country to increase development expenditures. As a result, the economy of Tanzania is an aid-dependent economy. Without further increase in tax revenue collection, necessary investments in education, health and infrastructure will be increasingly difficult to finance on a sustainable basis. Unambiguously, increased government investment in infrastructure, education and health can bring positive effects on labor productivity and employment, which in turn, promote long run growth. Likewise, budget deficits can have positive macroeconomic effects in the long run if it is used to finance extra capital spending that leads to an increase in the stock of national assets.

As reported earlier, budget deficit financing through external borrowing results into high-extension debt stock and debt burden which dampens investment through debt overhang effect, and crowding out effect. Indeed, excessive foreign indebtedness has remained a major impediment to economic growth and stability in Tanzania. Figure 3 reports the trend of total external debt in Tanzania. An increase in external debt from USD 4096.2 Million in 2006 to USD 15.049.2 Million in 2015 reflects an increase in external financing of budget deficits. Also,

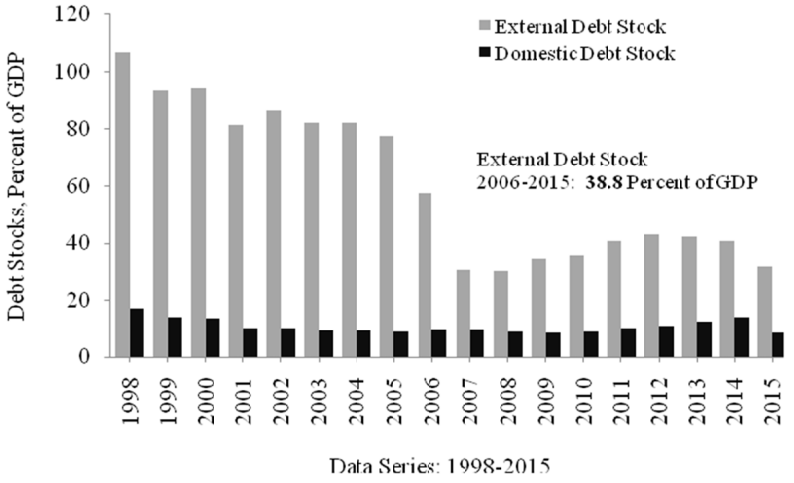
a steady rise in external debt stock reflects an increase in government expenditure. The growth of external debt as percent of GDP, however, has been gradual but steady since debt relief was provided under the Multilateral Debt Relief Initiative (Figure 4). Moreover, following debt relief, Tanzania adopted a fiscal anchor of no net domestic borrowing. With growth, this has meant that Tanzania's debt stock has reached very manageable levels of around 40 percent of GDP.

Figure 3. Total external debt stock (US dollars, Million)



Source: Author's computations using data from World Bank [2016].

Figure 4. External and domestic debt (percent of GDP)



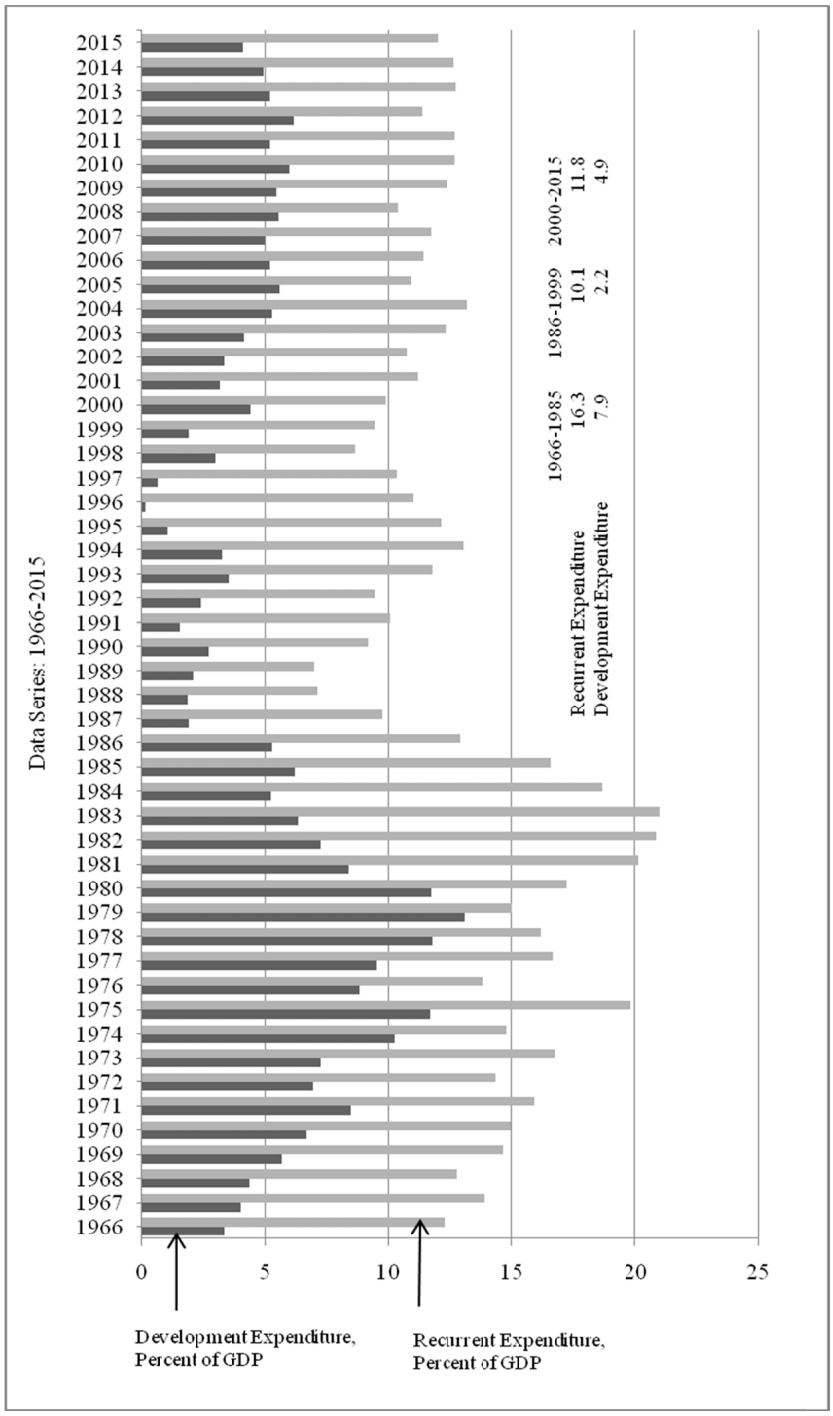
Source: Author's computations using data from Bank of Tanzania [2016].

Tanzania is one of the world's poorest countries. Around half of the population lives below the poverty line. Understandable, the Government has committed itself to a long-term strategy aimed at eradicating poverty by 2025. However, almost one-third of budgetary expenditure has been allocated to external debt servicing, dwarfing the resources available for development investment. Importantly, for government to achieve its policy objectives, it requires increasing amounts of finance. In the case of deficit financing, this tends to increase the national debt but enhances economic growth. This also suggests that a budget deficit policy may play a vital role in achieving economic objectives such as sustainable growth, macroeconomic stability, poverty reduction, and income redistribution if such deficits are effectively utilized to enhance economic growth.

Basic Keynesian analysis suggests that a rise in the budget deficit during a recession can reduce unemployment and increase economic growth through a rise in aggregate demand. The deficit spending can help promote higher growth, which will enable higher tax revenues and eventually the deficit falls over time. But if the deficit occurs during a period of strong economic growth, then as mention earlier, the government deficit may crowd out the private sector. This is because Government borrowing reduces private sector investment and spending. Also, by printing money, the government collects seigniorage revenue, which is in form of change in real cash balances and inflation tax. In this case, printing money to finance the budget deficit exerts upward pressure on inflation.

In Tanzania the key components of the recurrent budget are consolidated fund services which cover outlays for servicing the public debt, wages and salaries and administrative and running expenses. Development expenditure is that position of government budget for implementation of projects or investment activities. Major sectors for investment include social infrastructure such education, health and water; economic infrastructure such as transportation and communication and power. Other important sectors under this category are agriculture and environment. Data show that throughout the 1966-2015 period, recurrent expenditures were higher than development expenditures (Figure 5). Development expenditure as percent of GDP fell from 7.9 percent in the 1966-1985 to 4.9 percent in the 2000-2015 period. During the recent years, development expenditure has declined from 6 percent of GDP in 2010 to 4.0 percent of GDP in 2015 (Figure 5).

Figure 5. Government expenditure (percent of GDP, 1966-2015)



Source: Author's computations using data from Bank of Tanzania [2011; 2016].

The ratio of capital expenditure to GDP has also declined significantly [Baunsgaard et al. 2016]. Baunsgaard et al. [2016] reports that the decline in the development and capital expenditure suggests unrealistic budgeting; lower concessional project financing partly offset by external non-concessional loans. Furthermore, the interest bill has started to rise recently, reflecting debt accumulation, a shift towards more market debt, and exchange rate depreciation [Baunsgaard et al. 2016]. The gap between development and recurrent expenditure has consistently been widening since 2001. The persistent increase in budget deficit and a rise in recurrent expenditure above development expenditure is due to an increase in government wages and salary payment and other charges. This also corresponds to low tax base despite an increase in the number of civil servants and hence a higher wage and salary bill as well an increase in other administrative costs.

The relationship between budget deficits and macroeconomic variables represents one of the most widely debated topics among economists and policy makers in both developed and developing countries. A number of theories explain the relationship between budget deficits and macroeconomic factors such as real GDP growth, inflation, money supply, interest rate, exchange rate, among others [see for example Vuyyuri & Sesahiah 2004; Kosimbei 2009; Doh-Nani 2011; Georgantopoulos & Tsamis 2011; Lwanga & Mawejje 2014; Brima & Mansaray-Pearce 2015]. The most known and applicable school of thoughts include the Neoclassical, Keynesian and the Ricardian Equivalence. The Neoclassical school considers intuitive individuals planning consumption over their own life cycles. This school of thought views budget deficits as a way to raise lifetime consumption by shifting taxes to future generations. But higher consumption implies lower savings and thus interest rate must increase to bring equilibrium in the capital markets. As a result expansion in the government sector crowds out the private sector. Overall, the Neoclassical school proposes an adverse relationship between budget deficits and macroeconomic variables. According to this theory budget deficit leads to higher interest rates, discourages the issue of private bonds, private investments, and private spending. It also increases inflation level and the current account deficits. Generally, budget deficits adversely affect the growth of the economy through resources crowding out.

For precise picture, it is worthy to understand the historical nature of the relationship between budget deficits and selected macroeconomic variables through more visual examinations. Table 1 summarizes the trends of budget deficit and macroeconomic variables in Tanzania.

Table 1. Budget deficits and macroeconomic performance

Specification	1966-1975	1976-1985	1986-2005	2006-2015
Deficits, percent of GDP	5.4	9.3	3.6	6.3
Real GDP, annual growth	4.4	2.0	5.7	6.4
Inflation rate	12.8	20.6	8.9	9.1
Interest rate	8.2	9.2	20.4	15.8
M2, percent of GDP	24.4	35.7	14.8	17.0
RER	752.2	494.7	1299.0	1365.2

Source: Authors computations using data from Bank of Tanzania [2016] and WDI [World Bank 2017].

The key observation is that, on average, the economy evidenced a positive growth of real GDP over the 1966-2015. Growth declined from 4.4 percent in the 1966-1975 period to 2 percent in the 1976-1985 period while budget deficit rose from 5.4 percent of GDP in the 1966-1975 period to 9.3 percent of GDP over the 1976-1985 period. During the 1986-1995 period, real GDP growth, increased to 3 percent on average while deficit fell to 1.6 percent [World Bank 2017]. In the recent years however, both real GDP and budget deficit have risen. Economic transformation through industrialization, human development, and an improved business climate is expected to support economic growth in the long-run in Tanzania.

It is worth noting that both inflation rate and money supply as percent of GDP, respectively, increased from 8.9 percent and 14.8 percent over the 1996-2005 period to 9.1 percent and 17 percent during the 2006-2015 period [World Bank 2017]. In theory inflationary conditions reduce the real tax revenues collected by government, thus, pushing towards budget deficits. Moreover, inflation increases the nominal interest rates and consequently debt servicing, thus increasing the budget deficit. Generally, it is expected that inflation negatively affects fiscal balances. However, inflation may positively affect fiscal stance by raising revenues via income tax bracket creep [see Farajova 2011].

Table 1 further shows that, interest rate declined from 25.9 percent over the 1986-1995 period to 20.4 percent during the 1996-2005. Over the last 10 years, interest rate, on average, declined to 15.8 percent. Economic theory suggests that increase in budget deficits may lead to an increase in the interest rate which in turn leads exchange rate to appreciate. As a result, exports become relatively expensive and imports cheaper, thus generating a trade deficit. Also, a high interest rate worsens the overall budget balance via increasing interest expenditure on newly issued debt and on rolling debt [Farajova 2011]. By contrast, higher interest rates indicate higher opportunity costs of bond market financing, possibly urging governments to improve the fiscal deficit. Nonetheless, the first effect is expected to dominate, thus producing a negative correlation between interest rates and budget balances.

Empirical study on the relationship between the budget deficits and macroeconomic variables is very significant to enable policy maker better understand whether there is a causal relationship or merely a correlation between these variables. Notwithstanding, the relationship between budget deficits and macroeconomic fundamentals is not straight forward. For example, while the neoclassical theory proposes an adverse relationship between budget deficits and macroeconomic variables, the Keynesian economists propose a positive relationship between budget deficits and macroeconomic variables. Indeed, the Keynesians provide a counter argument to the crowd-in effect by making reference to the expansionary effects of budget deficits. Keynesians argue that usually budget deficits result in an increase in domestic production and aggregate demand. It also increases savings and private investment at any given level of interest rate. The Keynesian absorptive theory suggests that an increase in the budget deficits would induce domestic absorption and thus, import expansion, causing current account deficit [Eigbiremolen et al. 2015]. Even the Ricardian equivalence has a different view on budget deficits and economic variables. This view suggests that government budget deficits do not affect the economic growth and development. The hypothesis is that Governments may either finance their spending by taxing current taxpayers or they may borrow money. However, they must eventually repay this borrowing by raising taxes above what they would otherwise have been in future. According to this theory, an increase in government debt as a result of the deficit will imply future taxes with a present value equal to the value of the debt.

From the above discussion, there seems to be some relationship between budget deficits and macroeconomic fundamentals such as real GDP, inflation rate, interest rate, and exchange rate among other. However, the direction of the relation is very unclear. Even empirical studies fail to conclude concretely about the relationship between budget deficits and macroeconomic variables. For example, Odhiambo et al. [2013] and Buscemi & Yallwe [2012] find a positive relationship between budget deficits and economic growth while Nelson & Sing [1994] and Vuyyuri & Seshaiah [2004] show that budget deficits have no significant effect on the economic growth. Contrary, Mugume & Obwona [1998] reveal a negative relationship between fiscal deficits and economic growth. Similarly, the empirical results on the relationship between budget deficits and inflation have been invariably mixed. Some studies [see for example McMillin 1986; De Haan & Zelhosrt 1990; Edwards & Tabellini 1991; Easterly & Schmidt-Hebbel 1993; Metin 1998; Favero & Spinelli 1999; Ozatay 2000; Catão & Terrones 2005; Makochekanwa 2008; Lin & Chu 2013] find strong relationship between budget deficit and inflation. On the contrary, Ndanshau [2012]; Karras

[1994]; King & Plosser [1985] reveal that budget deficits do not contribute significantly to higher inflation.

In case of interest rate, several studies [Hutchison & Pyle 1984; Hoelscher 1986; Barro 1987; Evans 1987; Cebula 1988; Cebula & Koch 1989; Liargovas et al. 1997; Cebula 2000; Uwilingiye & Gupta, 2007; Bonga-Bonga 2011; Aisen & Hauner 2013] provide evidence of causal relationship between budget deficits and interest rates whereas Evans [1985] & Akinboade [2004] find no association between the budget deficits and interest rates. Similar controversies can be explained on the relationship between budget deficits and exchange rate. Some studies, such as Bisignano & Hoover [1982], show that deficits may appreciate or depreciate the exchange rate, depending on the relative importance of wealth effects and relative asset substitution effects. Also, Burney & Akhtar [1992] and Easterly & Schmidt-Hebbel [1993] find robust relationships between the fiscal deficit, the trade deficit, and the real exchange rate. By contrast, other studies such as Melzer [1993] and Humpage [1992] find no significant relationship between exchange rates and budget deficit in a long-run. Overall, as reported above, there have been conflicting and inconsistent theoretical and empirical findings about the relationship between budget deficits and macroeconomics variables reflecting differences in methodology, nature of data used and nature of the economy being investigated. Thus, the current study is very significant.

3. Description of the empirical analysis

3.1. Methodology

The literature provides alternative definitions of budget deficit (Table 2). The World Bank defines budget deficit as the difference between expenditure items including interest on government debt, transfers and subsidies, and revenue items including grants and sale of assets. Similarly, the IMF defines budget deficit as:

$$Fiscal\ deficit = \begin{bmatrix} (Expenditure\ on\ goods\ and\ services + transfers) \\ -(Revenue + grants) + (lending - repayments) \end{bmatrix} \quad (1)$$

These ways of measuring budget deficits reflect the financing gap that needs to be closed by way of net lending [Doh-Nani 2011]. Overall, budget deficit measures the extent to which government expenditure exceeds government revenue that needs to be financed.

Table 2. Alternative definitions of budget deficit

	Item of budget deficit	Definition
1	Conventional budget deficit	Total expenditure minus total receipt
2	Total budget deficit without grants	Conventional deficit (1) minus grants
3	External budget deficit	Government expenditure receipts (externally financed)
4	Domestic budget deficit	Total deficit minus external deficit
5	Primary budget deficit	Total deficit minus interest payments
6	Operational budget deficit	Primary deficit plus real interest payments
7	Current budget deficit	Current revenue minus current expenditure

Source: Jacobs, Schoeman & van Heerden [2002].

According to Catão & Terrones [2005], government spending (G) is financed by the extent of domestic tax collection (T). Now, assuming that Governments run balanced budgets,

$$G_t = T_t \tag{2}$$

However, Lwanga & Mawejje [2014] argue that government tax revenues may not be sufficient to finance Government expenditure. In this case, printing money (M), reduction in international asset holdings (A) or issuance of bonds (B) may be used to finance government expenditure. To shed light on Lwanga & Mawejje [2014] argument [Blanchard & Fischer 1989] presents budget deficit as:

$$Budget\ deficit = \begin{bmatrix} Money\ printing + (foreign\ \ reserve\ \ use + foreign\ \ borrowing) \\ + domestic\ \ borrowing \end{bmatrix} \tag{3}$$

This implies that the public sector can be financed by printing money, running down foreign exchange reserves, borrowing abroad, and borrowing domestically. Governments also receive grants. But econometric analysis of this paper excludes grants because they are usually not reliable as they are granted on the basis of donor discretion (see also [Lwanga & Mawejje 2014] for Uganda). Thus, budget deficit without grants pictures better the current situation and the work of the actual government.

Taking money printing, reduction in international asset holdings, and issuance of bonds into consideration, identity (2) can be expressed as:

$$G_t - T_t = M_t + A_t + B_t \tag{4}$$

In line with Catão & Terrones [2005] and Lwanga & Mawejje [2014] the budget deficit reported by identity (4) can be presented as follows:

$$\frac{B^g_{t+1}}{R^*_t} = T_t + B^g_t - G_t + \frac{M_{t+1} - M_t}{P_t} + A_t, \tag{5}$$

where:
G_t = government expenditure at time t,

T_t = tax revenue,
B_t^g = government net assets ,
R_t^* = international real interest rate,
M_t = currency in circulation.

Rearranging the identity (5) yields the budget deficit, expressed as:

$$G_t - T_t + \frac{B_{t+1}^g}{R_t^*} = B_t^g + \frac{M_{t+1} - M_t}{P_t} + A_t \tag{6}$$

where the left hand side is the total government deficit which includes the budget deficit, $G_t - T_t$ and the real net government assets. The right hand side constitutes the means of financing the budget deficit including Government debt instruments such as bonds [see also Lwanga & Mawejje 2014]. This also shows that widen budget deficits increase debts which must be financed together with the accompanying interest payments. Identity (6) can be expressed in form of econometric model as follows

$$\ln(G_t - T_t) = \xi_0 + \xi_1 \ln(B_t^g) + \xi_2 \ln(M_t) + \xi_3 \ln(A_t) + u_t \tag{7}$$

Furthermore, it is very important to understand that when budget deficit is financed by borrowing, it expands government's demand for credit through competition with households and business firms. This puts upward pressure on interest rate and slows down the rate of capital formation [Doh-Nani 2011]. In Keynesian model, this occurs through a rise in real interest rate which reduces investment purchases through the transmission mechanism. In addition, if budget deficit is monetized, it increases money supply. This exerts downward pressure on interest rate and upward pressure on equilibrium money stock and price level unless the economy is in deep recession. This leads to higher inflation, uncertainty and instability of real interest rate which tends to lower real tax revenue [Doh-Nani 2011]. Also, Ahking & Miller [1985], Vuyyuri & Seshaiah [2004] & Friedman [1981] suggest that if central bank monetizes the deficit, it will result to an increase in the money supply and the rate of inflation. Likewise, exchange rate may depreciate or appreciate due to budget deficits.

Furthermore, real GDP which is an indicator for the overall economic situation can affect budget deficit. For example, in boom times it may be easier to have low deficits as in recession times, where public spending is needed to stabilize the economy, while taxes are reduced. Thus model (7) can be expanded to examine the causal relationship between budget deficits, real GDP, inflation, lending rate, money supply, and real exchange rate. In the empirical analysis, primary model in this paper is expressed as:

$$\ln(BD_t) = \xi_0 + \xi_2 \ln(GDP_t^{real}) + \xi_3(P_t) + \xi_4(R_t^l) + \xi_5 \ln(M_t) + \\ + \xi_6 \ln(ER_t^{real}) + u_t \tag{8}$$

where:
BD_t = Natural log (ln) of budget deficit at time *t*,
GDP_t^{real} = Real GDP,
P_t = Inflation,
R_t^l = Lending interest rate,
M_t = Money supply,
ER_t^{real} = Real exchange rate,
u_t = white noise error term, i.e. $u_t \sim N(0, \sigma^2)$.

3.2. *Vector Autoregression and Vector Error Correction Models*

This paper adopts Vector Autoregression (VAR) and Vector Error Correction Model (VECM), in line with Georgantopoulos & Tsamis [2011] for Greece, Vuyyuri & Sesahiah [2004] for India, Lwanga & Mawejje [2014] for Uganda, and [Brima & Mansaray-Pearce 2015] for Sierra Leone. The VAR model is specifies as:

$$\ln(BD_t) = \xi_0 + \sum_{j=1}^{n} \xi_{1j} \ln(BD_{t-j}) + \sum_{j=1}^{n} \xi_{2j} \ln(GDP_{t-j}^{real}) + \sum_{j=1}^{n} \xi_{3j} P_{t-j} + \sum_{j=1}^{n} \xi_{4j} R_{t-j}^l + \\ + \sum_{j=1}^{n} \xi_{5j} \ln(M_{t-j}) + \sum_{j=1}^{n} \xi_{6j} \ln(ER_{t-j}^{real}) + u_{1t} \tag{9}$$

and the VECM for all the endogenous variables is expressed as follows:

$$\Delta \ln(BD_t) = \sum_{j=1}^{n} \xi_{1j} \Delta \ln(BD_{t-j}) + \sum_{j=1}^{n} \xi_{2j} \Delta \ln(GDP_{t-j}^{real}) + \sum_{j=1}^{n} \xi_{3j} \Delta P_{t-j} + \sum_{j=1}^{n} \xi_{4j} \Delta R_{t-j}^l + \\ + \sum_{j=1}^{n} \xi_{5j} \Delta \ln(M_{t-j}) + \sum_{j=1}^{n} \xi_{6j} \Delta \ln(ER_{t-j}^{real}) + \xi_7 C_t + \theta_1 \ln(BD_{t-j}) + \theta_2 \ln(GDP_{t-j}^{real}) + \\ + \theta_3 P_{t-j} + \theta_4 R_{t-j}^l + \theta_4 \ln(M_{t-j}) + \theta_5 \ln(ER_{t-j}^{real}) + u_{1t} \tag{10}$$

where:
Δ is the difference operator,
$\xi_7 C_t$ is a vector of exogenous variable (intercept).

Following Engle & Granger (1987) as well as Granger (1986) representation theorem, Model (10) can be used to test Granger causality among the variables over the short and long run[1].

3.3. *Econometric model estimation*

Before estimating the parameters and carrying out various hypotheses testing, the stationarity properties of the univariate time series are determined. This procedure is meant to avoid the problem of spurious regression results. The paper uses the Augmented Dickey-Fuller (ADF) [Dickey & Fuller, 1979] test to test for unit roots of the time series variables. The ADF test with a constant involves estimating the equation

$$\Delta x_t = \psi_0 + \psi_1 x_{t-1} + \sum_{i=1}^{q} \varphi \Delta x_t + u_t \tag{11}$$

and with time trend

$$\Delta x_t = \psi_0 + \psi_1 x_{t-1} + \psi_2 x_t + \sum_{i=1}^{q} \varphi \Delta x_t + u_t \tag{12}$$

where:
Δ – the difference operator,
t – a time trend,
x_t – the variable under consideration,
n – the number of lags and u_t is the stochastic error term.

The null hypothesis is that the series is nonstationary against alternative hypothesis that the series is stationary. If the absolute value of the ADF test statistic is greater than the critical values, we reject the null hypothesis and conclude that the series is stationary. We fail to reject the null hypothesis and conclude that the series is non-stationary if the absolute value of the ADF is less than the critical values. This test is done to determine the order of integration for each variable. Cointegration analysis helps us discover if there is indeed a tendency for a linear relationship to hold between variables over long time periods.

Once it is concluded that the variables are non-stationary and are integrated of the same order, i.e. $I(1)$, then the co-integration involving testing for the presence of long-run relationship between the variables is determined. The maximum likelihood test method recommended by Johansen & Juselius [1988, 1990]

[1] The Error Correction Model allows causality to emerge even if the coefficients of the lagged differences of the explanatory variables are not jointly significant [Anoruo & Ahmad 2001].

is used to identify long-run economic relationships between the variables. In fact, the co-integration requires the error term in the long-run relation to be stationary.

Before proceeding with the Johansen's test of co-integration and the VECM estimation, the optimal lag selection criteria is employed to determine the lag length to be used in carrying out the estimation. The lag order selection criteria for sequential modified likelihood ratio (LR), final prediction error (FPE), Akaike information criterion (AIC), Schwarz information criterion (SC), and Hannan–Quinn information criterion (HQ) are used in this paper to determine the number of lags in the cointegration test (order of VAR) and then the trace and maximal eigenvalue tests are applied to determine the number of cointegrating vectors present. The VECM is estimated for all the endogenous variables in the model. In addition, the variance decomposition tests are carried out to further understand the interactions of the variables.

3.4. *The variables, sources and type of data*

The basic estimation model has six main variables namely, budget deficit, real GDP, inflation rate, lending interest rate, money supply, and real exchange rate. The analysis is based on annual time series data for the 1966-2015 period. The data are obtained from publications of the Bank of Tanzania [2011; 2016] (*various issues*).

Descriptive analysis is conducted to ascertain the statistical properties of the variables. Table 3 presents descriptive statistics of the variables of the estimation model. It should be noted that the skewness and kurtosis of a normal distribution are 0 and 3, respectively. Positive skewness implies that the distribution has a long right tail and a negative skewness means that the distribution has a long left tail. Similarly, if the Kurtosis is less than 3, the distribution is flat relative to the normal. Based on the skewness, the descriptive statistics suggest that, budget deficit, real GDP, rate of inflation and money supply are approximately normally distributed because their respective skewness is equal or less than 0.5 in absolute values. In addition, the probabilities of these variables and that of real exchange rate fail to reject the null hypothesis of normal distribution at 5 percent level of significance. Also, based on kurtosis, lending interest rate tends to be mesokurtic because its value is approximately equal to 3. Overall, it can be concluded that there is evidence that there are no outliers in these respective time series causing the data sets to become relatively symmetrical.

Table 3. Descriptive statistics for the variables

Specification	$\ln(BD_t)$	$\ln(GDP_t^{real})$	P_t	R_t^l	$\ln(M_t^{real})$	$\ln(ER_t^{real})$
Mean	4.26	6.84	16.41	15.89	5.01	2.99
Median	3.82	6.81	12.75	15.00	5.09	3.08
Maximum	6.65	7.35	36.15	36.00	6.98	3.32
Minimum	1.86	6.46	3.49	7.500	2.93	2.52
Std. Dev.	1.57	0.25	10.41	7.96	1.25	0.20
Skewness	0.19	0.51	0.47	0.93	–0.07	–0.59
Kurtosis	1.63	2.23	1.76	3.03	1.69	2.33
Jarque–Bera	4.20	3.43	5.08	7.35	3.60	3.88
Probability	0.12	0.180	0.08	0.03	0.16	0.14
Sum Sq. Dev.	121.50	2.99	5313.70	3104.93	76.93	1.89
Observations	50	50	50	50	50	50

Source: Author's computations.

The results of pair-wise correlations of the variables of the estimation model displayed in the correlation matrix (Table 4) indicate positive correlations between budget deficit and money supply. The rate of inflation also seems to be positively correlated with budget deficit. Unsurprisingly, the correlation between economic growth and budget deficit is negative. Also real exchange rate seems to have a negative but less strong correlation with budget deficit. Overall, the depiction of correct signs on correlation coefficients confirms the economic relationships between these variables as envisaged by theory. In addition, the explanatory variables are not highly correlated suggesting that the problems related to multicollinearity are not bound to emerge.

Table 4. Correlation matrix

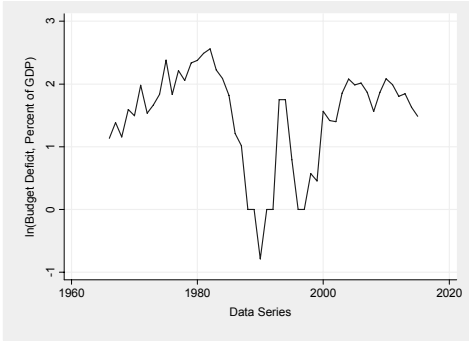
Specification	$\ln(BD_t)$	$\ln(GDP_t^{real})$	P_t	R_t^l	$\ln(M_t)$	$\ln(ER_t^{real})$
$\ln(BD_t)$	1					
$\ln(GDP_t^{real})$	–0.69	1				
P_t	0.40	–0.34	1			
R_t^l	0.10	0.34	0.30	1		
$\ln(M_t)$	0.61	0.51	0.23	0.53	1	
$\ln(ER_t^{real})$	–0.23	0.62	–0.27	0.67	0.69	1

Source: Author's computations.

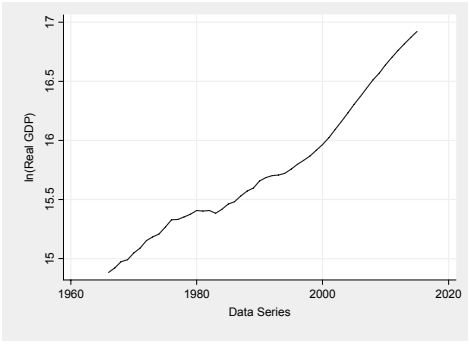
The time series of level variables are displayed graphically in Figure 6 (a-f). It is evident from the graphical displays that fiscal deficit is nonstationary and that over time, especially in the 1970s, early 1980s, 2000s and 2010s, it has been widening, suggesting that over time the government expenditure has been increasingly exceeding government revenue.

Figure 6. Time series plots of level variables

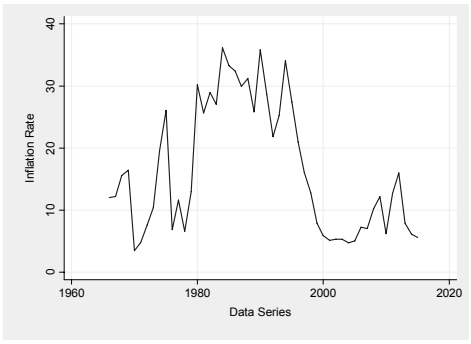
a) Budget deficit, $\ln(BD_t)$



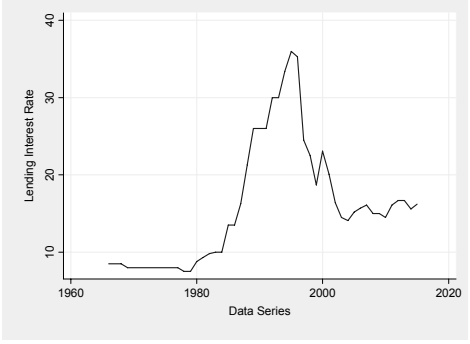
b) Real GDP, $\ln(GDP_t^{real})$



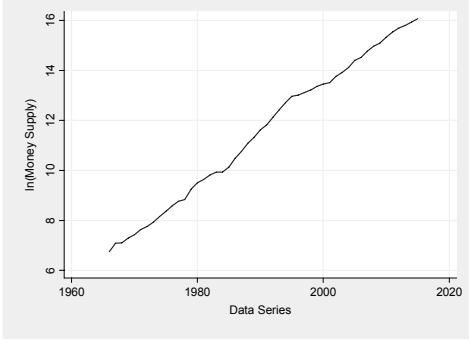
c) Inflation rate, (P_t)



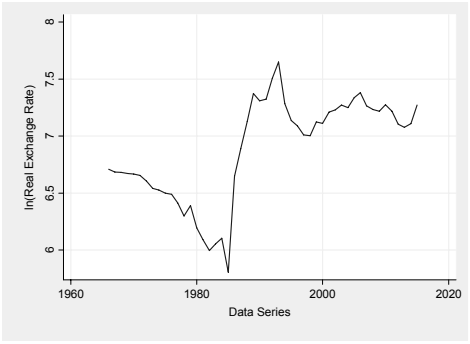
d) Lending interest rate, (R_t^l)



e) Money supply, $\ln(M_t)$



f) Real exchange rate, $\ln(ER_t^{real})$



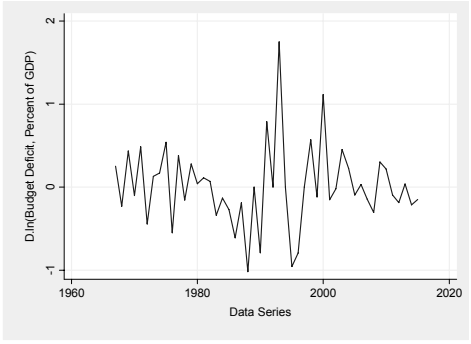
Source: Author's estimates.

Also, other variables such as real GDP and money supply generally exhibit upward trends. Contrary, lending interest rate, inflation, and real exchange rate are generally stable in the last 15 years. In general, all the variables are non--stationary. These series seem to exhibit a distinctive upward trend in levels. Hence,

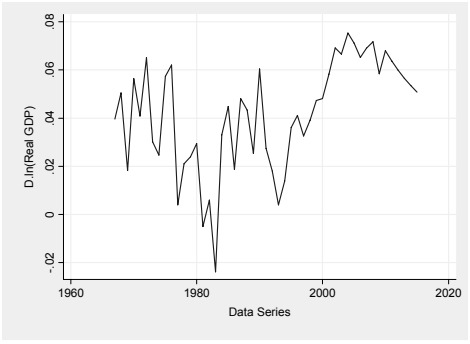
they have no constant mean and have a long memory in their increasing trend. The overall implication at this elementary stage is that all variables might be integrated of order one to make them stationary. This is very important because if the series are consistently increasing over time, the sample mean and variance will grow with the size of the sample, and they will always underestimate the mean and variance in future periods. In addition, if the mean and variance of a series are not well-defined, then its correlation with other variables is not defined as well. The time series in first differences are reported in Figure 7 (a-f). It is evident that Figure 7 show no changing means, implying that data have not unit root when integrated of order one.

Figure 7. Time series plots of first difference variables

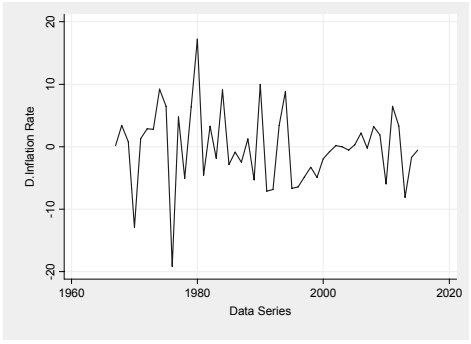
a) Budget deficit, $D.\ln(BD_t)$



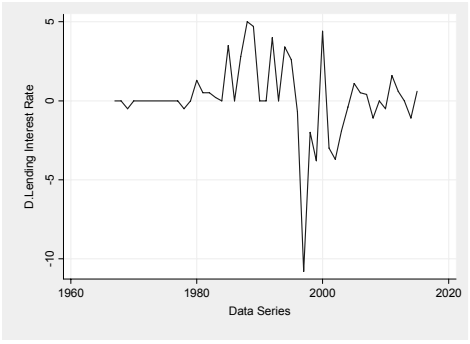
b) Real GDP, $D.\ln(GDP_t^{real})$



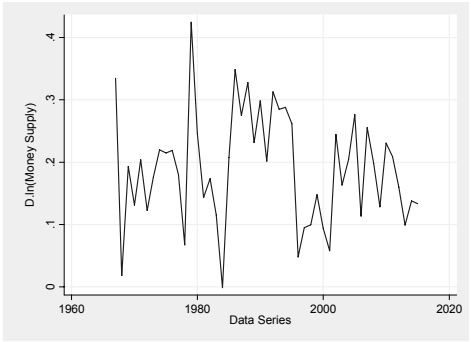
c) Inflation rate, $D.(P_t)$



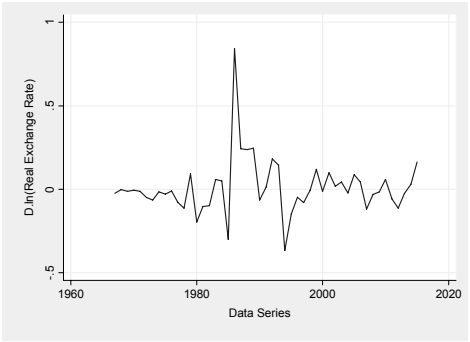
d) Lending interest rate, $D.(R_t^l)$



e) Money supply, $D.\ln(M_t)$



f) Rea exchange rate, $D.\ln(ER_t^{real})$



Source: Author's estimates.

4. Analysis of results

4.1. *Unit root test*

As reported earlier, when time series data are not stationary and are used in an econometric equation, there is the problem of spurious regression, which leads to unreliable results. In order to avoid this problem, it is necessary to investigate the time series data for their stationary properties. Table 5 reports the results of the ADF test in levels and in first differences of the data.

Table 5. ADF unit root test

	Levels		First difference, Δ	
Optimal Lag = 1	Constant $\alpha_1 = 0$	Constant & trend $\alpha_1 = \alpha_2 = 0$	Constant $\alpha_1 = 0$	Constant & trend $\alpha_1 = \alpha_2 = 0$
$\ln(BD_t)$	–0.344	–2.912	–7.548	–7.441
$\ln(GDP_t^{real})$	–1.937	–0.116	–3.574	–4.135
R_t^l	–1.273	–1.039	–5.319	–5.312
$\ln(ER_t^{real})$	–1.187	–1.789	–6.200	–6.134
P_t	–2.019	–2.225	–7.904	–7.894
$\ln(M_t)$	–0.198	–0.882	–4.656	–4.798
5% Critical Value	–2.924	–3.506	–2.924	–3.506

Note: Null Hypothesis: *there is a unit root*.

Source: Author's estimates.

The tests have been performed on the basis of 5 percent significance level, using the McKinnon Critical Values. Results show that all variables are non--stationary or have unit root in levels, *I(0)*. However, after transforming them into

first difference they become stationary. This also means that all variables are integrated of order one, *I(1)*. Notable, the optimal ADF specification is determined by means of Akaike Information Criterion (AIC) and the Schwarz Bayesian Criterion (SBC).

4.2. *Cointegration test results*

The fact that all the variables are integrated of order *I(1),* Johansen Cointegration test is used to tested whether there is a long-run relationship among the variables. Here, it should be understood that if cointegration exists among the variables, VECM approach will be used to determine long term relationships. However, as stated earlier, prior to the Johansen's test of co-integration and the VECM estimation, the optimal lag selection criteria is employed to determine the lag length to be used in carrying out the estimation. To determine appropriate lag length, a VAR is estimated with an arbitrary lag length. The lag order selection criteria for standard VAR are presented in Table 6. Based on the final prediction error (FPE), Akaike information criterion (AIC) and Hannan–Quinn information criterion, the appropriate lag length is 2. The results of the Johansen Cointegration Analysis with 2 lags order are presented in Table 7. As reported in the Table, the co-integration test results for the trace test indicates three co-integrating equations at the 5 percent significance level. Accordingly, it can be said that a long-run relationship exists among the macroeconomic variables included in the model.

Table 6. VAR lag order selection criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	–662.43	NA	4.80e+09	39.319	39.59	39.41
1	–373.59	458.75*	1728.66	24.45	26.33*	25.79
2	–338.09	43.85	1714.55*	23.61*	27.98	25.07*
3	–287.31	44.81	2195.62	24.48	28.72	25.35

* Indicates lag order selected by the criterion.

Note:
LR: Sequential modified LR test statistic (each test at 5% level).
FPE: Final prediction error.
SC: Schwarz information criterion.
AIC: Akaike information criterion.
HQ: Hannan–Quinn information criterion.

Source: Author's estimates.

Table 7. Johansen tests for cointegration

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None*	0.563196	123.3715	95.75366	0.0002
At most 1*	0.457695	84.44280	69.81889	0.0022
At most 2*	0.445468	55.68223	47.85613	0.0078
At most 3	0.338542	27.96956	29.79707	0.0801
At most 4	0.163754	8.544048	15.49471	0.4092
At most 5	0.002952	0.138931	3.841466	0.7093

* Denotes rejection of the hypothesis at the 0.05 level.
** MacKinnon, Haug & Michelis [1999] p-values.

Note:
Trace test indicates 3 cointegrating eqn(s) at the 0.05 level.

Source: Author's estimates

4.3. *Vector error correction estimation results*

Table 8 reports the vector error correction estimation results. In the VECM, the system includes residual from the vector in the dynamic VECM for Granger causality. An appropriate lag length of 2 was selected based on the final prediction error (FPE), Akaike information criterion (AIC) and Hannan–Quinn information criterion. It is worth noting that the VECM specification restricts the long-run behavior of the endogenous variables to converge to their cointegrating relationships while allowing a wide range of short-run dynamics.

Table 8. Vector Error Correction Estimates

Error Corr:	$\Delta\ln(BD)_t$	$\Delta\ln(GDP^{real})_t$	ΔP_t	ΔR_t^l	$\Delta\ln(M^{real})_t$	$\Delta\ln(ER^{real})_t$
1	*2*	*3*	*4*	*5*	*6*	*7*
CointEq1	–0.369 [–2.42]	–0.004 [–0.26]	9.103 [0.82]	4.290 [4.11]	–0.060 [–1.16]	0.012 [0.10]
CointEq2	2.277 [2.36]	0.017 [0.19]	–5.234 [–0.92]	2.006 [3.32]	0.120 [1.48]	–0.231 [–0.31]
CointEq3	0.002 [0.43]	–0.000 [–0.80]	–0.718 [–2.23]	–0.011 [–0.35]	0.050 [0.53]	0.003 [0.87]
$\Delta\ln(BD)_{t-1}$	–0.427 [–3.04]	–0.030 [–2.32]	21.093 [2.06]	1.880 [1.95]	–2.651 [–2.46]	–0.116 [–1.05]
$\Delta\ln(BD)_{t-2}$	0.136 [0.82]	–0.014 [–0.93]	2.726 [0.23]	3.335 [2.93]	–0.832 [–0.69]	0.042 [0.32]
$\Delta\ln(GDP^{real})_{t-1}$	–6.604 [–2.04]	0.170 [0.58]	–80.557 [–0.34]	(63.941 [2.87]	–0.005 [–0.42]	2.798 [1.10]
$\Delta\ln(GDP^{real})_{t-2}$	–2.804 [–1.00]	–0.100 [–0.39]	–30.816 [–0.15]	–14.638 [–0.76]	0.002 [0.70]	4.553 [2.07]
ΔP_{t-1}	0.011 [1.43]	0.002 [0.71]	0.240 [0.97]	0.022 [0.61]	0.003 [0.27]	–0.002 [–0.53]
ΔP_{t-2}	0.010 [1.99]	0.004 [1.25]	0.103 [0.40]	0.021 [1.05]	0.014 [1.19]	–0.003 [–0.24]

Table 8 cont.

1	*2*	*3*	*4*	*5*	*6*	*7*
ΔR^{l}_{t-1}	0.005 [0.41]	0.002 [1.57]	0.519 [0.53]	0.322 [3.50]	0.004 [0.27]	0.006 [0.59]
ΔR^{l}_{t-2}	0.051 [3.27]	0.001 [1.00]	–1.002 [–0.88]	0.126 [1.17]	0.013 [1.19]	–0.013 [–1.07]
$\Delta \ln\left(M^{real}\right)_{t-1}$	0.583 [0.82]	–0.090 [–1.80]	23.231 [0.47]	–10.282 [–3.17]	0.203 [0.71]	–0.023 [–0.04]
$\Delta \ln\left(M^{real}\right)_{t-2}$	1.252 [1.91]	–0.121 [–2.40]	–32.410 [–0.71]	–7.338 [–2.43]	0.041 [0.14]	–1.072 [–2.17]
$\Delta \ln\left(ER^{real}\right)_{t-1}$	–0.111 [–0.25]	0.073 [1.85]	17.160 [0.55]	14.501 [4.90]	0.022 [0.12]	–0.201 [–0.60]
$\Delta \ln\left(ER^{real}\right)_{t-2}$	–1.348 [–1.88]	0.111 [1.64]	–53.060 [–0.97]	5.438 [1.06]	–0.059 [–0.15]	–0.732 [–1.25]
C	0.290 [2.77]	0.011 [1.25]	–3.440 [–0.44]	–0.802 [–1.08]	0.084 [3.06]	–0.091 [–1.04]
R-squared	0.731	0.727	0.494	0.892	0.045	0.594
F-statistic	3.255	3.200	1.173	9.900	0.080	1.753

Source: Author's estimates.

VECM results show that budget deficits in Tanzania depend on the real GDP. The coefficient of real GDP in the two periods is negative and statistically significant. These results are in line with the Neoclassical School proposition that an increase in GDP reduces budget deficit. Empirical results also show that there is an existence of significant feedback between real GDP and budget deficits. The fact that budget deficit is negatively related with real GDP growth; increase in budget deficit may hamper economic growth in Tanzania. As for the rate of inflation, previous two years of inflation seems to have positive and statistically significant effect on budget deficit. This suggests that an increase in inflation may increase budget deficit. This result is in contrary to the neoclassical theory, but in conformity with the Keynesians theory, which holds that inflation leads to an increase in budget deficit. In addition, this result is consistent with that of Murwirapachena, Maredza & Choga [2013]; Olusoji & Oderinde [2011], Egwaikhide, Cheta & Falokun [1994]; Asogu [1991] and Busari [2007].

Results also show causal relationship running from budget deficit to lending interest rates and from lending rates to budget deficit. This implies that budget deficit leads to higher lending interest rates and vice versa. Significant feedback also exists between budget deficit and money supply suggesting that budget deficit is likely to increase money supply. Furthermore one unidirectional causal relationship found at 10 percent significant level; real exchange rate has unidirectional causal relationship with budget deficit running from real exchange rate to budget deficit.

4.4. *Variance decomposition analysis*

Variance decomposition results are reported in Tables 9-14. This analysis is employed as evidence presenting more detailed information regarding the variance relations between the selected macroeconomic variables. It should be noted here that the variance decomposition determines the amount that the forecast error variance of each of the variables can be explained by exogenous shocks to the other variables. The variance decomposition of budget deficit revealed in Table 9 indicates that 100 percent of budget deficit variance can be explained by budget deficit in the first period, however the percentage declined significantly at the end of the tenth periods reaching 12.9 percent. In the last three periods real GDP, inflation rate, and real exchange rate contribute a substantial proportion of the variation in the forecast error of budget deficit. Table 10 shows that the highest percentage error variance decomposition of real GDP originates from itself and slightly from innovations. 84.3 percent of the forecast error variance of real GDP is explained by its own shock in the first period, but it slightly decreased to 52.3 percent after a 10 year period. In this period, budget deficit explains 7.6 percent of the variation in real GDP while money supply and real exchange rate account for 11.5 percent and 15.3 percent respectively. Interest rate contributes very little for the variation in the forecast error of real GDP.

Table 9. Variance decomposition of budget deficit, $\ln(BD_t)$

Period	S.E.	$\ln(BD_t)$	$\ln(GDP_t^{real})$	P_t	R_t^l	$\ln(M_t^{real})$	$\ln(ER_t^{real})$
1	0.09	100.00	0.00	0.00	0.00	0.00	0.00
2	0.10	82.98	0.54	0.03	0.04	0.01	16.40
3	0.13	61.20	2.63	8.37	1.14	5.32	21.35
4	0.16	50.46	4.37	10.31	2.15	9.52	23.19
5	0.18	43.29	5.11	16.52	1.71	7.85	25.52
6	0.19	38.15	4.83	22.62	1.95	7.79	24.66
7	0.23	27.91	14.70	25.92	1.50	11.40	18.56
8	0.28	19.02	19.04	30.72	1.03	7.78	22.41
9	0.32	15.58	20.80	28.42	2.19	6.78	26.24
10	0.35	12.88	24.97	29.97	1.86	8.21	22.12

Source: Author's estimates.

Table 10. Variance decomposition of real GDP, $\ln(GDP_t^{real})$

Period	S.E.	$\ln(BD_t)$	$\ln(GDP_t^{real})$	P_t	R_t^l	$\ln(M_t^{real})$	$\ln(ER_t^{real})$
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*
1	0.01	15.69	84.31	0.00	0.00	0.0	0.00
2	0.01	10.75	75.73	0.55	0.01	4.66	8.31
3	0.02	12.68	58.78	0.23	0.82	7.30	20.19
4	0.03	12.21	64.83	0.85	1.50	5.97	14.64
5	0.04	11.05	68.36	0.63	1.62	5.64	12.69
6	0.05	10.02	60.47	1.08	2.34	8.46	17.64

Table 10 cont.

1	*2*	*3*	*4*	*5*	*6*	*7*	*8*
7	0.06	9.85	58.84	2.79	3.33	8.89	16.29
8	0.07	8.86	61.34	3.89	3.41	8.56	13.95
9	0.08	8.09	57.02	5.11	3.55	10.39	15.91
10	0.09	7.59	52.26	9.22	4.15	11.48	15.30

Source: Author's estimates.

Table 11. Variance decomposition of inflation rate, P_t

Period	S.E.	$\ln(BD_t)$	$\ln(GDP_t^{real})$	P_t	R_t^l	$\ln(M_t^{real})$	$\ln(ER_t^{real})$
1	6.21	4.00	0.95	95.05	0.00	0.00	0.00
2	8.66	2.24	1.85	89.02	1.82	4.72	0.34
3	11.05	3.08	11.28	68.32	1.12	2.93	13.23
4	11.81	4.06	18.24	60.50	1.59	3.13	12.49
5	12.69	3.66	22.55	58.84	1.38	2.72	10.85
6	15.01	3.23	17.50	46.11	1.72	6.67	24.78
7	15.27	3.50	18.81	44.59	2.62	6.45	24.03
8	16.38	3.49	20.72	38.99	2.47	7.73	26.61
9	17.42	3.11	18.36	34.58	2.21	10.25	31.48
10	18.28	3.19	17.91	35.23	3.36	11.02	29.30

Source: Author's estimates.

The variance of the rate of inflation as reported in Table 11 reveals that about 95.1 percent of the forecast error variance of rate of inflation is explained by its own shock in the first year but declined to 35.2 percent after a 10 year period where money supply contributes 3.2 percent for this variation in the forecast error of the rate of inflation. Inflation rate apart, a significant proportion of the rate of inflation variance is caused by real exchange rate and increased from 0.00 percent in the first period to 29.3 percent in the tenth. Both budget deficit and interest rate seem to have less significant influence on the rate of inflation. Table 12 presents the variance decomposition of the rate of interest. Results show that 75 percent of interest rate forecast error variance is explained by innovations in interest in period one. In the subsequent periods however, it declines significantly. It reaches 18.7 percent and 7.3 percent in periods five and ten respectively. In period 10, real GDP accounts for a largest percent of the rate of interest forecast error variance. It explains about 43.2 percent of the variation in interest rate. Both budget deficit and real exchange rate account for about 13.3 percent of the variation in the forecast error of interest rate after the tenth period, while money supply contributes very little especially in the last five periods.

Table 12. Variance decomposition of interest rate, R_t^l

Period	S.E.	$\ln(BD_t)$	$\ln(GDP_t^{real})$	P_t	R_t^l	$\ln(M_t^{real})$	$\ln(ER_t^{real})$
1	0.58	22.43	1.77	0.59	75.21	0.00	0.00
2	1.30	5.11	24.48	2.05	34.26	14.25	19.84
3	1.71	2.94	22.02	6.28	26.50	16.89	25.37
4	1.91	5.07	20.89	17.06	22.29	14.24	20.45
5	2.09	9.49	18.07	23.78	18.69	12.07	17.90
6	2.44	11.74	24.21	27.43	13.71	9.29	13.64
7	2.89	12.36	32.80	24.39	9.83	6.76	13.86
8	3.27	13.66	36.87	19.93	8.28	6.10	15.16
9	3.46	13.74	41.33	18.10	7.75	5.50	13.59
10	3.60	13.25	43.16	17.68	7.29	5.34	13.29

Source: Author's estimates

Table 13 shows that about 91.6 percent of money supply forecast error variance is explained by the innovations in money supply variable. Surprisingly, even after the ten year period the influence is still significant. In period ten, the other variables in the model explain about 31.7 percent of the variation in the forecast error of money supply. Notable, the contribution of real GDP to the variation in money supply is less significant.

Table 13. Variance of money supply, $\ln(M_t^{real})$

Period	S.E.	$\ln(BD_t)$	$\ln(GDP_t^{real})$	P_t	R_t^l	$\ln(M_t^{real})$	$\ln(ER_t^{real})$
1	0.04	5.03	0.67	2.62	0.11	91.57	0.00
2	0.06	2.63	0.37	1.23	0.05	94.89	0.84
3	0.07	1.61	0.95	2.96	0.19	89.26	5.02
4	0.09	2.15	0.70	3.02	0.51	87.10	6.53
5	0.10	3.69	0.70	3.96	0.89	83.02	7.74
6	0.11	5.06	0.86	5.32	1.36	78.61	8.80
7	0.13	6.18	1.03	6.77	2.22	74.51	9.29
8	0.13	7.00	1.10	7.93	3.21	71.46	9.31
9	0.14	7.65	1.06	8.76	4.02	69.50	9.01
10	0.15	8.28	0.98	9.34	4.55	68.34	8.51

Source: Author's estimates.

Finally, as reported in Table 14, 64.1 percent of the forecast error variance of real exchange rate is explained by its own shock in period 1 but it declined to about 36.2 percent in period 10. Real GDP, inflation rate, and money supply respectively, account for 20.8 percent, 20.1 percent, and 13.7 percent of the variation in the forecast error of real exchange rate in period 10. Budget deficit seems to contribute very little to the variation in the forecast error of money supply.

Table 14. Variance decomposition of real exchange rate, $\ln(ER_t^{real})$

Period	S.E.	$\ln(BD_t)$	$\ln(GDP_t^{real})$	P_t	R_t^l	$\ln(M_t^{real})$	$\ln(ER_t^{real})$
1	0.07	3.44	15.39	2.06	0.74	14.27	64.11
2	0.08	5.19	26.93	1.64	3.19	11.11	51.94
3	0.10	3.62	48.97	1.39	2.32	7.72	35.98
4	0.13	2.75	39.65	0.97	2.58	12.12	41.93
5	0.15	2.71	33.52	6.05	5.35	14.03	38.33
6	0.16	2.82	35.74	7.31	5.36	12.71	36.07
7	0.17	2.81	32.98	6.94	4.85	14.34	38.08
8	0.19	2.22	25.79	14.37	5.65	15.93	36.03
9	0.21	2.76	21.47	19.81	4.88	13.58	37.51
10	0.21	4.36	20.84	20.13	4.83	13.67	36.17

Source: Author's estimates.

4.5. Diagnostic tests

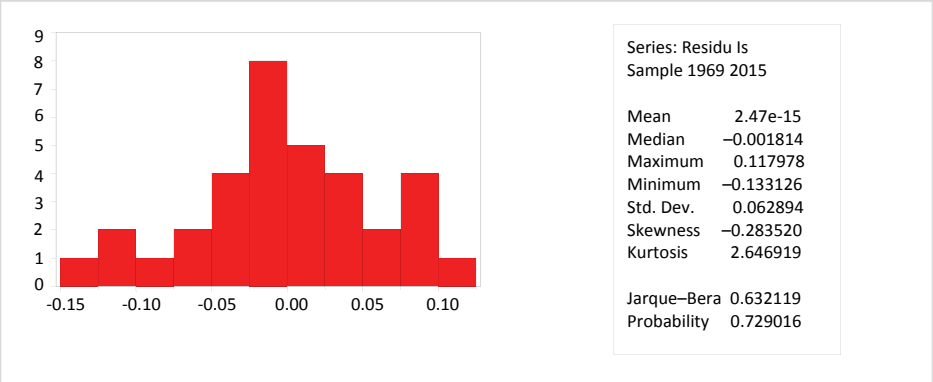
It is worth noting that the presence of regression pathologies such as serial correlation, multicollinearity and heteroscedasticity violates the classical assumptions of the OLS and hence invalidates statistical validity of parameter estimates. Thus, a battery of diagnostic instruments is applied to test if the main model, model (10) is statistically adequate. These tests are focused on the properties of residuals. Here tests for model specification and stability are discussed. The estimate of the cointegration budget deficit model indicates that approximately 73 percent of the variations in budget deficit is explained by the explanatory variable included in the model. These estimates have been obtained with F-statistic of 3.3 which rejects the null hypothesis that all the explanatory are equal to zero. The results of the diagnostic tests are reported in Table 15, Figures 8-9 and Appendix 1. Figure 9, indeed, confirms the presence of long run relationship between budget deficit and the explanatory variables.

Table 15. Diagnostic checking

Problem	Test Statistics	Probability	Inference
Normality	Jarque–Bera = 0.632	0.729	Normality Exists
Serial correlation	Breusch–Godfrey LM Test = 0.069670	Prob. F(2,21) = 0.9329	No Serial Correlation
Heteroskedasticity	Heteroskedasticity Test: ARCH = 0.014	Prob. F(1,30) = 0.9071	No Heteroskedastcity
Model specification	Ramsey RESET = 0.212	F(1,42) = 0.766	Correctly Specified

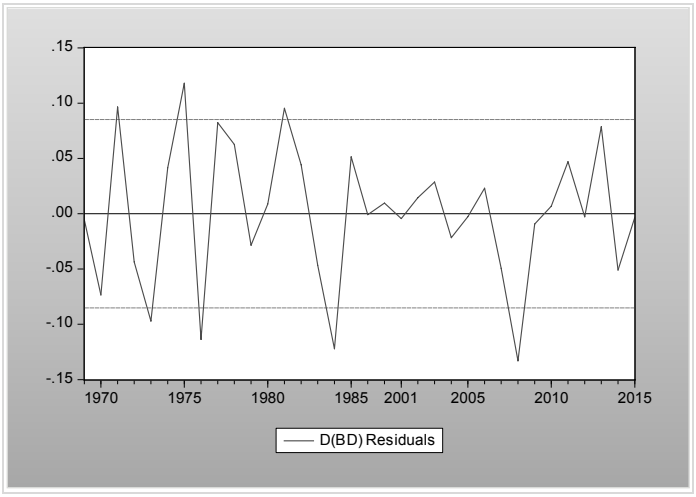
Source: Author's estimates.

Figure 8. Normality test of the residuals



Source: Author's estimates.

Figure 9. Plot of the series of residuals



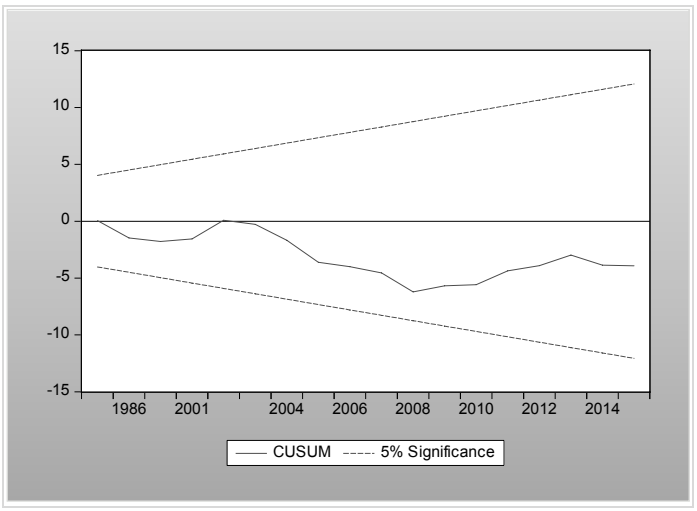
Source: Author's estimates.

Overall, results show that the model is good because we fail to reject the null hypotheses of no serial correlation and no heteroscedasticity. Moreover, model specification test indicates that the model is correctly specified. In addition, the normality test suggests that residuals are normally distributed as we unable to reject the null hypothesis of normality using Jacque–Bera at 5 percent. This makes it efficient in arriving at better conclusions.

Furthermore, CUSUM and CUSUM Q tests are performed in order to check stability of the budget deficit model over the period of the study. Figure 10 and Figure 11 show the results of the two stability tests. The straight lines represent

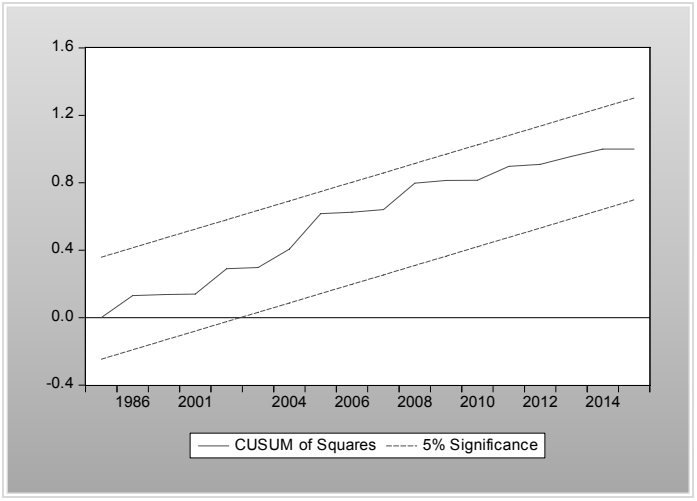
critical bounds at 5 percent significance level. Both CUSUM and CUSUM Q plots are within the critical bounds at 5 percent significance level. In this case, we failure to reject the null hypothesis of stability in the regression model. Hence, it is concluded that the cointegrating vector that links budget deficit and macroeconomic fundamentals is stable at 5 percent level of significance.

Figure 10. Plot of cumulative sum of recursive residuals



Source: Author's estimates.

Figure 11. Plot of cumulative sum of squares of recursive residuals



Source: Author's estimates.

5. Conclusions and policy implications

The main objective of this paper is to examine the causal relationship between budget deficits and macroeconomic fundamentals namely real GDP growth rate, the rate of inflation, interest rate, money supply and real exchange rate. The VAR-VECM and variance decomposition methods are applied to examine the causal relationship among macroeconomic variables. The paper uses time series annual data spanning from 1966 to 2015. Both unit root and cointegration tests are performed to ascertain if the variables are stationary and that a long run relationship exists among them. The results of the unit root test indicate that the variable are non-stationary and therefore are integrated of order one to make them stationary. The results of the cointegration test indicate that a long run relationship exist among the macroeconomic variables. This implies that the variables included in the mode will have transitory deviations from their long term common trend, eventually forces will be set in motion that will drive them together again.

The VECM and variance decomposition results provide evidence on the causal relationships between budget deficits and other macroeconomic variables included in the model over the period of study. Unsurprisingly, budget deficits and real GDP are negatively correlated. By contrast, budget deficits, and the rate of inflation and money supply are positively associated. These findings have important policy implications. First, the causal relationship that exists between the rate of inflation and budget deficits, suggests that relevant measures should be taken to enhance policy coordination between the monetary policy and the fiscal policy aiming at efficient money supply, budgetary planning, taxation and public sector spending. Second, the fact that one of the main objectives of the Government of Tanzania is to sustain high economic growth then, exchange rate targeting seems to be the suitable measure to adopt. Results show that real exchange rate and real GDP are positively related but budget deficit and real exchange rate are negatively correlated. Because budget deficits reduce real GDP growth, lead to higher inflation rate and money supply, it is necessary for the Government of Tanzania to reduce the size of the budget deficits, mainly by raising domestic revenue mobilization through tax base expansion while reducing foreign and borrowing deficit financing. Tax base can be expanded by lowering the size of informal sector, fighting against corruption and tax evasion, reducing unproductive tax exemption, and overall efficient improvement in tax administration. Reduction in the overall recurrent expenditure bill relative to GDP may also help to mitigate the budget deficit problem that leads to debt accumulation in Tanzania.

Admittedly, the correlation between budget deficits and various economic variables is complex; even the best mathematical model can hardly quantify this correlation. Nonetheless, high budgetary deficits cause macroeconomic problems including high level of inflation and low economic growth. If the government borrows money to finance its deficits, it may lead to an increase in interest rate and crowd out of private investment spending; and if the government finances its budget deficit by printing money, it may lead to high inflation. Thus, the best way of financing budget deficits is through improvement in domestic revenue mobilization and control growth in recurrent expenditure while increasing development expenditure.

It is worthwhile to mention that macroeconomic variables that are related to budget deficits are many and therefore it is very difficult to incorporate all of them in one study. To explore further relationships between budget deficits and macroeconomic variables, future study could include variables such as fixed gross capital formation, labor force and unemployment. Furthermore, future study may extend the analysis to capture the causal relationship between budget and current account deficits.

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Appendix 1. Autocorrelation and partial autocorrelation

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
. | . |	. | . |	1	0.061	–0.061	0.1378	0.710
. | . |	. | . |	2	0.033	–0.037	0.1789	0.914
.* | . |	.* | . |	3	0.125	–0.130	0.7986	0.850
. | . |	. | . |	4	0.022	–0.041	0.8186	0.936
. | . |	. | . |	5	0.005	–0.019	0.8194	0.976
. | . |	. | . |	6	0.008	–0.013	0.8225	0.991
. | . |	. | . |	7	0.024	–0.034	0.8479	0.997
. | . |	. | . |	8	0.055	–0.065	0.9923	0.998
** | . |	** | . |	9	0.225	–0.245	3.4764	0.942
. | . |	. | . |	10	0.071	0.019	3.7301	0.959
. | . |	. | . |	11	0.023	–0.064	3.7594	0.976
. |* . |	. | . |	12	0.100	0.032	4.3126	0.977
. | . |	. | . |	13	0.052	–0.061	4.4699	0.985
. | . |	. | . |	14	0.023	0.002	4.5028	0.992
.* | . |	.* | . |	15	0.097	–0.110	5.1140	0.991
. | . |	. | . |	16	0.034	–0.009	5.1916	0.995

Note:
No serial correlation in the model because none of the lag is found to be significant at 1 percent level.

Source: Author's estimates.