Empirical appraisal of fiscal stability: the case of Ghana

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Abstract

Purpose – The purpose of this paper is to appraise the stability of Ghana's fiscal policy by assessing government's reaction in the past to rising public debt over the last three decades.

Design/methodology/approach – Using quarterly data spanning 1990Q1-2013Q2, the study evaluated the mean reverting properties of Ghana's public debt and also estimate the fiscal policy reaction function. The complementary estimation techniques include Pesaran *et al.* (2001) bound testing cointegration test, differencing method and also Granger two-step cointegration methods.

Findings – Using quarterly data from 1990Q1 to 2013Q2, the study found the fiscal policy to be unstable in the 1990s, necessitating the adoption of Heavily Indebted Poor Countries' initiative in 2001. The fiscal situation however relatively stabilizes afterwards following the external debt relief in 2001. Nevertheless, the study reveals that the recent fiscal policy (since 2006) seems to be confronted with tremendous fiscal pressures, exacerbated by fiscal excesses during election cycles as well as excessive domestic and external borrowings. In addition, the economic growth-debt link was found to be weak, though debt appears to adversely affect economic growth.

Research limitations/implications – The study does not thoroughly explore the possibility of non-linear relationship between public debt and primary balance. Also, the result could be different using different data frequencies.

Practical implications – The state of government finance has implications on the monetary policy and economic growth prospects of an economy. As an inflation targeting central bank since 2002, a successful monetary policy implementation that reins in inflation requires fiscal policy that curtails fiscal volatilities originating from imprudent behaviour of government. Therefore, the looming fiscal pressures in recent times would impair the effective implementation of the inflation targeting framework by the central bank, and also retard economic growth as the bulk of these expenditures are usually recurrent in the case of Ghana.

Originality/value – This is the first paper to employ complementary econometric techniques to empirically evaluate fiscal sustainability in Ghana.

Keywords Sustainability, Public debt, Accumulated impulse response and Ghana,
Bound testing cointegration, Fiscal reaction function, Primary surplus

Paper type Research paper

1. Introduction

After reducing its three-decades debt burden through the adoption of Heavily Indebted Poor Countries' (HIPC) initiative alongside multilateral debt relief (especially in 2006), the Ghana Government is again confronted with rising debt levels. The mounting public debt of Ghana which currently stands at 55.1 per cent of GDP as at end-December 2013 (MPC Press Release, July 2014), is only 4.9 per cent shy of the IMF's critical debt threshold of 60 per cent of GDP and more than twice the three-decade low of 26 per cent of GDP in 2006. The rapid build-up in government debt since 2006

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is mainly attributable to persistent expenditure overruns which engendered continuous budget deficits. In recent years, the fiscal excesses have been worsened by the escalating public sector wage bill due to the implementation of single spine salary structure alongside the weakening fiscal revenue generation efforts.

The size and rapid rate of growth in public debt has exacerbated government's debt obligations, further compounding government's borrowing needs to contain its escalating interest cost and hence, exposing the economy to solvency risk especially in the period of economic downturn. The fiscal is said to be solvent (sustainable[1]) if the present value of the future stream on the country's income is larger than the size of the debt. Thus, the concerns of fiscal sustainability or solvency primarily hinge on economic growth implications of public debt accumulation. This development has engaged considerable academic and political attentions lately as the debts have largely gone to finance consumption expenditures[2] to the detriment of growth enhancing capital infrastructure and other developmental activities (see Akosah, 2013). Another significant feature of Ghana's public finance is a stringent fiscal consolidation after election spending excesses which considerably slow down economic growth. This is due to the fact that the already low capital expenditures further suffer from the post election fiscal consolidation process.

It is worthy to note, that in spite of the growing public debt, the government is resolved to develop some key sectors of the economy including the nascent oil and gas industry as stipulated in the 2014 fiscal budget. Much as such investments are essential to ensure sustain economic growth, the budget statement paradoxically indicates the capital expenditure projection of 5.7 per cent of GDP as against the projected interest payment of 5.9 per cent of GDP. On average, interest payment alone absorbed 15.3 per cent of total government expenditure per year over the last three decades. This goes to emphasize the extent of debt service burden on the economy. The magnitude and rapid growth of debt have both monetary and fiscal implications which in turn weaken the pace of economic growth via interest rate channel. Intuitively, since government needs to borrow to service the debt and also close the fiscal gap, interest rates are kept high and attractive. This worsens the debt burden as it causes the government to borrow more to service the debt. In the same vein, the higher interest rates tend to "crowd out" the private sector from accessing the limited loanable funds. This slows down investments by the private sector and hence restrains the momentum of economic growth. In addition, the monetization of the public debt via seigniorage financing has implications on monetary aggregates and inflation, hence, impeding the effectiveness of monetary policy by the central bank. Given, the fiscal, monetary and economic growth implications of rising public debt, the fundamental issues that arise are:

- is the current fiscal policy stable?
- how do governments react to the accumulation of debt?
- does the evidence support the notion that rapid debt accumulation has held back the pace of economic growth in Ghana?

This paper attempts to answer the above critical questions by carrying out an in-depth analysis on the sustainability of Ghana's public finance and to understand how government has in the past reacted to changing dynamics in the public debt. The paper is thus organized as follows. The next section outlines the evolution of Ghana's public debt over the last 30 years. It also examines regional comparison and economic growth implication of public debt. Section 3 provides the theoretical persuasions of fiscal

reaction function (FRF), while Section 4 outlines the data and the main methodologies employed for the empirical analysis. Section 5 provides an extensive empirical analysis of feedback rule from the level of public debt to the primary balance to see if we observe stabilizing fiscal surpluses as the public debt increases in Ghana, considering linear (parametric) models. For robust checks of the estimates, Section 6 presents alternative estimation of long run tax policy function. The final section provides the conclusion and policy recommendation.

2. Ghana's fiscal context: stylized fact

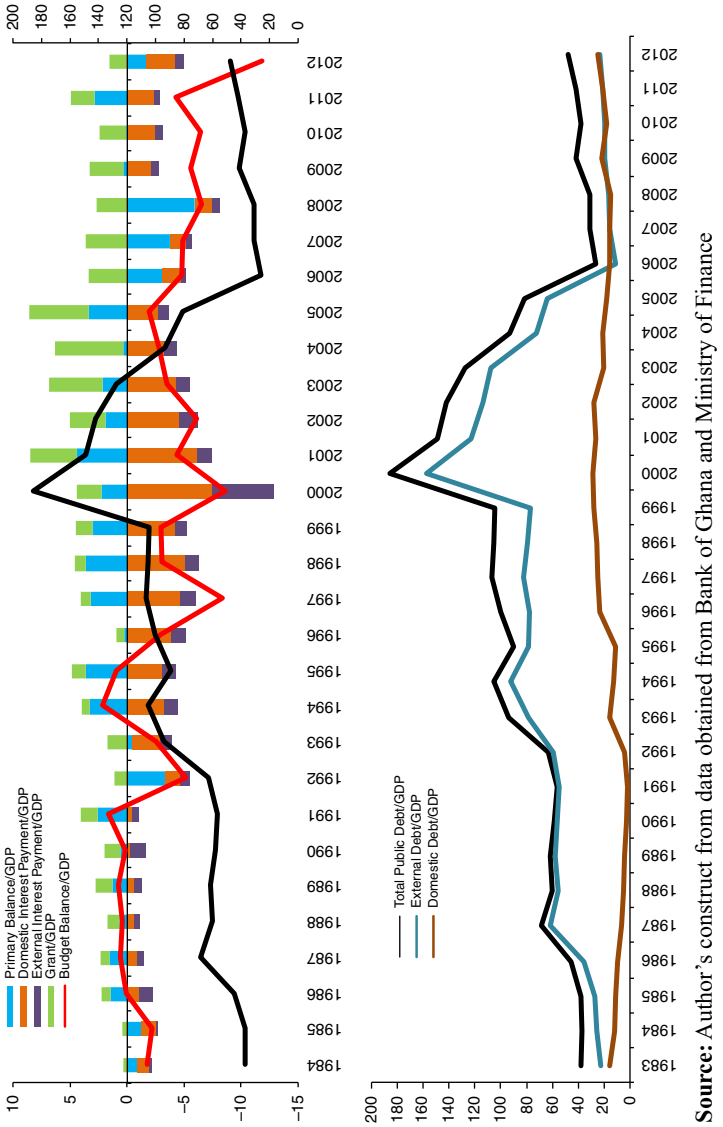
2.1 Fiscal policy and debt trajectory

Successive governments since independence in 1957 have pursued what I termed a "pseudo socialist agenda" (a mixture of socialism and capitalism) as the public sector remains the main driver of the economy in terms of employment and consumption demand. The big government, however, brought Ghana into a cycle of debt and currency overvaluation and by early 1980s, the economy of Ghana was in state of total collapse in the midst of declining production and official exports (fall in cocoa prices in 1977). This also compounded external borrowings, intensifying a self-destructive cycle largely driven by debt and reliance of vulnerable world commodity market (Bawumia, 2010).

The Government of Ghana accepted a stringent economic recovery policy in 1983, under the auspices of the IMF and the World Bank (see Ayensu, 2007; Bawumia, 2010). This led to a dramatic policy shift, fundamentally changing government's social, political and economic orientations, while primarily enabling Ghana to repay its external debts. Consequently, macroeconomic stability was restored between 1984 and 1991 with real GDP recording steady growth while inflation declined from 122 per cent in 1983 to 10 per cent by 1991. Government budget balance improved from a deficit of 2.5 per cent of GDP in 1983 to a surplus of 0.1 per cent of GDP by 1986. The overall budget, largely underpinned by increase in tax revenue and grant, remained in a surplus between 1986 and 1991 (see Figure 1), recording a surplus of 1.6 per cent of GDP by 1991, the highest since 1959. In sync, public debt declined from 68.7 per cent of GDP in 1987 to 56.6 per cent of GDP by 1991 (Bawumia, 2010).

However, the budget balance deteriorated significantly in the run up to the 1992 election to a deficit of 5.2 per cent of GDP. This reflected a rapid increase in government expenditure in the pace of the election amid weakened revenue sources, leading to a large primary deficit of 3.3 per cent of GDP. Due to the fiscal profligacy, the IMF and World Bank suspended their financial support to Ghana between 1992 and 1994 (see Bawumia, 2010). With significant decline in donor support which impacted negatively on revenue sources, the government of Ghana contracted new medium term non-concessional loans which compounded the external debt stock (Figure 1).

Although the IMF programme was reinstated in 1995 which resulted in accelerated divestiture of state enterprise and moderated the external debt levels, large fiscal slippages re-emerged to the run up of 1996 and 2000 elections (see Bawumia, 2010). This reflected an abrupt increase in domestic debt from 11.3 per cent of GDP in 1995 to 28.9 per cent of GDP by 2000, even though external debt moderated from 92.3 per cent of GDP in 1994 to 76.6 per cent of GDP by 1999 before picking up remarkably to 157.3 per cent of GDP in 2000 (Figure 1). The debt build-up during the late 1990s was also linked to the inclusion of revaluation stock to the domestic debt stock for the first time in 1996. Although significant primary surpluses were recorded during 1994-2000 period in an effort to ensure debt sustainability, the interest payment alone accounted



Source: Author's construct from data obtained from Bank of Ghana and Ministry of Finance

Figure 1.
Evolution of Ghana's public debt/GDP and budget balance/GDP ratios (per cent)

for 26.9 per cent of total government expenditure in 2000 from 8.1 per cent in 1991 (Figure 1). This exposed the economy to serious debt service challenges.

Against this background, the then government opted for the adoption of the HIPC initiatives[3] in March 2001. The initiative led to the external debt relief from donor countries and institutions, and coupled with a renewed focus on fiscal and monetary policy stringencies[4]. Implementation of HIPC and the attendant policies restored relative stability in the economy between 2001 and 2006 (see Bawumia, 2010). The debt trajectory changed remarkably after 2000 due to external debt forgiveness from donor partners and institutions (effective in 2006)[5]. Consequently, external debt declined drastically from the peak in 2000 (157.3 per cent of GDP) to a low of 10.7 per cent of GDP by 2006, reflecting a sharp improvement in both total public debt and budget deficit (Figure 1). All the debt indicators were also brought well within their sustainable thresholds. A notable development of debt composition during 2001-2006 period however was a remarkably shift of government borrowings towards domestic sources (Research Database, Bank of Ghana).

Notwithstanding, Ghana's debt trajectory has closely reverted to early1990 levels, rising from the trough in 2006 to record an overall public debt to GDP ratio of 55.1 per cent as at end-December 2013. This has reflected escalating external and domestic debt levels, driven by large fiscal and current account deficits as well as exchange rate depreciation. The deficits[6] were largely the consequences of fiscal slippages especially during elections in 2008 and 2012. Between 2006 and 2008, primary deficit averaged 4.2 per cent of GDP per year but the relatively high inflows of grants averaging 3.3 per cent of GDP per annum moderated the overall budget, and hence attenuated the build-up in public debt (Figure 1). In addition, government revenue mobilization improved remarkably with the onset of oil production and export in 2011. Government domestic revenue rose from 16.7 per cent of GDP in 2010 to 20.7 per cent of GDP in 2011. This led to a primary surplus of 2.8 per cent of GDP in 2011 (from a surplus of 0.1 per cent of GDP in 2010) and an improved budget deficit of 4.3 per cent of GDP (from −6.5 per cent of GDP in 2010). As usual, the primary balance, budget balance and the public debt worsened to −1.6 per cent of GDP, −11.8 per cent of GDP and 49.3 per cent of GDP, respectively in the run up of 2012 election (Ministry of Finance, Fiscal and Economic Data, 2012). The trend in fiscal developments have attested to the suggestion that election cycles in Ghana usually result in acute fiscal slippages which throw the public finance into disarray.

2.2 Regional comparison and economic growth implications of public debt accumulation

Although, the current public debt to GDP ratio is still within threshold, the recent trend places Ghana among the top five most indebted countries in the middle income group[7] of Sub-Saharan Africa (SSA) (International Monetary Fund, 2013). As shown in Figure 2, Ghana's average public debt for the period 2004-2012 exceeded all regional averages while overall budget deficit including grant exceeded both the regional averages and that of the peer economies.

However, economists are mostly interested in the economic growth implications of debt accumulation but not the level of the debt *per se*. Indeed, Ghana is among the fastest growing economies in the SSA in spite of twin deficits and debt problems. Nevertheless, the recent build-up in debt has raised serious concerns in academia, political and international discourses about its impact on economic growth. Ghana has recently been classified by the IMF as a "moderate risk" country due to the

heightened interest in Ghana's fiscal sustainability issue and this has occasioned series of downgrades by rating agencies such as Fitch, Moody's and Standard and Poors. The downgrades have highlighted the weakening ability of the economy to service its debt in the future, among other reasons.

The main debate has been whether or not the recent rapid debt accumulation would translate into fast economic growth to ease debt servicing. As exhibited in Figure 3, the positive correlation between real GDP growth and public debt/GDP ratio is insignificant, suggesting a weak link between the two.

Motivated by this concern, this study further tracked the historical output growth-debt dynamics by systematically exploring the bivariate correlation and impulse response function between growths in real GDP and public debt. In the bivariate correlation analysis, output growth was correlated with both the contemporaneous and lagged changes in public debt (not scaled by GDP) using annual (1976-2012) and quarterly (2000Q1-2013Q2) time series data. As exhibited in Table I (the correlation matrix) and Figure 4 (the accumulated impulse response), the results generally suggested a weaker link between debt build- up and output growth for the sample period.

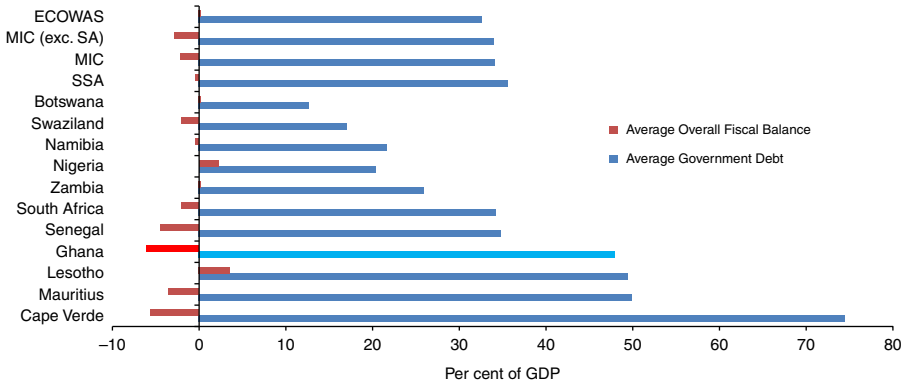


Figure 2.
Regional comparison of fiscal deficit and debt to GDP (average 2004-2012)

Source: Author's own construct from IMF's Regional Economic Outlook for Sub-Saharan Africa, October 2013

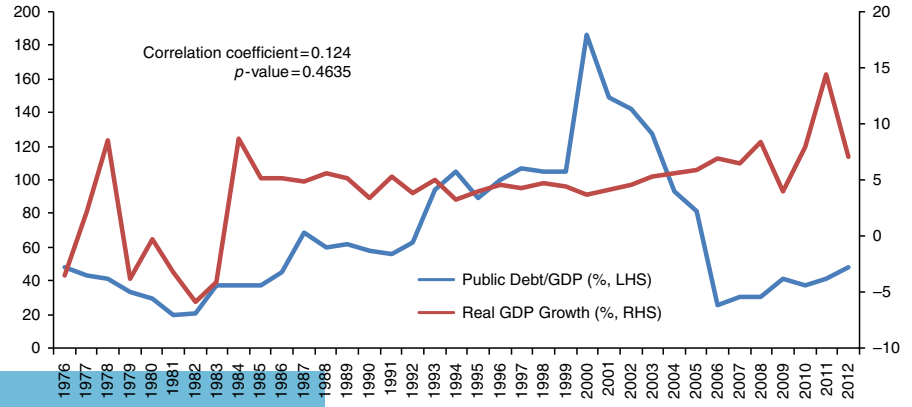


Figure 3.
Trends in real GDP growth and public debt/GDP

Although the growth-debt link requires further analysis (which is outside the scope of this paper), the weak link between public debt accumulation and economic growth is somewhat not surprising as recurrent expenditure has averaged 70 per cent of the total government expenditure over the last two decades. In fact, recurrent expenditure alone absorbed 83.5 per cent of total government expenditure as at end-December 2013, driven mainly by rising payments of employees' compensations and interest cost (Fiscal Database, Ministry of Finance; www.mofep.gov.gh). Consequently, the recent rapid build-up in Ghana's public debt warrants a critical assessment to track government's fiscal reaction in the past to growing debt.

3. Empirical literature of FRF

FRF is a rule that helps government forecast and prepare to react against some macroeconomic changes. Thus, for public finance to be sound and stable, there is need for a right FRF. To establish how fiscal authority react to its debt burden, the FRF estimates the reaction of primary balance/GDP ratio to changes in the one-period lagged public debt/GDP ratio while controlling for the influences of other macroeconomic variables. In the literature, most FRFs rely mainly on the following government inter-temporal budget constraint (IBC):

$$G_t + (1 + i_{t-1})D_{t-1} = T_t + D_t, \quad (1)$$

	Real GDP growth	
	Annual 1978-2012	Quarterly 2000Q1-2013Q2
Contemporaneous		
Growth in public debt	−0.261	0.010
Growth in domestic debt	−0.258	−0.226
Growth in external debt	0.046	0.067
Previous lagged		
Public debt growth	−0.077	−0.268***
Domestic debt growth	−0.144	−0.163
External debt growth	0.203	−0.249***

Note: ***Significant at 10 per cent level, respectively

Table I. Correlation between real GDP growth and debt

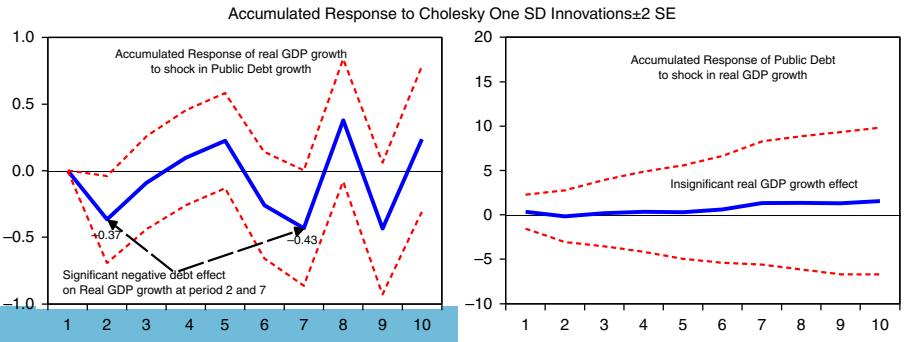


Figure 4. Accumulated responses of real GDP growth and public debt accumulation (2000Q1-2013Q2)

Bohn (1998) simplified government IBC into the form:

$$D_{t-1} = (D_t - Pb_t)(1 + R_{t-1}), \tag{1a}$$

From Equation (1), government's total receipts including tax (T_t) and borrowing (D_t) of the current period should equal the government's total spending (G_t) plus debt service (including principal from the previous period (D_{t-1}) and interest payment ($i_{t-1}D_{t-1}$). The second equation explores the relationship among government debt (D_t), primary balance (Pb_t), which is tax revenue minus non-interest government expenditure (+ surplus; −deficit), and the gross interest factor (R_{t-1}). These equations of government IBCs have been iterated by various researchers to produce different FRF to suit specific conditions of their research.

FRF has been estimated by Bohn (1998), De Mello (2005), Davig and Leeper (2007), Burger *et al.* (2011), Doi *et al.* (2011) and Hall (2013), among others. Some studies also examine fiscal stability by establishing a cointegrating relationship between tax revenue and government expenditure (see Trehan and Walsh, 1988, 1991). In the empirical literature, Bohn's (1998) influential study on the US fiscal policy in the period 1916-1995 was done using a simple FRF:

$$ps_t = \rho.d_t + \alpha.Z_t + \varepsilon_t = \rho.d_t + \mu_t, \tag{2}$$

where:

$$\mu_t = \alpha.Z_t + \varepsilon_t \tag{2a}$$

In this equation, ps_t and d_t are the primary balance/GDP ratio and debt/GDP ratio, respectively, ρ is the coefficient of debt/GDP ratio (i.e. reaction of ps_t to changes in d_t), Z_t is a set of other determinants of the primary surplus and ε_t is an error term. Due to omitted variable bias, Bohn therefore caution that empirical analyses should be based on an explicit theoretical model for fiscal policy. Following Barro's (1979) tax-smoothing model, Bohn extended the model in Equation (2) to include temporal government spending ($GVAR_t$) and business cycle indicator ($YVAR_t$):

$$ps_t = \rho.d_{t-1} + \alpha_0 + \alpha_G GVAR_t + \alpha_Y YVAR_t + \mu_t, \tag{2b}$$

Bohn's (1998) multivariate OLS estimation including government expenditure and business cycle indicator yielded significant positive response of primary surplus to changes in debt/GDP in the USA. He argued that the positive coefficient provide reliable information about sustainability irrespective of how interest rate and growth compare. Thus, if debt/GDP ratio keeps growing, a sustainable fiscal policy must ultimately respond by moving towards primary surpluses. He emphasized that a strict positive and at least linear response of the primary surplus to changes in the debt/GDP ratio turns out to be sufficient for sustainability. The potency of this sustainability test is that it does not entail any assumption about interest rate dynamics. In addition, it is applicable to economies with indiscriminate debt management policies, uncertainty, risk aversion and whether or not interest rates are above or below growth rate.

Following Bohn (1998) and Khalid *et al.* (2007) also estimated the FRF for Pakistan using VAR technique with three main variables including fiscal deficit, output gap and inflation. Burger *et al.* (2011) also extended the model with lag of primary balance and output gap to examine the fiscal sustainability and FRF of South Africa using OLS, VAR, GMM, VECM, among other models. They found that the South African

Government indeed did tighten fiscal policies when facing shocks to the debt/GDP position during the sample period.

Similarly, Doi *et al.* (2011) examined Japan's fiscal sustainability incorporating a quadratic term (a deviation of the previous debt from the mean), output gap and government expenditure using both simple linear (OLS) and non-linear Markov-Switching models. They found Japan's Government debt to be explosive as both models showed significant negative response of primary balance to changes in debt/GDP.

Also, Nguyen (2013) used Autoregressive Distributed Lag (ARDL) Model to estimate the FRF of India with tax revenue/GDP as a function of debt/GDP, output gap, interest rate, inflation and lagged tax revenue. The estimates showed that Indian Government followed a fiscal policy rule which strictly ruled out any sudden shock that could be deleterious for economic growth.

To capture the role of monetary policy in the government budget constraints, De Mello (2005) extended the Bohn's model by including monetary indicators in the estimate of the FRF for Brazil in the 1990s. De Mello established a cointegration relationship among the variables, indicating a stable FRF of Brazil.

4. Data and methodology

This study employed annual and quarterly time series data covering the period 1983-2012 and 1990Q1-2013Q2, respectively. The choice of the sample period was based on data availability and, in particular, to empirically appraise the decision for the adoption of HIPC initiative in 2001 by the then government. The data selection covered all the four sector of the economy. The time series data were obtained from Bank of Ghana, Ministry of Finance and Ghana Statistical Services.

The study empirically estimates the FRF to ascertain how Ghana Government reacts to rising public debt using linear models after subjecting the data to unit root tests. In this study, the paper carried out both bivariate and multivariate estimations of the FRF. If the unit root test suggests a mixed order of integration, the Johansen cointegration method would not tenable. Therefore, the short and long run FRFs would be estimated using econometric methods such as differencing method, ARDL and Engel-Granger two-step methods (residual-based cointegration method). However, the use of residual-based cointegration method was motivated by Johansen (1995) assertion that both stationary variables and trend-stationary variables are allowed in a cointegration equation, provided that there are at least two non-stationary variables that are integrated of the same order (Ahking, 2002).

In particular, since bound testing ARDL models are robust and indifferent about the order of integration of the interested variables, the paper mainly explores multivariate long run link between debt and primary balance using the following equation:

$$\Delta ps_t = \alpha_0 + \sum_{i=1}^{p} \alpha_i \Delta ps_{t-i} + \sum_{i=0}^{p} \beta_i \Delta d_{t-i} + \sum_{i=0}^{p} \gamma_i \Delta C_{t-i} + \varphi_1 ps_{t-1} + \varphi_2 d_{t-1} + \varphi_3 C_{t-1} + v_t, \quad (3)$$

where ps_t is primary balance/GDP[8], d_{t-1} is previous public debt/GDP, C_t is a vector of other variables that influences the primary surplus and v_t is an error term with zero mean and constant variance (δ^2). The vector inherent variables were carefully chosen.

Among these variable is a dummy to control for election spending effect as it is clearly evident that Ghana's political cycles influence government spending and hence budget deficit. In addition, GDP gap[9] was introduced to allow for the possibility that government pursues short run demand stabilization (Bohn, 1998) and also helps to capture the influence of business cycles on budget deficit (De Mello, 2005). Inflation was introduced to capture policy coordination between fiscal and monetary authorities (Khalid *et al.*, 2007) and also accounted for shocks to seigniorage revenue (Gali and Perotti, 2003). Another key variable controlled in the models is exchange rate depreciation which accords a lot of attention in policy cycles due to its pervasiveness in the Ghanaian economy as well as its impact on both external debt services and trade competitiveness. Also controlled in the model are the terms of trade shocks as Ghana is import dependent and government revenues rely heavily on proceeds from key exports. The terms of trade shocks were measured as the deviation from the Hodrick-Prescott trend. Following Doi *et al.* (2011), deviation of public debt from the trend level (an arithmetic mean) was also introduced to examine the possibility of a non-linear effect on primary balance.

The ARDL cointegration test makes use of the usual *F*-statistic and *t*-statistic. The null hypothesis that no long run relationship exists among all variables is *H0*: $\varphi_1 = \varphi_2 = \varphi_3 = 0$ against the alternative hypothesis of *H1*: $\varphi_1 \neq \varphi_2 \neq \varphi_3 \neq 0$. Pesaran *et al.* (2001) cointegration test does not use the standard *F*-test and *t*-test. They provided two other set of critical values called a lower bound and upper bound. The lower bound assumes that the variables are purely *I(0)*, while the upper bound assumes that variables are purely *I(1)*. These asymptotic critical value bounds also depend on whether intercept and trend are considered. The following are the three possible outcomes:

(1) If the computed Wald or *F*-statistic falls below the lower bound, then the null hypothesis is not rejected, and hence no cointegration relationship exists among the variables.

(2) If the computed *F*-statistic exceeds the upper bound, then the null hypothesis is rejected. In this case, a conclusive decision results without needing to know the stationary properties of relevant variables.

(3) However, if the computed *F*-statistic falls within these bounds, inference would be inconclusive and therefore, the knowledge of the cointegrating rank of the interest variables is required to proceed further.

5. Empirical results and inferences

5.1 Unit roots tests

This section assesses the stability of Ghana's fiscal policy by using data generating process, following Hamilton and Flavin (1986). Thus, it explores the transversality condition of fiscal policy using both Augmented Dickey-Fuller (ADF) and Philip-Perron (PP) unit root tests, encompassing both full and sub-sample analyses. Table AI shows the results of ADF and PP unit root tests (see, Appendix). Considering the ADF-test for the full sample (1990Q1-2013Q2), public debt ratio was non-stationary, that is *I(1)*, whereas primary balance ratio was found to be stationary, *I(0)*. This was corroborated by the PP tests.

Notwithstanding, it is also possible for the unit root tests to fail to distinguish between formally integrated series and stationary but very persistent series. As a result, further

sub-sample analysis was carried out using the year 2000 as the breakpoint to assess the robustness of the results. The choice of the breakpoint was based on the adoption of HIPC in 2001 by the then government. As a result, the two sub-periods used were 1990Q1-2000Q4 and 2001Q1-2013Q2. The results of the unit root tests for these two periods are displayed in column 4 and 6, respectively in Table AI. From both ADF and PP tests, public debt was found to be non-stationary for the period 1990Q1-2000Q4, but was found to be stationary during the period 2001Q1-2013Q2, supporting the weak significance of the correlation coefficient. Primary balance, on the other hand, was found to be stationary in both sub-periods, supporting the full sample results.

5.2 Estimates of fiscal policy reaction function (FPRF)

This section estimates the FPRF by examining the long run relationship between primary balance and debt using parametric (linear) models. These models assumed homogeneous (constant) error distribution.

Difference estimation. As shown in Table AI, both ADF and PP unit roots test show that public debt is generally non-stationary, *I(1)*, while primary balance is stationary, *I(0)*, for the full sample. According to Banerjee *et al.* (1993), the standard OLS tests are unreliable when faced with model that incorporates both stationary and non-stationary variables. Therefore, to apply the standard OLS test, all variables should be made stationary by differencing. Following the idea of Banerjee *et al.* (1993), the paper carried out both bivariate and multivariate[10] difference VAR estimations of the FRF. The lag length p was selected based on information criterion as well as VAR stability test. Following the unit root test results, primary balance was in levels while public debt generally entered the VAR model in first difference.

In this analysis, the interest variable is the coefficient of the immediate past value of public debt to GDP ratio, Δd_{t-1}, since debt is a stock variable. The intuition is that a country which is able to stabilize its indebtedness without a major effort can be regarded as safe (Lame *et al.*, 2012). That is, a debt reduction which requires only a minimal further improvement of the primary balance. In contrast, a debt stabilizing primary balance which is attainable only with difficulty (or for a longer period of time) signals possible trouble for the country to control its debt.

The parsimonious results of the bivariate FRF from the system iterative weighted least squares (SIWLS) method[11] are shown in Tables AII and AIII, while the multivariate difference estimation results are also displayed in Table AIV. Under the SIWLS method, the paper used simultaneous weighting matrix and coefficient iteration with 500 maximum iterations and convergence of 0.0001. Both the bivariate and multivariate difference estimations yielded similar results from both full and sub-samples analyses.

The results show delayed fiscal adjustment as a positive effect of public debt on primary balance was only found after two periods (quarters). The public debt equation, on the other hand, seems to indicate a negative feedback effect from primary balance after quarter three, suggesting a delayed bi-directional causality between the two interested variables. These results therefore reveal that Ghana's fiscal policy generally responds positively to growing public debt but with much delay, indicating that the fiscal profile could be sustainable but significant pressures still remain. This also attests to the notion that a country with higher public debt is more vulnerable to delays in fiscal adjustment and interest rate-growth differential shocks.

However, for the sub-period 1990Q1-2000Q4 (see Table AII), all the coefficient of public debt in the primary balance equation were found to be negative but insignificant, while no feedback effect from primary balance was detected in the public debt equation. This implies that Ghana's fiscal policy in the 1990s was generally unstable, lending support to the adoption HIPC in 2001. On the other hand, the estimates for the sub-sample 2001Q1-2013Q2 (see Tables AII) show a net positive effect of public debt on primary balance, suggesting that debt could be sustainable. Similarly, a negative feedback effect of primary balance at previous lag 3 was detected in the public debt equation, reiterating the dual causality.

A further scrutiny into the period 2001Q1-2013Q2 was carried out to assess the most recent policy stance using sub-periods 2001Q1-2005Q4 and 2006Q1-2013Q2. The choice of break was underscored by the receipt of multilateral debt relief in 2006 which led to a dramatic decline in external debt from the peak of 157.3 per cent of GDP in 2000 to the trough of 10.7 per cent of GDP in 2006, reflecting a sharp improvement in both total public debt and budget deficit. In addition, the public debt trajectory has seen significant and rapid upward movement since 2006 and is therefore essential to examine the potential threat to Ghana's fiscal stability. Table AIII shows the SIWLS estimation results for 2001Q1-2005Q4 and 2006Q1-2013Q2, respectively. For both sub-periods, the coefficients of lagged public debt in the primary balance equations were significant with a negative net effect. The coefficient of the interest variable (Δd_{t-1}) was significantly negative in the primary balance equation for the period 2001Q1-2005Q4, implying unstable fiscal policy. On the other hand, a positive significant responds of primary balance to changes in public debt was only noticed after the second quarter for the period 2006Q1-2013Q2, reinforcing the delayed fiscal adjustment.

ARDL estimation. It is essential to note that the difference estimation above essentially examines the short run dynamics and ignored the long run response of primary balance to changes in public debt. As a result, the paper captured the long run link using bound testing cointegration ARDL model which included lag levels in addition to the difference terms. As a prerequisite, lag selection was done based on AIC and SBC as well as other key diagnostics including model fitness (Ramsey reset test, Jacque-Bera test for normality, Breusch-Godfrey LM test for constant variance and serially autocorrelation test). Applying the ARDL method to Ghana's data with a maximum lag length of two ($p = 2$) yielded the following results.

From Table II the computed *F*-statistics from both models A and B exceed their respective critical upper bounds at 1 per cent significant level, indicating a rejection of the null hypothesis of no cointegration. This implies that a level relationship exists

Models	*F*-statistic (Full sample)	Significant level (%)	Critical values (restricted intercept, no trend) Lower bound	Upper bound
A ($k = 5$)	7.114	1	3.06	4.15
		5	2.39	3.38
		10	2.08	3.00
B ($k = 6$)	6.112	1	2.88	3.99
		5	2.27	3.28
		10	1.99	2.94

Table II.
Pesaran *et al.* (2001) cointegration bound test

between primary balance and public debt in Ghana. Details of ARDL cointegration test are also presented in Tables AV.

From Table AV, the coefficient of public debt at previous lagged level is positive and significant, symbolizing long run fiscal stability. In the long run, a 1 per cent increase in public debt leads to, on average, 0.01 per cent increase in primary balance. The short run coefficient of public debt is also positive and statistically significant, suggesting fiscal stability. It shows that 1 per cent growth in public debt/GDP ratio results in approximately 0.03 per cent increase in primary balance/GDP ratio in the short run.

For robustness, Tables AVI and AVII show the ARDL estimation results from sub-period analyses which were slightly similar to that of the multivariate differencing method. Both the short run and long run coefficients of public debt were positive but weakly significant during 1990s. The weak fiscal adjustment of primary balance to changes in public debt during this period confirmed that some fiscal pressures persisted in the 1990s. Similarly, both the short run and long run coefficients of public debt are positive and highly significant for the period 2001Q1-2013Q2, affirming a stable fiscal policy since 2001.

As exhibited in Table AVII, the fiscal policy during the period 2001Q1-2005Q4 (see models G & J) however contradicted the result from the difference estimation. This is because the significantly positive short and long run coefficients of public debt suggest a stable fiscal policy. This implies that the fiscal adjustment during the period was able to rein strongly in public debt accumulation. This is not surprising as the country benefitted immensely from the HIPC relief which saw a remarkable downward trajectory in public debt during that period. However, the looming fiscal pressures seem to be apparent during the period 2006Q1-2013Q2 (see models H & K) as the long run coefficient of public debt is negative and significant (5 per cent α level). This reaffirms the results from the difference estimation that the fiscal policy appears to be unstable in the long term since the mid-2000[12].

For other controlled variables in both estimation techniques, the level coefficient of nominal interest rate at previous lag was also positive and significant. This is consistent as it suggests that positive fiscal adjustments are made in response to public debt accumulation which prevent debt explosion for the sample period. The election dummy and deviation in government expenditure had expected negative coefficients and were statistically significant, reinforcing the notion that expenditure excesses during election periods throw the public finance into disarray. Output gap had a weakly significant negative coefficient for the sub-period 2001Q1-2013Q2, suggesting a little pro-cyclical fiscal policy. However, the coefficient of nominal exchange rate depreciation had insignificant negative sign, while the coefficient of inflation was strongly positive[13], which however seems to be consistent in the Ghanaian case. This is because rising inflation ultimately leads to depreciation in the domestic currency which in turn increases the interest burden on external debt component. Therefore, a positive fiscal adjustment to inflation is plausible for debt stability. In addition, the magnitude of inflation effect was found to be higher than that of output gap, implying that the effect of rising inflation expectations could be larger than the effect of a decline in real GDP (see Kwon *et al.*, 2006). Also, increase in central bank's financing of government expenditure, proxy by growth in high powered money (M1), was found to worsen the primary balance. The quadratic coefficient of debt deviation from its mean was found to be negative and statistically significant at 5 per cent α level. This suggests the

existence of a non-linear effect of public debt on primary balance. Intuitively, the negative sign of the debt deviation suggests that beyond a certain level of debt to GDP ratio, Ghana's fiscal policy becomes unsustainable.

5.3 Plausibility of the estimates: long run tax policy reaction function

The above deliberations suggest that Ghana's fiscal policy continue to face tremendous challenges with the exception of early 1990s and mid-2000 that experience some amount of easing driven by prudent fiscal measures at that time. The study further assessed the reliability of the above estimates by investigating the stability of the fiscal policy for the recent data. Since there is no widely accepted specification of fiscal policy, the FRF in this section followed the theoretical model used by Davig and Leeper (2007). According to Tehran *et al.*, fiscal policy is deemed to be stable and sound (sustainable) if a positive long run relationship is established between tax revenue and the state of government expenditure or indebtedness. This study therefore estimates a fiscal rule that link tax revenue ($taxrg_t$) to current government expenditure ($texpg_t$), lagged public debt ($pubdg_{t-1}$) and output gap ($ygap_t$). This fiscal rule assesses whether fiscal authority collects more tax to repay its current spending and service the previous period's public debt, amid current business fluctuations. The fiscal rule is thus modelled as in the following equation:

$$taxrg_t = \alpha_0 + \varphi_1 texpg_t + \varphi_2 ygap_t + \varphi_3 pubdg_{t-1} + \mu_t, \quad (4)$$

In Equation (4)[14], if the government expenditure ($texpg_t$) is moved to the left hand side, we will have a new variable similar to Bohn's (1998) primary surplus. Thus, there is an approximation between Bohn's (1998) and Davig and Leeper (2007) FRFs.

With the exception of output gap ($ygap_t$) which was stationary at levels from both ADF and PP unit root tests, the results for tax revenue ($taxrg_t$), government expenditure ($texpg_t$) and public debt ($pubdg_t$) were mixed (see Table AVIII). While the ADF-test showed $taxrg_t$ and $texpg_t$ to be non-stationary at levels and become stationary after first difference, PP-test suggested a stationarity with drift and/or trend for both series. ADF tests showed $pubdg_t$ to be stationary without intercept or trend, while PP-test indicated a stationary series with (or without) intercept at level. According to Johansen (1995), both stationary variables and trend-stationary variables are allowed in a cointegration equation, provided that there are at least two non-stationary variables that are integrated of the same order (Ahking, 2002). As a result, the paper adopted Engle and Granger (1987) two-step method to examine the long run relationships among these variables. As the method stipulates, tax revenue is initially regressed on current government expenditure, lagged public debt and output gap at levels and the residual (error) terms are obtained. Unit root test is performed on the residual terms to examine the order of integration. If the residuals are stationary, then a long run relationship exists between the variables (Asterios and Hall, 2007). After that a second regression is estimated in first difference which also includes the lagged values of the generated error terms (in levels) and lagged dependent variable. The results of Engel-Granger two-step method are shown in Table AIX.

In Table AIX, both ADF and PP unit root tests indicated that the residual terms (ECM_{t-1}) are stationary, *I(0),* indicating that a long run relationship exist between the variables. The error correction term (ECM_{t-1}) is also significantly negative and less than one in all the models, confirming the existence of a long run relationship among tax revenue, current government expenditure, previous public debt level and output gap. However, the cointegration relationship appears relatively weaker in the period

2001Q1-2005Q4. The speed of adjustment from the disequilibrium is much stronger for the period 2001Q1-2013Q2 (75 per cent) and 2006Q1-2013Q2 (83 per cent). In the long run, while coefficients of current government spending and output gap maintained positive signs, that of previous debt assumed different signs. Tax policy appears to be stable for the period 2001Q1-2013Q2 as tax revenue responds strongly to changes in current government spending ($\varphi_1 = 0.46$) and previous public debt ($\varphi_3 = 0.005$) since 2001. This implies that fiscal adjustment has by and large averted public debt explosion since the adoption of HIPC in 2001. Nevertheless, fiscal pressures remains in the period 2001Q1-2005Q4 as the policy adjustment to public debt accumulation was found to be significantly negative ($\varphi_3 = -0.016$) alongside a weak response to current government spending. The weak reaction of tax revenue to current government spending suggests a passive tax policy regime. However, tax revenue responds positive and strongly to current government spending ($\varphi_1 = 0.36$) during the period 2006Q1-2013Q2, symbolizing an active fiscal policy. Nevertheless, fiscal pressure seems to persist as tax revenue response to growth in government indebtedness is weak since 2006. This corroborates with the earlier findings that the current fiscal policy faces significant pressures.

6. Conclusion and policy recommendation

The study primarily appraised the sustainability of the past behaviour of Ghana's public finance. In particular, it explored governments' reaction to rising public debt accumulation in the quest to evaluating the stability of the immediate past fiscal policy to offer policy recommendation that would guide the current policy direction. The paper employed both annual and quarterly time series data spanning 1983-2012 and 1990Q1-2013Q2, respectively to empirically estimate the FPRF using a series of parametric techniques. Here, this paper examines two long run linear relationships following Burger *et al.* (2011) and Trehan and Walsh (1991). The first long run relationship was investigated between primary balance and total public debt, while the second estimates the tax policy reaction function which establishes the link between tax (or domestic) revenue and government expenditure/indebtedness. In addition, the paper investigated the economic growth implications of public debt accumulation. The following findings were observed:

- The study found a stable long run linear relationship between primary balance and public debt as well as active tax policy since 2001 as tax (or domestic) revenue appears to respond positively and significantly to rising government expenditure and indebtedness.
- There is also a clear evidence that Ghana's public finance was unstable in the 1990s, while significant fiscal pressures still persist after 2006 exacerbated by election cycles. Indeed, substantial evidence of negative election cycles effect on public finance was found.
- Delays in fiscal adjustments to rising public debt were observed to be up to two quarters.
- Weak relationship between economic growth and debt accumulation was also observed. In fact, rising debt level seems to retard economic growth in the long run, reinforcing that the debt accumulation appears not to be driven by growth enhancing activities.
- In addition, Ghana's budget deficit and debt levels were found to compare unfavourably to both regional averages and that of peer countries in SSA.

The above observations suggest that government efforts at ensuring long-term fiscal sustainability seemed to be inadequate in recent years as significant fiscal pressures persist. In order to ensure a long-term fiscal sustainability, the paper highly recommends drastic changes to current fiscal policy direction. While the primary recommendation for containing the debt will be to implement fiscal consolidation policies that aim at attaining surpluses on the fiscal, government may also find ways of generating more revenue. It should be acknowledged that reducing the fiscal expenditures may be challenging and politically costly given the numerous statutory social programmes and critical development projects that are crying for implementation. However, elimination of waste and switching of expenditure into more productive areas may be more beneficial. Thus, fiscal prudence is highly recommended, among others, by essentially wading off those public institutions that are capable of generating their own incomes from accessing the consolidated funds while plugging the bottlenecks in revenue generations. In addition, there should be strict fiscal policy rule that curtails fiscal excesses during election cycles.

Government's plan to restructure the debt should receive the utmost attention and be vigorously implemented to lessen short term interest burden. In addition, the treasury bill rates are too high when compared with the rate of inflation. The gaping difference between the saving deposits rate and rate on treasury bills is a big disincentive to the national savings drive. Therefore, the rate of the treasury bill should be made to come down by some basis points without hurting demand while giving tremendous boost to debt reduction. Also, the rate of depreciation in the domestic currency has to be restrained by enhancing activities that generate foreign exchange inflows while prudently managing the outflows. In particular, efforts must be made to boost the domestic production of import-competing goods while re-orienting the fiscal and financial policies to encourage more exports and inward transfers.

Notes

1. Fiscal sustainability refers to the ability of government to pay back its debt with the discounted sum of the primary surpluses generated in the future (Lame *et al.*, 2012).
2. For over two decades, public capital expenditure has remained meagre, averaging at 6.6 per cent of GDP while recurrent expenditure has averaged at 16.5 per cent of GDP.
3. The HIPC initiative was instituted by the IMF and World Bank to help countries bring their public and publicly guaranteed external debt within sustainable levels.
4. On the fiscal side, government budget was cast in a medium term framework with emphasis on fiscal consolidation via trimming the budget deficit, prudent spending, increasing revenue mobilization and stabilizing the domestic public debt. In addition, the government adopted a policy stance that emphasized on the private sector as the engine of growth. On the monetary side, the conduct of monetary policy by the central bank changed from monetary targeting to inflation targeting framework. The central bank also instituted a number of financial sector reforms which focused on deepening the financial sector to spearhead economic growth. To deal with fiscal dominance which had beleaguered the monetary policy, the Bank of Ghana Act (2002) (Act 612) explicitly placed a limit on central bank's financing of the government deficit (10 per cent of government's previous year's realized revenue).
5. According to Bawumia (2010), debt relief under G-8 initiative for Ghana amounted to US$4.2 billion in nominal terms, comprising approximately of IDA (US$3.5 billion), IMF (US$274.6 million) and AfDB (US$445.5 million).

6. Other contributory factors to the deficits were the capital expenditures related to events such as domestic energy crisis (2006), Golden Jubilee celebration (2007) and hosting of African Cup of Nations (CAN2008) coupled with the recent global financial crisis which negatively affected both capital inflows and international commodity prices.
7. On average, Seychelles is the most indebted country in the MIC group, followed by Cape Verde, Mauritius, Lesotho and then Ghana (International Monetary Fund, 2013).
8. The choice of primary balance was deemed reasonable, given that the primary expenditures are more easily controlled by government. In addition, it helps to evaluate the impact of automatic stabilizers and discretionary policy action while recognizing the effect of debt services over business cycle.
9. GDP gap was measured as a deviation of the Hodrick-Prescott trend.
10. Other key macroeconomic variables that were controlled included expenditure deviation from trend, output gap, interest rate, inflation, growth in high-powered money (proxy for central bank financing of government expenditure), deviation in domestic revenue, exchange rate depreciation and election effect, as well as lagged dependent variable to allow for the inertia in government behaviour.
11. This method accounts for cross-equation heteroskedasticity by minimizing the weighted sum of squared residuals. The equation weights are the inverses of the estimated equation variances, and are derived from unweighted estimation of the parameters of the system. This method yields identical results to unweighted single-equation least squares if there are no cross-equation restrictions (Eviews eight Manual).
12. This also attests to the notion that the market and the public attach great importance to a reasonably low and stable ratio of government debt to GDP, but a high and growing debt is interpreted as a signal of a looming public insolvency (Escolano, 2010).
13. According to Khalid *et al.* (2007), a positive coefficient of inflation in primary balance equation would imply policy coordination problem between fiscal and monetary authorities. He argued that in such situation the fiscal policy seems not to take into consideration inflationary pressures, as large primary deficit is expected to counteract the effects of higher (or rising) inflation. However, Escolano (2010) argued that inflation lowers the real interest rate paid on debt if only the debt issued in the past is not indexed to inflation or denominated in foreign currency and the markets did not fully anticipate future inflation.
14. The model allowed some of the complexity of tax policy with a rule that allows revenue impacts of automatic stabilizers, some degree of pay-as-you-go spending, and a response to the state of government indebtedness (see Davig and Leeper, 2007).

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(The Appendix follows overleaf.)

Appendix

Table AI.
Unit root tests

	Augmented Dickey-Fuller (ADF) test					
	Primary balance/GDP					
	1990Q1-2013Q2	Lag[a]	1990Q1-2000Q4	Lag[a]	2001Q1-2013Q2	Lag[a]
None	[0.0054]*	2	[0.0002]*	0	[0.0001]*	0
Intercept	[0.0000]*	0	[0.0002]*	0	[0.0012]*	0
Intercept and trend	[0.0000]*	0	[0.0005]*	0	[0.0050]*	0
First difference	[0.0000]*	1	[0.0000]*	1	[0.0000]*	1
	Public debt/GDP					
None	[0.2155]	0	[0.9419]	0	[0.0000]*	0
Intercept	[0.3489]	0	[0.9893]	0	[0.0287]**	3
Intercept and trend	[0.6752]	0	[0.9989]	0	[0.9970]	3
First difference	[0.0000]*	0	[0.0000]*	0	[0.0000]*	0
	Philip and Perron (PP) test					
	Primary balance/GDP					
	1990Q1-2013Q2	Bandwidth[2]	1990Q1-2000Q4	Bandwidth[2]	2001Q1-2013Q2	Bandwidth[2]
None	[0.0000]*	5	[0.0002]*	3	[0.0000]*	4
Intercept	[0.0000]*	5	[0.0002]*	2	[0.0007]*	4
Intercept and trend	[0.0000]*	5	[0.0004]*	1	[0.0026]*	4
First difference	[0.0000]*	10	[0.0000]*	41	[0.0000]*	3
	Public debt/GDP					
None	[0.2157]	1	[0.9245]	1	[0.0007]*	49
Intercept	[0.3402]	1	[0.9810]	2	[0.0089]*	25
Intercept and trend	[0.6656]	1	[0.9995]	3	[0.3360]	8
First difference	[0.0000]*	2	[0.0000]*	2	[0.0000]*	3

Notes: [a]Automatic lag selection based on SBC criteria. *,**Significant at 1 and 5 per cent levels, respectively

Table AII. System iterative weighted least squares (SIWLS) results for the full and sub-sample

	Full sample: 1990Q1-2013Q2				1990Q1-2000Q4				2001Q1-2013Q2			
	$PRIMBG_t$		$\Delta PUBDG_t$		$PRIMBG_t$		$\Delta PUBDG_t$		$PRIMBG_t$		$PUBDG_t$	
	Coefficient	*p*-value	Coefficient	*p*-value	Coefficient	*p*-value	Coefficient	*p*-value	Coefficient	*p*-value	Coefficient	*p*-value
$PRIMBG_{t-1}$	0.376	[0.0001]*			0.204	[0.2133]	−0.485	[0.7773]	0.200	[0.0589]***		
$PRIMBG_{t-2}$					−0.023	[0.8913]	−1.030	[0.5527]				
$PRIMBG_{t-3}$			−1.899	[0.0454]***	0.146	[0.3837]	0.206	[0.9067]	0.280	[0.0088]*	−2.129	[0.0304]**
$PRIMBG_{t-4}$					0.088	[0.6016]	−1.263	[0.4766]				
$PRIMBG_{t-7}$									0.298	[0.0080]*		
$PRIMBG_{t-10}$									−0.572	[0.0000]*		
$PUBDG_{t-1}$											0.661	[0.0000]*
$PUBDG_{t-2}$									0.041	[0.0002]*		
$PUBDG_{t-3}$									−0.024	[0.0296]**		
$PUBDG_{t-4}$											0.305	[0.0002]*
$PUBDG_{t-6}$									−0.035	[0.0010]*		
$PUBDG_{t-7}$									0.029	[0.0033]*		
$PUBDG_{t-8}$											0.363	[0.0002]*
$PUBDG_{t-9}$											−0.418	[0.0000]*
$\Delta PUBDG_{t-1}$					−0.002	[0.8704]	−0.087	[0.4936]				
$\Delta PUBDG_{t-2}$	0.027	[0.0020]*			−0.001	[0.9422]	−0.028	[0.8342]				
$\Delta PUBDG_{t-3}$					−0.003	[0.8482]	−0.090	[0.5250]				
$\Delta PUBDG_{t-4}$			0.428	[0.0001]*	−0.002	[0.8480]	0.781	[0.0000]*				
$\Delta PUBDG_{t-5}$	0.029	[0.0009]*										
$\Delta PUBDG_{t-7}$	0.024	[0.0050]*										
$\Delta PUBDG_{t-8}$	0.031	[0.0004]*	0.356	[0.0008]*								
Intercept	0.128	[0.2381]	0.341	[0.7593]	0.361	[0.1274]	3.572	[0.1517]	−0.870	[0.0037]*	2.447	[0.2976]
R^2	0.37		0.51		0.09		0.58		0.62		0.967	
DW statistic	2.139		1.995		1.978		1.516		1.763		1.595	

Notes: $PRIMBG_t$ and $PUBDG_t$ denote primary balance and public debt to GDP, respectively. *,**,***Significant at 1, 5 and 10 per cent levels, respectively

Table AIII.
SIWLS results for sub-periods 2001Q1-2005Q4 and 2006Q1-2013Q2

	2000Q1-2005Q4				2006Q1-2013Q2			
	$PRIMBG_t$		$\Delta PUBDG_t$		$PRIMBG_t$		$PUBDG_t$	
	Coefficient	*p*-value	Coefficient	*p*-value	Coefficient	*p*-value	Coefficient	*p*-value
$PRIMBG_{t-1}$	−0.631	[0.0032]*	1.715	[0.6258]			−0.873	[0.0759]***
$PRIMBG_{t-2}$			0.829	[0.8231]			0.833	[0.0491]**
$PRIMBG_{t-3}$	0.373	[0.0620]***	1.972	[0.6089]	0.438	[0.0001]*		
$PRIMBG_{t-4}$			5.153	[0.2327]	0.044	[0.6557]		
$PRIMBG_{t-5}$			1.434	[0.7355]	−0.244	[0.0182]**		
$PRIMBG_{t-6}$					−0.082	[0.4250]		
$PRIMBG_{t-7}$					0.233	[0.0266]**	0.894	[0.0375]**
$PRIMBG_{t-8}$					−0.007	[0.9400]	1.110	[0.0088]*
$PRIMBG_{t-9}$					0.195	[0.0561]***		
$PRIMBG_{t-10}$					−0.657	[0.0000]*		
$\Delta PUBDG_{t-1}$	−0.025	[0.0045]*	−0.473	[0.0077]*				
$PUBDG_{t-2}$					0.086	[0.0000]*	0.349	[0.0000]*
$\Delta PUBDG_{t-2}$			−0.602	[0.0001]*				
$PUBDG_{t-3}$					−0.041	[0.0354]**		
$\Delta PUBDG_{t-3}$			−0.601	[0.0000]*				
$PUBDG_{t-4}$					−0.081	[0.0001]*		
$\Delta PUBDG_{t-4}$			0.112	[0.3447]				
$PUBDG_{t-5}$					0.046	[0.0142]**		
$\Delta PUBDG_{t-5}$	0.019	[0.0087]*	−0.160	[0.1417]				
$PUBDG_{t-6}$					−0.002	[0.9223]	−0.010	[0.8843]
$PUBDG_{t-7}$					0.053	[0.0050]*	−0.128	[0.0850]***
$PUBDG_{t-8}$							0.191	[0.0152]**
$PUBDG_{t-9}$					−0.042	[0.0003]*	−0.008	[0.8906]
$PUBDG_{t-10}$							−0.109	[0.0914]***
$PUBDG_{t-11}$							−0.113	[0.0447]**
Intercept	0.608	[0.0024]*	−16.649	[0.0137]**	−1.186	[0.0109]**	31.917	[0.0000]*
R^2	0.52		0.86		0.83		0.86	
DW statistic	1.38		2.086		1.664		1.868	

Notes: $PRIMBG_t$ and $PUBDG_t$ denote primary balance and public debt to GDP, respectively. *,**,***Significant at 1, 5 and 10 per cent levels, respectively

Table AIV. Multivariate differencing estimation

Dependent variable $Primbg_t$	Full sample Panel A		Sub-sample 1990Q1-2000Q4 Panel B		Sub-sample 2001Q1-2013Q2 Panel C	
Variable	Coeff	*p*-value	Coeff	*p*-value	Coeff	*p*-value
C	−0.1985	[0.3713]	0.3872	[0.1034]	−0.6410	[0.1358]
$\Delta PUBDG_{t-1}$	−0.0003	[0.9624]	−0.0060	[0.3099]	−0.0013	[0.8577]
$\Delta PUBDG_{t-2}$	0.0201	[0.0218]**	−0.0042	[0.5698]	0.0242	[0.0131]**
$\Delta PUBDG_{t-3}$	0.0109	[0.2252]	−0.0030	[0.7340]	0.0118	[0.2782]
$\Delta PUBDG_{t-6}$	−0.0158	[0.0719]***	−0.0018	[0.8243]	−0.0248	[0.0289]**
$\Delta YGAP_{t-1}$	−0.0017	[0.8030]	0.0037	[0.6592]	−0.0170	[0.0903]***
$\Delta INTRATE_t$	−0.0634	[0.0313]**	−0.0348	[0.3184]	−0.0669	[0.2406]
INF_{t-1}	0.0165	[0.0205]**	−0.0006	[0.8961]	0.0418	[0.0247]**
$YVAR_t$	−0.5700	[0.0001]*	−0.8661	[0.0000]*	−0.4022	[0.0192]**
$DREVG\_GAP_t$	0.7777	[0.0000]*	0.9232	[0.0000]*	0.9007	[0.0001]*
$PRIMBG_{t-1}$	0.2932	[0.0048]*	0.1443	[0.0275]**	0.2170	[0.0478]**
$XDEPR_{t-1}$	1.9159	[0.3239]	3.2323	[0.0458]**	−0.7733	[0.8407]
Election_Dummy	−0.4069	[0.0746]***	−0.1747	[0.4146]	−0.6738	[0.1156]
Adjusted R^2	0.54		0.80		0.49	
Sum squared resid	48.26		4.26		30.70	
Log likelihood	−97.81		−12.50		−58.75	
F-statistic	9.50		13.14		4.85	
ADF-test	[0.0000]*		[0.0000]*		[0.0000]*	

Note: *,**,***Significant at 1, 5 and 10 per cent levels, respectively

Table AV.
ARDL bound testing results for the full sample

Dependent variable: $\Delta PRIMBG_t$	Model A Coeff	Model A *p*-value	Model B Coeff	Model B *p*-value
C	−0.6039	[0.0739]***	−0.5831	[0.1066]
$\Delta PUBDG_{t-2}$	0.0034	[0.6746]	0.0020	[0.8104]
$\Delta PUBDG_t$	*0.0284*	*[0.0656]****	*0.0307*	*[0.0107]***
$\Delta PRIMBG_{t-2}$	−0.2115	[0.0138]**	−0.1980	[0.0169]**
$\Delta PRIMBG_{t-1}$	−0.2103	[0.1070]	−0.1686	[0.2330]
$\Delta GVAR_t$	−0.3764	[0.0052]*	−0.3637	[0.0044]*
$\Delta LNOMRATE_t$	−2.2176	[0.4804]		
$\Delta YGAP_t$	0.0062	[0.5724]	0.0058	[0.5925]
$\Delta INTRATE_t$	0.0029	[0.9207]	−0.0166	[0.4743]
$PUBDG_{t-1}$	*0.0069*	*[0.0493]***	*0.0104*	*[0.0165]***
$PRIMBG_{t-1}$	−0.5480	[0.0001]*	−0.6330	[0.0000]*
$GVAR_{t-1}$	−0.1033	[0.5532]	−0.1345	[0.3378]
$YGAP_{t-1}$	−0.0112	[0.4412]	−0.0094	[0.4819]
$INTRATE_{t-1}$	0.0146	[0.0872]***	0.0076	[0.3852]
$LNOMRATE_{t-1}$	−2.1428	[0.3658]		
$(d_{t-1}-\mu^d)^2$			−0.0001	[0.0207]**
Election_Dummy	−0.5189	[0.0575]***	−0.4911	[0.0263]**
Adjusted R^2	0.466		0.493	
SSResid	59.916		57.617	
Log likelihood	−108.680		−106.936	
F-statistic	6.112		7.114	
Outside critical bounds	Yes (99% Confid.)		Yes (99% Confid.)	
Ramsey reset (Model Fit)	[0.5474]		[0.2499]	
Normality	[0.7049]		[0.9342]	
Autocorrelation	[0.6230]		[0.5515]	
Heteroskedasticity	[0.4501]		[0.4597]	
Cusum test (95% CI)	Within		Within	
Cusum of squares test (95% CI)	Within		Within	

Notes: Using the dependent variable of $PRIMBG_t$ does not change the result. *,**,***Significant at 1, 5 and 10 per cent levels, respectively

Dependent variable: $\Delta PRIMBG_t$	Model C 1990Q1-2000Q4 Coeff	*p*-value	Model D 2001Q1-2013Q2 Coeff	*p*-value	Model E 1990Q1-2000Q4 Coeff	*p*-value	Model F 2001Q1-2013Q2 Coeff	*p*-value
C	−1.0567	[0.0463]**	−0.2035	[0.5507]	−0.5708	[0.7838]	−1.2685	[0.3374]
$\Delta PUBDG_{t-2}$	−0.0057	[0.6280]	0.0137	[0.3580]	−0.0194	[0.1402]	0.0039	[0.6750]
$\Delta PUBDG_t$	0.0317	[0.2185]	*0.0382*	*[0.0147]***	*0.0367*	*[0.0860]****	*0.0318*	*[0.0099]**
$\Delta PRIMBG_{t-2}$	−0.1388	[0.3170]	−0.2947	[0.0082]*	−0.0350	[0.7880]	−0.1884	[0.0355]**
$\Delta PRIMBG_{t-1}$	0.0206	[0.9378]	−0.3211	[0.0931]***	−0.0376	[0.8998]	−0.1674	[0.2645]
$\Delta TEXPG_t$					−0.5357	[0.0322]**	−0.2493	[0.1225]
$\Delta TEXPG_{t-1}$					−0.2619	[0.2405]	−0.0858	[0.4246]
$\Delta GVAR_t$	−0.4944	[0.0447]**	−0.3398	[0.0649]***				
$\Delta YGDP_{t-1}$	0.0056	[0.7039]	0.0063	[0.7468]				
$\Delta INTRATE_t$	−0.0231	[0.5045]	0.0207	[0.6587]				
$\Delta LNOMRATE_t$					−2.4882	[0.4033]	−3.8289	[0.5007]
$PUBDG_{t-1}$	*0.0138*	*[0.0905]****	*0.0071*	*[0.1839]*	*0.0219*	*[0.2676]*	*0.0221*	*[0.0012]**
$PRIMBG_{t-1}$	−0.7615	[0.0040]*	−0.5438	[0.0050]*	−0.7763	[0.0069]*	−0.8219	[0.0002]*
$TEXPG_{t-1}$					−0.1545	[0.5026]	−0.0214	[0.9173]
$GVAR_{t-1}$	−0.3180	[0.1757]	−0.0032	[0.9888]				
$YGDP_{t-1}$	−0.0059	[0.6898]	−0.0136	[0.6012]				
$INTRATE_{t-1}$	0.0117	[0.3841]	0.0270	[0.1866]				
$LNOMRATE_{t-1}$					−0.0877	[0.8162]	2.0553	[0.0200]**
$(d_{t-1}-\mu^d)^2$	−0.0001	[0.0961]***	−0.0003	[0.0115]**				
Election_Dummy	−0.3731	[0.1916]	−0.9163	[0.0486]**	−0.4345	[0.0515]***	−0.8214	[0.0703]***
Adjusted R^2	0.443		0.442		0.477		0.525	
SSResid	17.907		33.566		18.115		31.724	
Log likelihood	−41.195		−59.525		−41.431		−59.573	
F-statistic	3.274		3.660		4.039		5.522	
Greater than critical upper bound	Yes (90% Confid.)		Yes (95% Confid.)		Yes (95% Confid.)		Yes (99% Confid.)	
Ramsey reset test	[0.1457]		[0.6278]		[0.6689]		[0.5729]	
Normality test	[0.0026]*		[0.6124]		[0.3870]		[0.5007]	
Autocorrelation test	[0.5360]		[0.3822]		[0.4536]		[0.7365]	
Heteroskedasticity test	[0.1684]		[0.9655]		[0.1094]		[0.7538]	
Cusum test (95% CI)	Within		Within		Within		Within	
Cusum of squares test (95% CI)	Not Within		Within		Within		Within	

Note: *,**,***Significant at 1, 5 and 10 per cent levels, respectively

Table AVI. ARDL bound testing results for 1990Q1-2000Q4 and 2001Q1-2013Q2

Dependent variable: $\Delta PRIMBG_t$	Model G 2001Q1-2005Q3 Coeff	*p*-value	Model H 2006Q1-2013Q2 Coeff	*p*-value	Model J 2001Q1-2005Q3 Coeff	*p*-value	Model K 2006Q1-2013Q2 Coeff	*p*-value
C	0.5239	[0.5275]	5.9935	[0.0290]**	−1.4073	[0.2008]	−74.2085	[0.0001]*
$\Delta PUBDG_t$	*0.0332*	*[0.0117]***	*0.0536*	*[0.1680]*	*0.0455*	*[0.0236]***	*−0.0739*	*[0.1662]*
$\Delta PUBDG_{t-2}$	−0.0107	[0.1556]	0.0536	[0.1680]	−0.0058	[0.4627]	0.0594	[0.7325]
$\Delta PRIMBG_{t-1}$	1.0669	[0.0066]*	−0.0165	[0.9160]	0.4777	[0.0148]**	0.1551	[0.3978]
$\Delta PRIMBG_{t-2}$	0.1358	[0.3128]	−0.2741	[0.1296]			−0.2741	[0.1296]
$\Delta TEXPG_{t-1}$	−0.0479	[0.6072]	0.3070	[0.2289]				
$\Delta TEXPG_T$	−0.2275	[0.0226]**	−0.8168	[0.0057]*				
$\Delta GVAR_t$					−0.0836	[0.1129]		
$\Delta INTPG_{T-1}$							−2.1069	[0.0602]***
$\Delta YGDP_{t-1}$					−0.0018	[0.6743]		
ΔINF_t	0.03378	[0.1719]	−0.2025	[0.2509]			−0.2126	[0.0539]***
$\Delta LNOMRATE_{t-1}$					−11.4416	[0.0060]*	−3.3732	[0.4263]
$PUBDG_{t-1}$	*0.0127*	*[0.0072]**	*0.0756*	*[0.1577]*	0.0311	[0.0350]**	−0.0734	[0.0282]**
$PRIMBG_{t-1}$	−3.1704	[0.0002]*	−0.9938	[0.0027]*	−2.2203	[0.0000]*	−1.1774	[0.0000]*
$TEXPG_{t-1}$	−0.1561	[0.0778]***	−1.0430	[0.0731]***				
$GVAR_t$							−1.0477	[0.0000]*
$RGDP_{t-1}$							8.7794	[0.0001]*
INF_{t-1}	0.0458	[0.0030]*	−0.0516	[0.4095]				
$(d_{t-1}-\mu^d)^2$					−0.0004	[0.0585]***		
Election_Dummy	−0.2515	[0.2556]	−0.5612	[0.2783]	−0.7178	[0.0051]*	−0.9453	[0.0086]*
Adjusted R^2	0.899		0.429		0.915		0.726	
SSResid	0.408		38.189		0.466		11.275	
Log likelihood	9.532		−64.210		7.344		−27.889	
F-statistic	14.365		4.065		21.276		7.403	
Outside critical bounds	Yes (99% Confid.)		Yes (99% Confid.)		Yes (99% Confid.)		Yes (99% Confid.)	
Ramsey reset	[0.7830]		[0.5905]		[0.8039]		[0.7433]	
Normality	[0.3069]		[0.9871]		[0.5711]		[0.2123]	
Autocorrelation	[0.1842]		[0.1208]		[0.4778]		[0.3575]	
Heteroskedasticity	[1.0000]		[0.9599]		[0.9994]		[0.9910]	
Cusum test (95% CI)	Within		Within		Within		Within	
Cusum of squares test (95% CI)	Within		Within		Within		Within	

Note: *,**,***Significant at 1, 5 and 10 per cent levels, respectively

Table AVII.
ARDL bound testing results for period after 2000

	ADF-test None	Intercept	Intercept and trend	First difference	PP-test None	Intercept	Intercept and trend	First difference
TAXRG	0.5329	0.3883	0.6241	0.0002*	0.3801	0.0001*	0.0003*	0.0000*
PUBDG	0.0216**	0.2297	0.9662	0.0206**	0.0007*	0.0089*	0.336	0.0000*
TEXPG	0.5862	0.1236	0.1790	0.0000*	0.3116	0.0000*	0.0000*	0.0000*
YGAP	0.0002*	0.0045*	0.0026*	0.0002*	0.0000*	0.0000*	0.0000*	0.0000*

Note: *,**Significant at 1 and 5 per cent levels, respectively

Table AVIII.
ADF and PP unit root tests (Period: 2001Q1-2013Q2)

	Variable	2001Q1-2013Q2 Coeff	*p*-value	2001Q1-2005Q4 Coeff	*p*-value	2006Q1-2013Q2 Coeff	*p*-value
Step 1	*Dependent variable:* $TAXRG_t$						
	C	0.7369	[0.1735]	5.6955	[0.0028]*	1.3088	[0.1260]
	$TEXPG_t$	0.4556	[0.0000]*	0.1328	[0.3937]	0.3641	[0.0023]*
	$YGAP_t$	3.3322	[0.1842]	8.5533	[0.0481]**	3.2692	[0.2140]
	$PUBDG_{t-1}$	0.0054	[0.0171]**	-0.0156	[0.0228]**	0.0026	[0.7743]
Step 2	*Dependent variable:* $\Delta TAXRG_t$						
	C	0.0343	[0.7056]	0.2512	[0.2454]	−0.0868	[0.3433]
	$\Delta TEXPG_t$	0.3639	[0.0001]*	0.2646	[0.2094]	0.4088	[0.0000]*
	$\Delta YGAP_t$	3.5774	[0.0690]***	5.5589	[0.2662]	2.8129	[0.1537]
	$\Delta PUBDG_{t-1}$	0.0156	[0.1057]	0.0208	[0.2146]	0.0133	[0.4342]
	$\Delta TAXRG_{t-1}$	−0.2391	[0.0467]**	-0.4201	[0.1788]	−0.1886	[0.1891]
	ECM_{t-1}	*−0.7533*	*[0.0000]**	*-0.6229*	*[0.0809]****	*−0.8257*	*[0.0000]**
Stationarity test for ECM_{t-1}							
ADF-test		−3.3075	[0.0014]*	-6.4022	[0.0000]*	−1.6791	[0.0875]***
PP-test		−5.8397	[0.0000]*	-6.3409	[0.0000]*	−3.7257	[0.0006]*

Note: *,**,***Significant at 1, 5 and 10 per cent levels, respectively

Table AIX.
Engel-Granger two-step cointegration results

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