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Public debts, fiscal balance and sustainability: What can African governments learn from debt sustainability models?

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Abstract: This paper examines the impact of public debt on fiscal balance. This study uses the standard debt equation in a fiscal reaction and impulse response functions framework to assess the trajectory of public debt and its sustainability within the Sub-Sahara region from 1980–2017. From the estimations of the fiscal reaction function, the lagged primary balance significantly affects the fiscal deficits of Sub-Saharan African countries. Also, public debts to the gross domestic product beyond a threshold of fifty percent are positive and significantly associated with the primary balance. Fiscal deficits contribute to increases in the debt stock of about 120% over the ten-year for the Sub-Sahara region. The results imply that fiscal governance is required to constrict fiscal deficits whenever debt stock levels approach a certain threshold and growth. Therefore, stakeholders should implement enhanced fiscal policy rules on fiscal balance, public debts, and economic growth to improve debt sustainability.

Subjects: Political Economy; Economics; Finance

Keywords: Public debt; primary balance; economic growth; fiscal policy; debt sustainability

1. Introduction

Public debts of economies continue to receive substantial attention as a main driver of most economic variables. For instance, data from the International Monetary Fund (IMF) fiscal monitor indicates that before 2000, debt ratios for developing countries were as high as that of advanced economies. These high ratios were significantly reduced through debt relief packages from 1996 to 2005. Despite these interventions, the debt ratios in Africa are still considered unsustainable even for countries that did complete the debt relief program (Yang & Nyberg, 2009).

Table 1 presents the average data on fiscal performance and debt sustainability indicators as of 2018. SSA countries' debt levels are incompatible with their fiscal balances, a glaring example of poor fiscal performance (Nabieu et al., 2020), while advanced countries are effectively using their debts, as seen by the low fiscal balances (Badinger & Reuter, 2017). The data shows that despite the low levels of debt ratios in developing regions like Sub-Sahara Africa (SSA), the fiscal deficits are higher than the other economic regions. The SSA countries will likely fall behind in their economic development due to these challenging fiscal performance measures.

Table 1. Indicators of fiscal performance developed Vs. developing countries

Analytical Group of Countries	Overall Fiscal Balance	Primary Balance	Cyclical Adjusted Balance	Cyclical Adjusted Primary Balance	Gross Debt	Net Debt
Advanced Economies	−2.6	−1.3	−2.8	−1.5	112.2	80.9
European	0.2	1.3	−0.3	.9	29.4	30.9
Sub-Sahara	−4.2	−2.2	−6.88	−2.45	48.47	36.61

Source: IMF Fiscal Monitor Database, 2018.

In addition, the IMF report (2014)[1] reveals that fiscal vulnerabilities continue to increase in many countries. Notably, spending has been growing unsustainably for the Ghanaian and Zambian economies. For instance, public servant wages increased sharply in Zambia without corresponding domestic revenue to match the expenses. In the same vein, Ghana's overall deficit level in the context of weak foreign reserves is challenging. Policy volatility could become more unsteady due to rising budget demands, difficult elections, and economic uncertainties. High debt levels limit a country's ability to respond to economic shocks. As of 2018, sixteen SSA countries are distressed and at high risk of unsustainable debts, including Cape Verde, The Gambia, and Seychelles (Outlook, 2019). These crises' cascading impacts are still felt today.

The sustainability of these rising public debts across different income groups has been a problem for nations and citizens. In search for the answers to this problem, a great strand of literature has examined public debt sustainability and economic growth (Égert, 2015; Greiner & Fincke, 2016; Herndon et al., 2014; Woo & Kumar, 2015), management and sustainability of public debts (Muhanji & Ojah, 2011; Paret, 2017; Wyplosz, 2011) and fiscal sustainability and growth (Afonso & Jalles, 2016; Budina & Van Wijnbergen, 2009; Burger et al., 2012). The relationships between fiscal balance and public debt, as well as the variables influencing the sustainability of fiscal policies and growth, have also been studied in the literature (Bohn, 1998; Chalk & Hemming, 2000). As a result, a positive fiscal balance, which is significantly influenced by the level of public debts, is a condition for a sustainable fiscal strategy. Government debt ratios have a favorable impact on primary surplus, as shown by the groundbreaking study of Bohn (1998) and more recent analyses by Greiner and Fincke (2016) and Kamiguchi and Tamai (2012).

Despite the wealth of research on fiscal sustainability and public debt that is already available, public debt unsustainability is still growing in many African nations. Evidence by Muhanji and Ojah (2011) shows that structural vulnerabilities and inaccurate debt thresholds, including a weak export base, weak institutions and governance, low revenue mobilization, and insufficient macroeconomic management capability cause SSA high debt ratios. The increasing public debt necessitates investigation because excessive public debt exposes government financial positions to substantial rollovers and exchange rate risk, and prevents investments. Further research is needed to understand the vulnerabilities and current public debt risk position of the SSA, as the debt patterns raise questions about fiscal sustainability.

Given the differences in perspectives, findings, and conclusions on the fiscal sustainability of the SSA, this research adds to the literature by analyzing the current state of the SSA's public debt under various debt sustainability models. This study's primary objective is to empirically estimate the fiscal reaction function and assess debt sustainability for Sub-Saharan Africa. This objective is achieved by answering the following key questions. 1) does public debt respond to fiscal balance under different models? 2) Does the public debt's response to the fiscal balance differ under the combined and cumulative effects of a standard deviation shock to each variable? 3) can the different models explain any discrepancies in the responses?

The study findings indicate that public debt significantly influences the fiscal balance of Sub-Saharan nations. Further, the effect of the output gap on fiscal balance was found to depend on the level of fiscal balance. Our study is useful to the extent that macroeconomists and policy analysts can apply the knowledge about the potential effects of fiscal unsustainability in the context of persistent challenging fiscal and monetary policies, currency fluctuations, and rising public debt financing for many developing countries. The rest of this essay is structured as follows: a brief literature review is presented in section 2, the data and methodology are described in section 3, and the discussion of the findings and conclusion is covered in sections 4 and 5.

2. Literature review

2.1. Theoretical literature on public debt and fiscal balance

The theoretical literature on the effects of public debt and fiscal balance connections on economic outcomes is mixed. First, Ricardian Equivalence argues that the mode of financing government expenditure has no impact on economic outcomes. The theory argues that households will save in full anticipation of future increases in taxation when debt is used to finance economic growth (Buchanan, 1976). Secondly, the Keynesian theory suggests that government spending financed by debt can increase employment and economic growth (Keynes et al., 1971). Accordingly, fiscal deficits and public debt can be countercyclical tools to boost aggregate demand and stabilize the economy during economic downturns. Contrarily, the Neoclassical theory emphasizes the potentially harmful effects of public debt and fiscal deficit. They argue that high public debt levels can discourage investments, raise interest rates and impede growth (Barro, 1974). Finally, there is also the optimal fiscal policy theory which suggests an optimal level of public debt and fiscal balance that maximizes welfare (Arrow & Kruz, 2013).

2.2. Empirical review—the fiscal reaction function and stochastic analysis

A review of the public debt literature suggests that "a debt is sustainable if the intertemporal solvency condition is satisfied" (Chalk & Hemming, 2000; Neck & Sturm, 2008). That is if the estimated present value of future primary balances covers the stock of existing obligations. The IMF and World Bank argue that debt is sustainable if a country or its government does not need to default, renegotiate, or restructure its debt in the future or recur to implausibly significant policy adjustments. Numerous studies have been conducted on public debt and fiscal sustainability. However, assessing them is challenging and highly individualized because they are forward-looking and unpredictable, and different evaluation methods have been employed (Wyplosz, 2011). Accordingly, from the perspective of economic theory, fiscal reaction functions and stochastic measures are typically used to illustrate how the fiscal balance responds to changes in factors that are anticipated to be the primary determinants of debt dynamics.

Extant literature has estimated fiscal reaction functions to identify the relationship between fiscal balance and the determinants of debt. In particular, most studies have specifically looked at whether the present primary surpluses can reduce the amount of future debt by using the fiscal reaction function (Burger et al., 2012; Celasun et al., 2006; Cevik & Teksoz, 2014). Other studies use the lagged primary balance as an additional explanatory variable to account for inertia in the primary balance (Afonso & Jalles, 2016; Burger et al., 2012; Paret, 2017). The majority of these empirics attempt to analyze data on the important factors that might be related to or influence policy decisions but neglect the causality between the variables. Accordingly, the following general specification for the Fiscal Reaction Function (FRF) in equation (1) has been commonly employed in the literature:

$$PB_{it} = a_0 + \alpha_1 PB_{it-1} + \alpha_2 D_{it-1} + \alpha_3 OG_{it} + \mu_i + u_{it} \quad (1)$$

where PB_{it-1} is the lagged primary balance ratio, D_{it-1} is the lagged public debt ratio, OG_{it} represents the output gap, μ_i is the country fixed effects and the error term while *i* and *t* represent the country and time respectively.

Accordingly, the prerequisite to a sustainable fiscal policy is a fiscal surplus (positive fiscal balance), which positively depends on public debt ratios. Government debt ratios have a positive impact on primary surplus, as shown by the ground-breaking study of Bohn (1998) and more recent studies by Greiner et al. (2007); Greiner and Fincke (2016); Kamiguchi and Tamai (2012)

The literature has no disagreements regarding the factors influencing debt sustainability analysis. However, when determining how to evaluate debt sustainability, there are differences in the Standard Debt Sustainability Analysis (DSA) used by the IMF, the World Bank, and in several empirical studies (Burger et al., 2012; Celasun et al., 2006; Debrun et al., 2006; Medeiros, 2012). The standard DSA is not stochastic and assumes that all countries will respond uniformly to changes in the macroeconomic environment. It is typically evaluated using baseline and risk scenarios that include a simple equation of debt developments that links the present value of debts to future debt-to-GDP ratios, fiscal balance, GDP growth, interest rates, and exchange rates (Akyüz, 2010).

According to Hostland and Karam (2006), Tanner and Samake (2008), and Kamiguchi and Tamai (2012), the sustainability of public debt is influenced by many interrelated factors, such as output volatility, financial fragility, negative shocks, endogenous risk premium, abrupt stops in private capital flows, and the exchange rate. Specifically, by considering the historical decomposition of public debts in Brazil, Mexico, and Turkey, Tanner and Samake (2008) showed that debt accumulation implies unsustainable policies and negative shocks. The study showed that a significant primary surplus is necessary to prevent the debt ratio from rising.

Additionally, the debt dynamics for countries that benefited from the Highly Indebted Poor Countries (HIPC) and Multilateral Debt Relief Initiative (MDRI) were also examined by Melou et al. (2014). The authors extended the stochastic approach to DSA to assess future debt paths for low-income countries. They found that countries with low debt levels recorded significant positive lags, whereas those with high debt levels above 50% of GDP had negative lags.

Again, Paret (2017) observed that the share of debt denominated in foreign currencies was not related to the origin of debt volatility caused by shocks to interest rates, real exchange rates, and growth, especially at higher levels. These findings suggest that strong fiscal responsiveness to debt drastically reduces debt ratios, especially for over-borrowed countries. Extensive evidence exists on debt sustainability analysis for developed countries (Ghosh et al., 2013; Greiner & Fincke, 2016; Greiner et al., 2007). But the literature is limited to developing and African countries for the deterministic sustainability analysis by IMF, UN, and other global organizations.

Many African countries are still struggling to adequately address their macroeconomic and fiscal imbalances. Therefore, key stakeholders are concerned about the persistent rise in government debt levels, budget deficits, and the fiscal fragilities of SSA countries. For instance, since 2010, the financial markets and reputable organizations have raised concerns about the stability of some African nations because of an increase in debt-to-GDP ratios and the issuance of sovereign bonds, a decrease in revenue mobilization levels, and a slowdown in economic growth (Herndon et al., 2014; Neck & Sturm, 2008; Reinhart & Rogoff, 2010). Unavoidably, Africa will need to develop a plan for achieving sustainable public finances (United Nations, 2015).

In light of efforts to determine the viability of public debt, our study adds to the body of knowledge by analyzing how public debt reactions have changed over time using various analytical methods. We present findings on the pattern of debt sustainability brought on by macroeconomic shock fluctuations and the responses of public debt to the fiscal balance under various models.

3. Methodology

3.1. Data sources and variables

An unbalanced panel data from 1980 to 2017 were used in this study. The World Development Indicators (WDI), World Economic Outlook (WEO), Worldwide Governance Indicators (WGI), and the Bank of Canada's Credit Rating Assessment Group (CRAG) database of sovereign defaults, as determined by data availability, were used to compile the dataset.

Primary Balance (PRBL) captures the general government's Cyclically Adjusted Balance (CAB) in this study. CAB is measured as the fiscal balance adjusted for the economic cycle effects, including movements in revenue, expenditure, and asset prices. General Government Gross Debt *(DEBT)* was measured using government debt liabilities (including loans, guarantees, accounts payables, and insurance) requiring principal and interest repayments at maturity. GDP Growth *(GDPG)* captures the growth of per capita real GDP at which an economy grows. The Real Interest Rate (*RIR)* represents the domestic lending interest rate adjusted by inflation. *RIR* is measured by the GDP deflator of a country. Exchange Rates (OEXR) measure a nation's exchange rate as set by its government or a recognized exchange market. The average of the local currency unit to the US dollar is used to calculate it. *DLIR* measures the average domestic lending interest rates on new external debt commitments. Debt Default (DTDF) is a US dollar-valued index that tracks the stock of government liabilities in default, including bonds and other marketable securities, bank loans, and defaulted official loans. According to the CRAG, a sovereign default occurs when a party to a contract fails to fulfill their commitment to pay interest or principle in full by the deadline. An indicator variable that assumes a value of 1 in episodes of default was used to measure DTDF. Trade (TRDE) stands for trade openness, measured as the aggregate change in the volume of goods and services exported and imported as a percentage of a country's GDP over time. Inflation (*INFL*) is an annual % change in the cost of goods and services. Output Gap (*OGAP)* represents the difference between actual output and the expected potential output of an economy. *OGAP* was measured as the percentage of actual GDP minus the % potential GDP divided by the % potential GDP. This study uses the Hodrick-Prescott (HP) Filter data-smoothing method to estimate OGAP using GDP growth.

3.2. Model specification

In line with the relevant literature, this study assumes the standard FRF by Celasun et al. (2006) and Paret (2017). The model explains how the primary balance reacts to changes in the key factors that influence public debt dynamics. Equation 2 adds the lags to account for the inertia in the primary balance and the debt-to-GDP (Burger et al., 2012; Cevik & Teksoz, 2014).

$$pb_{it} = \alpha_0 + \alpha_1 pb_{it-1} + \alpha_2 d_{it-1} + \alpha_3 ogap_{it} + \mu_i + \varepsilon_{it} \tag{2}$$

where: pb_{it} is the ratio of primary balance to GDP in the country*i* at year *t*, d_{it-1} is the public debt to GDP ratio observed at the end of year $t-1$, $ogap_{it}$ is the current output gap in country *i* at year *t*, μ_i is an unobserved country-specific fixed effect, and ε_{it} is the error term. The Instrumental variable technique was employed to estimate the FRF (Epstein, 1989). Because there are endogenous variables in this study, IV estimation is used to correct any potential correlation that could result from "reverse" causality, omitted variables bias (spuriousness), confounding variables (extra unaccounted variables), simultaneity, and non-random measurement errors of the explanatory variables (Sargan, 1958).

Building on the research of Chernozhukov and Hansen (2006) and Chernozhukov and Hansen (2008) on the IV model of quantile treatment effects and inference for structural models, this study employs the Instrumental Variable Quantile Regression (IVQR), which is equivalent to the 2SLS estimation effects, to correct any additional bias in the presence of endogeneity and heterogeneity treatment effects. Using quantile regressions (QR) in the FRF is expected to account for variations in the effects of debt accumulation and output gap under higher debt-to-GDP ratios, output gap cyclicality, and fiscal policy, respectively. Besides, QR estimates are more resistant to

outliers, the regressand measurement, various estimations of the central tendency (averages), and statistical dispersion (Koenker, 2005). Furthermore, QR allows for a meaningful, thorough study of the relationships between the variables (Koenker, 2005, pp. 146–7).

The FRF is estimated using Ordinary Least Square (Graybill, 1976), QR, and the system GMM for comparisons (Hansen, 2010; Koenker, 2017). Since d_{it-1} may be connected with a country fixed effects u_i, and the $ogap_{it}$ may also be correlated with the fiscal policy shocksε_{it}, the system GMM estimator of Arellano and Bover (1995) is used to correct any potential endogeneity problems.

The methodology's second stage requires identifying historical linkages between the debt ratios and other macroeconomic variables. This is achieved by estimating a Panel Vector Autoregressive Model (PVAR). The IMF and World Bank use standard deterministic DSA to assess various countries' debt sustainability. However, the deterministic bound-testing approach of DSA has major drawbacks of ignoring endogeneity issues. Likewise, shock patterns and co-movements among the determinants of debt dynamics are usually observed in economies. The PVAR model with the exogenous covariate model corrects for the endogeneity and co-movements among the determinants. The model derives all its main merits from the VAR models by treating variables as endogenous, as well as an added advantage of the models' ability and flexibility in incorporating true exogenous variables which affect the debt dynamics. In addition, PVAR models help analyze the impact of innovations since they permit variable interactions that result in dynamic deductions that are not possible with other typical models (Li et al., 2012). This study employs PVAR for the debt sustainability analysis due to its advantages in handling short-time dimensions brought on by the additional degrees of freedom from the addition of cross-sections; its capacity to include country-specific fixed effects and global time-invariant effects; and its advantage in displaying delayed effects of variables in the system using impulse response functions (Reed & Ye, 2011). Brooks (2019) suggested that we specify the general PVAR equation with exogenous factors in equation 3 as follows.

$$Y_{it} = \alpha_i + \Sigma_{j=1}^{p}\alpha_j Y_{it-j} + \Sigma_{k=1}^{q}\beta_k X_{it} + u_{it} \tag{3}$$

Given that debt sustainability must be based on the path of policy variables, variables such as primary balance, interest rates, growth rates, exchange rates, external factors, and other risk factors are considered for this analysis. Y_{it} and Y_{it-j} represent the vector of the current value and its previous values of the explained and explanatory endogenous variables respectively, X_{it} are K × 1 vectors of exogenous variables common to all countries. The Y_{it} in this study is a vector of real effective exchange rates, external or foreign lending interest rates, real interest rates, and GDP growth. Theα_i captures all the country's specific intercept term and fixed effects,$i = 1\ldots,N$ over $t = 1\ldots,T$ and u_{it} is a k ×1vector of random disturbance term. Policy decisions on macroeconomic variables largely determine the primary balance. A challenge faced by the impacts of macroeconomic variables on the primary balance is the endogeneity problem. This problem of dynamic interdependence is mitigated in this study using the PVAR estimation technique. The PVAR has the distinctive features of controlling for (a) *dynamic interdependencies* – which are accounted for by the incorporation of the lagged values of the endogenous variables; (b) *static interdependences* – where u_{it} are permitted to be correlated with the cross-sectional dimension *i*; and (c) cross-sectional heterogeneity—where the intercept, slope parameters, and variances of the shocks are allowed to vary across countries. We chose the best lag order for the PVAR analysis using the Schwarz information criteria.

4. Results and discussion

The descriptive statistics for each variable used in the debt sustainability analysis are shown in Table 2 below. Overall, the sample's average debt-to-GDP ratio is 73%, with minimum and maximum values of 0.07% and 495.20%, respectively. The debt to GDP ratio's standard deviation was around 63%. The high ratio of debt to trade demonstrates how significant public debt

Table 2. Descriptive statistics

Variable Name	Obs	Mean	SD	Min	Max
PRBL	1065	−5.431	29.289	−557.499	125.135
DEBT	883	73.836	63.681	0.070	495.201
OGAP	1564	0.115	65.982	−1231.097	1421.608
RIR	890	9.354	49.534	−93.514	1158.026
DLIR	920	21.929	49.028	4.737	1175.000
GDPG	1550	3.972	7.320	−52.428	149.973
OEXR	1630	4.120	1.660	0.000	6.720
DTDF	1407	.627	.484	0.000	1.000
TRDE	1431	65.852	33.531	6.320	311.354
INFL	1304	19.211	145.672	−17.640	4145.106

is as a source of funding in SSA. This suggests that public debts must be effectively managed and directed to boost GDP growth above the average rate of 3.9%, improve the primary balance, reduce the impact of debt on growth, and draw investors to Africa.

We performed a panel unit root test given the panel data structure of our dataset. This helped to determine the stationarity properties of the variables under investigation and also to account for cross-sectional heterogeneity and temporal dependencies appropriately. The Fisher Panel Unit Root Test was performed, which combines the p-values obtained from individual ADF tests performed on each cross-sectional unit. The basic idea is to exploit the additional information available in the panel data by pooling the test statistics and then calculating the Fisher-type statistic under the null hypothesis of a unit root (non-stationary). This combined statistic follows a non-standard distribution, which has been extensively tabulated and is used to derive critical values for assessing the presence of unit roots. The results of Table 3 show that the model variables are stationary. This guarantees that cross-sectional heterogeneity and serial correlation have been controlled, thereby leading to more efficient estimates of the parameters.

Table 3. Fisher panel unit root test

	Fisher Panel Unit Root Test			
Variable	*P* - Inverse chi-squared	Z – Inverse Normal	L – Inverse Logit	Pm – Modified Inverse chi-squared
DEBT	252.1558 (0.0000)	−10.1790 (0.0000)	−10.4865 (0.0000)	13.2869 (0.0000)
PRBL	487.4171 (0.0000)	−16.3939 (0.0000)	−20.6749 (0.0000)	31.1243 (0.0000)
DLIR	193.1977 0.0000	−7.2683 0.0000	−7.5250 (0.0000)	9.2232 (0.0000)
OEXR	131.7821 (0.0017)	1.8239 (0.9659)	2.9105 (0.9980)	3.3002 (0.0005)
RIR	498.9546 0.0000	−16.6503 0.0000	−22.0097 0.0000	36.2533 0.0000
GDPG	1022.3197 (0.0000)	−27.6032 (0.0000)	−42.5769 (0.0000)	70.4270 (0.0000)

Panel Unit Root Test. P-values are in parenthesis.

4.1. The fiscal reaction function

The estimates for equation (1)'s fiscal reaction functions for OLS, SGMM, and IV panel data are shown in Table 4. The FRF defines how the main balance will respond to changes in debt, output gap, and other factors that affect debt dynamics.

Table 4 shows that the lagged primary balance (α_1), represented in our model specification, is positive and statistically significant in all the estimation methods. This result lends credence to the view that primary balance is typically constant. This finding is supported by empirical research on developing economies done by Burger et al. (2012), Cevik and Teksoz (2014), and Paret (2017).

The sign and significance of the lagged debt-to-GDP ratio coefficient (α_2) are unknown and deviate from the estimates of some related studies in the literature. This demonstrates that the primary balance of SSA countries is not fully responsive to debts, indicating that the impact of public debt on the primary balance is limited and less resistant to different estimating methodologies. With the OLS estimation, the results are positive but not statistically significant; with the IV estimates, the results are positive and statistically significant at 10%; and with the SGMM estimates, they are negative but insignificant.

Similarly, the IV estimation shows that the output gap (α_3) coefficient's sign is positive and significant, indicating that the output gap is procyclical. However, this result is not robust under the other estimation techniques, making it difficult to conclude the cyclicality of the fiscal policy. Some prior empirical findings between the primary balance and output gap led to the perception of probable heterogeneous behaviors. For instance, Burger et al. (2012) and Celasun et al. (2006) reported positive coefficients, but Budina and Van Wijnbergen (2009) also found negligible coefficients. Mupunga and Le Roux (2015) recorded negative coefficients. These estimates may have been produced due to the variables' potentially different behaviors compared to the QR output in Table 5.

4.2. Estimations using quantile regression

Tables 5 and 6 display the results of QR and IVQR estimations. The instruments were selected based on the studies of Chernozhukov and Hansen (2006) and Chernozhukov and Hansen (2008).

A glance at both quantile regression results shows minimal variations among the coefficients. The lagged *pb* (α_1) appears persistent at the lowest quantile of 25% and converges at higher quantiles, as the coefficients are less than one. The reductions in the coefficient estimates indicate that African governments only start paying attention to their primary balances when they are

Table 4. FRF of the Primary Balance (PB) on debt and output gap

	OLS	IV	SGMM
LPB	1.171*** (0.000)	1.056*** (0.000)	0.397*** (0.000)
LDEBT	0.0189 (0.186)	0.012** (0.043)	−0.001 (0.889)
OGAP	0.001 (0.573)	0.026*** (0.000)	−0.240 (0.270)
_cons	−1.221** (0.025)	−0.893*** (0.001)	−1.708*** (0.000)
N	765	578	518
R-Squared	0.6928		

*p-values in parentheses, * p < 0.1, ** p < 0.05, *** p < 0.01. Note: The estimations methods in* Table 4 *include country dummies and are robust to heteroskedasticity. T-statistic are in parentheses, and R-squared is reported when available. We use the appropriate lags of the endogenous variable as instruments.*

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Table 5. QR of the fiscal reaction functions on the primary balance

Quantile Regressions

	QR1 (0.25)	QR2 (0.50)	QR3 (0.75)
LPB	0.964*** (0.000)	0.846*** (0.000)	0.751*** (0.000)
LDebt	0.001 (0.539)	0.003** (0.033)	0.004 (0.170)
OGAP	−0.001 (0.556)	−0.001 (0.635)	0.000 (0.770)
_cons	−1.666*** (0.000)	−0.771*** (0.000)	0.397** (0.045)
N	765	765	765

p-values in parentheses - * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 6. IVQR of the fiscal reaction function on the primary balance

	IVQR (0.25)	IVQR (0.50)	IVQR (0.75)
LPB	1.058***	0.812***	0.763***
	(0.000)	(0.000)	(0.000)
LDEBT	0.008**	0.006***	0.008***
	(0.014)	(0.000)	(0.000)
OGAP	0.000	0.006***	−0.001***
	(0.696)	(0.000)	(0.000)
_cons	−1.961***	−0.994***	0.213***
	(0.000)	(0.000)	(0.000)
N	765	765	765

p-values in parentheses - * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. *All the estimations in* Table 6 *include country dummies and are robust to heteroskedasticity. The estimations correspond to the 25th, 50th, and 75th percentile.*

above the 25th percentile. This suggests that SSA countries show greater policy concern only at higher levels of their primary balances.

The lagged debt coefficient (α_2) from the QR results indicates a varying pattern in the debts' responses to the primary balance's fluctuating trend. This possibly reflects an episode of fiscal fatigue[2]; as the quartile increases, it reaches it's optimum and requires drastic measures to be reduced. However, the IVQR estimates are positively significant in all the quantiles suggesting that SSA countries' fiscal policy is responsive to debt. This pattern demonstrates that the government relaxes its main balance when public debt declines and tightens its budget when the debt ratio rises, as observed by Bohn (1998).

The output gap outcomes are quite mixed. For instance, the output gap coefficients (α_3) show a pattern that suggests fiscal policy reaction to changes in the output gap is procyclical and countercyclical at a specific level of primary balance. At the lower level, the impact of the output gap is insignificant with the QR estimates. Considering the IVQR estimates, however, when the model is corrected for endogeneity, the output gap becomes significant at 1% above the 50^{th} quantile of the *PB*, suggesting fiscal policy is procyclical. This position leads to more pronounced booms and busts in economic activities between the 50^{th} and 75^{th} percentile of the output gap. Beyond the 75^{th} quantile, the output gap has a significant countercyclical effect suggesting that the output gap moves in the opposite direction from the primary balance. This helps to stabilize

the economy and increase employment during economic downturns. However, countercyclicality also has fiscal policy challenges, which can lead policymakers to implement contractionary fiscal measures such as reducing spending or increasing taxes to curb inflationary pressures and prevent overheating of the economy (Arrow & Kruz, 2013).

Some research supports the literature's assertion that most economies have rational budget responsiveness, consistent with the FRF's conclusions. Accordingly, depending on the primary balance's sign, some countries exhibit a strong primary balance response to debt increases (Bergman & Hutchison, 2015; Budina & Van Wijnbergen, 2009); others exhibit a weak primary balance fiscal response (Burger et al., 2012); and some find a broadly negative primary balance response to high debt ratios (Ghosh et al., 2013). The findings generally align with the idea that fiscal policy is cyclical and depends on how it responds to changes in the debt ratio and primary balance when they occur (Bohn, 1998; Ghosh et al., 2013; Icaza, 2018).

4.3. Analysis and discussion of PVARX results

This section presents and explains the diagnostic techniques required for the PVAR analysis. The endogenous macroeconomic variables in the debt dynamics model are simulated using the VAR as in Equation 3.

4.3.1. Lag order selection criteria

The VAR model selection criteria are fundamental and the starting point for determining unbiased estimates. The panel VAR model's dynamics are guaranteed to be properly accounted for by selecting the right lag length. This study selects two criteria out of the three methods to determine this study's lag length, as shown in Table 7.

In Table 7, the SIC and HQIC favor a lag length of one (1) against the lag length of six (6), as indicated by the AIC estimates. It is usual for the various SOC methods to produce conflicting optimal lag lengths. The study chooses a lag length of one (1) for this model based on the lowest lag length for parsimony and majority decision.

4.3.2. Granger causality or block exogeneity wald test

Table 8 displays the Granger Causality Test, which shows the causal relationship between and among the variables in the PVAR model.

In column 2 of Table 8, the primary balance granger causes debt. By inference, the result establishes a bidirectional causal relationship between primary balance and debt. Also, in columns three and four, lending interest rates and official exchange rates granger cause real interest rates

Table 7. VAR Selection Order Criteria (SOC)

VAR Lag Order Selection Criteria			
Lag	**AIC**	**SIC**	**HQIC**
0	48.93441	49.24202	49.05902
1	44.28152	45.20436*	44.65535*
2	44.30575	45.84381	44.92879
3	44.27821	46.43150	45.15047
4	44.02972	46.79824	45.15121
5	43.78401	47.16775	45.15471
6	43.76442*	47.76339	45.38434

*Indicates lag order selected by the criterion, Akaike information criterion (AIC), Schwarz information criterion (SIC), and Hannan-Quinn information criterion (HQIC).

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Table 8. Granger causality/block exogeneity test

Excluded	DEBT	PRBL	DLIR	OEXR	RIR	GDPG
DEBT	NA	3.278* (.0702)	0.691 (0.4057)	0.655 (0.4182)	0.087 (0.7674)	.530 (.4665)
PRBL	13.854*** (0.0002)	NA	0.277 (0.5982)	0.627 (0.4282)	0.533 (0.4652)	.529 (.4667)
DLIR	0.209 (0.647)	.372 (.542)	NA	0.609 (0.4351)	123.36*** (0.0000)	11.773*** (.0006)
OEXR	0.005 (0.9415)	.063 (.8022)	3.099* (0.0783)	NA	0.004 (0.947)	.163 (.6859)
RIR	0.198 (0.6561)	1.282 (.2575)	13.433*** (0.0002)	4.602** (0.0319)	NA	4.108** (.0427)
GDPG	2.294 (0.1299)	2.661 (.1028)	10.177*** (0.0014)	7.428*** (0.0064)	1.385 (0.2392)	NA
ALL	17.449*** (0.0037)	1.446* (.0635)	29.627*** (0.0000)	14.539** (0.0126)	128.92*** (0.0000)	15.118*** (.0099)
OBS	325	325	325	325	325	325

and GDP growth, respectively. GDP growth has a unidirectional causal relationship between lending and real interest rates. Overall, a causal relationship exists among all the variables as indicated by the high significance level of combined (ALL) results in the last row. The causal connections between the variables and the panel VAR stability test presented in Figure 1 below provide the reliability of the Panel VAR model applied in this study.

4.3.3. Stability test

In this study, the inverse roots of the AR characteristic polynomial were used to assess the stability of the VAR model. Typically, the VAR model is considered stationary if all roots have a modulus of less than one and are located inside the unit circle. Failure of the stationary test will result in inaccurate inferences due to incorrect estimates of the impulse response function and standard errors.

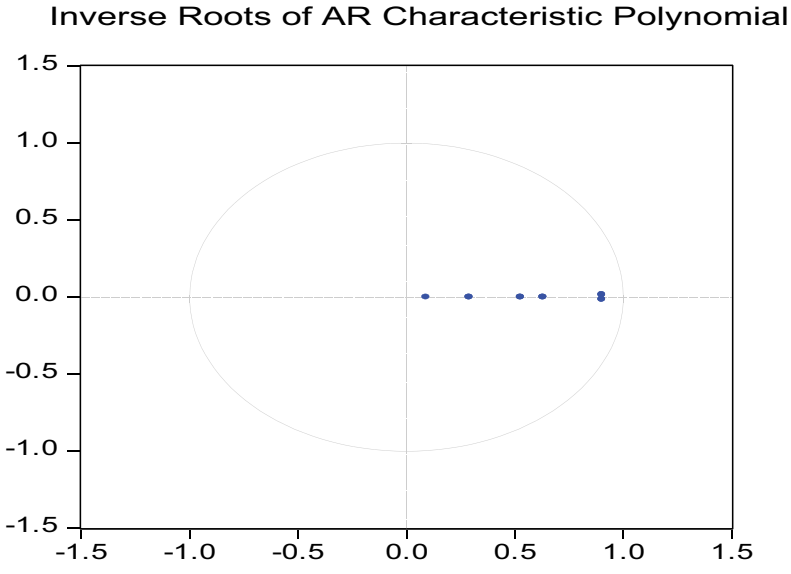

Figure 1. Stability test of the VAR model.

From Figure 1, the stationarity test demonstrates that the entire system's modulus lies within the unit root circle. This demonstrates the model's stability and shows why it is the best choice for estimating impulse response functions since system shocks will eventually converge.

4.3.4. Impulse Response Function (IRF)

The impulse responses are determined with the use of the Cholesky decomposition. This variance decomposition method is a structural decomposition framework that allows us to identify the underlying structural shocks that drive the dynamics and the causal relationship of the variables in the model. This study assumes that the variables' current values enter the model for subsequent variables in the order provided by performing Cholesky decomposition in the following order: *DEBT* → *PRBL* → *DLIR* → *OEXR* → *RIR* → *GDPG*. In this case, the current values of debt to GDP, primary balance to GDP, domestic lending interest rate, official exchange rate, and real interest rate can only enter the model for GDP growth rate.

The order presented above is based on the premise that government debts are borrowed because they are running primary deficits, and as such, they have no funds for other spending. A share of these borrowed funds could be used for unproductive spending, which means that the repayments of such debts may not be sustainable, further leading to increases in the primary deficits. Higher primary deficits lead to extended borrowing at higher lending interest rates, further increasing the debts. The financing option will depend on several factors (including finance cost, debt capacity, duration, financial market, availability of funds, etc.), eventually leading to higher lending interest rates. Financing at higher lending rates will affect exchange rates, domestic or real interest rates, and GDP growth.

Figure 2 displays the orthogonal impulse response functions with dynamic effects on debt growth rates for an average of ten years following a unit SD shock to the other variables in the system. First, carefully examining the impulse response graph's links between public debt and the primary balance reveals a strong inverse bidirectional relationship between the two variables. The response of Debt to GDP to a unit positive SD shock to primary balance is negative over the ten years. The shock decreases the debt-to-GDP ratio by about 5% by the fourth year. Again, the cumulative effect on the debt-to-GDP ratio in ten years results in a reduction of almost 40%. This reduction in the accumulated impulse function suggests that the negative primary balance and the other endogenous variables contributed to the debt stock increase of about 120% over the ten years. Our finding supports the arguments made by some stakeholders in favor of increasing revenue mobilization, reducing government spending, and reducing borrowing to lessen the shock to public debts and primary deficits (Abbas et al., 2011).

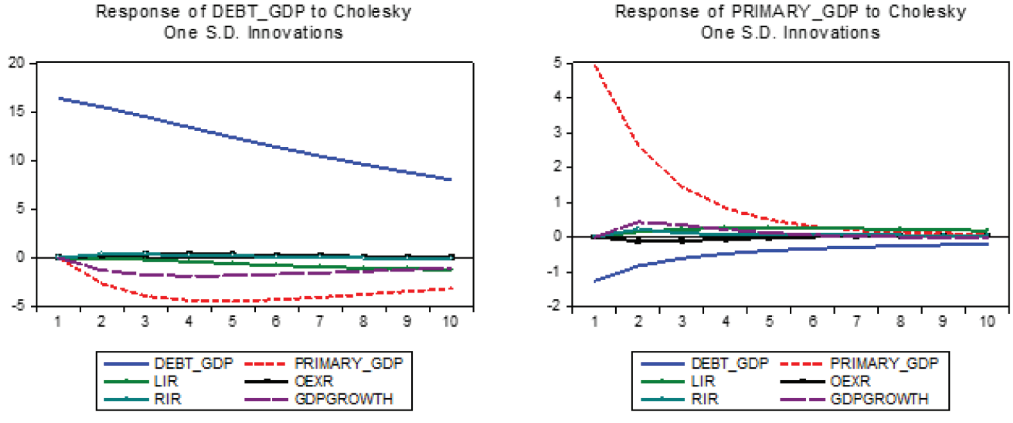

Figure 2. Combined effects of one standard deviation shock on each variable.

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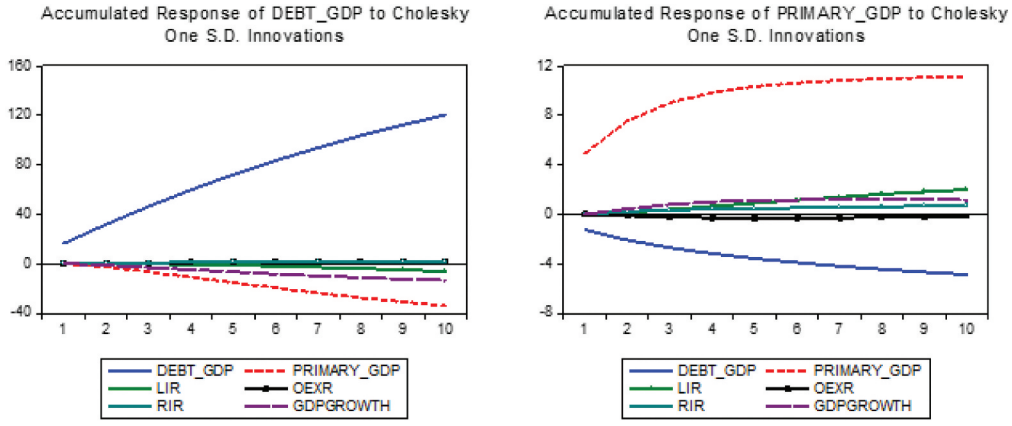
Figure 3. Cumulative responses to one SD innovations of the variables.



On the other hand, the response of the primary balance to a unit standard deviation shock to public debt also showed a negative impact that seems to persist for up to 7 years. A unit positive shock to the public debt leads to a 1.5% contemporaneous reduction in the primary balance. The cumulative impact of public debt on the primary balance was 27.5% over ten years.

Another observation is that GDP growth rates and public debt-to-GDP ratios exhibit a negative association, as shown by the impulse response function graph in Figure 2. Besides, over the six years, a unit positive shock to GDP reduces the debt ratio by 2%. Between years seven and ten, this effect is reduced to 1%. Figure 3 demonstrates that, over ten years, a percentage change in GDP growth rate cumulatively reduces the public debt ratio by around 14%. These findings are consistent with research on debt and economic growth done by Égert (2015), Herndon et al. (2014), and Woo and Kumar (2015).

This study examined public debts in line with theories of economics and the dynamics of debt. The critical source of threats to African countries is their inability to attain an ideal debt level due to weaknesses in their fiscal governance structures. Besides, the continent's fiscal mismanagement, which is largely caused by the global fiscal crises, ineffective fiscal policies (Allen & Giovannetti, 2011; Persson & Tabellini, 2000), a lack of institutional capacity, indiscipline, and negative attitudes that complicate the implementation of fiscal policies (Debrun et al., 2012; Lledó & Poplawski-Ribeiro, 2013), and an inadequate capacity of revenue mobilization (Mansour & Keen, 2009) all contributes to the soaring debts levels. Due to these problems, SSA countries are more susceptible to debt accumulation because they are compelled to borrow.

The findings on the unsustainable nature of public debt suggest that Africa requires a drastic fiscal management response. As suggested by Kopits and Symansky (1998), this will require the development of fiscal financial regulations to maintain public finances at a level that can be sustained. These regulations can correct some distortions, incentives, and desire to overspend by African governments given their low-income levels, worsening fiscal performance, and increasing debt and borrowing levels. Major changes in spending and debt levels are needed if extended borrowing and fiscal mismanagement are to be fully resolved. This study's inferences demonstrate that establishing fiscal laws and adapting fiscal governance can help African countries with their deficit and public debt issues (Nabieu et al., 2020).

5. Conclusion

This study sought to examine the effect of public debt on fiscal balance and perform a debt sustainability analysis in Sub-Saharan Africa over the 1987–2017 period. Knowing the potential effects of fiscal unsustainability is important for stakeholders in the context of persistent

challenging fiscal and monetary policies, currency fluctuations, and rising public debt financing for many developing countries. This study's analysis has demonstrated that the policies chosen will determine whether debt sustainability is achieved. Therefore, a government's decision to choose a reduced range of public debts is heavily influenced by the primary balances, GDP growth rates, and the specific fiscal strategy adopted.

The study employed Ordinary Least Squares, Quantile Regression, Instrumental variable Quantile regression, system GMM, and Vector Auto Regressions. The OLS and system GMM results revealed no effect of public debt on fiscal balance. The results from the quantile regressions show that while public debt has a statistically significant effect on the primary balance, the output gap's effect depends on the fiscal balance level.

The impulse reaction function of debts to a unit shock in the endogenous variables in the SSA countries has shown that the same scheme affects all the other countries. This results pattern is not solely caused by variation of macroeconomic shock as presented in the VAR estimations but also by the fiscal reaction functions of the countries over time. Overall, the sustainability of public debts in Africa hinges on managing the primary balance and gross domestic product growth rates. The results show that the impact of real exchange and lending rates is relatively negligible in solving Africa's debt sustainability problems. This study's analysis has demonstrated that the policies chosen will determine whether debt sustainability is achieved. Therefore, a government's decision to choose a reduced range of public debts is heavily influenced by the primary balances, GDP growth rates, and the specific fiscal strategy adopted.

Our results suggest some policy recommendations for SSA nations' debt sustainability. First, fiscal policies should be proactive enough to stop the debt ratios of most countries from increasing. For instance, if a country's primary balance reaction to debt is low with a weak fiscal consolidation record, the countercyclical fiscal policy during a recession could cause the debt to worsen further. Second, given the size of the public debt in SSA countries, PVAR research is constantly needed to pinpoint the precise macroeconomic reasons that make these countries' debt unsustainable and need prompt relief. Finally, our results indicate that a strong fiscal reaction to public debts is required to lower debt-to-GDP ratios.

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Notes
1. https://www.imf.org/. . ./Regional-Economic-Outlook-April-2014-Sub-Saharan-Africa.
2. A situation in which extremely high debt ratios do not react to changes in the primary balance through fiscal policy (Ghosh et al., 2013; Icaza, 2018).

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