Int. Journal of Economics and Management 14 (3): 447-460 (2020)

IJEM
International Journal of Economics and Management
Journal homepage: http://www.ijem.upm.edu.my

Non-Linear Effect of External Debt on Economic Growth: Evidence From Sub-Saharan African Countries

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ABSTRACT

The non-linear impact of external debt on economic growth has not been adequately investigated for sub-Saharan African (SSA) countries, as previous studies paid little attention to the region. Moreover, previous panel studies on the subject did not consider cross-section dependence in their analysis. Hence, this study aimed to fill this gap in the literature by investigating 30 SSA countries' panel data from 1985 to 2018 through the augmented mean group (AMG), and common correlated effects mean group (CCEMG) estimators. The study results indicate that external debt exerts a non-linear impact on economic growth in SSA countries and that the relationship between the two variables follows an inverted U-shaped pattern. Furthermore, thresholds of external debt beyond which it depresses economic growth in the region were computed at 44-53% of GDP and 196-232% of export. These results call for adopting a pragmatic approach on the part of SSA governments towards reducing their external debt burden, by way of efficient use of the already accumulated debt. The external debt thresholds should also be embedded in their external debt management strategy to reduce the negative impact of high external debt.

JEL Classification: G510, E100

Keywords: augmented mean group; economic growth; external debt; non-linear; sub-Saharan African countries

Article history:
Received: 1 March 2020
Accepted:16 October 2020

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INTRODUCTION

The need to attain robust growth and sustainable development has led most sub-Saharan African (SSA) countries to adopt different policies and strategies at various stages of their development since attaining their independence. However, owing to distortions in the economic, financial and institutional arrangements in this region in the 1960s, recourse to external debt to galvanise the economies towards sustainable development became the norm from the 1970s onwards (Fosu, 1996, 1999; Ouedraogo, 2015). Over the past few decades, the external debt stocks of SSA countries have increased significantly, making the debate on its role in financing these countries' development process particularly important (Drine and Nabi, 2010; World Bank, 2010, 2017). It has been documented that from the 1980s, when the debt crisis involving several nations of the world occurred, external debt in African economies had reached unsustainable levels, while they were simultaneously grappling with its concomitant negative macroeconomic effects (Fosu, 1996, 1999; Iyoha, 1999; Ndikumana and Boyce, 2011). As external debt is hardly denominated in a borrower country's currency, this situation predisposes these economies to various distortionary issues such as exchange rate fluctuation, sudden-stops in capital flows and sharp capital outflow which could potentially snowball into a full-blown macroeconomic crisis (Ekici and Nemlioglu, Hemming et al., 2003; Park et al., 2018; Pattillo et al., 2004).

The Heavily Indebted Poor Countries (HIPCs) initiative, which the International Monetary Fund (IMF) and the World Bank inaugurated in 1996, was the first comprehensive campaign to terminate unsustainable debt and assist the permanent exit from debt dependence among the poor economies of the world. Under this initiative, Western leaders agreed to write off large portions of several African nations' external debts. However, stocks of external debt have been increasing in most of these countries, following unbridled borrowing in recent years, coupled with the collapse in local currencies and commodity prices (World Bank, 2010; World Bank, 2017). A noticeably big beneficiary of the debt forgiveness initiatives in SSA was Mozambique, which had its external debt slashed to 60% of GNI in 2005, - from 116% of GNI in 2000. It declined even further to 36% of GNI in 2011. As of 2015, it had increased to 69.5% of GNI (World Bank, 2017). Similar trends can be observed for other SSA countries like Angola, Cameroon, Gabon, Senegal and Zambia. While facing this conundrum, they have equally been inundated with a series of debt-rescheduling, which has further aggravated the debt crisis. In SSA, debt rescheduling dates back to the 1980s, and the total which stood at US$13.94billion in 1989 rose to US$22.63billion by 2000. It nevertheless declined to US$1.03billion by 2007, due to the debt forgiveness initiative (Muhanji and Ojah, 2011). At this point, however, it needs to be stated that there is ample evidence in the empirical literature that if procured sustainably and applied productively, foreign loans can be an effective ancillary to economic growth (Cassimon and Vaessen, 2007; Claessens and Diwan, 1990; Easterly, 2002; Ferrarini, 2008). Examples of countries that have productively employed debt in the growth process include South Korea, Chile, Brazil and Ghana (Muhanji and Ojah, 2011).

The literature on the debt – economic growth nexus can be classified into three major strands. The first strand suggests that external debt negatively affects economic growth (Ali and Mustafa, 2012; Ciftcioglu and Sokhanvar, 2018; Dey and Tareque, 2019; Edo et al., 2020; Karagol, 2002; Soydan and Bedir, 2015; Were, 2001). This strand corroborates the neoclassical economists' position who equate debt to a future tax and focus on the negative effects of debt overload. The second strand holds that external debt positively impacts economic growth (Amin and Audu, 2006; Baker and Hassan, 2008; Joshua et al., 2020; Ogunlana, 2016; Pattillo *et al.*, 2004). Their position supports the Keynesians' stance that an increase in public debt impacts growth positively and is necessary for economic recovery. The third strand, which combines the first two strands, involves investigating a non-linear relationship between the two macroeconomic variables. In this strand, studies by Asafo et al. (2019), Blavy (2006), Schclarek (2004), Schclarek and Ramon-Ballester (2005), Senadzar et al. (2018) and Soydan and Bedir (2015) do not find evidence of a non-linear relationship between external debt and economic growth, while other studies, such as those by Adam and Bevan (2005), Cordella et al. (2005), Deshpande (1997), Dogan and Bilgili (2014), Ouedraogo (2015), Pattillo et al. (2002) and Qureshi and Liaqat (2020) claim that the nexus follows a non-linear pattern. Hence, findings from studies on the existence or otherwise of nonlinearity in the external debt-economic growth relation have been inconclusive. To buttress this position, Daud and Podivinsky (2014) posit that studies on the relationship between the two variables are far from being thorough or conclusive, especially for developing economies.

Meanwhile, only a few studies have examined the non-linear effect of external debt on economic growth for SSA countries, with many of the studies pooling a handful of SSA countries with other developing countries from different regions of the world (for example, Blavy, 2006; Clements and Krolzig, 2003; Fosu, 1996, 1999, Iyoha, 1999; Kourtellos et al., 2013; Ouedraogo, 2015; Pattillo et al., 2002; Pattillo et al., 2011; Pescatori et al., 2014; Presbitero, 2008; Qureshi and Liaqat, 2020; Schclarek, 2004; Schclarek & Ramon-Ballester, 2005). As such, most of the studies' findings cannot be solely relied upon for SSA, considering the lack of consistent uniformity in economic structures across different regions of the world. Furthermore, while findings from many of the studies indicate that the effect of external debt on economic growth is non-linear and hump-shaped, there is no consensus among them regarding the threshold of external debt, beyond which it depresses economic growth. On the other hand, results from some other studies find no evidence that the relationship between the two variables is non-linear (Asafo et al., 2019; Blavy, 2006; Hagos, 2011; Kourtellos et al., 2013; Pescatori et al., 2014; Schclarek, 2004; Schclarek & Ramon-Ballester, 2005; Senadzar et al., 2018; Soydan and Bedir, 2015). Thus, the precise nature of the relationship between external debt and economic growth in SSA countries cannot be said to be conclusive. Therefore, this study aims to contribute to this debate in the literature by focusing mainly on SSA countries. Another distinct contribution from this study to the literature is in the area of data estimation. Most previous studies on the subject (including those that focus mainly on SSA countries such as Edo et al., 2020, Fosu, 1996, 1999, Iyoha, 1999, Joshua et al., 2020, Lopes da Veiga, 2014 and Sanusi et al., 2019) employed estimation techniques such as random/fixed effect, GMM estimator, ARDL and pooled regression that assume slope homogeneity among cross-sections. As such, these studies overlook the likely presence of cross-sectional dependence in the data. According to Sadorsky (2013) and Turkay (2017), this assumption is inadequate and capable of generating misleading and invalid estimates. To address this issue, recent techniques of the augmented mean group (Eberhardt and Teal, 2010) and common correlated effects mean group (Pesaran, 2006) that accommodate cross-sectional dependence in panel data were employed to generate estimates in this study.

The remaining of the paper is as follows. Section 2 reviews relevant empirical literature; section 3 discusses the methodology. Section 4 presents the empirical results and the discussion thereof. Section 5 concludes the study.

REVIEW OF LITERATURE

There is a preponderance of studies on the existence or otherwise of nonlinearity in the debt-economic growth nexus, howbeit, with mixed findings. In an analysis of the impact of external debt on economic growth in six WAEMU countries, Ouedraogo (2015) established that external debt exerts a non-linear effect on economic growth. The relationship between the two variables is inverted U-shaped. They posited that external debt beyond a threshold of 51% of GDP is deleterious to economic growth. Meanwhile, a much earlier study by Fosu (1996) had used an augmented production framework to investigate external debt-growth nexus in SSA and concluded that the impact of external debt on growth is positive at low investment levels and becomes negative after it reaches a threshold of 16% of GDP. This result was later reinforced in a follow-up study of 35 SSA countries by Fosu (1999) who established that SSA economies would have grown by an additional 50% without the external debt burden. Furthermore, in their analysis of the non-linear effect of external debt on economic growth for ninety-three developing countries, Pattillo et al. (2002) utilised panel data covering the period 1969 to 1998. They contended that external debt has a non-linear effect on economic growth. Their results also revealed that external debt begins to impact growth negatively as soon as debt levels exceed 160% to 170% of exports and 35% to 40% of GDP. The results also suggested that doubling the debt in these countries leads to a slowdown of per capita growth by about half to a full percentage point. Moreover, Drine and Nabi (2010) employed a stochastic frontier model to examine the impact of external debt on output efficiency for twenty-seven developing countries covering the period 1970 to 2005. The analysis results confirmed that external debt has a non-linear effect on production efficiency, with a threshold of about 84%. The study also confirmed a non-linear effect of external debt on the formal sector. Similarly, using the OLS technique in a panel study involving a sample of seventy-nine developing countries for the period 1970 to 2002, Cordella et al. (2005) stated that a moderate relationship could be found between debt and economic growth at the intermediate level, but that the same could not be said of the lower levels. They also found that debt overhang holds its sway in countries with good governance and strong institutions as soon as debt stock exceeds the 15-30% debt/GDP ratio threshold, while the effect becomes irrelevant when the stock of debt reaches 70-80% of GDP. In a similar study for eighty-seven developing countries, Imbs and Ranciere (2005) employed OLS, fixed effects and system GMM to analyse the debt overhang issue. They argued that the debt-growth nexus in the sampled countries follows a non-linear pattern and that the negative effect of debt on growth takes effect as soon as debt levels reach 60% of GDP or 200% of exports. Moreover, out of the eighty-seven countries under study, they discover thirty-seven debt overhang cases, out of which twenty-three were in Africa, while twelve and two were in Latin America and Asia, respectively. In a recent investigation of 123 countries for the period 1990-2015 with the use of PVAR model, Qureshi and Liaqat (2020) established a non-linear effect of public external debt on economic growth. However, they found no evidence for a common threshold level for external debt. Besides, savings and investment were established as the primary channels through which external debt transmits its growth effect.

Meanwhile, a significant contribution concerning the non-linear effect of debt on growth is made in a seminal article by Reinhart and Rogoff (2010) who employed data spanning two hundred years gathered from forty-four advanced and emerging economies. Their results revealed that the impact of debt on growth is low for a debt-to-GDP ratio below 90% of GDP, but above this threshold, average growth rates fall by about 1%. They further declared that the threshold is lower for emerging countries at 60% of GDP, above which growth falls by 2%. This article's threshold result was analysed in a similar study by Minea and Parent (2012). By investigating the same panel of countries, excluding the period 1880-2009, their estimations reveal that although higher levels of debt are harmful to growth for debt ratios below the 90%, this adverse effect reduces as debt increases. They also identified a turning point of 115% debt-to-GDP ratio and argued that public debt positively affects growth below this threshold, but influences it negatively, above the threshold.

Meanwhile, by way of critique, the polemical work by Reinhart and Rogoff (2010) was replicated for the period 1790-2009 by Herndon et al. (2014). Following their analysis, they rejected the conclusion that debt depresses growth once the 90% of GDP debt threshold is exceeded. For them, there were no noticeable differences in the rate of growth for debt/GDP ratios below and above 90%. Instead, they asserted that the link between debt and growth differs substantially by period and country. Further to this, they averred that in Reinhart's and Rogoff's (2010) estimations, selective exclusion of available data, coding errors and inappropriate weighting of summary statistics led to miscalculations that portrayed the link between debt and growth incorrectly. On top of that, Lopes da Veiga et al. (2014) examined the significance of public debt on economic growth and inflation for a group of fifty-two African countries within a panel framework. They reported that the association between public debt and growth follows a non-linear pattern with an inverted U-shape relationship in the sample of countries. A threshold of 60% of debt/real GDP ratio and an average inflation rate of 8.2%, beyond which economic growth begins to experience a slowdown, was also identified in their estimations. The entire sample concluded that rising inflation levels and a high stock of public debt are associated with declining growth rates. Panel estimations were also conducted for 3 specific geographical areas within the sample of countries: The North African, the sub-Saharan African and the Southern African Development Community (SADC) countries, and the results from each of these three geographical areas corresponded to the overall result. Their results for the SADC region were corroborated in a different study by Sanusi et al. (2019) who affirmed the existence of nonlinearity between public debt and economic growth and put the threshold beyond which public debt restrains economic growth at 57% of GDP.

On the other hand, by employing a system GMM on data from 39 SSA countries from 1990 to 2013, Senadza et al. (2017) denies the existence of a non-linear relationship in SSA, but concludes that external debt mainly exerts a negative impact on economic growth in the region. A similar study by Asafo et al. (2019) used the same method for SSA countries for 1990-2017 and found no evidence of a non-linear relationship between external debt and economic growth. They also claimed that external debt exerts a negative impact on economic growth. These two findings have been corroborated by an earlier study by Soydan and Bedir (2015) who employed a common correlated effect (CCE) on data from moderately indebted middle-income countries from 1985 to 2013. They also concluded that external debt negatively affects economic growth and that there is no evidence of a non-linear relationship between the two variables. An interesting study on the existence or otherwise of an optimal debt level was also conducted by Schclarek (2004) who employed the system GMM technique on panel data from fifty-nine developing and twenty-four industrial countries for the period 1970 to

2002. The estimation results rejected the existence of an inverted U-shaped relationship between external debt and economic growth, as suggested by the nonlinearity argument. Specifically, he found a negative relationship between external debt and economic growth in developing countries, with the public's negative relationship, rather than private external debt. In industrial countries, the study found the relationship between debt and economic growth to be insignificant. In a related study, Schclarek and Ramon-Ballester (2005) examined the link between total external debt and economic growth for twenty Latin American and Caribbean countries from 1970 to 2002. They discovered that the relationship between total external debt and economic growth was significant and negative. According to the study, while the negative relationship emanated from a high level of public external debt, the high level of private external debt is not related to the slump in economic growth.

In conclusion, it is clear from the literature review on this subject that empirical results on the precise nature of the relationship between external debt and economic growth are inconclusive. It also shows that investigation of the subject for SSA has not received adequate attention in the literature; hence, this study.

RESEARCH METHODOLOGY

Empirical Model

To achieve the objective of this study, a quadratic relationship between external debt and economic growth is adopted, which is expressed as follows:

$$LGDP_{it} = \alpha_{1i} + \alpha_{2i}ED_{it} + \alpha_{3i}ED_{it}^2 + \alpha_{4i}X_{it} + \varepsilon_{it} \quad (1)$$

where i and t are cross-sectional units and the time period, respectively, $LGDP$ is log of real GDP per capita, representing economic growth, ED is the external debt variable, denoting the level of external debt, ED^2 is the squared term of the external debt variable, X is a vector of control variables (capital stock and trade openness), α_{1i}, α_{2i}, α_{3i} and α_{4i} are the parameters to be estimated and ε_{it} is the unobservable error term.

This model was based on the hypothesis that the impact of external debt on economic growth is not always negative or positive. External debt at lower levels could enhance growth before reaching a certain threshold beyond which it begins to negatively impact growth. Hence, in this model, the focal point would be the significance (or otherwise) and the magnitude of α_{2i} and α_{3i}. To establish nonlinearity in the relationship between external debt and economic growth, the two parameters must be significant and bear opposite signs, otherwise, the relationship would be adjudged linear. If α_{2i} and α_{3i} were both significant with the former and the latter being negative and positive, the relationship is U-shaped or convex. On the other hand, if α_{2i} and α_{3i} were both significant with the former and the latter being positive and negative, respectively, then the relationship is inverted U-shaped or concave. From the equation, the external debt threshold can be estimated (in the case of both coefficients being significant and bearing opposite signs) by finding the first-order partial derivative of real GDP per capita concerning external debt and setting the same equal to zero to obtain equation (2) as the external debt threshold :

$$\frac{\partial LGDP_{it}}{\partial ED_{it}} = \frac{-\alpha_{2i}}{2\alpha_{3i}} \quad (2)$$

Cross-sectional dependence test

Investigation through panel data analysis is highly advantageous in a number of ways, including more degrees of freedom, greater variability in dataset, and, ultimately, better estimation efficiency (Greene, 2011). However, due to issues arising from the presence of unobserved components, economic integrations and increasing interactions between countries, cross-sectional dependence in error terms may arise (De Hoyos and Sarafidis, 2006; Pesaran, 2004). Despite this, many panel data approaches do not account for the likelihood of cross-sectional dependence which could pose grave concerns to the reliability of results from unit root tests (Wagner, 2008). Previous studies on the relationship between external debt and economic growth predominantly employed first-generation panel unit root tests of Im et al. (2003), Maddala and Wu (1999) and Levin et al. (2002), which have been highly criticised for not accounting for cross-sectional dependence in data, as they falsely reject the null hypothesis when there is cross-sectional dependence in the data (Banerjee et al., 2001). Meanwhile, the second-generation panel unit root tests (Bai and Ng, 2004; Moon and Perron, 2004; Pesaran, 2007) are credited with overcoming this deficiency by accounting for the presence of cross-sectional dependence in panel data. To this end, given its reputation of overcoming the problem of false rejection of null hypothesis in data with cross-sectional dependence, the cross-sectionally augmented IPS (CIPS) panel unit root test developed by Pesaran (2007) is employed in this study. The representation of the CIPS panel unit root test is as follows:

$$y_{it} = \rho_i + \vartheta_{it} x_{it} + \mu_{it} \tag{3}$$

where i and t represent country and time period respectively, while ϑ_{it} and μ_{it} denote the slopes to be estimated and the residuals respectively. The equation indicates the relationship between y_{it} and time-invariant individual nuisance parameters ρ_i.

Before unit root testing, a cross-sectional dependence (CD) test of Pesaran (2004) is carried out to verify the presence or otherwise of cross-sectional dependence in the panel data under the null hypothesis of no cross-sectional dependence among the countries in the data. The hypotheses are formulated thus:

$$H_0: G_{iz} = G_{zi} = \text{cor}\ (\mu_{it}, \mu_{it}) = 0 \quad \text{for} \quad i \neq z \tag{4}$$
$$H_1: G_{iz} = G_{zi} = \text{cor}\ (\mu_{it}, \mu_{it}) \neq 0 \quad \text{for some } i \neq z \tag{5}$$

Panel cointegration test

To investigate the existence of long-run relationship among the variables in the model, this study employed the panel cointegration technique of Westerlund (2007) because of its superiority, especially in terms of efficiency over alternative cointegration methods. Older panel cointegration approaches that are mainly residual-based have been faulted in the literature for their failure to reject the null of no cointegration even when theory strongly suggests cointegration, which has been described as a common-factor restriction (Banerjee et al., 1998; Kremers et al., 1992). The panel cointegration technique of Westerlund (2007) overcame this deficiency by developing four new structural-based tests, which are unaffected by any common-factor restrictions. While two of the tests (group mean statistics) investigate the alternative hypothesis that the panel is cointegrated as a whole, the remaining two tests (panel statistics) investigate the alternative hypothesis that at least one unit in the panel is cointegrated. The test is conducted by investigating whether or not the error-correction term in a panel error-correction model is significant to determine cointegration. If the error-correction term is significant, then the null of no cointegration is rejected (Westerlund, 2007). This approach has been credited for its ability to account for the issue of cross-sectional dependence, as well as unit-specific short-run dynamics, unit-specific trend and slope parameters (Persyn and Westerlund, 2008). The error-correction representation of Westerlund (2007) panel cointegration approach is stated thus:

$$\Delta z_{it} = \rho_i' d_t + \beta_i z_{it-1} + \delta_i' x_{it-1} + \sum_{j=1}^{pi} \beta_{ij} \Delta z_{it-j} + \sum_{j=0}^{pi} \vartheta_{ij} \Delta x_{it-j} + \epsilon_{it} \tag{6}$$

where β_i is the error-correction parameter, measuring the speed at which the system is restored to equilibrium after an unexpected deviation from the path to long-run equilibrium. Also, $d_t = (1, t)'$ accommodates the deterministic components with $\rho_i = (\rho_{1i}, \rho_{2i})$ the vector of parameters.

Augmented mean group estimator

The review of the literature shows that in investigating models involving heterogeneous panels regarding external debt-economic growth relationship, previous studies have largely predicated their data analyses on the assumption of homogeneous slopes which, according to Turkay (2017) is unrealistic and capable of producing misleading estimates, especially in the face of time-variant heterogeneity and cross-sectional dependence. Pesaran (2006) suggests the need to control for residual cross-sectional dependence to prevent the concomitant bias of estimators. Hence, equation (1) is re-specified as follows:

$$LGDP_{it} = \alpha_{1i} + \alpha_{2i}ED_{it} + \alpha_{3i}ED_{it}^2 + \alpha_{4i}X_{it} + \theta_i + \tau_i f_t + \epsilon_{it} \quad (7)$$

In equation (7), the error term encapsulates country-specific time-invariant fixed effects (θ_i), an unobserved common factor f_t with factor loadings τ_i which account for time-variant heterogeneity and cross-sectional dependence and lastly, a white noise (ϵ_{it}).

To estimate equation (7) to overcome the abovementioned anomaly, the augmented mean group (AMG) estimator (Eberhardt and Teal, 2010) and the common correlated effects mean group (CCEMG) estimator (Pesaran, 2006) have been suggested. This study employed the AMG estimation approach, which accommodates cross-sectional dependence by introducing 'common dynamic effect' in regression. The AMG estimator obtains this effect from the time dummy coefficients of a pooled OLS regression in first difference. The generated common dynamic process is subsequently included as an additional regressor for each group-specific model. The AMG estimator has been reported as producing an equivalent level of quality and efficient estimates as a CCEMG estimator in the presence of cross-sectional dependence and non-stationary variables (Bond and Eberhardt, 2013; Eberhardt and Bond, 2009).

Data

This study employed panel data covering 34 years from 1985 to 2018 for a sample of 30 SSA countries. The list of the countries is available as an appendix. The choice of 1985 as the starting period was informed by the fact that SSA experienced the beginning of an upsurge in external debt accumulation and a massive slowdown in economic growth during the 1980s. Moreover, 30 SSA countries were captured because of the paucity of relevant data for the remaining SSA countries. To measure economic growth, real GDP per capita was employed; external debt variable was measured by external debt/GDP and external debt/export ratios; while control variables in the model include capital stock, measured by gross fixed capital formation as a percentage of GDP and trade openness, measured by total trade as a percentage of GDP [(import + export)/GDP]. All data sets were drawn from the World Development Indicators (WDI) of the World Bank.

EMPIRICAL RESULTS

The descriptive statistics of the variables are presented in Table 1. The mean GDP per capita is $1527, while those of the external debt variables are 98.8% of GDP and 402.4% of export for external debt/GDP and external debt/export respectively. Botswana recorded the lowest external debt/GDP and external debt/export figures of 3.90 and 6.26 in 2006, while the highest external debt/GDP of 1380.77 and external debt/export of 4245.39 were incurred by Liberia in 2003 and Sudan in 1993 respectively. Furthermore, all the variables are found to be stable, given their respective standard deviation statistics.

Table 1 Descriptive statistics of variables

Variable	Mean	Std. Deviation	Minimum	Maximum	Observation
Real GDP per capita	1527.19	2155.93	131.65	12042.43	990
External debt/GDP	98.76	128.15	3.90	1380.77	990
External debt/export	402.41	555.01	6.26	4245.39	962
Capital stock	20.22	8.64	-2.42	74.61	990
Trade openness	63.66	30.49	9.14	311.35	990

In recent time, the need to test for cross-sectional dependence in panel data has received increased attention in the literature as an important way of preventing misleading estimates (Turkay, 2017; Sarafidis and Robinson, 2009). To this end, the cross-sectional dependence (CD) test of Pesaran (2004) is conducted on each of the data series in the study and the results are presented in Table 2. It is observed that the null hypothesis of cross-sectional independence was rejected at 1% level of significance for each of the variables, which affirm the presence of cross-sectional dependence in the model. This result implies that first-generation panel unit root tests are inappropriate for this study, as they could generate substantial size distortions in the face of cross-sectional dependence (O'Connell, 1998). Hence, the need to apply a second-generation panel unit root test accommodates cross-sectional dependence.

Table 2 Cross-sectional dependence test

Variable	Test statistic	p-value
Real GDP per capita	19.721***	0.000
External debt/GDP	15.401***	0.000
External debt/export	21.237***	0.000
Capital stock	18.119***	0.000
Trade openness	13.608***	0.000

Note: *** represents significance at the 1% level.

Table 3 presents the results of the CIPS panel unit root test of Pesaran (2007), a second-generation unit root with the ability to provide reliable results even in cross-sectional dependence. The results indicate that none of the variables is stationary at level, but they all become stationary after taking the first difference. This implies that all the variables in the model are I(1) processes. Since there is no I(2) variable in the model, the AMG method of estimation can be employed.

Table 3 CIPS panel unit root test

Variable	Level	First Difference	Decision
Real GDP per capita	3.148 (0.173)	-2.518*** (0.000)	I(1)
External debt/GDP	-0.852 (0.304)	-2.871** (0.021)	I(1)
$(\text{External debt/GDP})^2$	2.149 (0.183)	-4.372*** (0.000)	I(1)
External debt/export	1.527 (0.117)	-5.281*** (0.000)	I(1)
$(\text{External debt/export})^2$	-0.247 (0.137)	-3.111*** (0.000)	I(1)
Capital stock	-1.051 (0.181)	-3.538** (0.015)	I(1)
Trade openness	2.226 (0.417)	-7.518*** (0.000)	I(1)

Notes: probability values are in parentheses; ** and *** indicate significance at 5% and 1% respectively.

Before proceeding to the estimation of parameters, there is a need to investigate cointegration among the variables. Consequent upon the earlier result indicating the presence of cross-sectional dependence, the error-correction-based test for cointegration of Westerlund (2007) is employed because of its ability to account for cross-sectional dependence, as against the residual-based approaches. The results for the cointegration tests which are presented in Table 4 indicate that the null hypothesis of no cointegration is rejected by group mean statistics (G_t and G_a) in the two models with external debt/GDP and external debt/export, as their respective probability values are below the 5% level. Similarly, panel statistics (P_t and P_a) also reject the null hypothesis of no cointegration in the two models, with all the probability values less than the 5% level. These results suggest the existence of a long-run relationship among the variables in the two models. Thus, the existence of panel cointegration among the variables, regardless of the measure of external debt employed enables us to investigate the non-linear effect of external debt on economic growth.

Table 4 Westerlund panel cointegration test

Test	Model 1: ED=external debt/GDP		Model 2: ED=external debt/export	
	Value	p-value	Value	p-value
G_t	-6.571***	0.000	-3.615**	0.017
G_a	-3.947***	0.000	-15.382***	0.000
P_t	-18.173**	0.028	-8.551**	0.011
P_a	-7.527***	0.000	-3.370***	0.000

Notes: ED = external debt; ** and *** indicate significance at 5% and 1% respectively.

Table 5 presents the AMG estimation results for the determination of long-run parameters in equation (7). The adoption of this estimation technique stems from its ability to accommodate cross-sectional dependence, which has been found to characterise the model. The results show that both external debt variables' coefficients and their respective squared terms are statistically significant at the 1% and 5% levels respectively. Also, both external debt variables and their individual squared terms bear opposite signs. This indicates that external debt exerts a non-linear impact on economic growth. Furthermore, the respective positive and negative signs of external debt variables and their squared terms establish that the relationship between external debt and economic growth follows an inverted U-shaped pattern. This implies that external debt has dual impacts on economic growth in SSA, in which case, external debt stocks at moderate levels drive economic growth, before depressing it after crossing a certain threshold. This finding corroborates Dogan and Bilgili (2014), Drine and Nabi (2010), Imbs and Ranciere (2005), Ouedraogo (2015), Pattillo et al. (2011) and Qureshi and Liaqat (2020) who claim that the relationship between external debt and economic growth is non-linear and inverted U-shaped. On the other hand, it contradicts findings from some other studies (Asafo et al., 2019; Schclarek, 2004; Schclarek & Ramon-Ballester, 2005; Senadzar et al., 2018 and Soydan and Bedir, 2015) who found no evidence of a non-linear relationship between external debt and economic growth.

The dual impacts of external debt on economic growth suggest a threshold of external debt beyond which it slows down economic growth. This threshold is determined by solving equation (2), in which case we obtain 47.7% of GDP [0.01049/2(0.00011)] for external debt/GDP, while for external debt/export, the threshold is computed at 231.5% of export [0.02130/2(0.000046)]. This result indicates that external debt becomes deleterious to economic growth when it grows beyond 47.7% of GDP and 231.5% of export. Based on this result, SSA countries would find their external debt stock beneficial to their economies if they could keep it below these thresholds. Table 1 shows that the average external debt stocks for SSA countries stand at 98.76/GDP and 402.41/export, exceeding the thresholds. This indicates that most SSA countries hold external debt stocks in excess of these thresholds. This possibly explains why external debt has been found to exert a negative impact on economic growth in most studies on SSA as detailed in the literature review. Meanwhile, previous studies have also proposed different thresholds of external debt beyond which it depresses economic growth. For example, while Imbs and Ranciere (2005) suggest a threshold for external debt stock at 55-60% of GDP for developing countries, Ouedraogo (2015) and Pattillo et al. (2011) estimate the threshold at 51% of GDP and 35-40% of GDP for West African and developing countries, respectively.

Capital stock is reported to positively affect economic growth in the two equations, going by the positive sign and significance of its coefficient at the 1% and 5% levels. This finding supports Ouedraogo (2015), Pattillo et al. (2011) and Schclarek and Ramon-Ballester (2005) who concluded that the stock of capital has a positive effect on economic growth. Furthermore, trade openness follows suit with positive and statistically significant coefficient, indicating that increasing openness to international trade is associated with higher levels of economic growth in line with existing findings (Cordella et al., 2005; Ouedraogo, 2015; Presbitero, 2008).

Table 5 Results of AMG estimation

Variable	External debt=external debt/GDP		External debt=external debt/export	
	Coefficient	p-value	Coefficient	p-value
External debt	0.01049***	0.000	0.02130***	0.000
(External debt)^2	-0.00011**	0.019	-0.000046**	0.036
Capital stock	0.00226***	0.008	0.00236**	0.027
Trade openness	0.0003**	0.021	0.01142*	0.083

Notes: Dependent variable = log of real GDP per capital *, ** and *** indicate significance at 10%, 5% and 1% respectively.

ROBUSTNESS CHECKS

The robustness checks for the results are in two forms. First, the two models were estimated employing common correlated effects mean group (CCEMG) of Pesaran (2006). This estimator has also been found to be robust to heterogeneously sloped and cross-sectionally dependent data, as well as unobserved common factors and structural breaks (Kapetanios et al., 2011). The CCEMG estimator operates by summing up the cross-section averages of the dependent and explanatory variables, which are included as additional regressors (Kapetanios et al., 2011; Pesaran, 2006). Second, to account for the likelihood of multicollinearity, occasioned by the inclusion of the squared external debt variables, another set of AMG and CCEMG regressions was carried out using the squared terms of demeaned external debt variables. Balli and Sørensen (2012) had argued that by construction, interaction terms and second-order/squared terms are likely to be correlated with the main terms, in line with the submissions of Althauser (1971) and Smith and Sasaki (1979). To account for this, they suggested a robustness check that employs the interaction or squared term whose main term has been orthogonalised to other variables. For the second robustness check, the external debt variables were demeaned before generating their squared term in line with Balli and Sørensen (2012) suggestion.

For the first robustness check, the results of the CCEMG estimations are presented in Table 6. As shown in the Table, the coefficients in both models are predominantly the same in terms of significance and signs, compared to those in the main results in Table 5, with the only clear differences being the coefficients' magnitudes which are expected. This indicates that the findings remain the same regardless of the estimation technique. The robustness test upholds the findings of nonlinearity and inverted U-shaped relationship between external debt and economic growth. In contrast, the thresholds of external debt beyond which economic growth is hampered are computed at 44.4% of GDP and 226.8% of export for external debt/GDP and external debt/export ratios.

Table 6 Results of CCEMG estimation

Variable	External debt=external debt/GDP		External debt=external debt/export	
	Coefficient	p-value	Coefficient	p-value
External debt	0.02218**	0.014	0.02903***	0.000
(External debt)^2	-0.00025*	0.051	-0.000064**	0.021
Capital stock	0.002524***	0.000	0.002090***	0.001
Trade openness	0.015559*	0.085	0.002581**	0.026

Notes: Dependent variable = log of real GDP per capital *, ** and *** indicate significance at 10%, 5% and 1% respectively.

For the second robustness check, each external debt variable is demeaned before its squared term is generated. The results from both AMG and CCEMG estimations are presented in Tables 7 and 8, respectively. The estimates generally conform to the main regression results, with the thresholds of external debt beyond which it depresses economic growth computed at 52.9% of GDP and 49% of GDP from the AMG and CCEMG regressions respectively. In comparison, it stands at 201.3% of export and 195.9% of export for the AMG and CCEMG regressions respectively.

Table 7 Results of AMG estimation

Variable	ED = external debt/GDP		ED = external debt/export	
	Coefficient	p-value	Coefficient	p-value
ED	0.300568**	0.015	0.007649***	0.000
$(ED-\overline{ED})^2$	-0.002838***	0.003	-0.000019**	0.042
Capital stock	0.200512***	0.000	0.121169***	0.000
Trade openness	-0.055025	0.879	0.163329*	0.071

Notes: Dependent variable = log of real GDP per capital *, ** and *** indicate significance at 10%, 5% and 1% respectively.

Table 8: Results of CCEMG estimation

Variable	ED = external debt/GDP		ED = external debt/export	
	Coefficient	p-value	Coefficient	p-value
ED	0.209865**	0.031	0.005486***	0.000
$(ED-\overline{ED})^2$	-0.002141**	0.020	-0.000014**	0.017
Capital stock	0.171336***	0.000	0.158760**	0.035
Trade openness	-0.317217	0.471	0.219799*	0.061

Notes: Dependent variable = log of real GDP per capital *, ** and *** indicate significance at 10%, 5% and 1% respectively.

CONCLUSION

This study was aimed at investigating the non-linear effect of external debt on economic growth in SSA countries. To this end, panel data comprising 30 SSA countries from 1985 to 2018 was estimated using the augmented mean group (AMG) estimation technique. The study indicated that external debt indeed exerts a non-linear impact on economic growth in SSA countries in the long run and that the relationship between the two variables is inverted U-shaped. This finding corroborates Dogan and Bilgili (2014), Imbs and Ranciere (2005), Ouedraogo (2015) and Pattillo et al. (2011) who claim that the relationship between external debt and economic growth is non-linear and inverted U-shaped. Furthermore, the estimates suggest that the thresholds beyond which external debt depresses economic growth stand at 47.7% of GDP and 231.5% of export. This indicates that external debt stock, when kept at moderate levels drives economic growth, but it depresses economic growth as soon as these thresholds are crossed. These estimates were found to be robust to alternative methods of estimation, as similar results were obtained when the common correlated effects mean group (CCEMG) estimator and the squared term of demeaned external debt variables were applied. The results also indicate that increase in capital stock and trade openness all positively affect economic growth in the long run. These results have policy implications. The external debt thresholds should be considered by SSA economies when formulating their external debt management policies, thereby reducing their reliance on external debt funds. Domestically generated revenue, especially tax revenue, should be revamped and galvanised (in such a way that tax avoidance and evasion would be reduced drastically) to bridge the resulting gap in expenditure. Another important policy implication of the negative effect of high external debt on economic growth is that governments of SSA countries should start adopting a pragmatic approach towards reducing their external debt burden by efficient use of the already accumulated debt. They should take practical steps towards total eradication of misallocation and squandering of the borrowed funds. Moreover, the funds should address many priority areas such as human capital development, poverty eradication, bridging infrastructural deficits, stimulating production, and other endeavours that promote the economy's welfare and development. Doing this would stimulate inclusive growth in the economy and eliminate the burden of external debt currently holding sway in the region.

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APPENDIX

LIST OF COUNTRIES

Angola	Ghana	Nigeria
Botswana	Guinea	Senegal
Burkina Faso	Guinea-Bissau	Sierra-Leone
Cameroon	Kenya	South Africa
Congo, Democratic Republic	Liberia	Sudan
Congo Republic	Madagascar	Tanzania
Cote d'Ivoire	Malawi	Togo
Ethiopia	Mali	Uganda
Gabon	Mozambique	Zambia
Gambia	Niger	Zimbabwe