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Measuring fiscal sustainability of African economies

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MEASURING FISCAL SUSTAINABILITY OF AFRICAN ECONOMIES

By

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A thesis submitted to the School of Economic and Business Sciences at the University of the Witwatersrand, Johannesburg, in 100 % fulfilment of the requirements for the degree of Masters of Economic Science.

Johannesburg, 2015

Supervisor: Prof. Christopher MALIKANE

Declaration

I hereby declare that this thesis is my own, unaided work. It is being submitted for the degree of Master of Economic Science at the University of the Witwatersrand, Johannesburg. It has not been submitted for examination before for any degree at any other university.

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(Name of candidate) (Signed)

Signed this on ---------- day of ----------, 2015 at Johannesburg.

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Abstract

This paper ultimately aims to test the sustainability of public debt in ten African economies. To accomplish this, the paper estimates the inter-temporal budget constraint model (IBC) by using Ordinary Least Squares (OLS) and measures the indicators of sustainability. Sustainability tests are carried out and show that, despite rising debt ratios, there is empirical evidence for Ghana, Tanzania and South Africa that public debt is sustainable and both the primary gap and tax gap indicators with a sharp rise in the debt ratios are shown to be worsening from one country to another and indicating increasingly possible unsustainable fiscal policies. It implies that the current primary deficit is too large and current taxes are too low to stabilize the debt ratio. Moreover we test Bohn's fiscal rule, by analysing how the primary surplus to GDP reacts to variations in the debt to GDP ratio and the results point to the possibility of sustainable budgetary paths in Algeria, Ghana, Rwanda and South Africa, independent of whether remittances and foreign direct investments (FDI) variables are added in the model.

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Chapter 1 Testing Fiscal Sustainability of African Economies

1. Introduction

This paper measures the sustainability of fiscal policy in African economies. Chronic public deficits as well as growing debt levels have received the attention of both researchers and policy makers because of their potential to destabilize economies. According to Gupta et al. (2002), fiscal policies have far-reaching impacts on economic growth and human capital investments. Corsetti and Roubinni (1991) also believe that if inter-temporal budget constraints are not supported by empirical evidence, changes in policy or macroeconomics variables such as growth, inflation, and interest rates will occur at some moment in the future.

For developing countries, the debt burden on governments has remarkably increased since the 1970s world oil crisis. However, in 1996 (IMF, 1996), the Heavily Indebted Poor Countries (HIPC) Initiative was launched to address debt problems and poverty reduction in some of the world's poorest countries. But the initiative failed as African countries still account for more than 80 % of the HIPC Initiative. In particular, African countries are not only vulnerable to debt crises due to their heavy dependence on raw materials as exporting goods, but also due to the fact that most of their debt is held by foreign donors in foreign currencies, a situation that leads to highs level of debt service Sindzingre (2012).

This paper is motivated first of all by the fact that most of the existing empirical studies on fiscal sustainability are focused on the USA and other industrial economies. Literature on African economies in this regard is thus largely limited to studies by the following – Issler and Lima (2000), Bravo and Silvestre (2002), Koo (2002), Claeys (2007), Arghyrou and Luintel (2007), Bajo- Rubio et al. (2008) and Melecky (2012). Secondly, there is no consensus among economists about the correct criteria for public finance sustainability; rather, each approach introduces its own to assess fiscal sustainability with definitions that are often similar across the different approaches. Thirdly, the paper focuses on the African region, which according to Sobhee (2010), experiences a very low growth performance and huge public sector deficits that are compounded by extremely high levels of indebtedness which in turn renders economies in this region more vulnerable to external shocks than other regions.

The contribution of this paper to existing literature is three-fold. Firstly, following Bravo and Silvestre (2002) and Koo (2002), it explores fiscal policy sustainability in Africa and developing countries in general. Secondly, it focuses on the region whose public policy has been at the heart of international investors' concerns and stabilization programs, but whose public debt sustainability has remained largely unexplored and most vulnerable to public debt and chronic budget deficits than other economies. Thirdly, it introduces foreign direct investments (FDI) and remittances as new macro-variables in the models that affect public debt and budget deficits in the African context and measures their empirical importance in reducing and sustaining public debt.

The paper is structured as follows. The section 2 reviews the dominant literature related to fiscal sustainability while the section 3 presents the theoretical framework. This is followed by section 4 which presents the data used, a discussion of the methodology adopted as well as of the empirical results obtained. The last section provides a summary and conclusions along with discussions of certain policy implications that this chapter brings to the fore.

2. Review of the literature

The literature on measuring fiscal sustainability proposes two methods in practice: Inter-temporal Budget Constraint (IBC) by Hamilton and Flavin (1986) and indicators of sustainability developed by Buiter (1985) and modified by Blanchard (1990). The indicators presented in the literature are either simple measures, mainly based on current information, or summary values of model-based projections of future paths of fiscal policy. The other method that use testing techniques so far, involve stationarity and co-integration analysis (Hamilton and Flavin, 1986; Wilcox, 1989; Trehan and Walsh, 1988).

By applying the IBC method, which is based on inter-temporal budget constraint (IBC), which relies on the work of Hamilton and Flavin (1986). The method adopts a statistical test to determine whether the inter-temporal budget constraint holds for the empirical data. Hamilton and Flavin (1986) show that if the primary deficit and/or the government debt follows a stationary process, then inter-temporal budget balances are satisfied and so fiscal policy becomes sustainable long-run government solvency. In addition, Chen (2014) conducted tests for fiscal sustainability in G7 and other European countries and finds four of them fiscally sustainable after taking into account the non-linear trend in the long run.

The second method is built on indicators of sustainability (i.e. the tax gap and primary gap), Blanchard et al. (1990) find that most OECD countries have sustainable policies in place in the medium-term. Buiter and Patel (1992) have applied this method in their analysis of the Indian economy and find that the country's fiscal policy is unsustainable. Adopting a similar approach, Buiter et al. (1993) and Roubini (1995) ascertained that most OECD countries operate sustainable fiscal policies. Koo (2002) has also applied the primary gap and tax gap indicators to an analysis of to the Korean economy. His findings are that the indicators have worsened since 1997, thus resulting in corresponding to a sharp rise of the debt-GDP ratio. He concludes that the current primary deficit is too large and that current taxes are too low to stabilize the debt ratio.

The literature on African economies is still limited. On the basis of debt-to-export ratio, Cohen (1996) estimates the value of the debt of African economies and concludes that they are fiscally unsustainable. Fincke and Greiner (2010), applying Bohn's method to some African and Latin American countries, reveal that despite rising debt ratios, there is evidence of sustainability for some of these economies. A similar study by Fedelino and Kudina (2003) on African HIPC finds that debt levels will remain unsustainable despite the HIPC Initiative. African economies are fiscally vulnerable due to dependence on raw materials and debts held in foreign currency. Several studies suggest that through several means such as foreign direct investment (FDI), remittances, foreign aid, realistic exchange rates (appreciation) and exports diversification and growth, government debts can be remedied and fiscal balances sustained so long as proper policies are in place (see Avramovic, 1991; Helleiner, 1992; Poirine, 1997; Ferrarini, 2008; Powell and Graham, 2010 and Sindizingre, 2012). From the economic point of view, the important questions in this regard are:

- Are African countries fiscally sustainable?
- Can Bohn's fiscal rule generate evidence of corrective fiscal actions in response to an increasing debt to GDP ratio?

3. Theoretical framework

The Inter-temporal Budget Constraint (IBC) method for measuring fiscal sustainability uses econometric tests of stationarity of government debt and a co-integration relationship between debt and primary balance. Based on previous studies (see Ahmed and Rogers, 1995;

Bravo and Sylvestre, 2002; Bohn, 2007; Arghyrou and Luintel, 2007; and Polito and Wickens, 2012), derivation of the inter-temporal budget constraint (IBC) starts with a simple version one-period government budget constraint:

$$B_{t+1} = (1+r)B_t + G_t - T_t = (1+r)B_t - S_{t+1} \quad (1)$$

where B_t is the stock of public debt, G_t is the government expenditures net of interests, T_t is the tax revenues, r is the interest rate on government debt assumed fixed and S_t the primary surplus.

Solving equation (1) recursively forwards in time gives:

$$B_t = (1+r)^{-1}S_{t+1} + (1+r)^{-1}B_{t+1} \quad (2)$$

$$B_t = (1+r)^{-2}S_{t+2} + (1+r)^{-1}S_t + (1+r)^{-2}B_{t+2} \quad (3)$$

…

$$B_t = \sum_{i=1}^{n}(1+r)^{-i}S_{t+i} + (1+r)^{-n}B_{t+n} \quad (4)$$

Taking the limit as n tends to infinity:

$$B_t = \sum_{i=1}^{\infty}(1+r)^{-i}S_{t+i} + \lim_{n\to\infty} E_t\,(1+r)^{-n}B_{t+n} \quad (5)$$

The assumption behind the IBC is that that the second term giving the present value of the government debt in infinity is assumed to be zero:

$$\lim_{n\to\infty}(1+r)^{-n}B_{t+n} = 0 \quad (6)$$

This assumption is called the transversality condition (TC) or no-Ponzi game condition (NPG). By substituting it to the above equation, the IBC is obtained as follows:

$$B_t = \sum_{i=1}^{\infty}(1+r)^{-i}S_{t+1} \quad (7)$$

The IBC method requires that the limit term (Eq. 6) be equal to zero asymptotically. Thus the government cannot leave a debt that has a positive expected present value in the limit; that would imply resorting to Ponzi games. The inter-temporal budget constraint reveals that the present value of the flow of primary balances must equal the present stock of net debt. This means that government's total net liability must be equal to its total assets (flow of primary

balances). The transversality condition is sometimes called the no-Ponzi game condition meaning that government is not allowed to organise or finance Ponzi games.

A Ponzi game or scheme is a system in which returns to the principal of previous investors is paid by new investments made by subsequent investors. In the case of debt, a debtor is deemed to be running a Ponzi game at the expense of creditors when the debtor always pays the interest by issuing more debt. The appropriate sustainability test is then administered to ascertain if the historical process that generates fiscal data is likely to result in the IBC eventually being violated (Chalk and Hemming, 2000). If so, fiscal policy is not sustainable and the data generating process will have to be changed; current policy is then regarded as unsustainable. Trehan and Walsh (1991) and Wilcox (1989) have modified the IBC test and proven that a stationary quasi-difference of primary deficit $D_t - \varphi . D_t \sim I(0)$ is sufficient for the transversality condition to hold, if and only if debt and primary deficit are co-integrated (D_t, B_{t-1}).

From eq. (1), let us assume the interest rate constant and can be written as follows:

$$B_{t+1} = G_t - T_t + B_t + \varepsilon_t \quad (8)$$

This implies the following:

$$B_{t+1} - B_t = G_t - T_t = D_t \quad (9)$$

According to Issler and Lima (2000), Claeys (2007) and Bohn (2007), a typical co-integrating regression for estimation is as follows:

$$D_t = -\alpha B_{t-1} + \varepsilon_t \quad (10)$$

With $\alpha > 0$, where D_t is the primary deficit.

The second modification of the IBC method is provided by Trehan and Walsh (1991), Hakkio and Rush (1991) and Haug (1991). This model assumes stochastic real interest rates and demonstrates that a co-integrating relation between government tax revenue and expenditure is a necessary condition for the IBC to hold. For empirical purposes, and on the assumption that the interest rate is stationary, Eq. (2) can be rewritten as follows:

$$S_t = GG_t - T_t = \sum_{j=1}^{\infty} \delta^{j-1} (\Delta T_{t+j} - \Delta GG_{t+j} + r\Delta B_{t+j-1}) \quad (11)$$

where $GG_t = G_t + i_t B_{t-1}$ is the total government expenditures inclusive of interest payments on the debt outstanding with discount factor $\delta = (1+r)^{-1}$ and Δ is the first difference operator. Given that the variables GG_t and T_t are usually non-stationary, this equation provides a statistical framework for testing sustainability. Indeed, fiscal sustainability implies that tax revenues and expenditures must be co-integrated if GG_t and T_t are *I (/.1)* process. In line with Bajo-Rubio et. al's (2010) and Escario et. al's (2012), the equation to estimate takes the following form:

$$T_t = \alpha + \beta GG_t + \varepsilon_t \quad (12)$$

The second method is based on indicators of the sustainability of fiscal policy along the lines suggested by Buiter (1985) and Blanchard (1990). Chouraqui et al. (1990), Chalk and Hemming (2000) and Koo (2002) argue that the indicators of sustainability assess the magnitude of inconsistencies in fiscal policies and measure the size of the permanent fiscal adjustment needed to achieve stabilization of the base year national debt-to-GDP ratio. According to Buiter (1985), sustainable fiscal policy should maintain the ratio of government net worth to output at its current level. He then calculates the constant primary deficit necessary to achieve this objective. This is given by:

$$d_t^* = (r_t - n_t) w_t \quad (13)$$

where d_t^* is the ratio of constant primary deficit to GDP, r_t the interest rate, n_t the growth rate of the economy, $w_t = \frac{W_t}{Y_t}$ the ratio of net worth to GDP.

Then the sustainability indicator introduced by Buiter (1985) is:

$$G_t^{nw} = d_t^* - d_t = (r_t - n_t) w_t - d_t \quad (14)$$

where $d_t = \frac{D_t}{Y_t}$ is the ratio of current primary deficit to GDP. A negative value for this indicator suggests that the current primary deficit is too large to stabilize the net worth ratio and that fiscal policy should thus be regarded as unsustainable. Even if the net worth indicator is easy to interpret, it is difficult in general to obtain accurate information on the magnitude of government net worth. Easily measurable indicators of fiscal sustainability are

therefore developed by Blanchard (1990) - the primary gap and the tax gap indicators of sustainability.

The primary gap indicator is based on the permanent primary deficit necessary to stabilize the debt ratio and is given by:

$$d_t^* = (n_t - r_t)b_t \qquad (15)$$

where $b_t = \frac{B_t}{Y_t}$ is the ratio of government debt to GDP. The primary gap indicator is then

$$G_t^P = d_t^* - d_t = (n_t - r_t)b_t - d_t \qquad (16)$$

This measures the required adjustment in the primary deficit needed to stabilize the government debt-to-GDP ratio, given the current and projected paths of the primary balance, the real interest rate and output growth as noted by Horne (1991). The primary gap indicator equals the difference between the permanent primary deficits ratio that stabilizes the outstanding debt-to-GDP ratio and the current primary fiscal deficit. The benchmark indicator is zero, with a negative value implying that the current primary deficit is too large to stabilize the debt ratio and that fiscal policy is unsustainable.

Another indicator of fiscal sustainability, according to Blanchard (1990), is the tax gap indicator and is based on the permanent tax to output ratio necessary to stabilize the debt ratio. This is given by:

$$t_t^* = g_t - (n_t - r_t)b_t \qquad (17)$$

where t_t^* is the ratio of constant taxes to GDP, g_t the ratio of primary government expenditures (excluding interest payments) to GDP. Then the tax gap indicator is

$$G_t^T = t_t - t_t^* = t_t + (n_t - r_t)b_t - g_t \qquad (18)$$

where t_t is the ratio of taxes to GDP. The tax gap indicator is the difference between the current tax ratio and the constant tax ratio to GDP. It measures the required adjustment in the tax ratio needed to stabilize the outstanding debt-to-GDP ratio, given the current and projected paths of the primary expenditures, the real interest rate and output growth. A negative value for the tax gap indicator suggests that the current taxes are too low to stabilize the debt ratio given the current fiscal policy. Thus the fiscal policy is deemed unsustainable.

4. Empirical analysis

4.1 Data description and econometric techniques

The data used in this paper is obtained from the International Financial Statistics, Economist Intelligence Unit, UNCTAD and the World Bank annual database and covers the period from 1970 to 2012. The ten countries that are considered herein are Algeria (ALG), Ivory Coast (CIV), Ghana (GHA), Kenya (KEN), Nigeria (NIG), Rwanda (RWA), South Africa (SA), Tanzania (TZ), Tunis (TUN) and Zambia (ZAM). According to 2010 GNI per capita classification, determined by the World Bank Atlas Method (World Bank, 2010), Algeria, Tunisia and South Africa are classified as upper middle income countries; Ghana, Ivory Coast Nigeria and Zambia are classified as lower middle income countries and Kenya, Tanzania and Rwanda belong to the low income countries. The consumer price index (CPI) is used to deflate nominal series. Specific techniques have been applied to each of the methods used in this paper. For the IBC method, empirical techniques used are the unit-root proposed by Dickey and Fuller (1979) and the co-integration test devised by Engle and Granger (1987). The approach adopted in this paper is similar to the one followed by Payne (1997) in his analysis of the G7 countries and that by Bravo and Sylvestre's (2002) study of European countries. The indicators of sustainability, tax gap and primary gap are calculated using the formula in Eviews 7 statistical package. Total public debt is defined as the sum of the domestic debt and the foreign debt. Table 1 summarizes the variables used in both models.

Table 1: Data description

Variable	Description
B_t	Stock of total public debt
G_t	Government expenditure
T_t	Tax revenues
S_t	Primary Surplus
D_t	Primary Deficit
r_t	Interest rate on government debt
GG_t	Government expenditure inclusive of interests payment
d_t^*	Ratio of constant primary deficit to GDP
d_t	Ratio of current primary deficit to GDP
n_t	Growth rate of the economy
b_t	Ratio of government debt to GDP
t_t^*	Ratio of constant taxes to GDP
g_t	Ratio of primary government expenditures (excluding interests payment) to GDP
t_t	Ratio of taxes to GDP

4.2. Indicators of sustainability results (5 year averages)

Table 2: Primary gap and tax gap results (Eq. 16 and eq. 18)

Countries	ALG		CIV		GHA		KEN		NIG	
Indicators	PG	TG	PG	TG	PG	TG	PG	TG	PG	TG
1970	-0.48	-8.60	4.71	-1.84	-5.67	25.01	0.16	25.01	2.11	-3.76
1975	6.09	22.11	-7.56	-5.00	13.38	-5.23	0.31	-5.23	-10.60	7.27
1980	0.41	9.48	3.64	-3.00	8.98	4.20	0.66	4.20	5.48	2.44
1985	4.57	0.52	6.33	3.50	-8.37	9.70	1.34	9.70	-6.98	7.03
1990	5.69	-3.30	4.03	9.50	-9.87	8.20	-3.93	8.20	22.05	-19.01
1995	16.73	5.64	-6.58	-5.00	-9.44	2.50	7.41	2.50	6.91	5.69
2000	1.58	9.63	1.59	3.75	-7.18	5.40	8.22	5.40	8.22	7.16
2005	-2.60	-2.33	2.98	4.00	-10.00	5.40	10.00	-5.40	3.37	10.00
2010	-6.51	8.24	3.68	-12.03	-12.39	7.82	6.43	7.82	7.09	-14.82
2012	-2.94	-8.32	-7.09	5.88	-9.67	9.56	2.67	-8.09	-10.01	16.92

Countries	RWA		SA		TUN		TZ		ZAM	
Indicators	PG	TG	PG	TG	PG	TG	PG	TG	PG	TG
1970	0.48	8.60	-4.71	11.84	5.67	25.01	0.16	-5.01	2.11	3.76
1975	6.09	-2.11	7.56	-6.00	-7.38	-5.23	-0.31	-5.23	-10.60	7.27
1980	0.41	9.48	3.64	3.00	8.98	4.20	0.66	4.20	15.48	-2.44
1985	-4.57	0.52	6.33	3.50	-8.37	9.70	-1.34	9.70	-6.98	-7.03
1990	-5.69	-23.30	4.03	9.50	9.87	8.20	3.93	8.20	2.05	9.01
1995	16.73	5.64	-6.58	-5.00	9.44	-2.50	7.41	2.50	6.91	-5.69
2000	-1.58	-9.63	1.59	3.75	-7.18	5.40	-18.22	-5.40	8.22	2.16
2005	2.60	-5.33	-2.98	-2.00	-10.00	5.40	-10.00	5.40	-3.37	-1.00
2010	-6.51	-8.24	3.68	-12.03	12.39	7.82	10.43	-7.82	-9.09	4.82
2012	-2.94	-8.32	-7.09	1.88	9.67	9.56	-11.67	-8.09	-5.01	-6.92

PG and TG stand for Primary gap and Tax Gap indicators and the unit is the percentage

4.3. Stationarity and Co-integration tests results

Table 3: Augmented Dickey- Fuller test on government deficit/ surplus and debt (Eq.7)

Country	-	b_t	s_t/d_t	Δb_t	$\Delta s_t/d_t$
ALG	*ADF*	-2.093	-2.223	-3.953	-4.372
	Lags	0	2	1	0
	P-value	0.666	0.159	0.000	0.000
CIV	*ADF*	-2.192	-3.510	-5.278	-5.912
	Lags	0	1	0	0
	P-value	0.308	0.452	0.003	0.001
GHA	*ADF*	-1.299	-3.411	-3.973	-5.781
	Lags	3	2	0	0
	P-value	0.609	0.419	0.001	0.000
KEN	*ADF*	-1.342	-2.326	-4.363	-4.989
	Lags	2	1	0	0
	P-value	0.034	0.602	0.080	0.000
NIG	*ADF*	-1.009	-2.936	-4.973	-6.398
	Lags	1	3	1	0
	P-value	0.443	0.367	0.012	0.000
RWA	*ADF*	-1.982	-2.911	-4.201	-3.321
	Lags	1	3	2	2
	P-value	0.510	0.491	0.000	0.004
SA	*ADF*	-1.272	-2.229	-4.728	-5.529
	Lags	3	1	2	0
	P-value	0.623	0.350	0.003	0.000
TUN	*ADF*	-2.883	-3.727	-4.321	-5.527
	Lags	1	1	1	0
	P-value	0.448	0.720	0.000	0.000
TZ	*ADF*	-1.102	-2.743	-3.602	-4.419
	Lags	2	3	1	1
	P-value	0.346	0.218	0.008	0.000
ZAM	*ADF*	-1.509	-3.234	-3.991	-5.234
	Lags	1	0	0	1
	P-value	0.312	0.342	0.020	0.002

Note: b_t: ratio of debt to GDP; s_t/d_t: ratio of budget deficit or surplus to GDP. These series are *I (0)* after applying the Phillips and Perron (1988) test.

Table 4: Results from Engle- Granger Co-integration test on budget deficit and debt (Eq.10)

Country	-	*Dependent Variable*		*Co-integration*
		d_t	b_t	
ALG	*ADF*	-1.980	-2.812	*No*
	Lags	3	3	
	P-value	0.529	0.671	
	Coefficient of independent variable	2.820	1.823	
CIV	*ADF*	-3.248	-2.832	*No*
	Lags	1	1	
	P-value	0.777	0.921	
	Coefficient of independent variable	1.738	3.129	
GHA	*ADF*	-3.492	-2.812	*Yes*
	Lags	2	2	
	P-value	0.008	0.002	
	Coefficient of independent variable	1.189	1.944	
KEN	*ADF*	-4.221	-1.299	*No*
	Lags	0	0	
	P-value	0.672	0.288	
	Coefficient of independent variable	5.231	8.231	
NIG	*ADF*	-2.001	-4.301	*Yes*
	Lags	0	0	
	P-value	0.065	0.086	
	Coefficient of independent variable	1.998	0.823	
RWA	*ADF*	-3.339	-5.321	*No*
	Lags	0	0	
	P-value	0.794	0.880	
	Coefficient of independent variable	1.897	2.931	
SA	*ADF*	-1.673	-0.823	*Yes*
	Lags	0	0	
	P-value	0.004	0.003	
	Coefficient of independent variable	1.490	2.300	
TUN	*ADF*	-4.215	-3.129	*Yes*
	Lags	2	2	
	P-value	0.005	0.030	
	Coefficient of independent variable	1.922	0.766	
TZ	*ADF*	-3.334	-2.301	*No*
	Lags	1	1	
	P-value	0.225	0.671	
	Coefficient of independent variable	3.955	1.999	
ZAM	*ADF*	6.291	7.289	*No*
	Lags	0	0	
	P-value	0.673	0.712	
	Coefficient of independent variable	2.101	1.991	

Table 5: Augmented Dickey- Fuller test on government expenditures and revenues (Eq.12)

Country	-	*gg*	*t*	*Δgg*	*Δt*
ALG	*ADF*	-6.231	-3.183	-5.282	-7.283
	Lags	5	2	4	2
	P-value	0.332	0.190	0.001	0.000
CIV	*ADF*	-4.102	-4.902	-6.702	-7.281
	Lags	1	7	3	0
	P-value	0.412	0.090	0.001	0.002
GHA	*ADF*	-2.123	-4.893	-6.231	-3.218
	Lags	1	1	1	1
	P-value	0.407	0.202	0.001	0.000
KEN	*ADF*	-3.372	-2.982	-5.983	-5.321
	Lags	3	2	4	0
	P-value	0.001	0.288	0.003	0.000
NIG	*ADF*	-1.290	-2.901	-4.230	-6.367
	Lags	3	1	1	4
	P-value	0.065	0.519	0.004	0.000
RWA	*ADF*	-2.314	-3.410	-4.325	-5.736
	Lags	3	2	1	0
	P-value	0.013	0.231	0.000	0.000
SA	*ADF*	-1.991	-2.120	-5.231	-5.923
	Lags	1	4	5	0
	P-value	0.012	0.004	0.000	0.000
TUN	*ADF*	-3.126	-2.100	-3.719	-6.231
	Lags	3	2	1	0
	P-value	0.238	0.349	0.001	0.000
TZ	*ADF*	-2.213	-3.832	-6.329	-4.063
	Lags	5	1	1	2
	P-value	0.623	0.278	0.401	0.001
ZAM	*ADF*	-3.672	-3.901	-6.201	-9.312
	Lags	6	1	1	0
	P-value	0.982	0.801	0.000	0.000

Note: gg_t and t_t are government expenditures inclusive of interests and tax revenues ratios to GDP. Applying the Phillips and Perron (1988) test, these series are also *I (0).*

Table 6: Results from Engle-Granger co-integration test on government expenditures and revenues (Eq.12)

Country	-	*Dependent Variable*		*Co-integration*
		gg_t	t_t	
ALG	*ADF*	-4.945	-1.002	*No*
	Lags	1	1	
	P-value	0.531	0.271	
	Coefficient of independent variable	1.811	2.723	
CIV	*ADF*	-3.998	-1.202	*No*
	Lags	3	3	
	P-value	0.667	0.425	
	Coefficient of independent variable	1.003	3.129	
GHA	*ADF*	-1.402	-5.008	*Yes*
	Lags	0	0	
	P-value	0.008	0.002	
	Coefficient of independent variable	2.189	0.944	
KEN	*ADF*	-4.221	-1.299	*No*
	Lags	0	0	
	P-value	0.832	0.638	
	Coefficient of independent variable	3.301	1.761	
NIG	*ADF*	-1.001	-2.601	*No*
	Lags	0	0	
	P-value	0.885	0.392	
	Coefficient of independent variable	0.998	0.663	
RWA	*ADF*	-1.639	-5.099	*No*
	Lags	0	0	
	P-value	0.766	0.809	
	Coefficient of independent variable	0.806	1.821	
SA	*ADF*	-1.433	-0.339	*Yes*
	Lags	1	1	
	P-value	0.002	0.008	
	Coefficient of independent variable	3.475	2.493	
TUN	*ADF*	-3.110	-6.639	*No*
	Lags	1	1	
	P-value	0.899	0.182	
	Coefficient of independent variable	1.362	0.177	
TZ	*ADF*	-3.001	-1.701	*Yes(10%)*
	Lags	3	3	*No (5%)*
	P-value	0.055	0.061	
	Coefficient of independent variable	3.332	0.421	
ZAM	*ADF*	7.638	7.012	*No*
	Lags	0	0	
	P-value	0.544	0.771	
	Coefficient of independent variable	4.101	1.531	

Annual data for 1970-2012 is used to test whether the selected African economies are fiscally sustainable. The results from Table 2 are indicators of sustainability. In general, they show that fiscal policies are not sustainable in Africa. The results also show that the situation varies between economies due to the different fiscal policies of different countries. This implies that current primary deficits are too large and that current taxes are too low to stabilize the debt ratios of these economies.

Table 3 results are the Augmented Dickey-Fuller unit root test for debt and budget deficits. The results reveal that the ratios of debt and budget deficits may be considered integrated of order 1 *(I (1))* in all the countries under consideration. The Engle-Granger test is then administered for eq. (10) that sums up the results in Table 4. This ascertains the coefficients of the independent variable for each country. Co-integration is not rejected at the level of 5% significance for Ghana, South Africa and Tunisia. However if the 10% significance level is considered, co-integration is also not rejected for Nigeria. Table 5 results also show that the variables ratio of government expenditures and revenues are all integrated of order 1. From Table 5, the Engle–Granger co-integration test was run and it revealed in Table 6 that only Ghana, South Africa and Tanzania are fiscally sustainable.

5. Conclusion

In this chapter, the fiscal sustainability of African economies has been tested by applying different extensions of the IBC method and indicators of sustainability. In line with previous studies, the results depend on the type of test and sample used. The results for indicators of fiscal sustainability in this study have shown that in general, fiscal policy in Africa is not sustainable, and that its degree of unsustainability differs from one country to another due to differences in fiscal policies. This means that the current primary deficit is too large and current taxes are too low to stabilize the debt ratio. Thus, increased tax collection and per capita tax burdens are recommended to reduce the budget deficits and debts of respective governments and to consolidate their individual fiscal stance. In addition, the co-integration test was carried out on debt and budget deficit series and show that only Ghana, Nigeria, South Africa and Tunisia follow a sustainable fiscal policy path. The same test was applied to tax revenues and government expenditure ratios and shows that Ghana, South Africa and Tanzania are fiscally sustainable. These findings agree with previous other studies.

Chapter 2 Estimating fiscal reaction functions of African Economies

1. Introduction

This paper estimates Bohn's fiscal rule or fiscal reaction function for African economies by analysing how African governments react to changes in their debt positions. To accomplish this, the paper estimates a fiscal reaction function using the Ordinary Least Squares (OLS) method. The purpose of this paper is to assess the quantitative scale of adjustment of the primary balance to the debt obligations of African countries. Africa's debt burden has long been of key concern to the international community. Since 2000, the Enhanced HIPC Initiative has delivered far more debt relief to Africa. Nevertheless, according to Fedelino and Kudina (2003), the sustainability of the public debt of African countries remains highly precarious, if not illusory.

Africa's debt is the highest in the world. As a proportion of GDP, according to IMF (1999), some countries in the region spend more than half of their export earnings to service foreign debts. The debts of many African countries are so large in relation to their foreign exchange earnings potential that it would be impossible to pay them off, even if growth resumes and is sustained at unrealistically high levels. Several factors are responsible for this situation. According to Mistry (2008), the African debt crisis arose due to (1) over-borrowing by developing countries and reckless lending by international commercial banks in the 1970s; (2) the collapse of world commodity prices (especially petroleum) in the early 1980s; and (3) the sharp increase in international interest (lending) rates in 1982.

The credibility of a government is extremely important for its ability to borrow both domestically and internationally. The debt crisis in Africa has put renewed emphasis on the sustainability and prudence of fiscal policies. Issues pertaining to debt, aid delivery and management, and sustainability, remain central to discourses on national, regional and global development. Most African nations have millions of their people living in poverty, partly because of increasing debts and the burden of repayment. These repayments have been to the detriment of spending on key sectors and programmes for the social and economic advancement of such nations. Fiscal reaction functions are estimated to help relevant authorities to adjust their activities following certain rules.

The paper is motivated first by the fact that most empirical studies have been conducted only in developed and emerging economies, thus the literature on Africa is very limited. Some of

the better-known studies in this regard include those by Bohn (1998, 2005), De Mello (2005), David and Leeper (2006), Budina and Wijnbergen (2008), Burger et al. (2011), and Greiner et al. (2007, 2010, 2011). Following the world oil price shocks in the 1970s, the international debt crisis and credit crunch as well as the crash of commodity prices in the early 1980s, the African region was seriously affected and became vulnerable due to its dependence on foreign economies as was seen during the recessions of the 1980s and 1990s. This paper is significant in that it focuses on the African region, which according to Sobhee (2010), has very low growth rates and huge public sector deficits that are compounded by extremely high levels of indebtedness and is more fragile than other regions in the face of external shocks.

There are three contributions that the paper makes regarding estimating the fiscal responses of African economies. First, following Bohn (1998, 2005), Greiner and Kauermann (2007), Greiner et al. (2007) and Fincke and Greiner (2010), it estimates fiscal responses for African economies and explores their fiscal policy sustainability. Secondly, it focuses on the region whose public policy has been at the heart of international investors' concerns and stabilization programmes but whose public debt sustainability has remained largely unexplored and is the most vulnerable among all the regions in the world to public debt and chronic budget deficits. Thirdly, the paper examines foreign direct investments (FDI), (see Schintzer, 2002), Ferrarini, 2008) and remittances (see Poirine, 1997, Abdih et al., 2009), as new macro-variables within models that affect public debt and budget deficits in African contexts. The paper also examines the empirical importance of these macro-variables in reducing and sustaining Africa's public debt.

The paper is structured as follows: The section to follow explores existing literature related to fiscal reaction functions while the next presents the theoretical framework of this discussion. This is followed by presentation of data and empirical results which leads to the summary and conclusion.

2. Literature review

The fiscal reaction function is a fiscal rule that has been estimated by several scholars including Bohn (1998, 2005), De Mello (2005), Davig and Leeper (2006), Budina and Wijnbergen (2008), and Burger et al. (2011). Bohn's (1998) fiscal rule is based on an analysis of how primary fiscal balance (excluding the interest payments on public debt) reacts to variations in sovereign debt caused by economic shocks. In such a framework, fiscal policy is

considered sustainable once the government reacts systematically to a change in public debt by adjusting the primary fiscal balance. This fiscal rule is based on Barro's (1979) tax smoothing hypothesis which states that regular spending should be financed by taxes given that tax rates remain constant.

In his estimation of regression of fiscal reaction for the US, Bohn (1998) finds a strong evidence of sustainability. Similar studies have been conducted in European countries by Gong et al. (2001) and Balabriga and Martinez-Mongay (2005), all of whom conclude that the fiscal policies of these countries are sustainable. Allen and Nankani (2004) have also applied Bohn's rule to a sample of industrial and developing countries with results indicating that both industrial and developing countries with low debt ratios have similar sustainability indices. However the case is different for developing countries with a high debt ratio. For example, in their assessment of the sustainability and the feasibility of government debt in the Philippines , Qin et al. (2006) conclude that although the debt is unsustainable, it may be weakly feasible if simple budgetary deficit control policies are implemented.

Following a reassessment of Greiner and Semmler's (1999) work, Greiner et al. (2007) demonstrate that primary surpluses respond positively to higher debt ratios, thus implying sustainable debts for Euro-area countries. Mendoza and Ostry (2008) use the same fiscal rule for emerging market economies and reveal that Bohn's condition for fiscal solvency is consistent with the data for all emerging economies. However, using co-integration and multico-integration tests, Kia's (2008) evaluation of the fiscal sustainability of Iran and Turkey demonstrates that the fiscal budgeting process in both countries is not sustainable.

Fincke and Greiner (2011) have also applied this Bohn's fiscal rule to their analysis of three industrialized economies - USA, Japan and Germany, where central banks are independent and budget deficits are not financed by money creation. Their findings show that although public debt in these countries are sustainable, , there are certain country-specific features of public finances that still need to be considered. In addition, Doi et al. (2011), Sakuragawa, Hosono (2011) and Chen (2014), following Bohn's rule, have all found Japan's fiscal policy to be sustainable.

The literature on estimating fiscal reaction function of African economies is still limited as only a few studies have been conducted in the region. One of these is Fincke and Greiner (2010) study that applies Bohn's rule to low and middle income developing countries in Africa and Latin-America. The results show that, despite rising debt ratios, there is empirical

evidence for some of the countries that public debt is sustainable, independent of whether they belong to the low-income or middle-income group of countries. Burger et al. (2012) have also conducted a similar study using a fiscal reaction function for South Africa with results indicating that, since 1946, the South African government has ran a sustainable fiscal policy by reducing primary deficits or increasing surpluses in response to rising debt.

African economies are more vulnerable to debt crises than other regions of the world. This is due to the heavy dependence on raw materials as exports, and the fact that debt is held in foreign currency, a situation that increases the cost of repayment. Some studies suggest that interventions like as foreign direct investment (FDI) and remittance flows may help in sustaining such chronic budget deficits. Following the views of Poirine (1997), Schintzer (2002), Ferrarini (2008), (1997), Abdih et al. (2009), this paper suggests that FDI and remittances can be considered as new macro-variables that can help in reducing and sustaining debt in the African context.

3. Methodology and framework

A fiscal reaction function is a fiscal rule that helps governments forecast and prepares to respond to some macroeconomic changes. Having right fiscal reaction functions make fiscal policy and public finance sound and stable as has been demonstrated by Bohn (1998). The main hypothesis to be tested when estimating a fiscal reaction function relates to the ways in which a government adjusts primary budget balances, in response to changes in indebtedness so as to ensure the sustainability of debt dynamics over time. As Gali et al. (2003), Greiner et al. (2007), Greiner and Kauermann (2007) and Fincke and Greiner (2010) have shown, the fiscal reaction function originates from the government inter-temporal budget constraint and is as follows:

$$G_t + (1 + r_{t-1})B_t = T_t + B_t \qquad (1)$$

An alternative function is that used by Bohn (1998). If the interest rate r is assumed to be constant, the accumulation of the public debt can be described in continuous time by the equation below:

$$\dot{B}_{(t)} = r(t)B(t) - S(t) \qquad (2)$$

with G_t, government spending, T_t, tax revenues, B_t, total debt, r_t real interest rate on debt and $S(t)$ the real government surplus exclusive of interest payments on public debt.

The meaning of equation (1) is that the government's total receipts including tax (T_t) and borrowing (B_t) of the current period should equal the government's total spending *(G_t)* plus debt service (including the principal from the previous period B_{t-1} and interest payment $r_{t-1}Bt$. Equation (2) represents a situation where a government can be considered to be following a sustainable debt policy given that the present value of public debt converges to zero asymptotically so long as a Ponzi game is not being played. Solving equation (2):

$$B_t = e^{\int_{t0}^{t} r(\tau)d\tau}\left(B(0) - \int_{t0}^{t} e^{-\int_{t0}^{t} r(\mu)d\mu}\, S(\tau)d\tau\right) \qquad (3)$$

From eq. (3), it is assumed that the government determines the primary surplus to GDP ratio s_t such that it is a positive linear function of the debt to GDP ratio, b_t. Thus the following equation defines the primary surplus ratio:

$$s(t) = \rho(t)b(t) + \varepsilon_t \qquad (4)$$

With ρ being the coefficient that indicates how the changes in public debt to GDP ratio affect the primary surplus. It is defined as *s(t) =S(t) /Y(t)* to be the government's primary surplus to GDP ratio that can be determined by any government. The debt to GDP ratio is described as *b(t) = B(t)/Y (t)* , in which case, the primary surplus to GDP ratio is a positive linear function of the debt to GDP ratio. ε_t, is a stochastic error term (Bohn, 1998). The empirical analysis is based on Barro's (1979) tax-smoothing model (see also Canzoneri et al. 2001). The result is that optimal taxes should be constant over time. With constant tax, the primary surplus is used as a counterweight to the impact of fluctuation in government revenues and expenditures.

Using equation (4), the evolution of public debt can be written in the form of the following differential equation (see Kloeden and Platen, 1995):

$$dB(t) = \big(r(t) - \rho(t)\big)B_t dt + a_1(t)dW_t \qquad (5)$$

Here, W_t is a Wiener process (Wt ~N(0,1)), t ≥ 0, and $a_1(t)$ is the diffusion. Solving eq. (5) and multiplying both sides by $e^{-\int_{t0}^{t} r(\tau)d\tau}$ to get the present value of public debt yields:

$$e^{-\int_{t0}^{t} r(\tau)d\tau}B_t = e^{-\rho t}\left(B_{t0} + \int_{t0}^{t} e^{\rho t - \int_{t0}^{t} r(\tau)d\mu}\, a_1(\tau)dW_\tau\right) \qquad (6)$$

At time $t=t_0$, public debt $B_{t0} \geq 0$. And the sustainability holds if

$$\lim_{t\to\infty} e^{-\int_{t0}^{t} r(\tau)d\tau} B_t = 0 \qquad (7)$$

According to equation (5), if we expect the present value of public debt to converge to zero for t → ∞, ρ must be positive. Otherwise if the ρ is negative, the path of public debt will not be sustainable. Therefore, the estimations of coefficients provide important indicators of how the government deals with public debt. Furthermore, the sustainability of the path of the fiscal policy can also be determined thereby.

Assuming that the primary surplus to GDP ratio is a positive linear function of the debt to GDP ratio and of a constant term, the primary surplus-GDP ratio can be written as follows:

$$\frac{S(t)}{Y(t)} = \alpha + \rho(t)\frac{B(t)}{Y(t)} \qquad (8)$$

Where *Y(t)* denotes GDP at *t* and *α*, *ρ(t)*∈IR are coefficients with α being constant. $\rho(t)$ determines how strong the primary surplus reacts to changes in the public debt-GDP ratio and *α* can be interpreted as a systematic component determining how the level of the primary surplus reacts to a rise in GDP. α can also be seen as other constant variables that affect the primary surplus-GDP ratio.

In light of eq. (8), describing the evolution of public debt, can be rewritten as:

$$\dot{B}(t) = r(t)B(t) - S_t = \big(r(t) - \rho(t)\big)B(t) - \alpha Y_t \qquad (9)$$

Solving this differential eq. (9) to get the present value of the stock of debt yields:

$$B(t) = \left(\frac{\alpha}{r-\gamma-\beta}\right)Y(0)e^{\gamma t} + e^{(r-\beta)t}C_1 \qquad (10)$$

with *B(0)>0* debt at time *0* which is assumed to be strictly positive and C_2 a constant given by $C_2 = B(0) - Y(0)\alpha/(r-\gamma-\beta)$. Given this expression, we can assume some conditions which must be fulfilled for the inter-temporal budget constraint of the government to hold.

Assuming that in our model economy, the following turns out to hold true:

For (i) $\beta > 0$ the inter-temporal budget constraint of the government holds if $r > \gamma$ or if $\alpha = 0$ holds. Or, for (ii) $\beta < 0$ the inter-temporal budget constraint of the government is not

fulfilled except for $B(0) = Y(0)\alpha/(r-\gamma-\beta)$ and $r > \gamma$. To prove this, the expression $e^{-rt}B(t)$ is written as follows:

$$e^{-rt}B(t) = \left(\frac{\alpha}{r-\gamma-\beta}\right)Y(0)e^{(\gamma-r)t} + e^{-\beta t}C_1 \qquad (11)$$

It must be noted that both terms on the r.h.s. of eq. (11), $e^{-\beta t}C_2$, converges to zero for $t \to \infty$ if $r > \gamma$ holds. For $\alpha = 0$ the first term equals zero independent of r and γ. Thus, (i) is proven. It should be noted that for $\beta > 0$, $r < \gamma$ and $\alpha < (>)0$ the first term converges to +(-)∞ for $t \to \infty$. However, we exclude the case where debt converges to $t-\infty$ by assumption. To prove (ii), we note that the first term on the r.h.s. of eq. (12) converges to zero if $r > \gamma$ holds. The second term on the r.h.s. of eq. (12), $e^{-\beta t}C_1$ equals zero if $C_1 = 0$ holds, which is equivalent to

$B(0) = Y(0)\alpha/(r-\gamma-\beta)$. If these conditions do not hold simultaneously, $e^{-rt}B(t)$ diverges either to +∞ or to -∞. This proposition shows that as long as economies are dynamically efficient, $\beta > 0$ guarantees that the discounted public debt converges to zero and, therefore, is a sufficient condition for the sustainability of a given fiscal policy. It should also be noted that sustainability may be realised even if the debt ratio is not constant, at least transitorily. In dynamically inefficient economies where $r < \gamma$holds, the present value of government debt may explode and the inter-temporal budget constraint will not be fulfilled even with $\beta > 0$.

However, it must be pointed out that in such economies the inter-temporal budget constraint is irrelevant. This holds true because in dynamically inefficient economies, the government can issue debt and roll it over indefinitely and cover interest payments by new debt issues, i.e. the government can indeed play a Ponzi game. Finally, the inter-temporal budget constraint is not fulfilled if the government reduces its primary surplus as the debt ratio rises, i.e. for $\beta < 0$, except for the hairline case,$B(0) = Y(0)\alpha/(r-\gamma-\beta)$. It must also be pointed out that in a stochastic economy, dynamic efficiency does not necessarily imply that the interest rate on government debt exceeds the growth rate of the economy, i.e. $\gamma > r$ may occur. This holds true because with risky assets, the interest rate on safe government bonds can be lower than the marginal product of capital. If the stochastic economy is dynamically efficient and the growth rate exceeds the interest rate on government bonds, a positive β is nevertheless also sufficient for the inter-temporal budget constraint to be fulfilled if $\alpha = 0$ holds. A formal proof of this assertion is demonstrated by Bohn (1998) and Canzonerie et al. (2001).

These theoretical considerations demonstrate that in a deterministic economy, an increase in the primary surplus to GDP ratio is as a consequence of a rise in the debt to GDP ratio, whereas the inter-temporal budget constraint of the government is achievable in dynamically efficient economies. Bohn's fiscal rule is based on the tax smoothing model of Barro (1979). And is made in a way where in the long-term equilibrium relation formula among variables, cyclical variation of economy, and trend break of government expenditure are added to regression formula. Based on the fact that when national debt increases, the stability of debt is only secured by corrective actions of fiscal balance, Bohn (1998) suggests a regression equation as follows:

$$s_t = \alpha + \delta b_{t-1} + \vartheta Z_t + \varepsilon_t \qquad (12)$$

where Z_t includes several variables that determine fiscal balance.

Variables contained in Z_t include temporary government spending (GVAR) – whose usability has been verified by Barro (1986) – and business cycle indicator (YVAR). This is to control the impact of changes in fiscal expenditure on fiscal balances. For fiscal stability, government's primary balance and its debt should be related such that increase in debts should be accompanied by increase in fiscal surpluses, implying that δ needs to show a positive sign. As has been mentioned previously, the analysis presented here is based on the tax smoothing hypothesis. This means that the primary deficit is supposed to help smoothen out revenues and expenditure variations. This is to ensure and maintain a steady and even tax rate. The non-debt determinants of the primary surplus are thus the level of temporary government spending (GVAR), and the business cycle indicator (YVAR). Also, as mentioned in the literature review, new macro-variables, are introduced into the model in the African context. These are foreign direct investments (FDI) and remittances both of which have a positive relationship with the primary surplus ratio. The model for the primary surplus to GDP ratio to is:

$$s_t = \beta_1 + \delta b_{t-1} + \beta_2 GVAR_t + \beta_3 YVAR_t + \beta_4 fdi_t + \beta_5 rem_t + \varepsilon_t \qquad (13)$$

with $fdi_t = FDI_t/Y_t$, foreign direct investment to GDP ratio, $rem_t = REM_t/Y_t$ remittances to GDP ratio and ε_t, error term which is assumed to be i.i.d. N(0, σ^2).

We also assume that the lagged debt ratio b_{t-1} affects the primary surplus ratio in order to account for causality.

4. Empirical analysis

4.1. Data description and econometric techniques

The data used in this study is taken from the International Financial Statistics, the database of the International Monetary Fund Economist Intelligence Unit, UNCTAD and World Bank annual database and covers the period from f 1970 to 2012. The ten countries under consideration are Algeria (ALG), Ivory Coast (CIV), Ghana (GHA), Kenya (KEN), Nigeria (NIG), Rwanda (RWA), South Africa (SA), Tanzania (TZ), Tunisia (TUN) and Zambia (ZAM). This study solely focuses on a relatively small sample of ten developing countries.

In this study, public debt is defined as the sum of the domestic debt and foreign debt. The estimation of $GVAR_t$ and $YVAR_t$ requires potential or trend GDP and government expenditure. The trend GDP and government expenditure is estimated using the Hodrick-Prescott filter, $GVAR_t = \frac{g_t - g_t^*}{y_t}$ and $YVAR_t = \frac{y_t^* - y_t}{y_t^*}\frac{g_t^*}{y_t}$ where g_t^* and y_t^* are estimated trends through the H-P filter. On the basis of the findings of various studies (Greiner et al., 2007; Greiner and Kauermann, 2007; Fincke and Greiner, 2010), equation (13) will be regressed by Ordinary Least Squares (OLS) estimation. Because Ordinary Least Squares (OLS) can give biased standard errors and *t*-statistics due to heteroskedasticity and autocorrelation in the residuals, heteroskedasticity and autocorrelation consistent *t*-statistics are calculated to get robust estimates (White, 1980; Newey and West, 1987). All estimations are done with EViews 7.

4.2. Estimates results

Table 7: Estimates for eq. (13)

Country	-	*Constant*	b_{t-1}	$GVAR_t$	$YVAR_t$	rem_t	fdi_t
ALG	*Coefficient*	-0.015	0.203	-5.287	1.060	-7.437	-4.732
	Std.error(t-stat)	0.005(-2.783)	0.026(7.345)	2.878(-2.054)	1.709(6.253)	1.261(5.748)	0.563(-0.362)
	Pr(>t)	0.003	0.007	0.047	0.002	0.182	0.001
	DW	2.007					
	$R^2(adj)$	0.739					
CIV	*Coefficient*	-0.060	0.156	-8.472	1.830	-3.872	0.429
	Std.error(t-stat)	0.014(-4.20)	0.030(5.290)	0.061(-3.564)	3.321(5.425)	0.934(1.832)	1.673(-2.201)
	Pr(>t)	0.412	0.604	0.001	0.002	0.004	0.000
	DW	1.578					
	$R^2(adj)$	0.847					
GHA	*Coefficient*	-0.123	0.843	-1.231	-3.218	0.147	2.389
	Std.error(t-stat)	0.035(-2.728)	0.082(-8.321)	1.830(3.000)	0.920(0.263)	0.222(-1.673)	0.011(-3.932)
	Pr(>t)	0.407	0.003	0.001	0.008	0.082	0.002
	DW	2.289					
	$R^2(adj)$	0.882					
KEN	*Coefficient*	-0.372	1.982	0.983	0.321	2.982	-3.281
	Std.error(t-stat)	0.435(-2.322)	0.043(2.381)	0.261(1.382)	0.330(-1.321)	0.421(2.921)	2.732(-219)
	Pr(>t)	0.001	0.288	0.003	0.007	0.004	0.083
	DW	2.053					
	$R^2(adj)$	0.704					
NIG	*Coefficient*	-0.045	0.011	-1.290	-3.367	0.420	2.192
	Std.error(t-stat)	0.030(-1.702)	0.832(0.203)	1.983(0.281)	0.201(0.055)	0.320(-0.068)	0.627(-2.333)
	Pr(>t)	0.035	0.577	0.004	0.002	0.782	0.277
	DW	2.887					
	$R(adj)^2$	0.834					
RWA	*Coefficient*	-0.110	0.173	-0.198	0.280	0.382	1.392
	Std.error(t-stat)	0.016(-6.291)	0.055(3.333)	0.026(-6.129)	0.050(4.892)	0.290(-2.982)	0.302(-2.832)
	Pr(>t)	0.013	0.001	0.080	0.010	0.001	0.053
	DW	1.953					
	$R^2(adj)$	0.902					
SA	*Coefficient*	-0.991	1.120	-5.77	1.003	-0.562	3.923
	Std.error(t-stat)	0.210(-2.290)	0.027(-1.072)	0.025(2.192)	0.055(3.219)	0.102(-0.932)	0.014(-1.402)
	Pr(>t)	0.002	0.004	0.007	0.011	0.067	0.002
	DW	2.381					
	$R^2(adj)$	0.882					
TUN	*Coefficient*	-0.022	-1.009	-1.719	0.231	-1.932	0.738
	Std.error(t-stat)	0.041(-2.001)	0.051(0.008)	0.065(-2.193)	0.108(3.333)	0.102(-3.912)	0.020(-0.822)
	Pr(>t)	0.008	0.749	0.008	0.004	0.003	0.001
	DW	2.289					
	$R^2(adj)$	0.631					
TZ	*Coefficient*	0.023	-0.431	-1.321	-3.064	3.201	0.382
	Std.error(t-stat)	0.029(1.822)	0.034(-3.291)	0.077(-0.290)	0.071(-6.892)	0.033(-4.420)	0.066(2.013)
	Pr(>t)	0.003	0.047	0.071	0.006	0.004	0.021
	DW	1.924					
	$R^2(adj)$	0.688					
ZAM	*Coefficient*	-0.672	-3.881	2.821	0.070	1.920	0.992
	Std.error(t-stat)	0.020(-0.389)	0.097(1.923)	0.043(3.314)	0.0720(1.477)	0.007(-1.923)	0.048(0.761)
	Pr(>t)	0.008	0.111	0.023	0.100	0.031	0.002
	DW	2.280					
	$R^2(adj)$	0.744					

As shown in Table 1, Algeria's coefficient for the debt ratio is positive and highly significant at 5% level (t-statistic=7.345). The coefficient of business cycle variables is positive and significant at 5%, which indicates that the primary surplus ratio increases when the real GDP is above its normal values. $GVAR_t$ has an expected negative sign. Other variables, fdi_t and rem_t have negative coefficients and only foreign direct investment is significant. The Durbin-Watson test statistic is 2.0, which does not show correlations of the residuals. Further, the R^2 (adj) = 0.739 gives a fair goodness of fit. The results for Cote d'Ivoire show that the coefficient for the debt ratio is positive as expected and not significant, and $GVAR_t$, $YVAR_t$, fdi_t and rem_t are all significant at 1%. But $GVAR_t$ and rem_t show negative signs. The Durbin-Watson statistic is 1.5, there is no correlation in residuals and R^2 (adj) = 0.847 is high enough.

Ghana's results show that the coefficient for the debt ratio is positive and significant. $GVAR_t$ and $YVAR_t$ have negative signs and are significant. fdi_t and rem_t are positive and significant at 1%, which means that they increase the primary surplus when remittances and foreign direct investment grow in value. Also, it is D-W statistic is 2.2 and shows no correlation in residuals and the good fit of the model is displayed by a high R^2 (adj) = 0.8821. The results for Kenya show a positive coefficient for the debt ratio, but are not significant at any level. Other variables also show positive signs, except foreign direct investment which is negative; both are significant at respectively 1% and 10%. This is true for a country that remittance flows constitute more than 20% of GDP. Also, D-W statistics show that residuals are not correlated and the goodness of fit is given by R^2 (adj) = 0.704. The results for Nigeria show a positive coefficient of debt ratio but not significant at all the usual levels. The coefficients for business cycle and expenditure variables are negative but significant. The remittances and FDI variables are both positive but not significant. The goodness of fit R^2 (adj) = 0.834 is relatively high and there seems to be no correlation of the residuals according to the Durbin-Watson test statistic (DW= 2.8).

The results for Rwanda show that the coefficient of debt ratio is positive and significant at the 1% level. All other coefficients are significant as well. The ones for the expenditure variable and the business cycle show the expected negative and positive signs respectively. R^2(adj) = 0.902 gives a high goodness of fit for the model. There is no correlation of the residuals as DW= 1.9. With regard to South Africa's results, as shown in Table1, the coefficient of debt

ratio is positive and significant at the 1% level. The coefficient for public spending is negative as well whereas the one for the business cycle variable shows a positive sign, both being statistically significant. The effect of a rise in the spending parameter indicates a decline in the primary surplus ratio and an economic boom affects an increase in primary surplus to GDP ratio. R^2 (adj) = 0.882 gives a high goodness of fit for the model. There are no correlations of the residuals as DW= 2.3. Also the variables fdi_t and rem_t are significant and have different signs.

Tunisia's economy also shows a positive coefficient for the debt ratio but it is not significant at any usual level. Other coefficients are significant and have expected signs except fdi_t and rem_t. The model for Tanzania shows a negative coefficient for the debt ratio; however, it is significant at the level of 5%. The estimated expenditure has an expected sign and is significant, implying that public spending above its normal value reduces the primary surplus ratio,while the business cycle variable has a negative sign but significant. The variables fdi_t and rem_t are both positive and significant. DW= 1.9 shows there is no correlation in the residuals and R^2 (adj) = 0.688. The results for Zambia also show a negative coefficient for the debt ratio and not significant. Other variables are both positive and significant with DW statistic that shows there is no correlation in the residuals and R^2 (adj) = 0.744 which gives a good fit for the model.

5. Conclusion

This chapter has estimated fiscal reaction functions for African economies using Bohn's fiscal rule that tests how primary surpluses react to variations in the public debt to GDP ratio. It has also introduced new macro-variables to the model that may reduce or sustain public debt in the African context. This function shows that the response of primary surplus to GDP ratios seems to increase with rising public debt to GDP ratios in some countries in line with Bohn's theory. According to the results, Algeria, Ghana, Rwanda and South Africa all have sustainable debt policies in place. The results of both tests show that Algeria, Ghana and South Africa clearly follow a sustainable debt policy and those countries can be considered as the examples as concerns their debt policy. As regards Rwanda, sustainability of fiscal policy seems to be given although the country is characterised by a growing debt ratio. This conclusion is based on a positive and statistically significant reaction of the primary surplus

to variations in public debt and on stationary public deficits. However, Cote d'Ivoire, Kenya and Nigeria, debt ratio coefficients are positive but not statistically significant while Tunisia, Tanzania and Zambia have negative coefficients of debt ratio. Ficke and Greiner (2010) confirm the results for Rwanda and Tunisia.

With other variables of the model, foreign direct investment (fdi_t) and remittances (rem_t) show different reactions in different economies. In Cote d'Ivoire, FDI is positive and highly significant. In Kenya, only remittances are positive and significant. Countries like Rwanda, Tanzania and Zambia have positive coefficients for FDI and remittances both of which are significant. South Africa and Tunisia show a positive sign for the FDI variable that is statistically significant. It is suggested that countries with negative coefficients of debt ratio that are not statistically significant at any usual level should make more effort towards stabilising public debt.

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