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Public debt and macroeconomic stability among sub-Saharan African countries: a system GMM test approach

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ABSTRACT

This study examined the effect of public debt on macroeconomic stability among 45 sub-Saharan African (SSA) countries for the period 2005–2022 using the two-step system Generalized Method of Moments (GMM). The study disaggregated public debt into domestic and foreign borrowing and determined the effect of each on inflation and economic growth. In agreement with recent studies, we found compelling evidence of negative effect of both domestic and foreign borrowing on economic growth and a positive effect on inflation among SSA countries. The empirical results reveal that a unit increase in domestic borrowing reduces economic growth by 0.06 percent and raises inflation by about 0.14 percent, while the same increase in foreign borrowing reduces economic growth by 0.01 percent and increases inflation by 0.05 percent holding other factors constant. These results imply that increase in public debt causes macroeconomic instability, and that domestic borrowing has a relatively larger impact on macroeconomic variables compared to foreign borrowing. The policy implication of the current study is that SSA countries should avoid excessive borrowing by operating a fiscal deficit within individual country threshold limits to contain growth in public debt. The SSA countries should also ensure borrowed funds are channeled into projects that bring revenue and other investment opportunities to amortize the debt stock.

IMPACT STATEMENT

Accumulation of public debt tend to have a negative impact of the countries macroeconomic stability depending on how it is financed. This is common especially in developing countries where different debt instruments among them domestic and foreign borrowing are used as mean to mobilize financial resources for covering budget deficit as well as investment in development projects. This study determines the effect of public debt (domestic and foreign) on main macroeconomic variables (inflation and economic growth) to determine the effect of each tool on the selected variables in sub-Saharan African countries. The results of this study will help the policy makers in choosing appropriate debt instrument to minimize negative effect on macroeconomic stability.

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Introduction

The effect of public debt on major macroeconomic variables such as gross domestic product (GDP) and inflation remains a major global concern among economic policymakers and researchers (Daba Ayana et al., 2023). Over the last decade the concern has picked up due to escalation of public borrowing owing to the need to finance infrastructural project, war and other calamities (Okoye et al., 2019). For instance, during the COVID 19 period, governments intensified borrowing to enhance their economic status and address the vagaries of the pandemic (Weicheng Lian et al., 2020). Prior to the pandemic period, the escalation in public debt particularly in SSA has been attributed need to finance high capital

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projects such as railways and roads which saw public debt especially external debt increase rapidly (Azolibe, 2022). Although borrowing to finance capital projects has been justified as means to increase capital base and guarantee future income flow to the developing countries, the effect of such action remains the central challenge among developing countries. This is so since in some cases borrowed funds have been misappropriated through corruption and embezzlement (Manasseh et al., 2022).

As at 2020, out of \$92 trillion global public debt, developing countries owe almost 30% of this amount with over 70% of its debt owed to China, Brazil and India (Kharas & Bhattacharya, 2023). The African countries' public debt in particular has increased to \$1.8 trillion, a 183% growth since 2010 and four times higher than the GDP growth rate which has been termed to be a significant increase that might have adverse effect on the macroeconomic stability (UNCTAD, 2023). More so, the problem is pronounced in developing countries such as sub-Saharan African where governments have continued to acquire expensive commercial loans issued both locally and from international sources as the quickest means to finance budget deficit (Manasseh et al., 2022). Therefore, assessing the effect of public debt on major macroeconomic variables such as inflation and economic growth in these countries is essential. This study selected inflation and economic growth as the representatives of macroeconomic stability due to their direct effect on peoples' living standards, the purchasing power of the vulnerable group in the society as well as political and economic effect. For instance, political class is likely not to allow undue inflation and declining economic growth since it would affect the voters attitude and government choice during elections (Fasanya et al., 2021).

While there are numerous studies that have been conducted on the nexus between public debt and macroeconomic stability, no consistent evidence exist especially on the effect public debt on inflation and economic growth on either positive or negative direction. The results and evidence obtained differ significantly based on the region, analytical model employed and public debt categorization. For example studies such as, Oyeleke (2021) in Nigeria, Ssebulime and Edward (2019) and Aimola and Odhiambo (2021a), in Ghana found a positive relationship between public debt and inflation while others such as Aimola and Odhiambo (2020) found negative relationship between public debt and inflation. Similarly, Tarawalie and Jalloh (2021) study on external debt and economic growth nexus among the Economic Community Of West African States (ECOWAS) member countries using panel corrected standard errors model found no significant relationship between public debt and economic growth. Jama (2021) on the other hand found that increase in public debt increases economic growth in East African countries. The negative relationship between public debt and economic growth has also been reported by Rana and Wahid (2017), Saungweme and Odhiambo (2021) and Afonso and Ibraimo (2020) in Bangladesh, South Africa and Mozambique respectively.

The discrepancies in the results obtained from the sampled studies reveal that there is still no consensus on the direction of the relationship between public debt and our selected macroeconomic variables, which formed the basis of the current study. The current study makes the following primary contributions to the existing studies; First, it contributes to existing body of literature on the effect of public debt on the selected macroeconomic variables since their yet to be consensus on actual relationship between these variables. Second, the current study disaggregated the public debt into domestic and foreign borrowing and determined the potential effect of each debt instrument on macroeconomic stability as suggested by Aimola and Odhiambo (2021b). Disaggregating public debt into domestic and foreign debt helps in capturing the effect of individual debt instrument on macroeconomic stability because these variables have varying vulnerability, especially in developing countries where they are used simultaneously (Afonso & Ibraimo, 2020). Third, this study enables policy makers to understand the link between public debt instruments (domestic and foreign debt) and main macroeconomic variables (inflation and GDP growth). Finally, the study used the system-generalized method of moments (GMM) for 45 SSA countries spanning from 2005 to 2022, which updates the stock of available literature using current data set.

Public debt, inflation and economic profile in Sub-Saharan African region

The debt burden in sub-Saharan African countries has been termed as a major hindrance to growth and development as wells as macroeconomic management (Manasseh et al., 2022). For instance, high debt

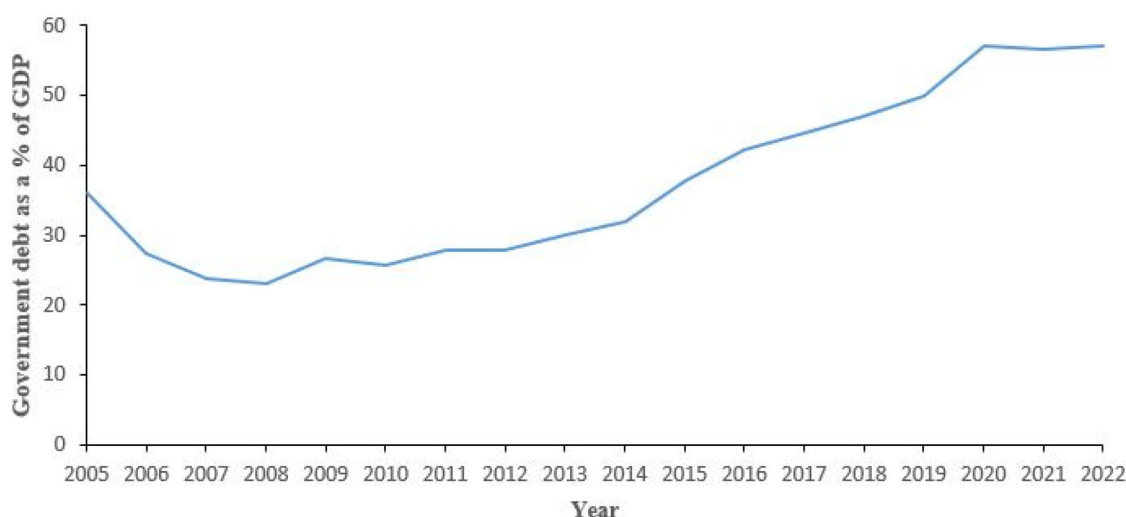


Figure 1. Public debt (% of GDP) profile in the sub-Saharan African region.

stock in the region has continued to hamper domestic revenue mobilization, which has further led to escalation of debt burden in the region. The region's public debt profile from 2005 to 2022 can be visualized as shown in [Figure 1](#). Trend analysis over this period is crucial because it represents the time when public debt had a wide range of variation. For example, it is over this period when the Paris Club external debt relief deal and exit from London Club debt obligations were executed between 2005 and 2006, thus considerably reducing debt burden for the member countries (Aimola & Odhiambo, 2021a). As shown in [Figure 1](#), public debt in the sub-Saharan African region shows a declining trend from 36.01% in 2005 to the lowest of 23.2% in 2008, before rising to the highest point of 57% in 2020. Individually, SSA countries public debt profile has a mixture of high and low levels of public debt as a percentage of GDP with more than half of countries having public debt greater than 50% of the GDP. For instance, some countries such as Eritria, Carbo Verde, Mozambique Republic of Congo, Sierra Leone and Zimbabwe have had instances higher public debt of over 90% of the countries' GDP. Countries Eritria, Carbo Verde and Mozambique have also recorded the highest public debt at 163.8%, 127.4% and 104.5% as at 2022. On the other hand, countries such as Democratic republic of Congo, Botswana and Equatorial Guinea have maintained a low public debt profile amounting to 14.6%, 19.9% and 27.1% of the GDP implying that the public debt in the region have a diverse trend (Africa, 2023).

Prior to 2005, public debt in most developing countries was characterized by huge external borrowing to meet the governments' financial needs, this led to the overall debt accumulation. The debt stock continued to grow due to capitalization of interest defaults as well as payment of arrears, even when no new loans are acquired. The implementation of the first and second phases of Paris Club debt relief paid which off external debt arrears and reduced external debt stock by almost 33% came as a savior to most developing countries, SSA inclusive. Since 2009, public debt as a percentage of GDP has shown a steady rise. This is mainly due to a shift in countries' borrowing priorities from external to domestic borrowing to meet their financial obligations. Since then, the domestic versus external debt ratio has grown from as low as 11:89 in the early 1990s to 37:63 in 2019 (Heitzig, 2021). The debt problem continues to be a major challenge especially among SSA countries, given that most borrowed funds are misappropriated either through corruption or investing in low-priority projects due to poor governance (Oyeleke, 2021). As pointed out by Daba Ayana et al. (2023), public debt could serve as a major hindrance to macroeconomic performance in SSA characterized by high inflation incidences and low economic growth across countries. The trend in inflation and economic growth in the SSA region from 2005 to 2022 can be visualized is as shown in [Figure 2](#). From this figure, we notice that the two variables seem to have a mix of upward and downward movement with some years' inflation rate rising to double digits' values, while economic growth shrinks to negative values. To start with, the inflation rate, the region has experienced various instances of high inflation rates running to the double-digit figure. For instance, years such 2008, 2012 and 2022 have recorded highest levels of inflation at 10.3%, 6.5% 9.3%



Figure 2. Trend in inflation and economic growth in sub-Saharan African region from 2005 to 2022.

respectively with the highest rate being in 2008. The high inflation rate in the region has mainly been due to the adoption of expansionary fiscal policies financed by central banks to cover up the fiscal deficit that has kept unfolding badly by causing macroeconomic instability through rising inflation. Other instances of high inflation, especially between 2007 and 2009, are attributed to the ripple effects of the 2008 global financial crisis, which led to a decline in oil prices and rising global unemployment (Botta, 2020). SSA economic growth trend over the period has also mixed up and downward trends, with some years such as 2020 recording negative growth rates. In general, the rate of economic growth in the region remained very low, with the highest rate being 5.9% in 2010. The low economic growth rate in the region over the years can be attributed to a number of underlying factors, such as low levels of domestic investments, misplaced economic priorities, political instability in some countries, and the recent 2019-2020 COVID 19 pandemic. The COVID 19 pandemic for instance led to lockdowns in most countries which shrunk business operations and global production. This can explain why the region's economic growth rate was negative in 2020, as most of economies relied on imported goods and materials for consumption and production. The trend analysis of inflation and economic growth in the region shows some level of macroeconomic instability, which needs to be addressed.

The rest of this paper is organized as follows; section two provides an overview of the theoretical and empirical literature. Section three presents the study methodology. Section four presents the results of the study and a discussion, and lastly, section five provides the study conclusion and policy recommendations.

2. Theoretical and empirical literature review

2.1. Theoretical literature review

Keynesian expenditure theory postulates that public debt is necessary for stimulating aggregate demand and keeping the economy towards a full employment path. In contrast, some economists have argued that increasing taxes is the best way to finance government expenditures. This is however faced with the challenge of reduction in consumers' disposable income, which lowers aggregate demand and general consumption power in the economy (Ribeiro & Lima, 2019). This makes incurring public debt an option for increasing governments' financial resources even though it has a varying effect on macroeconomic stability. Hilton (2021), suggest that rising public debt adversely affects macroeconomic stability in the following ways: First, acquiring public debt to finance recurrent government expenditure increases aggregate demand relative to supply, which causes inflation. Second, acquiring domestic debt increases the interest rate in financial markets that crowds-out local private investments, thus negatively affecting

economic growth. Further, increasing government debt causes an intergenerational challenge in bearing the burden. This implies that reckless borrowing in the current period has a negative effect on the capital stock of future generations. This is emphasized by Ikiz (2020) who states that raising current government debt will force future governments to raise taxes to offset the debt obligations as proposed by Ricardian Equivalence Theory.

The classical economists such as Adams Smith, on the hand argue that the government is naturally wasteful hence increased borrowing should always be viewed as a policy concern (Albu & Albu, 2021). The wastefulness of the state hinders capital formation, which in turn hinders economic growth while causing inflation especially when the borrowed funds are used in financing recurrent government expenditures, which surge aggregate demand (Sinaga et al., 2021). According to the classical theory of public, the government should be sensible like the household in operating a balanced budget while refraining from excessive borrowing. The classical economist argue that public borrowing should be reserved for investment in development projects or for financing war and should be repaid as soon as possible to avoid the accumulation of penalties and interests. Otherwise, public debt will be burdensome if used to finance other government outlier expenditures (Bofinger, 2022).

Additionally, modern theory of public debt believes that internally held public debt element (domestic borrowing) is non-detrimental to the economy since it is owed to self. According to this theory, external debt is the only harmful, since it is paid to foreigners. This is so since the process of repaying principal and interest on debt, the transfer of real goods, as well as services is involved from the debtor to the creditor, leading to the loss of assets that could otherwise remain in the country to develop the economy (Barreyre & Delalande, 2020).

Though Keynesian and classical theories of public debt agree that public debt of any kind can causes macroeconomic instability, the modern theory of public beliefs that only external/foreign debt hinders the stability of macroeconomic variables. This justifies disaggregating the public debt into domestic and foreign debt to determine the effect of each debt type on selected macroeconomic variables. Disaggregating the variables is also supported by Olaoye et al. (2022) who argue that what matters when analyzing public debt and its macroeconomic effect is the mode of public debt financing. This is because of the maturity period mismatch for domestic debt, and exchange rate vulnerability for the foreign debt. For instance, exchange fluctuation, experienced in most developing countries, puts the economy into a vulnerable situation when much of the public debt is foreign denominated due to disruption of capital flow as well as volatile GDP growth. The shift from foreign to domestic borrowing is also associated with the challenge of loan maturity mismatch, where short-term loans are invested in long-term development projects. This brings a challenge during debt repayment since the government will be forced to repay debts who investments are yet to start generating revenue. Another challenge associated with domestic debt is too much absorption financial resources by the government from local banks and other lending institutions. This causes financial instability and crowding out of private investment (Bashir Jama, 2021).

2.2. Empirical literature review

2.2.1. Public debt and inflation nexus

Despite the available theoretical literature on the macroeconomic effect of public debt and a widely accepted thought that the mode of financing public debt matters for macroeconomic stability, the literature on this subject is still scarce. For instance, most of the available studies have concentrated on the effect of aggregate debt stock on macroeconomic stability. Similarly, less research has been done in developing countries, especially in SSA, regarding how the mode of public debt financing could affect macroeconomic stability. To start off on the empirical literature, Da Veiga et al. (2016) analyzed the relationship between public debt and inflation in African economies and revealed that public debt increases inflation. The study analyzed secondary panel data for 52 African states between 1950 and 2012 while considering three public debt levels as a percentage of GDP ($\leq 30\%$, 30% to 60% , and $90\% \geq$). The positive relationship between these variables is further supported by Fasanya et al. (2021) who used the Autoregressive Distributed Lag (ARDL) model with structural breaks to test whether Nigeria's fiscal deficit is inflationary. In this study, consumer price index was used as the dependent variable while money

supply and fiscal deficit were the main explanatory variables. To add on, a study by Olaoye et al. (2022) among 25 sub-Saharan African countries using Driscoll–Kraay standard error and the dynamic panel threshold model also found that out increase in the foreign debt worsens inflation which is in support of the modern theory of inflation. The study by Olaoye argues that continuous accumulation of public debt more so the foreign debt exposes the country to exchange rate fluctuation, which causes inflation.

Some studies have also shown that public debt does not cause inflation hence appropriate. For example Aimola and Odhiambo (2021a) study on the public debt and inflation nexus in Nigeria using Autoregressive distributed lag bounds model found that public debt does not cause inflation either in long or short run.

2.2.2. Public debt and economic growth nexus

Empirical studies on the relationship between public debt and economic growth have also shown a wide range of results as follows; To start with Rana and Wahid (2017) study on the relationship between fiscal deficits and economic growth in Bangladesh, the relationship between public debt and economic growth is negative. This study employed the error correction model, ordinary least squares, and Granger causality tests as analytical models and found a negative relationship between fiscal deficit and economic growth between 1981 and 2011. This is also supported by Sandow et al. (2022) study on the external debt and economic growth in 31 SSA countries. In this study, the negative relationship between external debt and economic growth was found in only those countries that had low public sector management, otherwise the relationship was found to be positive. To add on Yusuf and Mohd (2021) study on the impact of public debt on economic growth in Nigeria also found out a negative relationship between domestic debt and economic growth in short run. In this study, Autoregressive distributed lag model was employed on the time series data set between 1980 and 2018.

Some studies around this subject have also found positive relationship between public debt and economic growth. For example Kryeziu and Hoxha's (2021) study on the fiscal deficit and its effect on economic growth for the Eurozone countries between 1995 and 2015 and found out that there exists a positive relationship between fiscal deficit and economic growth. This study used multiple regression least squares model for analysis. The positive relationship between public debt and economic growth is also confirmed by Aragaw (2021) on the study twin deficit and economic growth in selected African countries. This study used the panel threshold model in addition to the bootstrap panel granger causality test and found that public debt has a significant positive effect on economic growth when the debt-to-GDP ratio is low.

To sum up, negative effect of public debt on macroeconomic stability which is widely accepted proposition is caused by the problem of debt overhung that results from excessive wasteful borrowing (Botta, 2020). The debt-overhung problem creates fear among investors that they would be overtaxed to repay debt, which makes them to shift their businesses to other countries with less debt obligations. It also increases debt servicing costs at the expense of investing in development projects, which would otherwise generate income and create employment (Onafowora & Owoye, 2019).

3. Methodology

3.1. Data description

The data for this study was annual panel data sourced from the World Bank database (World Development Indicators) and the IMF (world economic outlook). Given that some data was not available on IMF and World Bank data bases, some data sites such as www.tradingeconomics.com as well as individual countries' central banks were also used for collecting data. Unbalanced panel data covering the period between 2005 and 2022 for 45 countries in SSA was collected. All variable data, except domestic borrowing, were obtained directly from the stated databases in their respective measurement units. The author calculated the data for domestic debt by dividing the total value of domestic debt by the total GDP in a given year, both expressed in constant local currency units (LCU). Although there are long panels for some countries, 2005–2022 was selected as the study period to ensure uniform coverage for all countries, since it is the period when data on most variables is available.

3.2. Justification of two-step system GMM estimation model

The two system-generalized method of moments (GMM) proposed by the Blundell and Bond (1998) and Arellano and Bover (1995) was used as the main estimation model in this study. The model was chosen since it is designed to suit the dynamic panel data analysis with short panels and many cross-sectional units. The GMM standard procedure basically differentiate the instruments and instrumental variables in which endogenous variables are put in the instrumental variables group as lags of these variables. Similarly, the exogenous regressors as well as other appropriate instruments are included in the model's instrumental variables (IV) procedure which corrects autocorrelation in panel data analysis (Van Bon, 2015). In particular, the two-step system GMM was selected for this analysis based on the following considerations. First, the model is usually appropriate when the number of cross-section units (N) is greater than the number of time series (T), which suits our data set with 45 cross-sections (countries), spanning over 17 years from 2005 to 2022. Second, the model has the ability to solve the problem of weak instruments as well as the downward/upward bias problem which is associated with the difference GMM model and common in panel data analysis. Third, the system GMM model also corrects the problem of reverse causality and endogeneity bias caused by feedback relationship between variables, as well as omitted variable biases that are common in macroeconomic analysis. Moreover, the two-step system GMM model controls for the individual country-specific effect (π_i) as well as time effects (δ_t) and is more efficient than the one-step system GMM model (Caporale et al., 2015). To test the validity of the estimated results, this study conducted two main GMM post-estimation tests which are Hansen test for instruments validity and the Arellano-Bond test for first and second order autocorrelation. The Hansen test provided the null hypothesis of over-identifying restrictions, implying that instruments used in the model are valid, hence uncorrelated with the error term, which should not be rejected. This means that the p-value of Hansen test should be as large as possible. The Arellano-Bond test for first and second order auto correlation were used to detect the autocorrelation problem. While the first order autocorrelation (AR1) could be ignored since it is expected to be significant, the second order autocorrelation is emphasized on seeking not to reject the null hypothesis at the 5% confidence level in order to show that the model does not suffer from autocorrelation problem.

3.3. Model specification and data

This study analyses the link between public debt (domestic and foreign borrowing) and selected macroeconomic variables (inflation and GDP growth). In the model specification, the study used both theoretical and empirical literature to select the independent variables and classified them as the main independent variables and control variables. Two models were specified with GDP growth and inflation (INF) as the dependent variables. In the first equation, this study modeled GDP growth as a function of domestic borrowing (DB), foreign borrowing (FB), official development assistance (ODA), gross capital formation (CPF), real interest rate (RIR), exchange rate (EXR) and foreign direct investment (FDI). In the second model, foreign borrowing (FB), domestic borrowing (DB), real interest rate (RIR), exchange rate (EXR) official development assistance (ODA), gross capital formation (CPF) and money supply (M2) were independent variables to explain the inflation as the dependent variables.

In the measurement of the study variables, foreign borrowing was measured as the total external debt obligations owed to non-residents of a country while the domestic debt was measured as the total financial obligations owed to local lenders including banks and non-bank financial institutions. Both variables were expressed as a percentage of GDP and they also served as main explanatory variables in both models.

Other variables in the study such as real interest rate (RIR), exchange rate (EXR) and broad money supply (M2), were measured as annual percentage domestic interest rate in the economy, change in value of local currency against US dollar and annual percentage increase in money supply in the economy respectively. Official development assistance inflow (ODA), gross capital formation (CPF) and foreign direct investment (FDI) were expressed as percentages of GDP. These groups of variables served as control variables, supported by theories such as the fiscal theory of price level, Keynesian expenditure theory, and also empirical studies like Afonso and Ibraimo (2020), Ho et al. (2021), Agoba (2021), and Aimola and Odhiambo (2021b) who used them as independent variables. For instance, Afonso and Ibraimo (2020), points out that public debt influences macroeconomic stability through interest rate and

exchange rate variations depending on the mode of debt financing. Similarly, domestic debt and domestic debt servicing affect lending interest rates due to competition in the financial markets, while foreign debt is influenced by exchange rate fluctuations since the depreciation of the local currency implies paying more for debt denominated in foreign currency. Other variables, such as official development assistance, capital formation, money supply, and foreign direct, are also supported by studies such as Ho et al. (2021), Agoba (2021), and Aimola and Odhiambo (2021a), who used them as determinants of macroeconomic stability.

To analyze and provide estimates on the link between our variables of interest, this study adopted a two-step system Generalized Method of Moments (system GMM) by Blundell and Bond (1998) and Arellano and Bover (1995) and assumed a dynamic relationship between the variables as follows:

$$\ln\text{GDP}_{it} = \alpha_0 + \alpha_1 \ln\text{GDP}_{it-1} + \alpha_2 \text{FB}_{it} + \alpha_3 \text{DB}_{it} + \alpha'_4 X_{it} + \pi_i + \delta_t + \varepsilon_t, \quad (1)$$

$$\ln\text{INF}_{it} = \beta_0 + \beta_1 \ln\text{INF}_{it-1} + \beta_2 \text{FB}_{it} + \beta_3 \text{DB}_{it} + \beta'_4 M_{it} + \pi_i + \delta_t + \varepsilon_t, \quad (2)$$

where $\ln\text{GDP}_{it}$ and $\ln\text{INF}_{it}$ represent the natural log of current gross domestic product and inflation level, respectively while $\ln\text{GDP}_{it-1}$ and $\ln\text{INF}_{it-1}$ are the one-year lags of gross domestic product and inflation respectively. X_{it} and M_{it} represent the set of control variables, which also served as independent variables while π_i , δ_t and ε_t represent country-specific effects, time effects, and stochastic error terms, respectively. $\alpha_1, \alpha_2 \dots \alpha_4$ and $\beta_1, \beta_2 \dots \beta_4$ are the parameters to be estimated. Theoretically, this study assumed a positive relationship between independent and dependent variables.

4. Results and discussion

4.1. Descriptive statistics

The descriptive statistics of the collected data is presented in Table 1. From this it can be observed that the standard deviation of domestic and foreign debt is high, implying that SSA countries are indebted differently. For instance, foreign borrowing has a mean value of 42.4 with standard deviations of 38.8, minimum and maximum values of 0.46, and 497.93, while domestic debt has a mean value of 25.44, the standard deviation of 22.23, and minimum and maximum values of -23.20, and 142.63, respectively.

4.2. Diagnostic tests

4.2.1. Unit root test

The current study conducted a unit root test prior to the empirical estimation to determine whether the variables used were stationary. The test was essential because time-series variables are analyzed in terms of trends, which in most cases tend to be non-stationary and hence need to be converted to their respective stationary form before analysis. The non-stationary dataset usually gives inappropriate (spurious) estimates because the critical value of the F-statistics assumes that the variables used in a multiple linear regression are stationary. For this purpose, the current study used the Fisher-type test to check whether the panel data collected was stationary and presented the results as in Table 2. The Fisher-type test was selected since it is suitable for unbalanced panel data, which the current study uses. The results

Table 1. Descriptive statistics of the model variables.

Variable	Acronym	Mean	Standard deviation	Min	Max
Inflation	INF	1.58	1.08	-3.20	6.32
Exchange rate	EXR	1.44	0.79	-3.38	3.03
Gross domestic product	GDP	5.12	2.02	-0.09	9.19
Official development assistance	ODA	8.12	8.67	0.01	92.14
Foreign borrowing	FB	42.42	38.82	0.46	497.93
Domestic borrowing	DB	25.44	22.23	-23.19	142.63
Total debt as % GDP	TB	66.38	50.52	-21.91	607.10
Broad money supply	M2	32.94	22.18	4.53	163.84
Capital formation	CPF	23.37	10.45	-3.95	79.40
Foreign direct investment	FDI	5.07	8.66	-11.19	103.33
Real interest rate	RIR	8.21	11.08	-79.80	65.31

Note. Inflation and exchange rates as expressed in log form.

Table 2. Panel test stationarity.

Variable	Inverse chi-squared (P)	Inverse normal (Z)	Inverse logit (L*)	Modified inv. chi-squared (Pm)
Inflation	222.29***	-6.79***	-7.31***	9.86***
Exchange rate (d)	394.19***	-13.63***	-15.82***	23.08***
Gross domestic product	359.42***	-8.45***	-12.50***	20.08***
Official development assistance	270.08***	-6.81***	-9.51***	13.42***
Foreign borrowing	442.60***	-5.96***	-13.16***	26.28***
Domestic borrowing (d)	388.26***	-11.61***	-15.33***	22.63***
Money supply (d)	226.97***	-7.97***	-8.19***	10.47***
Capital formation	147.01***	-2.10***	-2.99***	4.24***
Foreign direct investment	248.81***	-8.07***	-8.75***	11.83***
Total public debt as % of GDP	144.26***	-1.95**	-2.79*	4.04***
Real interest rate	318.44***	-10.62***	-12.94***	18.08***

Note. ***, ** and * denote 1%, 5% and 10% significance levels respectively.

Table 3. Cointegration test results.

Kao test for cointegration	Statistic	p-value
Dickey-Fuller t	6.27***	0.000
Modified Dickey-Fuller t	10.55***	0.000
Augmented Dickey-Fuller t	6.08***	0.000
Unadjusted modified Dickey-Fuller t	5.27***	0.000
Unadjusted Dickey-Fuller t	7.36***	0.000
Pedroni test for cointegration		
Modified Phillips-Perron t	5.95***	0.000
Phillips-Perron t	1.56**	0.028
Augmented Dickey-Fuller t	-2.18**	0.015
Modified Phillips-Perron t	5.95***	0.000

Note. ***, ** and * denote 1%, 5% and 10% significance levels respectively.

Table 4. Correlation matrix.

	INF	GDP	EXR	ODA	FB	DB	CPF	TB	RIR	M2	FDI
INF	1.00										
GDP	0.13	1.00									
EXR	0.17	0.05	1.00								
ODA	0.08	0.14	0.14	1.00							
FB	-0.15	-0.25	0.31	0.24	1.00						
DB	-0.07	-0.08	0.02	-0.01	-0.03	1.00					
CPF	-0.03	0.11	0.06	-0.077	0.19	0.08	1.00				
TB	0.01	0.26	-0.15	0.25	0.92	0.86	0.08	1.00			
RIR	0.14	0.04	0.09	0.03	0.06	0.12	0.18	0.07	1.00		
M2	-0.13	-0.17	0.08	0.01	0.07	0.49	0.01	0.02	0.13	1.00	
FDI	0.06	0.14	0.11	0.17	0.22	-0.01	0.02	0.26	0.21	0.18	1.00

reported in Table 2 show that all variables apart from the nominal exchange rate, domestic borrowing, and broad money supply are stationary at a level with the integration of order zero. The non-stationary variables were transformed to their first difference, indicated as (d), after which they became stationary in the same integration order of zero (I0). Integration of the same order among all variables implies a long-run relationship between them; hence, dynamic analysis is appropriate (Arellano & Bond, 1991).

4.1.3. Cointegration and correlation analysis

Given that some panel data sets used in this study are non-stationary, it was necessary to conduct a cointegration test to identify whether the non-stationary panels are integrated in such a way that they have stable relationship long-run (Ikiz, 2020). To this effect this study employed Kao (1999) as well as Pedroni (1999) test for cointegration in both tests seeking to reject the null hypothesis of no cointegration against the alternative hypothesis of cointegration across all panels. The results for the cointegration test is presented in Table 3. From the results, this study finds a very strong evidence for rejection of null hypothesis that there is no cointegration between panels. We therefore conclude that the variables used in the model have long-run stability (cointegrated) as required. Turning to correlation analysis, Table 4 presents the statistical correlation analysis of the study variables. This test is relevant since it help in the selection of the variables to include in the model so as to contain the problem of lack of independence between independent variables. This prevents independent variables from affecting the test power of one another (Sutihar, 2016). The results show a low pairwise correlation coefficient

Table 5. Public debt and inflation among sub-Saharan countries.

Variable name	OLS	FEM	DIF-GMM	SYS-GMM
lnInftaion(-1)	0.569*** (0.000)	0.151** (0.002)	0.158 (0.310)	0.366*** (0.000)
Domestic borrowing (d)	0.006** (0.044)	0.011 (0.146)	0.146** (0.010)	0.142*** (0.000)
Foreign borrowing	0.0002 (0.157)	0.001** (0.013)	0.008** (0.026)	0.049** (0.002)
Official development assistance	0.010** (0.021)	0.020** (0.005)	0.068** (0.012)	0.071*** (0.000)
Capital formation	-0.002** (0.032)	-0.0003 (0.945)	-0.025** (0.029)	-0.022** (0.001)
Real interest rate	-0.001* (0.083)	-0.018** (0.001)	-0.042** (0.001)	-0.024* (0.053)
Money supply (d)	0.030** (0.024)	0.024** (0.053)	0.032 (0.743)	0.066* (0.036)
Gross domestic product	-0.002 (0.831)	0.007 (0.441)	.035** (0.048)	0.068** (0.013)
AR(1)			0.022	0.007
AR(2) test			0.500	0.396
Sagan test for over identification			0.550	0.534

Note. ***, ** and * denote 1%, 5% and 10% significance levels respectively.

between the study variables except that of total public debt, domestic and foreign debt. This made the current study to drop total public debt as an independent variable in the final modeling since it could affect the test power of domestic and foreign debt in a multiple regression model (Akoglu, 2018). The pairwise correlation between the rest of the variables was less than 0.5 or 50% which is way below the threshold level conventionally set at 0.8 or 80% (Yusuf & Mohd, 2021).

4.3. Empirical results

4.3.1. Public debt and inflation in sub-Saharan countries

This study started by estimating effect of public debt on inflation, in which four analytical models were estimated and the results presented in Table 5. The first two columns present the results for the OLS model and fixed effects model, respectively, while the third and fourth columns are the results for the two-step difference GMM and two-step system GMM. Both GMM models are two-step and asymptotically more efficient than their one-step GMM counterparts. The first three models were used to justify the section final two-step system GMM as superior model and also serve as study's robustness checks. The selection of the system GMM model was validated by the fact that the difference GMM model in column three suffers from downward bias. The downward bias problem arises when the time series (T) is less than the cross-sectional units (N), such that the estimated parameters are smaller than the true value estimates. The coefficient of the lagged dependent variable in the difference GMM model is used to check for the downward bias problem. The fixed effect model and OLS model were estimated to provide the lower and upper bound estimates which are used to detect downward or upward bias problem. The difference GMM model is said to suffer from downward problem if the estimated lagged variable coefficient is close or below to that of fixed effect model. Otherwise, if the the coefficient is close to OLS's model then it is said to be having an upward bias problem (Blundell & Bond, 1998). In this case, the difference GMM suffers from the downward bias problem because the coefficient of ln inflation (-1) in the DIF-GMM model (0.158) is close to ln inflation (-1) in the FEM model (0.151).

From the two-step system GMM model presented in column four of Table 5, results show that the coefficients of domestic and foreign borrowing are positive and statistically significant, implying that public debt is inflationary. Similarly, the lagged inflation rate, official development assistance, money supply, and GDP growth have positive coefficients, implying that an increase in these variables is associated with an increase in inflation level among SSA countries. In addition, the coefficient of domestic debt is 0.142 and highly significant at all three significance levels, while foreign debt has a coefficient of 0.049 and significant at only 5% and 10% significance levels. This means that domestic debt is more inflationary than foreign debt holding other factors constant. On the other hand, the coefficients of

capital formation and real interest rates are negative and significant, implying that increasing interest rates and capital formation (domestic investment) lowers the inflation rate among SSA countries.

The findings of this study are consistent with studies such as Fasanya et al. (2021), Bolarinwaa and Olubiyi (2018), and Parsad and Inaba (2021), who found that public debt has a positive effect on inflation. The inflationary effect of public debt in most developing countries is due to the fact that these countries borrow to finance consumption and recurrent expenditure, which in turn raises aggregate demand relative to supply, thus causing inflation. The rising effect of GDP growth, money supply, and official development assistance rate on inflation is also supported by studies such as Moreira (2019). In this study an increase in economic parameters such as GDP growth increases people's living standards through enhanced economic income, which exerts demand pressure, causing demand-pull inflation, given the inelastic nature of the market supply side in most developing countries. This study also found that real interest rate and gross capital formation have negative effect on inflation, which is equally supported by studies such as Aimola and Odhiambo (2021b), who argue that inflation may decline when the interest rate increases because a high interest rate limits household borrowing thus lowering aggregate demand. On the other hand, an increase in gross capital formation is associated with the creation of more goods and services in the county, which lowers aggregate demand pressure.

These findings also contradict prior studies, such as Saungweme and Odhiambo (2021), who found a negative relationship between public debt on inflation. Although from previous studies, the effect of public debt on inflation is inconclusive, as shown by varying results which ranged from positive to negative and even no significant effect of public debt on inflation, the findings of the current study support the positive relationship between these variables.

Similarly, the two-step system GMM model suitability is justified by the Arellano-Bond test, the first and second autocorrelation, and the Sagan test for instrument validity (over-identification) tests. According to Blundell and Bond (1998), the estimated system GMM results are consistent if the Arellano-Bond first-order autocorrelation (AR1) is significant, whereas both the Arellano-Bond second-order (AR2) and Sagan tests are statically insignificant. The results from all AR1, AR2, and Sagan tests are satisfactory at probability values of $0.007 < 0.05$, 0.396 , and $0.534 > 0.05$, respectively, implying that the GMM model used is reliable and the results obtained are valid. The consistency of the variables' coefficient signs and size, as well as significance across the different models implies that the estimated results are highly robust.

4.3.2. Public debt and economic growth in sub-Saharan countries

The estimated results for the effect of public debt on economic growth are presented in Table 6. Four different models (OLS, fixed effect, two-step difference GMM, and two-step system GMM) were as well estimated to justify the selection of the study's final model, which is the system GMM model. Just as in the case of previous (public debt-inflation nexus) model estimation of OLS model was meant to give the

Table 6. Public debt and economic growth among sub-Saharan African countries estimation results.

Variable name	OLS	FEM	DIF-GMM	SYS-GMM
ln.GDP(-1)	.3657** (0.000)	.2407*** (000)	.1999** (0.007)	.3372** (0.004)
Domestic borrowing (d)	-.0119** (0.040)	-.01449** (0.014)	-.0391* (0.094)	-.0560*** (0.001)
Foreign borrowing	-.00197** (0.027)	-.0109 (0.334)	-.00432** (0.043)	-.0092** (0.002)
Official development assistance	.00853** (0.044)	.00233* (0.099)	.0076 (0.275)	.0265** (0.010)
Capital formation	.00754** (0.021)	.01618** (0.006)	.01439** (0.043)	.0130* (0.097)
Real interest rate	-.010132** (0.008)	-.0210** (0.001)	-.03027 (0.259)	-.0526** (0.029)
Foreign direct investment	.00890** (0.026)	.0183*** (0.000)	.0333* (0.064)	.0551** (0.022)
EXR	-.00315* (0.097)	-.008580 (0.873)	-.0316 (0.299)	-.0307* (0.085)
AR(1)			0.005	0.017
AR(2) test			0.584	0.244
Sagan test for over-identification			0.389	0.285

Note. ***, ** and * show 1%, 5% and 10% significance levels respectively.

upper bound of the coefficient, as the fixed effect model gives the lower bound. The selection system GMM is as well justified in this estimation because the lagged dependent variable's (GDP (-1)) coefficient in the difference GMM model is 0.1999, below the fixed effect coefficient of 0.2407, implying that the difference GMM suffers from a downward bias problem.

The estimation results reveal that domestic and foreign debt, as well as real interest and exchange rates, have negative and significant effects on economic growth. On the other hand, a one-year lag in GDP growth, official development assistance, gross capital formation, and foreign direct investment have a positive and significant effect on GDP growth among SSA countries.

These findings support previous empirical studies such Sharma (2021), Manasseh et al. (2022), and Afonso and Ibraimo (2020), who found that an increase in fiscal deficit is detrimental to the economy, especially when there is a problem of indebtedness. This is so since as government continues to operate fiscal deficit, the public debt increases leading to higher costs of debt servicing in terms of interest and principal for the maturing loans hence negative effect on economic growth. In most cases, countries find themselves in a public debt circle where new loans are borrowed to service the old one leading an indebtedness crisis (Manasseh et al., 2022). This continuous circle leads to serious indebtedness problem especially when it accompanied by low investment and revenue collection added to high interest on borrowing. These results explain why bilateral, multilateral, and many other forms of loans that have been advanced to SSA have not influenced development, such as infrastructure in the region. Similarly, the positive effect of lagged GDP growth on current economic growth is also logical because we expect the channels of growth, such as increased investment, to be persistent and, thus, likely to influence economic growth over time.

On the other hand, the findings of this study contradict the propositions of the neoclassical growth theories, as well as empirical studies such as Yusuf and Mohd (2021) who argue that public debt positively influences economic growth, and Ndoricimpa (2020) study argues that public debt is neutral (has no effect) on economic growth at low levels of debt.

The validity of the estimated results were equally tested using the Arellano-Bond test for the first-order (AR1) and second-order autocorrelation (AR2), as well as the Sagan test for instrument identification. The results from the AR1, AR2, and Hansen tests are satisfactory, as presented in model four, implying that the system GMM used in this study does not suffer from second-order serial correlation and that the instruments used are valid.

5. Conclusion and policy recommendations

This study examined the effect of public debt on macroeconomic variables, namely GDP growth and inflation, among SSA countries. The study employed a number of estimation models among them OLS, fixed effect, two step difference and system GMM models. The two-step system GMM was adopted as the final analytical model where public debt was disaggregated into domestic and foreign borrowing as the main explanatory variables, while inflation and economic growth were the dependent variables. Other variables in the models were of exchange rates, real interest rates, official development assistance, gross capital formation, foreign direct investment, and broad money supply, which served as control. The results of this study show that the effect of domestic borrowing is significantly negative on economic growth ($\beta = -0.0560$) and positive ($\beta = 0.142$) on inflation. Similarly, foreign borrowing was found to have significant negative effect on economic growth ($\beta = -0.0092$) and positive ($\beta = 0.049$) significant effect on inflation. The findings showed that domestic borrowing had a higher regression coefficient implying it causes more macroeconomic instability than foreign borrowing among SSA countries. This study also found that increase in capital formation and real interest rates lowers inflation, while official development assistance inflow, money supply, and GDP growth increase inflation. Furthermore, increase in capital formation and official development assistance inflow were found to have a positive effect on economic growth, while increases in real interest rates and exchange rates (local currency depreciation) were found to have a negative and significant effect on economic growth.

The main conclusion derived from this study is that increase in public debt financed by either domestic or foreign instruments hinders economic growth and increases the inflation rate among SSA countries. The study also concludes that both inflation and economic growth are more responsive to

domestic than foreign borrowing. This is because domestic borrowing has a higher crowding out effect on private invests due to limited access to financial resources in case of high domestic government borrowing. Given that most of sub-Saharan African countries are driven by private and informal sector, crowding out of private investment leads to a sharp decline in output (negative economic growth) as wells supply shortage causing demand-pull inflation in the economy (Alper et al., 2020).

The policy implication of the current study is that sub-Saharan African countries should reduce public debt by designing robust ways of generating domestic revenue such as adoption of public private partnerships with investment schemes that will ease pressure on the fiscal budget and growth on public debt. Specific recommendations of this study are as follows; First, since public debt has negative effect on macroeconomic stability, this study recommends policy maker to prioritize on maintaining sustainable public debt by operating a low debt rates in the economy. This can be achieved through designing a threshold debt level that public debt in an economy should not exceed. Second, since it almost impossible for developing countries such as SSA countries to stop borrowing completely, this study recommends a reduction in domestic debt as a component of total public debt since this variable has proven to have a severe adverse effect on macroeconomic stability. Third, we recommend the management of exchange rate fluctuations through the adoption of fixed exchange rate regime and maintaining a stable interest rate to achieve macroeconomic stability since these variables have proven to have adverse effect on macroeconomic stability when left to fluctuate. Finally, this study also recommends SSA countries to encourage foreign direct investment and capital formation, since these variables have shown stabilizing effect on the price level and enhanced economic growth.

6. Study limitation and recommendation

Although this study has addressed its objective, it was limited by the fact that other measures of macroeconomic stability were not included in its analysis. This study used economic growth and inflation as measures of macroeconomic stability. Future studies are encouraged to replicate this study by including more macroeconomic variables, such as employment and the balance of payments. Equally, the current study concludes that public debt acquisition hinders the achievement of macroeconomic goals, yet from the experience of developed countries and countries with low debt levels, public debt has proven to enhance macroeconomic stability. Therefore, future studies are also encouraged to determine the threshold level of public debt below which it is macroeconomic enabling. This will form the basis for setting a debt cap in sub-Saharan African countries.

Authors contributions

Jerry Ogutu Sumba, Initiated the research, collected data, conducted the analysis and drafted the manuscript Rogers Ochenge, Paul Mugambi, and Collins Muimi Musafiri, supervised the study, conducted data analysis, reviewed the draft manuscript and approved it for submission.

Disclosure statement

This research has no any competing interest; it was carried out as part of fulfilment of academic requirement for master's degree from University of Embu.

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Data availability statement

The data used in this study is freely available on World Bank Open Data base (<https://data.worldbank.org/>), International Monetary Fund IMF (<https://www.imf.org/en/Data>) and www.tradingeconomics.com and also upon requesting the corresponding author.

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