Government Borrowing, Infrastructure, Human Development and Economic Growth in Africa: A Panel Threshold Approach

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Abstract

In this paper, we examined the effect of external borrowing on infrastructure, human development and economic growth in Africa. Using the panel threshold regression, we explored whether the threshold effect that often characterize the debt-growth nexus also applies to key drivers of economic growth, inequality and sustainable development such as infrastructure and human development. Data for the study covered the period 1990 to 2019 for 49 countries in Africa. Findings showed non-existence of a threshold effect between external public debt and infrastructure as well as human development. Finding from the fixed effects model for infrastructure and HDI showed insignificant effect of external borrowing on the index of infrastructure and significant negative effect on human development. The result support literature evidence of a threshold effect between borrowing and economic growth. Findings suggest less allocation of borrowed funds to improvement in infrastructure and use of deficit financing in areas that are not targeted at improving human devilment. Policy directive in this regard has implication for income potential, debt repayment and sustainable development.

1. Introduction

African economies are generally identified in the group of developing countries and public borrowing is quite high in the region. As at 2017, 19 African countries had exceeded the 60 percent debt-to-GDP threshold set by the African Monetary Co-operation Program (AMCP) for developing economies (IMF, 2018). Surpassing this threshold means that these countries are highly vulnerable to economic changes and their government have reduced ability to provide support to the economy in the event of a recession (Onyekwena & Amara, 2019). Borrowing can be beneficial particularly in economies with substantial development challenges such as those in the African region. In this case, borrowed funds are used to finance growth-enhancing investment

in areas such as infrastructure, health care, and education. Government borrowing can also be appropriate as part of temporal counter-cyclical fiscal policy, to boost demand and other economic activity in economic downturns (Kose et al., 2020; Ndoricimpa, 2020). However, high government debt can limit the size and effectiveness of fiscal stimulus during downturns, weigh down productivity enhancing investment and hence dampen long-term growth investment (Kose et al., 2020).

The relationship between government debt and GDP has often been characterized by an inverse U-shaped relationship such that positive debt impact is observed on economic growth until the point where the debt to GDP ratio exceeds a threshold level and a negative impact is experienced. Despite the consensus among most researchers about the existence of this relationship, there is no clarity about the specific threshold where government debt to GDP ratio starts to exhibit negative influences on a economic growth, and the extent of the negative impact on growth (Alzahrani, 2018; Baum et al., 2013; Eberhardt & Presbitero, 2015; Siddique et al., 2016). There are also suggestions that government debt do not have significant effect on economic growth in developed and developing economies (Schclarek, 2004).

While studies in the literature have commonly focused on the role of public borrowing on economic growth, not much is known about the relationship that characterize debt and potential drivers of inequality and sustainable development mainly in terms of infrastructure and the human development index. Focus on this relationship is motivating specifically for African as the region is characterized with poor infrastructure development and very low human development indices (UNDP, 2016). The inadequate and poor performing infrastructure is recognized as a major obstacle to reaching higher growth rate and achieving sustainable development (Khan et al., 2020; Zolfaghari et al., 2020).

In this paper, we examined the role of public external borrowing on infrastructure and human development in Africa with findings also shown for debt effect on economic growth. The focus on the debt growth nexus despite several literature evidence in this regard is to contribute to the discus as there is not yet a total agreement among all researchers regarding the nonlinear relationship between government debt and growth. We explored whether the nonlinear relationship that often characterize debt and growth is observed in the debt-infrastructure and debt-human development nexus. We explored the nonlinear impact of debt on infrastructure and human development as well as economic growth using the Panel Threshold Regression (PTR) model introduced by Hansen

(1999). This method has the advantage of estimating the debt threshold level from the sample rather than selecting them arbitrarily.

This paper contributes to the literature on debt and sustainable development in a number of ways. First, this study contributes to the scant literature relating the debt infrastructure and HDI relationship in Africa. Second, the focus on the role of public borrowing on infrastructure and the HDI gives empirical insight to whether public borrowing in the African region increases the chances of debt repayment and does not undermine the income potential of future generation in creating an enabling environment for increased productive capacity and wage. Third, to the best of our knowledge, this study is the first to investigate the debt infrastructure and HDI relationship exploring whether a nonlinear effect exists. Fourth, we contribute to the extant literature discuss on the debt-growth link using data from Africa.

Our study is divided into the following sections. Section two provides the review of literature. Section three shows the methodology applied. Section four presents the empirical results and discussion of findings while section five covers the study conclusion

2. Literature Review

Studies have generally associated infrastructure improvement to increase not only in economic growth but also in reduction in income inequality and human development. For instance, Calderón, (2009) and Calderón & Servén, (2010) showed that improvement in infrastructure has a positive impact on long-run growth and a negative impact on income inequality. Findings by Whajah et al., (2019) showed that public indebtedness has negative effect on inclusive growth that in turn works to promote reduction in income inequality. Mohanty et al., (2016) also showed significant role of infrastructure improvement in attaining high Human Development in India. Similar finding was shown by Kusharjantoa & Kim, (2011) in Indonesia and in a cross country study by Sapkota, (2014) with focus on the role of infrastructure on the components of the HDI. Asongu & Nwachukwu, (2016) also associated improvements in the human development index in sub-Sahara Africa with infrastructure development captured using mobile phone as a means of knowledge diffusion. Using data from African economies, Oladipo,(2019) also showed significant effect of infrastructure on human development with findings also indicating the existence of bidirectional effect. With key role of infrastructure on development, government spending on infrastructure will in no doubt raise the possibility of improving human development as well as economic growth.

In examining the debt growth nexus, the argument of an inverse U-shaped relationship as shown in most studies, follows from the role debt plays as a stimulant for aggregate demand (Elmendorf & Mankiw, 1999; Kose et al., 2020). Negative effects of debt on economic growth are noticed in the long run where high debt burden and long term interest rates induce a crowding out of private investment (Gale & Orszag, 2003; Kose et al., 2020; Kumar & Baldacci, 2010). Regarding the nonlinear effect of debt on growth, countries at the early stages of development generally experience growth as they make use of borrowing to finance investment opportunities yielding high rates of return due to lower levels of capital stock. With increase in debt stock, the ability to repay borrowed funds often becomes difficult especially with rise in interest payment (Cecchetti et al., 2011; Kose et al., 2020). Negative effects of debt on growth can also be linked to proposition of the debt 'overhang; theory that high debt can lead to distortionary taxes discouraging new domestic and foreign investments, which, in turn, slows down capital accumulation (Diamond & He, 2014; Krugman, 1988; Sachs, 1989). Increase in debt levels can also reduce growth by lowering total factor productivity and hinder government incentives to engage in technology improvement, infrastructure and more efficient use of resources (Kose et al., 2020; Poirson et al., 2004).

In terms of the turning point of the debt growth relationship, studies generally do not show uniform results. Rogoff & Reinhart, (2010) for instance provided evidence of a weak relationship between government debt and long-term growth when debt-to-GDP ratio is below 90%, but above this level, the impact of debt on economic growth is negative. Checherita-Westphal & Rother, (2012) show that the effect of debt on growth becomes negative when debt to GDP ratio is above 90–100%. Findings by Baum et al., (2013) suggested positive short-run effect of debt on economic growth only to the point where debt-to-GDP ratio is less than 67%. At this point the impact faded away, and turned negative for debt-to-GDP ratio above 95%. Findings by Afonso & Jalles,(2013) pegged the turning point at which the impact of debt on economic growth turned negative at 59%. Evidence by Woo & Kumar, (2015) showed that beyond 90% of GDP, government debt induces negative impact on economic growth. Using data for a sample of 18 countries in the Organization for Economic Corporation and Development (OECD) Cecchetti et al.,(2011) estimate a threshold level of 95% for government debt to GDP ratio. Caner et al. (2010) find the threshold level as 77% beyond which public debt hampers growth for a panel data set of 25 developed and 74 developing economies. They also showed lower threshold level of 64% for developing countries.

In examining the turning point between debt and growth, studies have sometimes made use of simple descriptive statistics (Rogoff & Reinhart, 2010). The simplest and the most common method applied for testing non-linearity is with the use of a quadratic term in the growth regression (Checherita-Westphal & Rother, 2012). The spline regression has also been used in this regard. Kumar & Woo,(2010) made use of the spline regression for a sample consisting advanced and developing countries to determine the turning point of public debt to GDP ratio.

The use of quadratic term in the growth equation to capture the turning point between debt and growth is criticized based on exogenous determination of thresholds (Karadam, 2018). To overcome this challenge, non-linear panel data method specifically the Panel Threshold Regression (PTR) is often preferred. This method allows estimating the debt threshold level from the sample rather than selecting them arbitrarily (Hansen, 1999). However, in PTR model, observations are mostly divided into a small number of (mostly two) distinct regimes depending on the values of threshold variable. There is also the Panel Smooth Transition Regression (PSTR) model developed by Gonzalez et al.,(2005). The PSTR model, has essentially the same features as the PTR model but allows the regression coefficients to change gradually when moving from one group to another. The threshold regression approach was applied by Chang & Chiang, (2009), to investigate the nonlinear relationship between government debt ratio and growth for a sample of 15 OECD countries for the period 1990–2004. Minea & Parent, (2012) also made use of this approach to examine the nexus between debt and growth. (2018) made use of this approach in examining the debt growth relationship using unbalanced panel of 135 countries (24 industrial, 111 developing) for the period 1970–2012. Among other things, findings showed that the direction of the effect of public debt on growth changes smoothly from positive to negative depending on the level of indebtedness. The debt threshold was also shown to be lower for developing countries implying that public debt can hurt growth at lower levels of debt for those economies relative to advanced countries.

The extant literature mainly covers the threshold effect of debt on growth and is scant with findings in this regard for infrastructure and human development. Besides the existing literature examining the debt infrastructure and human development relationship are not very common.

3. Methodology

3.1.Empirical Model

We analyze the debt-infrastructure relationship empirically using the baseline linear specification stated as:

$$INF_{it} = \mu_i + \alpha Debt_{it} + \beta Z_{it} + \varepsilon_{it} \quad 1$$

where INF_{it} is infrastructure, and $Debt_{it}$ is the gross general government debt to GDP in country i at time t for $i = 1, \dots, N$ and $t = 1, \dots, T$. μ_i represents individual fixed effects, while βZ_{it} is the vector of control variables. We include four control variables that potentially affect infrastructure in an economy; GDP per capita, trade in percent of GDP and population growth and globalization. We expect to see a positive effect between debt to GDP ratio and infrastructure where borrowed funds are efficiently utilized to promote investment in infrastructure. This effect may however disappear and turn negative with high debt burden suggesting that the threshold effect exists. We also expect to see positive effect of increase in GDP per capita on infrastructure assuming higher infrastructure investment accompanies increase in macroeconomic income. Increase in trade volume is generally observed where countries operate open border policy. In this case the ease of movement of goods across countries and knowledge transfer aids production techniques and rise in income invariable suggesting higher investment generally plus spending on infrastructure. Increase in population relative to income induces a strain on fiscal spending and hence is expected to impact negatively on investment even in infrastructure. More globalized economies have the potential for improved infrastructure through improvement in knowledge base and technology.

We examined the model for debt-human development relationship using the linear specification model stated as:

$$HDI_{it} = \mu_i + \alpha Debt_{it} + \beta W_{it} + \varepsilon_{it} \quad 2$$

Where HDI_{it} is the human development index used to capture human development, and $Debt_{it}$ is the gross general government debt to GDP in country i at time t for $i = 1, \dots, N$ and $t = 1, \dots, T$. μ_i represents individual fixed effects, while βW_{it} is the vector of control variables. Additional control variables include per capita income, gross investment, trade openness, population growth, infrastructure and globalization. Essentially, improvement in income should ordinarily translate to higher consumption as well as spending on key component of the HDI. In The same way, rise in investment should ordinarily raise income as well as the HDI. The influx of improved

technology and knowledge transfer from trade openness should positively influence the HDI however where the production function of domestic firms cannot accommodate global technological advancement, openness may show a negative effect on HDI. Population growth induces a strain on fiscal finance in health and education and hence may negatively influence the HDI. Improved infrastructure is expected to positively influence HDI as it raises the potential for increase in income, literacy and health. Globalization generally, erodes national boundaries, integrates national economies, cultures, technologies and governance. This process influences the health condition of a population in terms of better technology transfer. The erosion of national boundaries also has impact on the level of literacy and civilization and income potential. Hence globalization is expected to have strong effect on the HDI.

We measure a the level of overall human development, using the human development index (HDI), which was developed by the United Nations Development Program (UNDP) in 1990, aiming to provide a yardstick of human development of all member countries of the United Nations. Thus we used HDI and its component indexes as a dependent variable because its principles are reflected in the SDGs framework as it also sets health- and education-related goals together with income or poverty goals (Sapkota, 2014).

To empirically analyze debt-growth relationship, the baseline linear specification for growth regression can be written as:

$$GDP_{it} = \mu_i + \rho Debt_{it} + \theta W_{it} + \varepsilon_{it} \quad 3$$

Where $GDP_{it\,it}$ is real GDP per capita, and $Debt_{it}$ is government external debt to GDP in country i at time t for $i = 1, \dots, N$ and $t = 1, \dots, T$. μ_i represents individual fixed effects, while θW_{it} is the vector of control variables. In line with earlier studies showing a link between debt and growth, we include variables measuring growth specifically gross fixed investment, trade openness, infrastructure and globalization. We expect to see a nonlinear effect between debt and economic growth as shown generally in the literature. It is also expected that a rise in income of production factors that ordinarily should accompany increase in investment, will lead to a rise in per capita income. The effect of trade openness cannot out rightly be defined as it will depend on the competitiveness of domestic products in the international market. The effect of globalization is expected to be positive as increased rate of civilization that comes with globalization can induce better production methods and raise the potential for improved industrial activities.

In line with Hansen, (1999) equations (1), (2) and (3) are examined using the fixed-effect panel threshold model. To do this, we first fit a single-threshold model and examined the boot-strap results. Where the F-statistic is significant, we reject the linear model and fit a double- or triple-threshold model. The choice of fitting a double or triple threshold is determined by the probability value of the F-statistic for the threshold effect test from the bootstrap result. We examined the PTR rather than the PSTR as the latter is essential same as the PTR but only differs in terms of examining a smooth transition. Our interest is not whether the transition is smooth or not but mainly to determine the nature of the relationship between debt infrastructure an HDI and whether the association is linear or nonlinear as commonly shown in the debt growth nexus.

For each equation specified for infrastructure, HDI and growth, we first fit a single-threshold model in the form;

$$y_{it} = \mu + X_{it}(q_{it} < \gamma)\beta_1 \ + \ X_{it}(q_{it} > \gamma)\beta_2 \ + \mu_i + \ \varepsilon_{it} \qquad 4$$

Where the variable y_{it} is the dependent variable, q_{it} is the threshold variable in this case external debt, γ is the threshold parameter that divides the equation into two regimes with coefficients β_1 and β_2. the parameter μ_i is the individual effect, while ε_{it} is the disturbance term.

Testing for a threshold effect is the same as determining whether the coefficients are the same in each regime. The null hypothesis and the alternative hypothesis (the linear versus the single-threshold model) are

$$H_0 = \beta_1 = \beta_2 \ ; \ \ H_a = \beta_1 \neq \beta_2 \qquad 5$$

The F-statistic is constructed as

$$F_1 = \frac{S_O - S_1}{\sigma^2} \qquad 6$$

Under H_0, the threshold γ is not identified, and F_1 has nonstandard asymptotic distribution. S_O is the RSS of the linear model.

In the case of a multiple thresholds, we fit the model sequentially. For a double-threshold model for instance, the specification is stated as:

$$y_{it} = \mu + X_{it}(q_{it} < \gamma_1)\beta_1 \ + \ X_{it}(\gamma_1 \leq q_{it} < \gamma_2)\beta_2 \ + \ X_{it}(q_{it} \geq \gamma_2)\beta_3 + \ \mu_i + \ \varepsilon_{it} \qquad 7$$

Here, γ_1 and γ_2 are the thresholds that divide the equation into three regimes with coefficients β_1

β_2 and β_3. In the case that we reject the null hypothesis in a single-threshold model, then we must test the double-threshold model. The null hypothesis is a single-threshold model, and the alternative hypothesis is a double-threshold model. The F-statistic is again used to determine the preferred threshold. We use the F Test approach to test the existence of threshold effect. The specification of the F-test is similar to that earlier presented. The procedure continues until the appropriate threshold is determined using the F-statistic.

3.2.Data Source

The main variable of interest, external debt as a percentage of GDP, real GDP per capita, investment, population growth and trade openness (trade to GDP ratio) are obtained from World Development Indicators provided by the WorldBank, (2019). Data for infrastructure index is obtained from the African infrastructure index provided by the African Development Bank ADB, (2018). Data for the Human development Index is obtained from the Human Development Data provided by the United Nations Development Program. We made use of the Konjunkturforschungsstelle (KOF) index of globalization introduced by Dreher,(2006) because of its comprehensiveness and data availability. Based on the availability of data for the variables used, the study covered the period 1990 to 2019.

4. Results

4.1 Summary Statistics

We begin the presentation of results by showing the summary statistics

Table 1 Descriptive statistics

Variable	Mean	Std. Dev.	Min	Max
Variable	Mean	Std. Dev.	Min	
External Debt/GDP	75.93724	81.36694	2.555617	915.9496
GDP Per capita	1858.532	2724.636	102.598	22942.58
Gross investment/GDP	20.85051	8.762361	2.42436	93.54746
Trade/GDP	0.62635	0.419769	0	3.479965
Population growth	2.37106	1.101118	6.76622	8.117929
Infrastructure index	20.87873	18.43709	0.005702	94.96979
HDI	0.435225	0.190275	0	0.801

Globalization	44.13761	10.39428	19.2	72.7

The summary statistics show considerably high level of average external debt to GDP at about 75%. Average per capita income at local currency unit is approximately 1,858.532. This value is however associated with high standard deviation of about 2,724. This can be related with the heterogeneous nature of the data set. Average gross investment/GDP at approximately 21 % is low and depicts low level of economic activities in the region. Trade/GDP ratio of 0.63 depicts less trade compared to GDP. Population growth rate is observed as 2% on the average and mean infrastructure index is also low at 20%. The index for human development of 0.43 groups African economies in the category of countries with low human development (UNDP, 2018). Average globalization index of 44.1 suggests that the region is less globalized relative to western industrialized societies. The value is less than average globalization index in the globe of 60 as far back as 2004 (Dreher et al., 2008)

4.2. Threshold Effect test and Estimation Results

Table 2 presents the results of the panel threshold test for linear and single threshold model using infrastructure index as the dependent variable.

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Table 2: Threshold effect test: Dependent variable infrastructure index

	Threshold Variable: External debt		
Threshold	Threshold	Lower	Upper
Th-1 (Single)	181.5245	178.6556	184.9181
$H_0 = \beta_1 = \beta_2$ (Linear model) $H_a = \beta_1 \neq \beta_2$ (Single threshold model)	2716.66 (0.2067)		

Note: F-statistic reported for hypothesis test with p-value in bracket

In table 2, the single-threshold model estimator is 181.5245 with 95% confidence interval [178.6556, 184.9181]. The F statistic is insignificant. Therefore, we reject the single threshold model and fit a linear model. The result indicate non-existence of a threshold effect between external debt and infrastructure unlike what is often observed in the debt-growth relationship. Based on the result suggesting a linear relationship between debt and infrastructure, we examined

the relationship between the variables using the fixed effect model and examining the hausman test statistic (Hausman, 1978). Findings are shown with additional control variables in the model.

Table 3 Estimation results: (Fixed-effects (within) regression model)

Dependent Variable: Index of infrastructure

Variables	FE regression Estimates
External debt/GDP	0.000596
	(0.00185)
GDP per capita	0.00164***
	(0.000143)
Trade/GDP	0.680
	(0.825)
Population growth	-0.821***
	(0.236)
Globalization	0.722***
	(0.0314)
Constant	-18.81***
	(1.635)
Observations	1,470
Number of id	49
R-squared Overall	0.5302
Hausman	17.23 Prob>chi2 = 0.0041

Note: Fixed effect estimates reported with standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Our variable of interest, Debt/GDP showed no significant effect on infrastructure improvement. This implies that public borrowing are not channeled towards investment in infrastructure in the region. This has implication on the sustainability of debt servicing as investment in infrastructure has the potential to raise income and economic advancement. The result for other variables suggest key role of per capita income and globalization in promoting infrastructural development in the

African region. The estimates however showed stronger effect of globalization on infrastructure development. The magnitude of the effect of a one percent increase in per capita income on infrastructure is relatively small (0.00164) compared to that for globalization (0.722). As expected, findings show negative effects of increase in population size on infrastructure development. Rise in population induces a strain on fiscal spending especially in highly informal economies where the tax base is generally low.

The result for the threshold effect test with HDI as the dependent variable eternal debt as the threshold variable is shown in table 4.

Table 4: Threshold effect test: Dependent variable HDI

	Threshold Variable: External debt		
Threshold	Threshold	Lower	Upper
Th-1 (Single)	287.5681	265.2056	309.9744
Hypothesis: $H_0 = \beta_1 = \beta_2$ (Linear model) $H_a = \beta_1 \neq \beta_2$ (Single threshold model)	-1433.52 (1.0000)		

Note: F-statistic reported for hypothesis test with p-value in bracket

In table 4, the single-threshold model estimator is 287.5681 with 95% confidence interval [265.2056, 309.9744]. The F statistic is insignificant suggesting a linear relationship rather than a U-shaped effect of debt on HDI. The threshold effect does not also exist in the debt-HDI model. We therefore, reject the single threshold model and fit a linear model. We fit a fixed effect model based on the hausman test statistic. We controlled for other variables that influence HDI in the model. Findings for the fixed effect model is shown in table 5.

Table 5 Estimation results: (Fixed-effects (within) regression model)

Dependent Variable: HDI

Variables	FE regression Estimates
Log external debt/GDP	-0.00724***
	(0.00142)

Log GDP per capita	0.0219***
	(0.00220)
Gross fixed capital formation	0.000563***
	(0.000113)
Trade openness	-0.0125***
	(0.00346)
Population growth	0.00695***
	(0.000963)
infrastructure	0.000743***
	(0.000111)
globalization	0.00468***
	(0.000177)
Constant	0.114***
	(0.0185)
Observations	1,470
Number of id	49
R-squared	0.746
Hausman	29.51 Prob>chi2 = 0.0001

Note: Fixed effect estimates reported with standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Contrary to expectation, we find negative effect of borrowing on HDI. With a 1 percent increase in external debt/GDP, the index of human development falls by approximately 0.01 percent. This implies that external debt does not improve welfare in Africa and also suggests that borrowed funds are not invested in sectors that promote human development such as health and education. The possibility of increase in inflation rate that accompany fiscal spending of borrowed fund in an unproductive way, can also account for the negative effect of external borrowing on HDI as the increase in prices reduces consumption basket accessible by individuals and households. Similar finding of negative effect of external borrowing on the HDI was observed by Imide & Imoughele, (2019) with evidence provided using country data for Nigeria. The result further showed

significant positive effect of per capita income, gross investment, population growth, infrastructure and globalization on the HDI. These findings are in line with expected result except for population growth that showed positive rather than expected negative effect on the HDI. The result for positive effect of an increase in population growth on the HDI can be explained by the social capital potential of population growth. With rise in population individuals have access to social capital in terms of family support during illness or periods of financial crisis that in turn influences wellness and wellbeing. The result for negative effect of trade openness on the HDI can be linked with the lack of international competitiveness that characterize most firms in developing countries.

We present results for the threshold test for GDP per capita in table 6.

Table 6: Threshold effect test: Dependent variable GDP per Capita

	Threshold Variable: External debt		
Model (threshold)	Threshold	Lower	Upper
Th-1 (Single)	37.2698	36.3882	37.5961
Th-21 (Double)	120.8353	118.4511	121.3882
Th-23 (triple)	37.2698	36.1274	37.5961
H_0 (Linear model) H_a (Single threshold model)	80.63 (0.0800)		
H_0 (Single-threshold model) H_a (double threshold model)	160.01 (0.0033)		
H_0 (Double-threshold model) H_a (Triple threshold model)	53.65 (0.6700)		

Note: F-statistic reported for hypothesis test with p-value in bracket

In table 6, the single-threshold model's estimator is 37.2698 with 95% confidence interval [36.3882, 37.5961]. The F statistic is significant. Therefore, we reject the linear model and fit a double and a triple-threshold model to determine the threshold that best suits the data. Based on the result for the threshold test, the double-threshold model is accepted with highly significant F-statistic. We reject the triple threshold model with evidence of insignificant F-statistic. The estimated threshold variable γ is approximately 37.2% for the single threshold model and 120.8%

for the double threshold model. The result support literature finding of a threshold effect of debt on growth.

We further present the results adding control variables that influence economic growth.

Table 7 Panel threshold regression estimation results; Dependent Variable: GDP per capital

Variables	Estimation results
Log External debt/GDP	-0.374***
	(0.0137)
Gross fixed capital	-0.00633***
	(0.00119)
Trade/GDP	-0.348***
	(0.0355)
Infrastructure index	0.0141***
	(0.00113)
Globalization	0.0155***
	(0.00184)
C_regime 1	0.191***
	(0.00920)
C_ regime 2	0.270***
	(0.0141)
Constant	6.456***
	(0.118)
Observations	1,470
R-squared	0.719
Number of id	49

Note: Double threshold estimation results reported with standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

The result in table 7 show negative effect of external debt on economic growth. With a 1 percent rise in debt, growth falls by approximately 38 percent. This finding support evidence that increase in debt levels can reduce growth. Contrary to expectation, we find that increase in gross investment did not raise per capita income. Increase in investment should ordinarily lead to a rise in the productive capacity of an economy. However where investment is in areas that an economy does not have competitive advantage it will mean that the impact of the investment will not translate to a rise in output. In addition, where an economy invests heavily in industrial promotion activities with less focus on the requisite skills and education to take advantage of the potential that is associated with gross investment, the effect between capital formation and output will likely be negative. The result for negative effect of trade openness on output is in line with argument that the poorly competitive nature of firms in developing economies hinder the benefits of trade deals across boundaries. In line with expectation, the result showed significant positive effect of infrastructure improvement and globalization on output.

5. Conclusion

Following literature evidence of the role of external borrowing on economic performance with most studies showing an inverse U-shape relationship, we examined the effect of external debt on infrastructure and human development exploring the existence of an inverse U-shape relationship. We further examined the debt growth relationship to add to literature findings in Africa. The panel threshold test showed non-existence of a threshold effect of external debt on infrastructure and human development. The result suggest insignificant linear effect of external debt on infrastructure with significant negative effect on HDI. The result showed the existence of a threshold effect of external debt on GDP. Findings suggest less investment of borrowed funds in sectors that promote infrastructure and human development and this has unfavorable implication for the potential of debt repayment. Fiscal spending especially of borrowed resources should be targeted at improving infrastructure and human development in the African region otherwise the crisis associated with debt financing will worsen the ability of African economies to attain any form of sustainable development.

End Notes:

a. We dropped 5 countries with missing data for debt from the analysis (Libya, Morrocco, Namibia, South Sudan, Seychelles) to enable us estimate the threshold model.. We also made use of moving average to update our data to 2019.

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