External public debt and economic growth relationship: Evidence from developing Sub-Saharan African countries, 1980–2018

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This study empirically evaluates external public debt and economic growth relationships in the Sub-Saharan African region; it anchors on the classical, neoclassical, and Keynesian economic growth theories. Given the lack of consensus amongst researchers from different countries, several research outputs on external public debt have yielded conflicting results. Based on the World Development Indicators (WDI) panel dataset for 1980–2018, this study applies Autoregressive Distributed Lagged Model (ARDL) using balanced cross-sectional panels. The study makes a novel contribution using vector autoregression (VAR), impulse response functions (IRF), and variance decomposition to show the impact of external public debt innovation shocks on economic growth. The findings of this study support classical economists and Keynesian conflicting views on economic growth and the external public debt relationship. The results reveal a positive and statistically significant long-run relationship between external public debt and economic growth in the countries studied. A positive short-run and negative long-run relationship between economic growth and external public debt are observed in Kenya and Nigeria. These findings are consistent with the classical economist's stance, suggesting that public debt hampers economic growth. Conversely, Keynesian propositions are confirmed in Malawi, Botswana, and Lesotho, where external public debt has a negative short-run and positive long-run impact on economic growth. Most of these countries responded differently in terms of growth, which may be

Regional Statistics, Vol. 13. No. 5. 2023: 824–862; DOI: 10.15196/ RS130503

Keywords:
external public debt,
economic growth,
ARDL,
VAR,
Sub-Saharan Africa

attributed to the differences in financial deepening, quality of institutions governing fiscal and monetary policies, and trade openness. This study's empirical results imply that policymakers should focus on a stable fiscal and monetary policy framework. This is possible by ensuring debt sustainability with a sound and secure macroeconomic policy environment in the selected countries.

Introduction

The world economy has experienced recurring debt build-up over the last 50 years, affecting both low-income countries and emerging markets. In 2018, global debt reached an all-time high of nearly 230 per cent of the world's gross domestic product (GDP), another surge since the global financial crisis (Kose et al. 2019). In recent years, the Sub-Saharan Africa region has enhanced development initiatives, which has resulted in a sharp growth in external public debt, putting significant strain on the region's macroeconomic policy framework. In 2021, the debt-to-GDP ratio of several Sub-Saharan African countries crossed the debt sustainability threshold (IMF 2021). This was mostly attributed to the increased debt appetite among African governments to borrow credit for belt and road infrastructure development initiatives, for example, roads, railways, ports, sewer systems, urban lighting, and developments associated with modern economic growth. Given the poorer growth prospects, limited budgetary headroom, and higher refinancing risks resulting from short-term public debt, emerging economies, and developing nations are facing difficult development challenges. Most of these nations are facing macroeconomic structural rigidities because they have insufficient revenue to finance their development priorities. Moreover, their tax revenue, as a share of GDP, is low compared to that of emerging and developed economies. Additionally, it is important to note that the exports of most countries in the region are insufficient, prompting them to turn to external sources of finance, such as multilateral and bilateral arrangements, to finance their development priorities. The last decade has seen a surge in Eurobonds in the region because many countries have turned to the east and west to fund their development deficits. The situation is getting worse, particularly with the emergence of the global COVID-19 health crisis more than two years ago. Several countries in the region have implemented cash transfer programmes to aid vulnerable households, businesses, health and hospitality industries, and the tourism sector affected by the pandemic. Given the economic slowdown caused by the pandemic, the affected major sectors have seen unprecedented fiscal deficits. Moreover, spending is increasing, and tax revenues are falling. Therefore, most countries are looking overseas to finance their development deficit. This study was motivated by the widespread concern about Sub-

Saharan Africa's profligacy and fears that unprecedented public debt is on a dangerously unsustainable path because of the massive road and belt infrastructure development initiatives across the region.

This study confirms and proposes alternative arguments on classical, neoclassical, Keynesian, and neo-liberal economists' propositions on the impact of public debt on economic growth. As part of our novel approach, two aspects relate to the modelling of economic growth relationships that are common or different across countries. First, this study applies an Autoregressive Distributed Lagged Model (ARDL) to analyse the external public debt–economic growth relationship across all the five selected Sub-Saharan African (SSA) countries. Second, the study employs vector autoregression (VAR), impulse response functions (IRF), and variance decomposition to analyse shocks arising from external public debt and other macroeconomic variables, along with their impact on economic growth. This study applies IRF and variance decomposition to graphically demonstrate the size of the shift in fiscal impulse through external public debt. This may help policy analysts to establish how much the fiscal policy adds to or subtracts from economic growth. IRF and variance decomposition may enable policy analysts to study the magnitude and direction of fiscal policy and make future projections to determine when to add economic stimulus to the economy. This research aids the region's fiscal and monetary policy experts in adopting prudent macroeconomic policies. The study recommends a macroeconomic policy climate that influences the private sector's confidence to invest in the SSA region. Furthermore, we prove how external public debt influences economic growth under different macroeconomic structural orientations using data from five developing African economies. Consequently, we identify several policy interventions that these SSA economies could employ to change their economic, financial, and trade architecture in the presence of public debt to spur economic growth.

Literature review

Theoretical literature review

To theorise public debt and economic growth dynamics, a theoretic framework proposed by classical, neo-classical, and Keynesian economic schools of thought is employed to explain the nexus between external public debt and economic growth. According to the classical economic paradigm, domestic government borrowing causes liquidity problems and interest rate hikes, which hinders private investment (Mankiw 2000, Modigliani 1961). They have further suggested that debt-financed government spending does not entirely offset the negative impact of crowding-out private investment, culminating in an economic disaster (Domar 1944). Classical economists criticised government borrowing for distorting private capital from its

productive role to non-productive uses, hampering capital accumulation and the overall growth of the economy. The theory explains that indebtedness impedes a nation's natural march towards riches and prosperity. It diverts resources that would otherwise go to productive uses in the private sector to fund the state's wasteful expenditure, wasting the possibility of future reproduction. In an extremely indebted economy, crowding-out effects are likely to arise from high real interest rates, deteriorating trade, and the unavailability of external credit markets. Furthermore, the crowding-out effect reduces a nation's ability to retain debt, resulting in little money for domestic investments when struggling to meet prior commitments (Patenio–Agustina 2007). A decrease in investment is caused by decreased resources available to finance investment and macroeconomic activities (Claessens et al. 1996). Krugman (1988) has described the negative relationship between external public debt and economic growth as a 'debt overhang,' which occurs when the repayment potential of outstanding facilities falls below their signed value. The theoretical case for debt overhang has been supported by several scholars, such as Elbadawi et al. (1997), Chowdhury (2001), Greene–Villanueva (1991), and Sachs (1988).

The Keynesian ideology modifies the classists' highly liberal assumptions and ideas. The Keynesian theory places a high value on the state, which is not condemned for its interventions in the economy and society. It is also called upon to complement the market's activities and remedy its flaws. In terms of the economic implications of public debt, the Keynesian viewpoint significantly differs from that of classical economists because public borrowing is no longer blamed for its negative consequences. Instead, according to Keynesians, debt-financed public sector expenditure has a crowding-in effect, resulting in a positive multiplier impact on growth (Elmendorf–Mankiw 1999). In the Neoclassical growth environment, Diamond (1965) has contended that public debt boosts economic growth, but Saint-Paul (1992) and Modigliani (1961) have argued that public debt reduces growth in an endogenous growth setting. Moreover, the standard neoclassical model suggests that debt boosts transitional growth because it considers capital mobility and flexibility of borrowing and lending from foreign sources. For nations with limited capital, external borrowing and investing is more attractive because the marginal product of capital is higher in developing countries than in high-income countries (Pattillo et al. 2002). The findings of many research studies have suggested that developing countries that borrow externally within sustainable limits have a greater chance of increasing their economic growth (Wang 2009). Economic growth is attributed to capital accumulation and increasing factor productivity (Hameed et al. 2008). In developing economies, capital is scarce, so foreign loans intended for investment are particularly encouraged when they generate a higher return than their financing costs (Pattillo et al. 2004).

Neo-liberal economists contend that the primary reason for opposing state indebtedness stems from the creation of an adverse effect known as the 'crowding-

out effect,' which is when public authorities use public loans to compensate the budget shortfalls. When it comes to the market for loanable funds, the crowding-out effect posits that when public bodies are in debt, the demand for loanable funds rises. Simultaneously, the offer stays unchanged, increasing the interest rate in the market. This subsequently affects private investment, which is sensitive to interest rate changes. Therefore, private capital funds 'flee' to the public sector to finance public expenditure. Overall, the monetarists have underlined that, in this manner, the predicted beneficial effect on GDP growth caused by encouraging debt-financed budget deficits may become very modest, if not zero. Moreover, Borensztein (1990) has identified debt overhang and credit rationing as two ways external debt might affect investment. Edo (2002) also confirmed the crowding out theory, using Morocco and Nigeria as case studies to analyse the foreign borrowing issues faced by African countries. In their study of the Nigerian economy, Ashinze–Onwioduokit (1996) confirmed the crowding out effect using macroeconomic modelling.

Empirical literature review

This study emphasises on external public debt literature in developing, emerging, and developed economies. Moreover, it evaluates literature that applies panel and time-series data, VAR, and ARDL to evaluate external public debt dynamics. Several scholars have endeavoured to study external public debt from different macroeconomic perspectives. Guei (2019) have found no robust effect of external public debt on economic growth but observed a negative short-run effect in emerging economies. Zouhaier–Fatma (2014) have observed the negative impact of external public debt on economic growth by examining nineteen developing countries. Chiu–Lee (2017) have incorporated political and financial risk factors while analysing external public debt and economic growth nexus. They observed that external public debt responds positively with minimal risk factors and negatively in a risky political and financial environment. Bélanger (2021) has examined a theoretical review of the external public debt and economic growth relationships in a monetary union framework and discovered no explicit and clear response between the two factors. Mohsin et al. (2021) have considered the South Asian region using fixed effects, quartile regression, and panel ordinary least squares method. The study found that external public debt negatively affects economic growth in the South Asian region. Similarly, Babu et al. (2014) have studied external public debt and economic growth relationships in the East Africa Community (EAC), employing a panel dataset from 1970 and 2010 and a panel fixed-effects model. According to the study, external debt negatively affects economic growth in the EAC, which suggests that governments should reduce their reliance on external public debt to stimulate economic growth. Hassan–Meyer (2021) have examined the transmission channels between external public debt and economic growth nexus across 30 SSA countries. A non-linear relationship between economic growth and external public debt is revealed by the

generalised method of moment (GMM) estimation model. Among the factors contributing to this effect were total factor productivity, private investment, and public investment. Udoh–Rafik (2017) have focused on the drivers and transmission mechanisms of external public debt in Malaysia for the period covering from 1970 to 2013. The results suggested a negative relationship between economic growth and external public debt. Siddique et al. (2016) have evaluated the influence of external public debt on economic growth across 40 highly indebted poor countries (HIPC) economies. According to the study, external public debt has a positive impact on short-term economic growth but a negative and statistically significant impact on long-term growth.

Using the VAR model, Jurčić et al. (2012) have investigated the interdependence of the factors that caused the sharp rise in Croatian external debt. The results suggested that budget deficits and current account were the most significant variables, while real Kuna exchange rates and interest rate differentials were not significant in explaining external public debt variability. Hurić-Bjelan–Hadžiahmetović (2020) have analysed external public debt dynamics in Bosnia and Herzegovina using the VAR approach. Their results show that a growing foreign-trade deficit has been the leading driver of the country's indebtedness, while movements in EURIBOR rates do not explain this variability very well. Consistent with this argument, Onafowora–Owoye (2019) have used variance decomposition to show that IRF and structural vector autoregressive model (SVAR) affect the relationship between external public debt and economic growth in Nigeria. The study revealed that external public debt, investment, and economic growth are negatively correlated. Additionally, they found that while external public debt innovations positively affected inflation, the exchange rate had a minor impact and trade openness had a negative effect. Moreover, Qureshi–Liaqat (2020) used a panel of 123 upper-middle and lower-income nations and World Bank data from 1990 to 2015 to investigate external public debt and economic growth nexus. The study used the panel vector autoregressive model (PVAR) and GMM framework to demonstrate a negative long-run relationship between the two variables. Using the ARDL model and panel data from ten Eurozone countries, Makun (2021) found a negative relationship between economic growth and external public debt using the ARDL methodology. The study further proved the imbalance between external public debt and economic growth. In addition to total factor productivity, the study demonstrated that exports play a vital role in the economic growth of the Fiji Islands. Klutse et al. (2022) have applied GMM and ridge regression to evaluate exchange rate market pressure (EMP) in the presence of imports and short-term external debts in Sub-Saharan Africa during 2002–2017. The study revealed a positive impact of short-term external debt and imports on EMP in the SSA region. Petrakos et al. (2021) examined political budget cycles and excessive deficit procedures in Greece using annual administrative data from 1987 to 2017. In the study, extensive electorally motivated cycles have been observed in Greece's economy, which are not

common in advanced economies. Furthermore, the study found that these pre-election fiscal policy manipulations were suppressed by corrective fiscal measures imposed by EU institutions in response to the Greek debt crisis.

Literature evaluation reveals that researchers have adopted different philosophical paradigms, estimation techniques, and methodologies and focused on developing, emerging, and developed economies. These approaches deviate from the vision of our study; first, we set out our research lens to explain external public debt and economic growth policy phenomena against a theoretical canvass proposed by classical, neo-classical, and Keynesian economic schools of thought. These three economic schools of thought have conflicting views on public debt and the economic growth nexus. Moreover, given the lack of consensus amongst researchers from different countries, several research outputs on public debt have yielded conflicting results. Our novelty will be to join the academic discourse to confirm, contribute, enrich, challenge, and propose alternative arguments on the role of external public debt on economic growth in the selected SSA countries.

Data description and methodology

This study applies the ARDL model to disentangle the long- and short-run relationship between real GDP and external public debt. In our analysis, the ARDL model gave the short-run association in every panel, which was instrumental in establishing a country-specific relationship between external public debt and economic growth that has been considered in this study. A simple ARDL (1,1) model is given by y_t equation, outlined below. In an ARDL model framework, explanatory variable y_t is explained by its past values y_{t-1} and the current and previous values of explanatory variables x_t and x_{t-1},respectively. This model allows determining the effects of a change in a policy variable. $y_t = m + \propto_1 y_{t-1} + \beta_0 x_t + \beta_1 x_{t-1} + \mu_t$. In the model y_t and x_t are stationary variables, and μ_t is white noise. A sequence of $\{\mu_t\}$ is a white noise process if each value has a zero mean, a constant variance, and are serially uncorrelated.

Econometric model specification and estimation techniques

This model is applied to five developing selected SSA countries, Nigeria, Kenya, Malawi, Botswana, and Lesotho. We show how real GDP responds to external public debt in an autoregressive process.

$$\Delta\, loggdp_t = \phi_0 + \sum_{i=0}^{p} \psi_i\, \Delta \mathrm{LogGDP}_{t-1} + \sum_{i=0}^{p} \phi_{i1}\, \Delta \mathrm{LogExPDT}_t + \sum_{i=0}^{p} \phi_{i2}\, \Delta \mathrm{LogExPDT}_{t-1} + \delta_1 \mathrm{GDP}_{t-1} + \delta_2 \mathrm{ExPDT}_t + \delta_3 \mathrm{ExPDT}_{t-1} + \delta_4 \mathrm{ECMt} + \mu_t$$

where ϕ_0, ψ_i, $\phi_{i1}, and\ \phi_{i2}$ are long-run parameter estimates; δ_1, δ_2,, and δ_3 are short-run parameter estimates of the model; GDPt is the real GDP, the explained

variable/proxy to economic growth; $EXPDT_t$ is the external public debt/explanatory variable. ECM_t is the error correction term/short-run disequilibrium speed of adjustment. If the government's foreign debt results in an external shock to the economy, it returns real GDP to a steady state equilibrium. μ_t is a stochastic/disturbance term or white noise residual used to take care of other factors affecting economic growth other than external public debt, Δ difference operator, (i) the lag indicator, and ($_t$) time trend covering the period from 1980 to 2018 for all the variables. Variables are log-transformed to take care of the linearity assumption of the classical regression model (CLRM) and reflect the elasticities of variables. The study tests the null hypothesis (H_0); thus, there is no significant relationship between external public debt and economic growth.

Data description

This study adopts panel data. Arellano–Bond (1991) have defined panel data as a cross-section of observations over a period. This method overcomes some of the limitations of strictly cross-sectional or time-series analyses. The ARDL model estimated in this study is based on two macroeconomic variables: real GDP, denoted by (*gdp*), and external public debt, denoted by (*expd*). Annual time-series data for these variables were obtained from the World Bank Development indicators database (World Bank 2021). All the variables are computed in millions of United States dollars (USD). The variables were collected between 1980–2018. The study relied on World Bank data because they were assessed by the regulatory authorities and forwarded to World Bank for publication. Data were checked for stationarity using Levin, Lin, and Chu test, Breitung, LM, Pesaran and Shin, Augmented Dickey–Fuller (ADF) and PP Fisher Chi-square, and ADF–Fisher PP Chi-square test. The unit root tests at the level and first difference were also reported, as shown in Tables 3–6.

Results and discussions

Table 1 presents the descriptive analysis of our study. The table indicates the number of observations, minimum, maximum, mean and standard deviation for real GDP (*gdp*) and external public debt (*expd*). The average means recorded were 9.92 and 7.92 for real GDP and external public debt, respectively. Real GDP records a standard deviation of 1.25 with minimum and maximum values of 317.5903 and 6.17E+10, respectively. External public debt recorded minimum and maximum values of 719.41751 and 5.42E+10, with a standard deviation of 1.16. Furthermore, the descriptive statistics indicate significant variability in the real GDP and external public debt across the panels in the data set, as depicted by the standard deviation values.

Table 1

Descriptive statistics

Variable	Obs.	Mean	Standard Deviation	Min	Max
gdp	195	9.92	1.25	317.5903	6.17E+10
expd	195	7.92	1.16	719.41751	5.42E+10

Panel unit root test

Data with long time dimensions (t=39) are used in this study. Therefore, the variables employed are likely to exhibit non-stationarity. As a preliminary step to estimation, a series of panel unit root tests proposed by Levin et al. (2002), Breitung (2000), Breitung–Das (2005), and LM, Im et al. (2003) are computed. Theoretically, if the time series is non-stationary, regression results based on the ordinary least square method would produce spurious results Granger–Newbold (1974) and Hendry (1995). A summary of all the unit root test results employed in E-Views is reported in Tables 2and 3. ADF, PP, LM Pesaran and Shin tests assume individual unit root process, while the Breitung t-test and Levin, Lin and Chu test assumes common unit root process. We test for null hypothesis H_0: panels contain unit roots implying non-stationarity of the series against alternative hypothesis H_1: panels are stationary.

Table 2 presents the real GDP stationarity test results at the level. The following two tests confirmed the stationarity of real GDP at the level. Levin, Lin and Chu test with p-value (0.0082) <0.05 and ADF–Fisher PP Chi-square test with p-value (0.0067) <0.05. However, stationarity was not established by Breitung t-statistic, LM, Pesaran, and Shin W-statistic and ADF–Fisher Chi-square test with all p-values > 0.05.

Table 2

Panel unit root test for real GDP at level

Test statistic	t-statistics	Prob.	Order of integration
Levin, Lin & Chu t*	–1.24013	0.0082***	I(0)
Breitung t-stat	0.62164	0.7329	I(1)
LM, Pesaran and Shin W-Stat	0.67353	0.7497	I(1)
ADF–Fisher Chi-square test	14.3203	0.1589	I(1)
ADF–Fisher PP Chi-square test	24.4218	0.0067***	I(0)

Note: Probabilities for the Fisher Chi-square test are computed using asymptotic Chi-square distributions. All other tests assume asymptotic normality. ***, **, and * denote significance at the 1% (∝=0.01), 5% (∝=0.05) and 10% ∝=0.1) *levels, respectively.* H_0: Non-Stationarity/Unit Root. Automatic optimal lag length selection based on minimum values of Lag length: *loggdp* (AIC=2). The smaller the lag, the better the model.

Table 3

Panel unit root test for external public debt at level

Test statistic	t-statistics	Prob.	Order of integration
Levin, Lin & Chu t*	–3.1353	0.0009***	I(0)
Breitung t-stat	2.32123	0.9899	I(1)
LM, Pesaran and Shin W-Stat	–1.3352	0.0909	I(1)
ADF–Fisher Chi-square test	27.1759	0.0024***	I(0)
ADF–Fisher PP Chi-square test	33.2970	0.0002***	I(0)

Notes: Probabilities for the Fisher Chi-square test are computed using asymptotic Chi-square distributions. All other tests assume asymptotic normality. ***, **, and * denote significance at the 1% (∝=0.01), 5% (∝=0.05) and 10% ∝=0.1) *levels, respectively*. H_0: Non-Stationarity/Unit Root. Automatic optimal lag length selection based on minimum values of Lag length: *logexpd* (Akaike Information Criterion – AIC=2). The smaller the lag, the better the model.

Table 3 presents external public debt stationarity test results at the level. Non-stationarity of the variables at the level is revealed by the Breitung t-stat and LM, Pesaran, and Shin W-Stat, with p-values > 0.05, as shown in the table. Stationarity was confirmed by Levin, Lin, and Chu, ADF – Fisher Chi-square test, and ADF–Fisher PP Chi-square test, with p-values < 0.05. These tests were applied with intercept and tended to improve their statistical power and size in the estimation process.

Panel unit root test for real GDP at first difference

Tables 4 and 5 show unit root test results of the two variables at first difference. ARDL is not applied when variables are not stationary at first difference. The results confirm that the variables were integrated of order *I (1)* and were stationary at first difference. This fulfils the requirements for using the ARDL model for estimation. Tables 4 and 5 show the stationarity status of the variables at first difference. We evaluated the hypothesis at a 5 per cent level of significance ($\alpha = 0.05$).

Table 4

Panel unit root test for real GDP at first difference

Test statistic	t-statistics	Prob.	Order of integration
Levin, Lin & Chu t*	–4.2233	<0.001***	I(1)
Breitung t-stat	–2.6816	0.0037***	I(1)
LM, Pesaran and Shin W-Stat	–4.2233	<0.001***	I(1)
ADF–Fisher Chi-square test	35.4347	<0.001***	I(1)
ADF–Fisher PP Chi-square test	82.3287	<0.001***	I(1)

Notes: Probabilities for the Fisher Chi-square test are computed using asymptotic Chi-square distributions. All other tests assume asymptotic normality. ***, **, and * denote significance at the 1% (∝=0.01), 5% (∝=0.05) and 10% ∝=0.1) *levels, respectively*. H_0: Non-Stationarity/Unit Root. Automatic optimal lag length selection based on minimum values of Lag length: *loggdp* (AIC=2). The smaller the lag, the better the model.

Table 5

Panel unit root test for external public debt at first difference

Test statistic	t-statistics	Prob.	Order of integration
Levin, Lin & Chu t*	–5.3010	<0.001***	I(1)
Breitung t-stat	–3.7371	<0.001***	I(1)
LM, Pesaran and Shin W-Stat	–3.7138	<0.001***	I(1)
ADF–Fisher Chi-square test	31.6320	0.0005***	I(1)
ADF–Fisher PP Chi-square test	70.4412	<0.001***	I(1)

Notes: Probabilities for the Fisher Chi-square test are computed using asymptotic Chi-square distributions. All other tests assume asymptotic normality. ***, **, and * denote significance at the 1% (∝=0.01), 5% (∝=0.05) and 10% ∝=0.1) *levels, respectively*. H_0: Non-Stationarity/Unit Root. Automatic optimal lag length selection based on minimum values of Lag length: *loggdp* (AIC=2). The smaller the lag, the better the model.

Tables 4 and 5 indicate the results of the unit root test for real GDP and external public debt at first difference. All the variables become stationary after the first difference, suggesting that they are integrated of order I(1) with p-values < 0.05 for all the variables, as indicated in Tables 4 and 5. Therefore, we conclude that the variables do not have unit roots at first difference.

Durmitrescu Hurlin panel Granger causality test

Granger (1969) causality is based on the idea that the cause occurs before the effect; hence, if an event X is the cause of another event Y, then X should precede Y. A variable X is said to be Granger's cause of variable Y if past and present values of X contain information that helps predict the future value of Y better than using the information contained in past and present values of Y alone. Our interest was to establish three types of causalities – unidirectional, bidirectional, and mutual or feedback causalities – and their magnitude based on p-values. This concept is fundamental to our study because, in the ARDL model, we evaluate the cause-effect relationship between the present and past values of real GDP and external public debt in an autoregressive process. Table 6 provides Granger causality results for the two variables employed in this study.

Table 6

Pairwise Durmitrescu Hurlin panel Granger causality test

Null hypothesis	W-Stat	Zbar-Stat	Prob.
dlogexpd does not homogeneously Granger cause *dloggdp*	16.3576	2.37993	0.0173**
dloggdp does not homogeneously Granger cause *dlogexpd*	10.3739	0.35255	0.7244

Notes: ***, **, and * denote significance at the 1% (∝=0.01), 5% (∝=0.05), and 10% (∝=0.1), *levels respectively*. H_0: External public debt (*dlogexpd*) does not Granger cause real GDP (*dloggdp*), automatic optimal lag length selection based on the minimum values of Lag length AIC = 5; causality was only ascertained at the eighth lag.

Table 6 provides the results of the Durmitrescu Hurlin Panel Causality Test with eight lags at a 5 per cent level of significance. The study found a positive relationship at a 5 per cent significance level for the unidirectional causality magnitude between external public debt and real GDP. The aforementioned results suggest that causality runs from external public debt to economic growth.

F-bound panel cointegration test

The model was subjected to the bound test to prove the existence of a long-run relationship between the variables, that is, economic growth and external public debt. The bound test is applied when variables are cointegrated in different orders. The decision was based on Wald or F-statistics with upper or lower critical value bounds at 1%, 5% or 10% level of significance, denoted by 1% ($\propto$=0.01), 5% ($\propto$=0.05), and 10% ($\propto$=0.1) *level, respectively*. The result of the F-bound test is given in Table 7.

Table 7

F-bound panel cointegration test

F-bounds test		Null hypothesis: No levels relationship		
test statistic	value	signif., %	I (0)	I (1)
			Asymptotic: n=1000	
F-statistic	2.375697	10	3.02	3.51
K	1	5	3.62	4.16
		2.5	4.18	4.79
		1	4.94	5.58
Actual sample size	194		Finite sample: n=80	
		10	3.113	3.61
		5	3.74	4.303
		1	5.157	5.917

Notes: The null hypothesis (H_0): No cointegrating equation against H_1: H_0 is not true. We applied the level and log transformed variables because F-bound is not performed on the first difference of the variables.

Table 7 reveals the non-existence of a long-run relationship between economic growth and public debt in the region with $F_{Cal} = 2.375697 > I\ (0)$ values. Therefore, the study concludes that there is no long-run equilibrium relationship between economic growth and external public debt.

Model estimation

Tables 8 and 9 provide empirical results of the multivariate ARDL (2,2) model on the relationship between economic growth measured by real GDP and external public debt in the region. The lag length selection for the model was based on the minimum values of the AIC, given as –5.707472 and estimated at a one per cent level of significance as presented in Table A1 in the Appendix. The study's findings reveal that, in the long run, a one per cent increase in external public debt leads to a 0.135004

per cent increase in economic growth at a 1 per cent significance level in the region. The Error Correction Term (CointQ01) suggest a disequilibrium speed of adjustment of 20.8674 per cent. This implies that, in an event with real GDP short-run disequilibrium caused by external public debt shock in the region, it takes 20.86 per cent adjustment speed, in the long run, to bring back economic growth to its equilibrium state.

Table 8

Panel long-run regression equation

Variable	Coefficient	Std. error	t-statistic	Prob.
logexpd	0.135004	0.025170	5.363684	<0.0001***
C	3.782639	1.168854	3.236196	0.0015
@TREND	0.006974	0.001820	3.831553	0.0002

Notes: ***, **, and * denote significance at the 1% (∝=0.01), 5% (∝=0.05) and 10% ∝=0.1) *levels, respectively*. The automatic optimal lag length selection is based on minimum values of Lag length AIC (-5.707472), SIC (5.146853), and HQ (5.480069); the smaller the lag, the better the model. We use *gdp* as the explained variable in the estimation process.

Table 9

Short-run regression equation

Variable	Coefficient	Std. error	t-statistic	Prob.
COINTEQ01	–0.208674	0.054832	–3.805668	0.0002***
D (*loggdp* (–1))	0.131192	0.107284	1.222846	0.2231
D (*logexpd*)	–0.017653	0.023036	–0.766348	0.4446
D (*logexpd* (–1))	0.014665	0.022315	0.657160	0.5120
C	3.782639	1.168854	3.236196	0.0015***
@TREND	0.006974	0.001820	3.831553	0.0002***

Note: ***, **, and * denote significance at the 1% (∝=0.01), 5% (∝=0.05) and 10% ∝=0.1) levels; automatic optimal lag length selection is based on minimum values of Lag length AIC (–5.707472) SIC (5.146853), HQ (5.480069). We use *loggdp* as the explained variable in the estimation process.

Testing for cross-sectional dependence

In any panel analysis, it is natural to suspect cross-sectional dependence across homogeneous groups of economies. Therefore, we evaluate for cross-sectional dependence to check whether the errors or disturbances in panel data regression are cross-sectionally correlated or dependent. The assumption is that the panel data regression is free of econometric problems when the cross-sectional dependence is absent in the residuals or disturbances. Cross-sectional dependence is caused by the interdependence of countries through trade and financial integration, which invariably affects the countries involved. If something happens in one country, there is a spillover or backwash effect in other countries in terms of financial flows. If cross-sectional dependence is ignored, ordinary least squares **(**OLS) estimators are

inefficient and biased, thereby generating invalid test statistics. We accept the null hypothesis with no cross-sectional dependence if P < 0.05; otherwise, we reject the null hypothesis. The choice of the test is based on the differences in period (t) and the number of parameters (n). If t > n, we employ Breusch–Pagan LM test. When (t) is very small or almost equal to (n), we adopt Pesaran 2004 CD test. Finally, when (t) and (n) are too large, we use BF and Kow test. The result of cross-sectional dependence is given in Table 10.

Table 10

Cross-sectional dependence

Test	Statistics	d.f..	Prob.
Breusch–Pagan LM	43.75782	10	<0.001***
Pesaran scaled LM	7.548478		<0.001***
Pesaran CD	1.847398		0.0647*

Note: ***, **, and * denote the significance at 1% (∝=0.01), 5% (∝=0.05) and 10% ∝=0.1) *levels, respectively.*

The estimated time is more than the number of observations (t=39, n=2; t > n). Therefore, we employ the Breusch–Pagan LM test. Table 10 shows cross-sectional dependence results, with Breusch–Pagan P-Value of 0.0001 < 0.05, implying no cross-sectional dependence between economic growth and external public debt in the five panels considered. Thus, we conclude that errors in one panel are not correlated to those in others.

Table 11

Short-run diagnostic test results

Test	Null hypothesis	F-statistics	Prob.
Jarque Bera	There is normal distribution	61619.50	<0.001
Breusch Godfrey LM Test	No serial autocorrelation	0.051113	0.9502
Breusch–Pagan LM Test	No heteroscedasticity	50.44959	<0.001
Ramsey RESET	No misspecification	0.081026	0.7762

Note: ***, **, and * denote the significance at 1% (∝=0.01), 5% (∝=0.05) and 10% ∝=0.1) *levels, respectively.*

To avoid spurious regression results, the short-run diagnostic tests are evaluated to ensure that the assumptions of the classical linear regression model are observed. Table 11 shows the results of the Breusch Godfrey LM test, indicating that no serial correlation exists between economic growth and external public debt. Model stability is checked using Ramsey RESET, which ascertains the stability of the model. Normality and heteroskedasticity are tested using Jarque Bera and Breusch–Pagan LM tests, respectively, as shown in the table above. Non-normality and heteroscedasticity problems were addressed by log-linearising and transforming the data into the first difference.

Impulse response function analysis using VAR model framework and theoretical foundation of VAR modelling

To generate the Monte Carlo VAR decomposition and VAR impulse response functions, we employed the VAR framework described next. This methodology is applied to gain a deeper understanding of the magnitude and relationship between external public debt shocks and economic growth in individual countries.

In structural time-series modelling, economic theory is used to model the relationships among the variables. Unfortunately, economic theory is largely incapable of providing the dynamic specifications that identify the relationships among different variables of interest. The application of VAR methodology to economic research was first proposed by Nobel laureate Christopher Sims (1980). Sims argued that structural models embody incredible identifying restrictions; however, the restrictions needed to claim exogeneity for certain variables would not be valid in an environment where agents optimise intertemporally. Furthermore, estimation and inference are complicated because endogenous variables may appear on both the left and right sides of the equation (Sims 1980). These problems lead to alternative and non-structural approaches to modelling the relationship among several variables. VAR is a multivariate stochastic time-series model in which each variant is expressed as a function of its own lagged values and those of other variables in the system. A VAR methodology is applied by specifying and estimating model parameters, estimating IRFs, and decomposing the variance of predicted errors. Following Sims's (1980) methodology, we present the VAR model by the following system of equations to show the relationship between economic growth proxied by real GDP (gdp) and external public debt ($expd$), in a VAR model framework.

$$gdp_t = \beta_{10} - \beta_{12} expd_t + \gamma_{11} gdp_{t-1} + \gamma_{12} expd_{t-1} + \mu_{gdpt}$$

$$expd_t = \beta_{20} - \beta_{21} gdp_t + \gamma_{22} gdp_{t-1} + \gamma_{22} expd_{t-1} + \mu_{expdt}$$

In the aforementioned two equations, real GDP (gdp_t) and external public debt ($expd_t$) are stationary, and μ_{gdpt} and μ_{expdt} are uncorrelated to white noise disturbance. These equations are not reduced form equations because $expd_t$ has a contemporaneous impact on gdp_t through β_{12}, and gdp_t has a contemporaneous impact on $expd_t$ through β_{21}. Thus, μ_{gdpt} is correlated with $expd_t$ and μ_{expdt} is correlated with gdp_t. This presents the problem of endogeneity in the model. The system is transformed to circumvent endogeneity to obtain consistent OLS estimators.

$$\begin{bmatrix} 1 & \beta_{12} \\ \beta_{21} & 1 \end{bmatrix} \begin{bmatrix} gdp_t \\ expd_t \end{bmatrix} = \begin{bmatrix} \beta_{10} \\ \beta_{20} \end{bmatrix} + \begin{bmatrix} \gamma_{11} & \gamma_{12} \\ \gamma_{22} & \gamma_{22} \end{bmatrix} \begin{bmatrix} gdp_{t-1} \\ expd_{t-1} \end{bmatrix} + \begin{bmatrix} \mu_{gdpt} \\ \mu_{expdt} \end{bmatrix}$$

$$B = \begin{bmatrix} 1 & \beta_{12} \\ \beta_{21} & 1 \end{bmatrix}, x_t = \begin{bmatrix} gdp_t \\ expd_t \end{bmatrix}, T_0 = \begin{bmatrix} \beta_{10} \\ \beta_{20} \end{bmatrix}, T_1 = \begin{bmatrix} \gamma_{11} & \gamma_{12} \\ \gamma_{22} & \gamma_{22} \end{bmatrix}, \mu_t = \begin{bmatrix} \mu_{gdp_t} \\ \mu_{expd_t} \end{bmatrix}$$

The aforementioned system is rewritten as follows.

$$Bx_t = T_0 + T_1 x_{t-1} + \mu_t$$

Pre-multiplying the system by the inverse of the B Matrix, B^{-1}, we obtain the following equation:

$$x_1 = A_O + A_1 x_{t-1} + e_t$$

$$\begin{bmatrix} gdp_t \\ expd_t \end{bmatrix} = A_O + A_1 \begin{bmatrix} gdp_{t-1} \\ expd_{t-1} \end{bmatrix} + e_t$$

where $A_O = B^{-1}T_0$ $A_1 = B^{-1}T_1$, $e_t = B^{-1}\mu_t$ constitute vector of innovations/shocks $gdp_t = a_{10} + a_{11}gdp_{t-1} + a_{10}expd_{t-1} + e_{gdp_t}$.

Using notations a_{i0} and a_{it} as elements i of vector A_O and e_t, respectively, and a_{ij} as the element in row i and column j, the transformed equation is rewritten as follows:

$$e_{gdpt} = (\mu_{gdpt} - \beta_{12}\mu_{expdt})/(1 - \beta_{12}\beta_{21})$$

$$e_{expdt} = (\mu_{expdt} - \beta_{21}\mu_{gdpt})/(1 - \beta_{12}\beta_{21})$$

Generalised impulse response function

Impulse response analysis employs vector autoregressive models. Their main purpose is to describe the evolution of the model's variables in reaction to a shock in one or more variables in the system. In this study, we use IRF to trace the dynamic impact of a system of shocks/innovations – occasioned by external public debt and other macroeconomic policy variables – on economic growth. We evaluate the behaviour of real GDP as a proxy for economic growth because of the exogenous changes in external public debt shocks. Next, we predict the implication of shocks on the macroeconomic policy framework in the selected SSA countries. Koop et al. (1996) have outlined IRF as a method for investigating dynamic models. The IRF function is given by $IRF(h, \delta) = \frac{\partial Y_{t+h}}{\partial \varepsilon_t}$. The equation shows how a shock $\epsilon_t = \delta$ at time t impacts a system at time $t + h$, assuming no further shocks, $\epsilon_{t+h} = 0 \; \forall \; h$. It can also be thought of as comparing two concurrent realisations, one with the shock and one without it:

$$IRF(h, \delta, \omega_{t-1}) = E\{Y_{t+h} | \varepsilon_t = \delta, \varepsilon_{t+h} = 0, \omega_{t-1}\} - E\{Y_{t+h} | \varepsilon_t = 0, \varepsilon\}$$

where ω_{t-1} refers to the history of the process, that is, the values up to time $t.j$ An important characteristic of IRF is that, for linear processes, the IRF has the following properties: (1) It is linear in the shock, that is, $IRF(h, \lambda\delta, \omega_{t-1}) = \lambda IRF(h, \delta, \omega_{t-1})$, (2) It is symmetric in the shocks, and (3) It is independent of the history, that is, $IRF(h, \delta, \omega_{t-1}) = IRF(h, \delta, \omega'_{t-1})$. In the case of a threshold model, it is clear that initial conditions ω_{t-1} matter. However, if the IRF starts in a low or high regime, the impacts will vary. Furthermore, the size of the shock δ also matters. It explains whether the shock is small and if the process has stayed in the same regime or whether it has triggered a regime change, having a different impact. Finally, the value of subsequent shocks ε_{t+h} also matters. This is because, even if the initial shock keeps the process in the same regime, further shocks trigger a regime change. The general IRF is given by the following equation:

$$GIRF(h, \delta, \omega_{t-1}) = E\{Y_{t+h} | \varepsilon_t = \delta, \varepsilon_{t+h} = \delta, \omega_{t-1}\} - E\{Y_{t+h} | \omega_{t-1}\}$$

In a $GIRF$, one is not comparing the shock $\epsilon_t = \delta$ with the absence of shock $\epsilon_t = 0$ anymore. Instead, the benchmark shocks are averaged out. The aforementioned equations are derived from Koop et al. (1996). In a VAR model, coefficients cannot be directly interpreted, and instead, innovation accounting techniques are adopted to interpret the results. These are the IRF and variance decomposition (VD). Using these techniques, we examine how each variable affects the others in the system. While the IRF shows the dynamic effect of each variable on the shocks in other variables in the system, the VD shows the variability of forecast error for each variable to the shocks in all variables (Enders 1995). We use the IRFs to forecast the response of current VAR error values. It is assumed that errors revert to zero in subsequent periods *ceteris paribus*. Furthermore, several variables were deemed suitable for influencing public debt levels to avoid misspecification of the model, that is, exchange rates, interest rates, and inflation. The VD presented in Tables 14 to 18 are ordered as *dLogGDP*, *dLogEXPD*, *dLogINTR*, *dLogEXCH*, and *dLogCPI*. The forecast VD is the percentage of the variance of the errors made in forecasting economic growth caused by innovations in external public debt, interest rates, exchange rates, and inflation at horizons one to ten. VD is applied to show the percentage interaction between real GDP and variables ordered in the recursive VAR system.

Stationarity test of the variables at level and first difference

Macroeconomic observations gradually arise from different distributions, posing difficult problems for empirical modelling. When non-stationary variables are estimated, the error term is likely non-stationary. This implies that u_t is heteroscedastic because $var(u_t)$ increases with time t, u_t is not independent of u_j for $j = 0$. Therefore, the autocorrelation function of an $I(1)$ series does not rapidly decay towards zero. The $cov(x_t, u_{t)}) = 0$, because the covariance between any two non-stationary variables is non-zero. This violates the three assumptions of classical linear regression model estimators, giving rise to spurious regression problems. Non-stationarity of variables emanates from the sluggishness of economic time series. All variables must be stationary as a necessary condition for the application of VAR.

The study employs ADF–Fisher Chi-square tests to confirm the stationarity of the variables before model evaluation. The results confirmed the non-stationarity of the variables at the level and stationarity at the first difference, as reported in Table 12.

Table 12

Test for stationarity of the variables

Variable/ Country	Test statistic		Kenya	Nigeria	Malawi	Botswana	Lesotho
logRGDP	ADF	Level	0.9959	0.9744	0.9943	0.0035***	0.1014
		1St Diff	0.0075***	0.0002***	<0.0001***	0.0006***	<0.0001***
LogEXPD	ADF	Level	0.9999	0.0824	0.3919	0.3776	0.0147***
		1St Diff	0.0012***	0.0001***	0.0001***	0.0001***	0.0003***
logINTR	ADF	Level	0.4771	0.4394	0.3354	0.4944	0.2439
		1St Diff	<0.0001***	<0.0001***	0.0002***	<0.0001***	< 0.0001
logEXCH	ADF	Level	0.8242	0.9117	0.7631	0.3092	0.2934
		1St Diff	<0.0001***	<0.0001***	0.0021***	0.0001***	<0.0001
logINFL	ADF	Level	1.0000	0.6535	0.6992	0.2327	0.0123***
		1St Diff	0.0839*	0.0019***	0.0188**	<0.0001***	<0.0001***

Notes: We apply Augmented Dickey–Fuller (ADF) to test for stationarity with Mackinnon Critical Values at 1%, 5% and 10% levels of significance. ***, **, and * denotes significance at 1% (t = 3.605593), 5% (t = –2.936942), and 10% (t= –2.606857) levels of significance, respectively. Lag length (SIC = 1) level. H_0: Non-Stationarity/ Unit Root.

Johansen Cointegration Analysis

Two time-series variables are cointegrated if they are bound together in a long-run equilibrium relationship. Johansen (1988) has demonstrated that cointegration can be modelled within a modified VAR framework. This study applies the Johansen unrestricted cointegration rank test, consisting of trace and maximum eigenvalues, to evaluate the long-run relationship between external public debt and economic growth. The results shown in Table 13 suggest no cointegrating relationship between economic growth and external public debt across the five countries selected. VAR is applied when there is no cointegration between or among the variables being investigated. The results in Table 13 show no cointegration between external public debt and economic growth across all the five countries investigated, implying that the two variables do not have a stable long-run relationship. Given the absence of a long-run relationship, we apply the VAR impulse response function and VD to investigate the impact of shocks from macroeconomic variables on economic growth dynamics in the SSA countries selected.

Table 13

Johansen cointegration test

Country/Tests	Unrestricted vointegration rank test (Trace)				Prob.**
	Hypothesised No. of CE(s)	Eigenvalue	Trace statistic	0.05 Critical value	
Nigeria	None	0.143580	7.476402	15.49471	0.5230
	At most 1	0.000764	0.036677	3.841466	0.8481
Kenya	None	0.103265	5.273025	15.49471	0.7792
	At most 1	0.000860	0.041292	3.841466	0.8389
Malawi	None	0.158743	7.270656	15.49471	0.5464
	At most 1	0.013477	0.529188	3.841466	0.4669
Botswana	None	0.199528	15.16778	15.49471	0.0560
	At most 1	0.170877	6.933319	3.841466	0.0850
Lesotho	None	0.240239	12.08042	15.49471	0.1531
	At most 1	0.050430	1.914618	3.841466	0.1665

Notes: H_0: No cointegrating equation; H_1: H_o is not true; Trace test indicates no cointegration at the 0.05 level; * denotes rejection of the hypothesis at the 0.05 level **MacKinnon-Haug-Michelis (1999) p-values. Lag interval Kenya (1,1), Nigeria (1, 1), Malawi (1,1), Botswana (1,3) and Lesotho (1,3).

The results of impulse response functions and variance decomposition

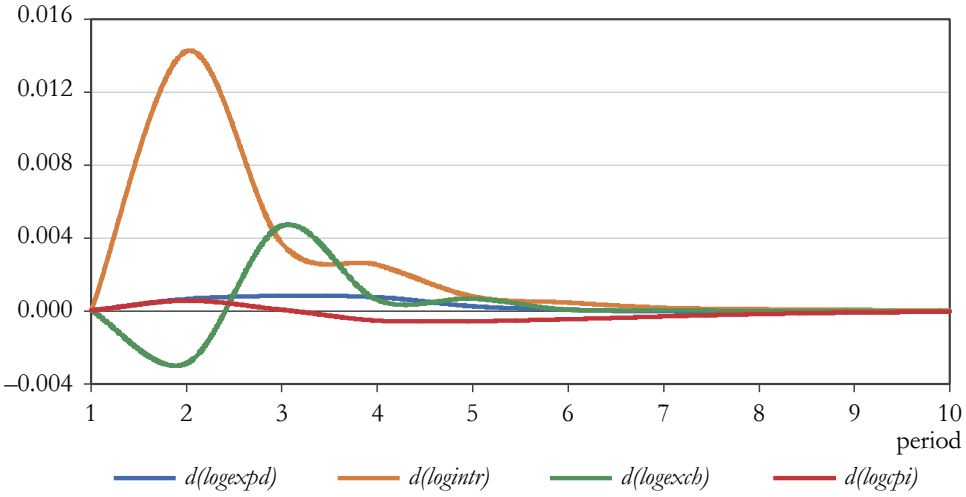
The results of the impulse response functions and VD are given in Figures 1 to 5 and Tables 14 to 18, respectively. The study further confirmed the absence of serial correlation by VAR residual correlation tests as shown in Tables A2 to Table A6 in the Appendix. Moreover, the stability of the VAR model system was ascertained by roots of characteristic polynomials presented in Table A7 in the Appendix.

Figure 1 shows the response of economic growth proxied by real GDP to a one standard deviation shock in external public debt in Nigeria. In the earlier stages, the short-run period, there is economic growth from period (1) to period (4), followed by a drastic fall from period (4) to (10). This is confirmed by the VD in Table 14. The economic intuition for the growth shocks occasioned by external public debt, interest rates, exchange rates, and inflation is given below the VD. These results are consistent with the observations of Sharif (2021), whose study revealed a negative effect of external public debt in Egypt, caused by both negative and positive shocks driven by external public debt. Shittu et al. (2018) have noted the negative effect of external public debt on economic growth caused by debt overhangs in SSA countries. The results further coincided with those of Mohsin et al. (2021), who investigated the external public debt-economic growth nexus in Asia and revealed that when the external debt reaches a threshold, it becomes a drag on economic growth and causes a more substantial negative impact on growth. Other studies that found a negative

relationship between external public debt and economic growth relationship are Doğan–Bilgili (2014), Al Kharusi–Ada (2018), and Çiftçioğlu–Sokhanvar (2018).

Figure 1

Response to Cholesky one standard deviation (SD) innovations in Nigeria



The results presented in Table 14 show the impact of external public debt on the real GDP in Nigeria. The VD was based on the lagged values of the explanatory variables. The number of time lags was found to be one based on AIC for the VAR model as shown in Table A8 in the Appendix. One period of time lag has a valid justification in economic intuition. This study focuses on the real GDP and external public debt relationship. According to the results, column (3) shows a 100 per cent effect of a unit shock of real GDP on itself, *ceteris paribus,* at period (1). The second period suggests an innovation impact of 90.7 per cent. However, after the second quarter, from period (3) to period (10), a decrease is observed from 89.6 per cent to 89.3 per cent by the end of the tenth period. In column (4), the results suggest that external public debt shocks have a contemporaneous positive long-run impact on economic growth. Accordingly, a unit SD shock in external public debt leads to a 0.01 per cent deviation in economic growth. The deviation is sustained up to period (10) with a 0.069 per cent increase in economic growth. Between columns (5) ad (7), interest rates, exchange rates, and inflation show a positive and significant impact on economic growth from period (2) to (10), as shown in Table 14 given above. The dynamic behaviour of external public debt shocks on economic growth may be consistent with the view that long-term potential production growth will be stimulated by a rise in business and fixed investments because of the lower interest rates in the short-run and long-run periods. This suggests lower prices and higher investment in the interest-rate-sensitive private sector. As a result of the multiplier

effect caused by government spending, the crowding-in effect is strengthened, and fixed investment is stimulated by the acceleration effect in the long run. These views are consistent with those of Iya et al. (2013).

Table 14

Variance decomposition of dLogGDP using Cholesky (d.f. adjusted) factors for Nigeria

(percentage point)

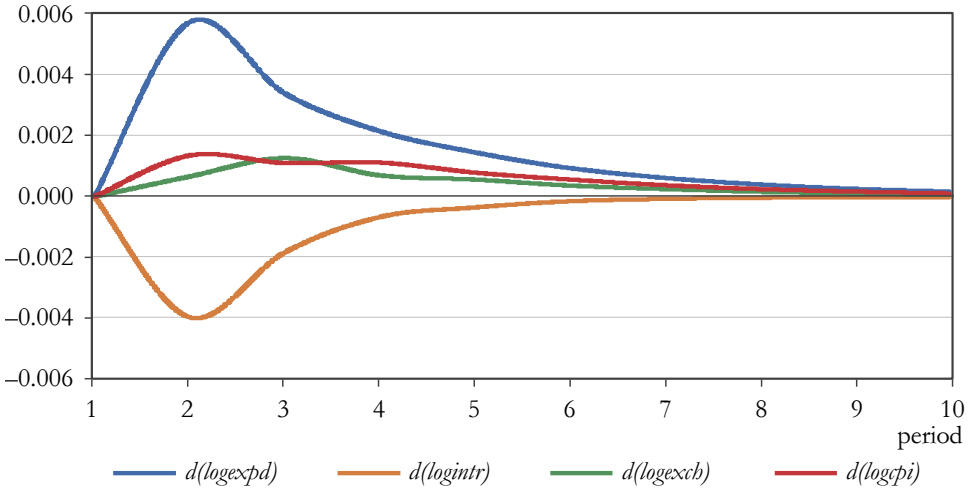
Period	S.E.	D(LOGGDP)	D(LOGEXPD)	D(LOGINTR)	D(LOGEXCH)	D(LOGCPI)
1	0.043811	100.0000	0.000000	0.000000	0.000000	0.000000
2	0.047608	90.74578	0.017503	8.855713	0.368188	0.012820
3	0.048707	89.65958	0.044064	9.023306	1.260741	0.012308
4	0.048836	89.40635	0.065997	9.235168	1.267655	0.024827
5	0.048869	89.36222	0.068229	9.247262	1.283523	0.038765
6	0.048876	89.34768	0.068272	9.252713	1.283233	0.048098
7	0.048878	89.34311	0.068372	9.252963	1.283138	0.052418
8	0.048878	89.34121	0.068515	9.252968	1.283180	0.054127
9	0.048879	89.34055	0.068612	9.252921	1.283206	0.054716
10	0.048879	89.34031	0.068656	9.252901	1.283226	0.054902

Cholesky Ordering: D(LOGGDP) D(LOGEXPD) D(LOGINTR) D(LOGEXCH) D(LOGCPI).

Figure 2 shows the response of economic growth proxied by real GDP to a one standard deviation shock in external public debt in Kenya. In the short run, a rise in external public debt leads to increased economic growth. Economic growth increases in the short run from period (1) to period (2). However, it gradually falls from period (2) to period (10) in the long run. These innovations and responses are consistent with intuition and economic theory. The Keynesians contend that public debt boosts economic growth because of the crowding in of private investment. It is evident from this finding that external public debt promotes economic growth in Kenya in the short run. The Keynesian contention holds in the short run. However, external public debt – when used prudently – increases aggregate demand due to the country's specific domestic fiscal and monetary policies. Accordingly, it stimulates resource employment in the private sector, which increases the supply of goods and realises GDP growth. When private investment crowds in, more resources are employed, increasing aggregate demand in the economy; this positively impacts economic growth. In the long run, the Kenyan economy is classical. These findings are consistent with those of Atique–Malik (2012), Ezeabasili et al. (2011), and Ogege–Ekpudu (2010). Although external debt supplies much-needed funds, it may not be used for productive economic activities, where returns are greater than the interest payable, which explains the negative relationship. Several factors may contribute to this, including misappropriation and inefficient fiscal and monetary policy management in the long run.

Figure 2

Response to Cholesky one SD innovations in Kenya



The lag length selection criteria for the VAR model was based on minimum values of AIC presented in Table A9 in the Appendix. The given Table 15 shows the results of VD for Kenya. As indicated in column (3), one SD innovation in lagged values of real GDP affects economic growth by 100 per cent, holding other factors constant. The shock decreases from 100 per cent in period (1) to 44.73 per cent in period (10). Furthermore, as shown in column (4), the results reveal that a unit shock in external public debt has a positive short-run impact on economic growth in Kenya. This is demonstrated by a 20.74 per cent increase in period (2) and a 34.81 per cent increase in period (10). From Figure 2, external debt has a short-run positive impact and a long-run negative impact on economic growth. Therefore, there is a sharp increase from period (1) to period (2), followed by a gradual decrease from period (2) to period (10) in the long run. The short-run findings of the growth-external debt relationship in Kenya are consistent with those of Bamidele–Joseph (2013), who found that external debt is positively related to economic growth. However, in column (5), there is a decrease in economic growth because of one SD in interest rate shock in the short-run, as shown in Table 15, from period (1) to period (4). In column (6), a standard deviation shock in exchange rates and inflation enhances productivity. Theoretically, depreciated exchange rates boost export diversification and, consequently, economic growth. In column (7), one SD innovation in inflation positively impacts economic growth. This is shown by a 0.04 per cent increase in period (2) and an 8.12 per cent increase in period (10). The macroeconomic conjecture is that positive shocks caused by inflation in the economy may cause producers to receive distorted signals about the demand for their goods, which affects their production decisions. In the event of a surge in nominal income, producers' product demand may rise, leading to more productivity. Hence, economic growth is

realised in the short run. The long-run negative external debt growth relationship may be supported by the findings of Joy–Panda (2020), Ramzan–Ahmad (2014), Silva (2020), Irfan et al. (2020), and Moh'd al-Tamimi–Jaradat (2019). The results are further consistent with classical economists' observations; external debt leads to a spike in interest rates in the economy. This leads to a crowding out of private investment and negatively affects long-term economic growth (Mankiw 2000, Modigliani, 1961).

Table 15

Variance decomposition dLogGDP using Cholesky (d.f. adjusted) factors for Kenya

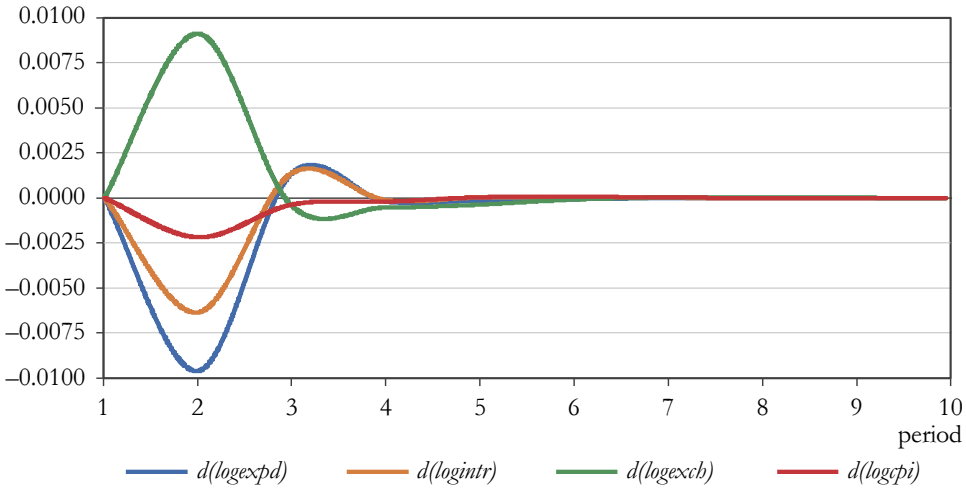
(percentage point)

Period	S.E.	D(LOGGDP)	D(LOGEXPD)	D(LOGINTR)	D(LOGEXCH)	D(LOGCPI)
1	0.017610	100.0000	0.000000	0.000000	0.000000	0.000000
2	0.022995	70.59958	20.73846	5.233742	3.386004	0.042213
3	0.024636	62.86791	27.04514	4.581778	5.458861	0.046314
4	0.026757	53.35680	38.04101	3.885877	4.629929	0.086388
5	0.028106	48.69316	38.27479	6.850889	4.228565	1.952594
6	0.029165	45.65905	35.55587	6.401490	5.344502	7.039090
7	0.029423	45.28352	34.93689	6.365554	5.434637	7.979394
8	0.029571	45.06119	34.58829	6.946835	5.386818	8.016869
9	0.029672	44.75697	34.82425	6.917972	5.403494	8.097314
10	0.029682	44.73161	34.81219	6.930446	5.409744	8.116012

Cholesky Ordering: D(LOGGDP) D(LOGEXPD) D(LOGINTR) D(LOGEXCH) D(LOGCPI).

Figure 3

Response to Cholesky one SD innovations in Malawi



In the given Figure 3, the study shows how economic growth reacts to one SD external public debt shock in Malawi. The VAR lag length selection was based on AIC

given in Table A10 in the Appendix. The results suggest negative economic growth caused by external public debt shocks. A decrease in economic growth is shown in period (3), an increase from period (1) to period (2). Neoclassical theory predicts a fall in private consumption after a fiscal shock, which might be attributed to the crowding out of private investment negatively affecting economic growth. From periods (2) to (3), there is a rapid increase in economic growth, occasioned by external public debt shocks. This is supported by the Keynesian view that aggregate consumption increases after a spending shock. Economic growth might be attributed to the increases in aggregate demand and the crowding-in effect of private investment during this period. There is a gradual decrease in external public debt shocks from period (3) to period (10), as shown in Figure 3.

Table 16

Variance decomposition dLogGDP using Cholesky (d.f. adjusted) factors for Malawi

(percentage point)

Period	S.E.	D(LOGGDP)	D(LOGEXPD)	D(LOGINTR)	D(LOGEXCH)	D(LOGCPI)
1	0.047815	100.0000	0.000000	0.000000	0.000000	0.000000
2	0.051016	91.21877	3.672262	1.610287	3.309053	0.189624
3	0.051064	91.07647	3.738212	1.680830	3.309811	0.194674
4	0.051068	91.06310	3.738969	1.681015	3.320469	0.196443
5	0.051070	91.05751	3.739494	1.680955	3.325552	0.196489
6	0.051070	91.05686	3.739625	1.681017	3.325814	0.196681
7	0.051070	91.05677	3.739622	1.681035	3.325845	0.196726
8	0.051070	91.05672	3.739625	1.681034	3.325896	0.196727
9	0.051070	91.05671	3.739627	1.681034	3.325905	0.196728
10	0.051070	91.05670	3.739627	1.681034	3.325905	0.196728

Cholesky Ordering: D(LOGGDP) D(LOGEXPD) D(LOGINTR) D(LOGEXCH) D(LOGCPI).

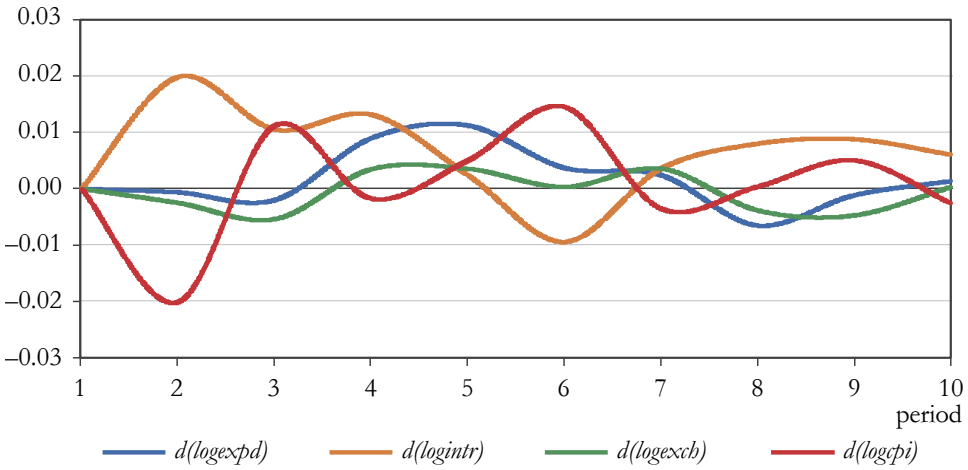
Table 16 presents the results of a unit shock in external public debt and shocks from other macroeconomic variables analysed in the VAR system. In the short run, findings suggest that the variability of economic growth is explained by its shocks. In column (3), other factors are held constant. The 100 per cent forecast error variance in real GDP is explained by the variable itself, while other variables do not have a strong endogenous influence over it. In column (4) of Table 16, economic growth positively reacts to a one SD shock in external public debt. The government spending shock raises real GDP by 3.67 per cent in period (2) to 3.74 per cent in period (10). The shock impact multiplier is positive and higher than one. The cumulative response of GDP to external public debt shocks is positive across the ten periods. The growth reaction shocks are also observed from the control variables with interest rate shock of 1.61 per cent in period (2) to 1.68 per cent in period (10), exchange rate shock of 3.31 per cent in period (2) to 3.33 per cent in period (10), and inflation shock of 0.190 per cent in period (2) to 0.197 per cent in period (10). The positive economic growth and external public debt relationship, as observed in Table 16, is consistent with

theoretical Keynesian arguments on the relationship between economic growth and external public debt.

Figure 4 shows a noticeable Cholesky response of real GDP to a one standard deviation shock in external public debt shocks in Botswana. The effect of this fiscal shock gradually decreases real GDP from period (1) to period (3). There is a gradual increase from period (3) to period (5) before it decreases in period (8).

Figure 4

Response to Cholesky one SD innovations in Botswana



The results depicted in Table 17 show the impact of a one standard deviation shock in external public debt and other macroeconomic variables on economic growth in Botswana. Table A11 in the Appendix shows the minimum lag length of VAR model based on AIC. In the initial period, approximately 100 per cent of the variations in real GDP are caused by shocks to the variable itself. This is shown in column (3) of the table, from 100 per cent in the short run at period (1) to 36.05 per cent in the long run at period (10). Economic growth shocks have a declining explanatory power, while shocks from other variables gain more power in explaining economic growth variations. Furthermore, the contribution of external public debt shocks to economic growth changes fairly over the ten periods, reaching 0.02 per cent in period (2) before diverging to a moderately strong impact of 8.18 per cent in period (10). The contribution of interest rate shocks to real GDP variations rises strongly, from 20.73 per cent in period (2) to 28.49 per cent in period (10). The rise in economic growth from interest rate shocks may be caused by the crowding-in effect of private sector investment in the short to long-run periods. However, there is a slow but positive contribution of exchange rate shocks to variations in economic growth, increasing from 0.33 per cent in period (2) to 3.25 per cent in period (10). This might be attributed to overvalued exchange rates or export sector instabilities. The results also suggest a very strong contemporaneous impact of inflation shocks on economic growth, ranging from

21.28 per cent in period (2) to 24.03 per cent in period (10). The positive economic growth trajectory in the country, as shown in Figure 4, is consistent with economic theory. This is because when there is more income in the economy, people tend to spend more, which leads to more consumption, subsequently creating aggregate demand for production. Thus, investment goes up, leading to economic growth. These findings resonate with those of Sulaiman–Azeez (2012). Furthermore, the findings confirm the Keynesian argument that public sector debt-financed expenditure results in economic growth through the positive multiplier effect.

Table 17

Variance decomposition dLogGDP using Cholesky (d.f. adjusted) factors for Botswana

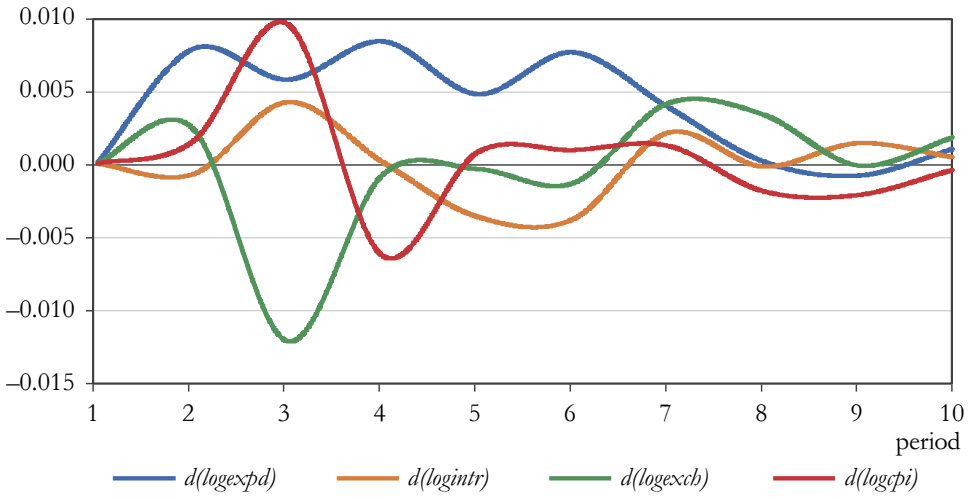
(percentage point)

Period	S.E.	D(LOGGDP)	D(LOGEXPD)	D(LOGINTR)	D(LOGEXCH)	D(LOGCPI)
1	0.032192	100.0000	0.000000	0.000000	0.000000	0.000000
2	0.043657	57.63850	0.021138	20.72731	0.332061	21.28099
3	0.047070	51.40412	0.196962	22.83865	1.597838	23.96243
4	0.049886	45.88015	3.427341	27.33094	1.906223	21.45535
5	0.051850	43.55527	7.889750	25.52839	2.240673	20.78592
6	0.054960	39.31699	7.479671	25.67246	1.997988	25.53289
7	0.055513	39.08793	7.524030	25.58018	2.382441	25.42543
8	0.056628	37.68290	8.553502	26.58205	2.743065	24.43848
9	0.057816	36.41201	8.246405	27.83122	3.301927	24.20844
10	0.058263	36.04725	8.176336	28.49338	3.254076	24.02895

Cholesky Ordering: D(LOGGDP) D(LOGEXPD) D(LOGINTR) D(LOGEXCH) D(LOGCPI).

Figure 5

Response to Cholesky one SD Innovations in Lesotho



The given Figure 5 shows the response of real GDP to a one standard deviation shock in external public debt in Lesotho. There is a sharp increase in economic growth in the short run, from period (1) to period (2)>. This may be attributed to positive external public debt shocks. From period (2) to (3), there is a steady decline before it picks up and stabilises by period (8).

Table 18

Variance decomposition dLogGDP using Cholesky (d.f. adjusted) factors for Lesotho

(percentage point)

Period	S.E.	D(LOGGDP)	D(LOGEXPD)	D(LOGINTR)	D(LOGEXCH)	D(LOGCPI)
1	0.016827	100.0000	0.000000	0.000000	0.000000	0.000000
2	0.019397	81.50689	16.22309	0.152952	1.545557	0.571513
3	0.026713	49.68048	13.15222	2.534051	21.58693	13.04632
4	0.028778	43.30945	19.73312	2.184497	18.67830	16.09464
5	0.029848	43.19892	20.85743	3.538030	17.38037	15.02525
6	0.031296	40.65315	24.86916	4.727347	16.00121	13.74913
7	0.032155	40.16277	24.99297	4.901934	16.78029	13.16204
8	0.032706	40.76695	24.16008	4.742683	17.26820	13.06208
9	0.032903	40.79263	23.93981	4.859627	17.06432	13.34362
10	0.032970	40.62674	23.92992	4.855564	17.28055	13.30723

Cholesky Ordering: D(LOGGDP) D(LOGEXPD) D(LOGINTR) D(LOGEXCH) D(LOGCPI).

Table 18 presents the robust VAR results for real GDP variations in Lesotho. The VAR system lag length was determined by minimum values of AIC as shown in Table A12 in the Appendix. According to the results, variation in economic growth (column 3) is largely explained by its own shocks, followed by variations in external public debt shocks (column 4), exchange rates shocks (column 6), inflation shocks (column 7), and interest rates shocks (column 5). In the initial periods, economic growth explains its variation by 100 per cent. However, the explanatory power decreases by period (10), reaching 40.63 per cent. A standard deviation shock in external public debt has a strong endogenous impact on real GDP variations, as shown in Table 19. This is revealed in column (4) of Table 18, from 16.22 per cent in period (2) to 23.93 per cent in period (10). The external public debt shocks increased from 16.22 per cent to 23.93 per cent eight periods ahead, followed by exchange rate shocks at 1.54 per cent in period (2) to 17.28 per cent in period (10). Moreover, the inflation shocks increase from 0.57 per cent in period (2) to 13.31 per cent in period (10). There is a very low effect of interest rate shocks on real GDP variations, observed at 0.15 per cent in period (2) and 4.86 per cent in period (10). Therefore, the overall results suggest that external public debt shocks significantly contribute to real GDP growth variations in the long run, compared to the short-run period in Lesotho.

Conclusions

This study aimed to empirically investigate the dynamic relationship between external public debt and economic growth. The study applied ARDL and unrestricted VAR, consisting of IRFs, and the VD approach. The studies across low-income economies (Presbitero 2012) and advanced nations (Reinhart–Rogoff 2013, Reinhart–Trebesch 2014) demonstrate that high levels of debt hinder economic growth by crowding-out investment. However, factors such as macroeconomic conditions and institutional qualities determine how much high public debt hinders the economic growth of several countries. While policymakers and academics have debated whether external public debt benefits economic growth in SSA, the overall cost of debt to African governments has been an issue of concern. Although it is agreed upon that foreign public debt is unavoidable in supporting fiscal activities in SSA economies, it is worth noting that severe external debt administration procedures may overshadow any welfare advantages achieved from such borrowings. It is a wake-up call for African governments that external public debt is rising beyond sustainable levels, and economies are increasingly using a lot of their revenue to service debt instead of investing in critical sectors of the economy. The results of this study confirmed mixed relationships between external public debt and economic growth across the five SSA countries investigated. The results revealed a short-run positive and long-run negative relationship between economic growth and external public debt in Kenya and Nigeria. These results confirmed the findings of Sachs (1988) and Krugman (1988). The 'external debt overhang' in heavily indebted nations has been identified as a major of productivity and economic growth slowdowns (Bulow–Rogoff 1990, Sachs 1989). Given that these countries may lose confidence in private investors, economic growth will slow, debt service will consume a large portion of their revenues, and their chances of returning to growth will be weakened (Levy-Livermore–Chowdhury 1998). The debt overhang phenomenon has further been confirmed by Karagol (2004), Clements et al. (2005), and Metwally–Tamaschke (1994). Moreover, the study revealed that public spending shocks generally generate positive output responses, except for Malawi, in the short term. Although the magnitude significantly differs across the five countries investigated, the results are consistent with those of Mountford–Uhlig (2009), Perotti (2004), and Neri (2001).

The study also noted different responses across three other countries. The Keynesian propositions were confirmed in Malawi, Lesotho, and Botswana, where external public debt positively impacts economic growth in the long run. This supports the Keynesian view of the positive impact of debt on economic growth. Low-income countries that borrow at sustainable amounts are more likely to boost their economic growth (Wang 2009). These observations corroborate the neoclassical economic theory, which allows for financial deepening and flexibility to include international sources in borrowing and lending, which enhances transitory growth.

Given that the marginal product of capital is greater than the world interest rate, capital-scarce nations are more likely to borrow and invest (Pattillo et al. 2002). From an economic standpoint, developing economies have a scarcity of capital, which is why they are encouraged to sign for external debt intended for investment, especially if the return on investment exceeds their cost of financing. This positively impacts economic growth (Pattillo et al. 2004). Furthermore, capital formation is *a sine qua non* to make profitable investments (Ugochukwu–Chinyere 2013). These viewpoints were held and backed by Yotopoulos–Nugent (1976), as confirmed by Bakare (2011). These findings are also consistent with those of Adegbite et al. (2008) and Bamidele–Joseph (2013).

Policy recommendations/Suggestions

To respond to the developmental challenges, SSA countries should reduce their debt burden by mobilising their domestic financial resources. Given the enormous financial resource gap, most African economies borrow externally to fund infrastructure development projects, which does not translate to economic growth in the short-run period. A critical element of unlocking development opportunities for SSA countries is investing public debt in productive sectors of the economy, such as energy, industrialisation, and agriculture, in the short run. Apart from their unsustainability, any debt increase should also be accompanied by a corresponding increase in economic growth, technological innovations, and employment opportunities. In most African countries, governments lack the policies and legal frameworks to protect themselves from external shocks and crises triggered by public debts. Therefore, to support regional economic growth initiatives, policymakers should strive for judicious management of foreign public debt. Realising these challenges requires fiscal discipline, fundamental reforms in the public sector, and adequate institutional capacity-building initiatives. Therefore, policymakers should provide a sound fiscal balance sheet, which would permit borrowing to fund emergencies, such as natural disasters, pandemics, and geopolitical threats. Moreover, developing countries in SSA regions should prioritise research and development of projects financed by public debt, for example, research on climate change and agricultural programmes. Additionally, the budget should shift away from consumption and towards investing in as many sectors of the economy as possible, reforming the budget policy process. This debt should be used to promote economic policies instead of political interests. To maintain a stable and macroprudential fiscal and monetary policy environment in the region, SSA governance needs to establish regional monetary integration to address structural rigidities, control the multiplicity of lenders in the debt market, and intervene in the fiscal and monetary policy frameworks of most African economies. Through regional monetary institutions, economies could effectively maintain a balanced money supply, responsibly finance fiscal deficits, create credit, and decide when and for what reasons economies need to borrow.

Appendix

Table A1

ARDL model selection criteria

Model	LogL	AIC*	BIC	HQ	Specification
6	530.403796	–5.707472	–5.146853	–5.480069	ARDL (2, 2)
5	525.147994	–5.704549	–5.234352	–5.513823	ARDL (2, 1)
2	524.278495	–5.694611	–5.224415	–5.503886	ARDL (1, 2)
1	518.527407	–5.686028	–5.306253	–5.531980	ARDL (1, 1)
7	533.113950	–5.681302	–5.030261	–5.417221	ARDL (2, 3)
9	527.713742	–5.676728	–5.116109	–5.449325	ARDL (3, 1)
10	532.465184	–5.673888	–5.022846	–5.409807	ARDL (3, 2)
3	526.550260	–5.663432	–5.102812	–5.436028	ARDL (1, 3)
11	534.936977	–5.644994	–4.903530	–5.344235	ARDL (3, 3)
13	528.962323	–5.633855	–4.982813	–5.369774	ARDL (4, 1)
14	533.328365	–5.626610	–4.885146	–5.325851	ARDL (4, 2)
15	535.877652	–5.598602	–4.766715	–5.261165	ARDL (4, 3)
4	524.412434	–5.581856	–4.930815	–5.317775	ARDL (1, 4)
12	533.183038	–5.567806	–4.735920	–5.230369	ARDL (3, 4)
8	528.111007	–5.566983	–4.825519	–5.266224	ARDL (2, 4)
16	534.112077	–5.521281	–4.598972	–5.147166	ARDL (4, 4)

* ARDL model Selection criteria is based on minimum value of BIC, HQ or AIC (–5.707472).

Table A2

VAR residual serial correlation LM tests_Kenya

Lag	LRE* stat	df	Prob.	Rao F-stat	df	Prob.
Null hypothesis: No serial correlation at lag h						
1	31.73832	25	0.1657	1.325009	(25, 83.2)	0.1718
2	37.23113	25	0.0549	1.602857	(25, 83.2)	0.0580
Null hypothesis: No serial correlation at lags 1 to h						
1	31.73832	25	0.1657	1.325009	(25, 83.2)	0.1718
2	64.05621	50	0.0873	1.361728	(50, 80.9)	0.1072

* Edgeworth expansion corrected likelihood ratio statistic.

Table A3

VAR residual serial correlation LM tests_Nigeria

Lag	LRE* stat	df	Prob.	Rao F-stat	df	Prob.
Null hypothesis: No serial correlation at lag h						
1	33.93198	25	0.1094	1.434044	(25, 83.2)	0.1142
2	36.91918	25	0.0588	1.586642	(25, 83.2)	0.0621
Null hypothesis: No serial correlation at lags 1 to h						
1	33.93198	25	0.1094	1.434044	(25, 83.2)	0.1142
2	58.20250	50	0.1990	1.200004	(50, 80.9)	0.2301

* Edgeworth expansion corrected likelihood ratio statistic.

Table A4

VAR residual serial correlation LM tests_Malawi

Lag	LRE* stat	df	Prob.	Rao F-stat	df	Prob.
Null hypothesis: No serial correlation at lag h						
1	20.87378	25	0.6996	0.820692	(25, 83.2)	0.7055
2	24.23238	25	0.5060	0.970463	(25, 83.2)	0.5136
Null hypothesis: No serial correlation at lags 1 to h						
1	20.87378	25	0.6996	0.820692	(25, 83.2)	0.7055
2	40.20093	50	0.8376	0.755631	(50, 80.9)	0.8562

* Edgeworth expansion corrected likelihood ratio statistic.

Table A5

VAR residual serial correlation LM tests_Botswana

Lag	LRE* stat	df	Prob.	Rao F-stat	df	Prob.
Null hypothesis: No serial correlation at lag h						
1	14.32115	25	0.9558	0.439787	(25, 16.4)	0.9688
2	19.47925	25	0.7736	0.662334	(25, 16.4)	0.8280
3	34.39190	25	0.0998	1.594445	(25, 16.4)	0.1653
4	22.32801	25	0.6167	0.804096	(25, 16.4)	0.6962
5	25.86408	25	0.4149	1.001471	(25, 16.4)	0.5113

* Edgeworth expansion corrected likelihood ratio statistic.

Table A6

VAR residual serial correlation LM tests_Lesotho

Lag	LRE* stat	df	Prob.	Rao F-stat	df	Prob.
Null hypothesis: No serial correlation at lag h						
1	26.41913	25	0.3855	1.034791	(25, 16.4)	0.4827
2	45.86602	25	0.0067	2.740433	(25, 16.4)	0.0192
3	35.89019	25	0.0733	1.718695	(25, 16.4)	0.1293
4	31.57163	25	0.1708	1.377942	(25, 16.4)	0.2535
5	29.61539	25	0.2390	1.240135	(25, 16.4)	0.3310

* Edgeworth expansion corrected likelihood ratio statistic.

Table A7

Test for model stability

Root	Modulus
Roots of characteristic polynomial_Kenya	
0.646920	0.646920
0.409156	0.409156
0.232841	0.232841
–0.184374 – 0.060729i	0.194118
–0.184374 + 0.060729i	0.194118
Roots of characteristic polynomial_Nigeria	
0.490195 – 0.083587i	0.497271
0.490195 + 0.083587i	0.497271
–0.330154	0.330154
0.283817	0.283817
0.117660	0.117660
Roots of characteristic polynomial_Malawi	
0.296504 – 0.368287i	0.472810
0.296504 + 0.368287i	0.472810
–0.103794	0.103794
0.080328 – 0.014737i	0.081669
0.080328 + 0.014737i	0.081669
Roots of characteristic polynomial_Botswana	
–0.516231 + 0.740203i	0.902439
–0.516231 – 0.740203i	0.902439
0.876663	0.876663
0.412546 – 0.758136i	0.863113
0.412546 + 0.758136i	0.863113
0.764310 – 0.393898i	0.859841
0.764310 + 0.393898i	0.859841
–0.270397 + 0.792479i	0.837340
–0.270397 – 0.792479i	0.837340
–0.829471	0.829471
–0.757124 – 0.298408i	0.813808
–0.757124 + 0.298408i	0.813808
–0.071719 – 0.791619i	0.794861
–0.071719 + 0.791619i	0.794861
0.767330 – 0.200678i	0.793137
0.767330 + 0.200678i	0.793137
0.459297 + 0.578302i	0.738503
0.459297 – 0.578302i	0.738503
–0.342985	0.342985
–0.041722	0.041722

(Table continues on the next page.)

(Continued.)

Root	Modulus
Roots of characteristic polynomial_Lesotho	
0.941724	0.941724
0.561514 + 0.727058i	0.918646
0.561514 – 0.727058i	0.918646
–0.591382 – 0.696287i	0.913536
–0.591382 + 0.696287i	0.913536
0.052196 + 0.904053i	0.905559
0.052196 – 0.904053i	0.905559
0.793259 – 0.364628i	0.873048
0.793259 + 0.364628i	0.873048
–0.292640 – 0.792095i	0.844425
–0.292640 + 0.792095i	0.844425
0.129787 – 0.804526i	0.814927
0.129787 + 0.804526i	0.814927
–0.800525	0.800525
–0.719013 + 0.286494i	0.773988
–0.719013 – 0.286494i	0.773988
0.283110 + 0.312976i	0.422025
0.283110 – 0.312976i	0.422025
–0.187619 + 0.275350i	0.333194
–0.187619 – 0.275350i	0.333194

Notes: No root lies outside the unit circle. VAR satisfies the stability condition.

Table A8

VAR lag order selection criteria_Nigeria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	158.1529	NA*	8.42e-11*	–9.008994	–8.784529*	–8.932445*
1	180.0537	36.07193	1.03e-10	–8.826689*	–7.479900	–8.367395
2	206.3874	35.62799	1.05e-10	–8.905143	–6.436031	–8.063105
3	229.1186	24.06824	1.60e-10	–8.771680	–5.180243	–7.546897
4	250.0975	16.04272	3.81e-10	–8.535147	–3.821387	–6.927620

* VAR Lag length selection criteria is based on minimum value of BIC, HQ, or AIC (–9.008994).

Table A9

VAR lag order selection criteria_Kenya

Lag	LogL	LR	FPE	AIC	SC	HQ
0	367.5033	NA*	6.94e-16*	–20.71447	–20.49228*	–20.63777*
1	389.0502	35.70630	8.60e-16	–20.51715	–19.18400	–20.05695
2	416.3901	37.49475	8.26e-16	–20.65086	–18.20674	–19.80715
3	446.1049	32.26178	8.14e-16	–20.92028*	–17.36520	–19.69307

* VAR Lag length selection criteria is based on minimum value of BIC, HQ or AIC (–20.71447).

Table A10

VAR lag order celection criteria_Malawi

Lag	LogL	LR	FPE	AIC	SC	HQ
0	54.51434	NA*	0.000156*	–3.089079	–2.999293*	–3.058459*
1	56.04788	2.796459	0.000181	–2.943993*	–2.674635	–2.852134
2	58.33933	3.908946	0.000200	–2.843490	–2.394561	–2.690392
3	59.24307	1.435354	0.000242	–2.661357	–2.032856	–2.447020
4	60.06913	1.214785	0.000296	–2.474655	–1.666581	–2.199078

* VAR Lag length selection criteria is based on minimum value of BIC, HQ or AIC (–3.089079).

Table A11

VAR lag order selection criteria_Botswana

Lag	LogL	LR	FPE	AIC	SC	HQ
0	421.2482	NA	1.60e-17	–24.48519	–24.26072*	–24.40864
1	461.5857	66.43831	6.61e-18	–25.38740	–24.04061	–24.92810
2	491.4981	40.46960*	5.48e-18	–25.67636	–23.20724	–24.83432
3	514.0938	23.92488	8.37e-18	–25.53493	–21.94349	–24.31015
4	561.6097	36.33573	4.19e-18*	–26.85940*	–22.14564	–25.25187*

* VAR Lag length selection criteria is based on minimum value of BIC, HQ or AIC (–24.48519).

Table A12

VAR lag order selection criteria_Lesotho

Lag	LogL	LR	FPE	AIC	SC	HQ
0	322.2460	NA	5.41e-15*	–18.66153	–18.43707*	–18.58498*
1	342.8748	33.97678	7.13e-15	–18.40440	–17.05761	–17.94511
2	374.1950	42.37439*	5.44e-15	–18.77618	–16.30706	–17.93414
3	392.7262	19.62133	1.05e-14	–18.39566	–14.80422	–17.17088
4	432.1238	30.12757	8.52e-15	–19.24258*	–14.52882	–17.63505

* VAR Lag length selection criteria is based on minimum value of BIC, HQ, or AIC (—18.66153).

Acknowledgement

I want to thank the journal reviewers for their constructive input and appreciated recommendations. Furthermore, I convey my profound gratitude to the Hungarian government through the Tempus Public Foundation for the PhD Scholarship award and to the Kenyan government for nominating and granting me the chance to study in Hungary. I acknowledge my supervisor, Dr Daniel Kehl of the Doctoral School of Regional Policy, and Economics, for his technical advice, support, and continued encouragement while preparing this research manuscript.

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