



Analysis of the Relationship between Public Debt Service and Education Expenditure: A Pooled Mean Group Approach

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Author's contribution

The sole author designed, analyzed, interpreted and prepared the manuscript.

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ABSTRACT

This study examined the relationship between public debt service and education expenditure in 15 Sub-Saharan and South American countries from 1995 to 2022. Utilizing the Pooled Mean Group (PMG) estimation method within an Auto Regressive Distributed Lag (ARDL) framework, evidence of cointegration between public debt service and education expenditure is presented. PMG regression results indicate that, in the short run, public debt service does not have a statistically significant impact on education expenditure per student. However, in the long run, an increase in government debt service exerts a significant negative effect on education expenditure. This result aligns with existing literature, which argues that increased debt obligations divert financial resources

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away from essential public services, including education. The Hausman test confirmed that the PMG estimator was more efficient than the Mean Group (MG) and Dynamic Fixed Effect (DFE) estimators. These findings suggest that maintaining low debt levels is crucial to prevent adverse impacts on educational funding, which is vital for long-term economic development.

Keywords: Public debt; education expenditure; ARDL; pooled mean group; developing, cointegration.

JEL Codes

H52 and H63

1. INTRODUCTION

Public debt levels have recently skyrocketed. Global debt has risen by more than fifteen trillion US dollars in 2023, setting a new record of three hundred and thirteen trillion dollars [1]. High levels of debt is not a new phenomenon. Kose et al [2] have pointed out that before the current debt waves, emerging market and developing countries faced three debt waves between 1970 and 2009. Although the problem of debt is not a new phenomenon, Kose et al [2] have highlighted that the current debt wave is unique in a way that annual increase in debt since 2010 is significantly larger than the preceding three waves and also the current wave is widespread. Fig. 1 and Fig. 2 show the levels of debt for the 15 countries under study and African countries respectively.

Debt distress has been a problem largely associated with the developing countries since they are not independent economically. Many nations categorized as Heavily Indebted Poor Countries (HIPC) by the International Monetary Fund (IMF) are developing economies that urgently require debt alleviation measures. In most developing countries external financial

inflows play a significant role in financing development [3]. Additional debts are used by countries in growth-enhancing projects, such as education [4].

Countries in Africa are struggling to service both domestic and external debts. This has been attributed to various factors including the coming of COVID-19 which has adversely affected the sources of revenue for developing countries which were initially being used to service debts. Another more current and significant factor is climate shock. In recent years, African countries have experienced damaging tropical cyclones and droughts which have hit hard key sectors of the economies. Climate shocks may decrease the effectiveness of financial inflows, particularly for countries with low absorptive capacity [3,2]. Latin and the Caribbean countries are not exempted from the problem of debt. Debt levels in Latin America and the Caribbean have risen significantly, reaching US\$5.8 trillion or 117% of GDP, with the largest economies seeing figures as high as 140% of GDP. Public debt exceeded 70% of GDP during the pandemic due to increased government spending and corporate borrowing to cope with the crisis. Although this financial support helped mitigate the immediate effects of the pandemic, it is has been creating economic challenges for the region (Inter-American Development Bank, 2024).

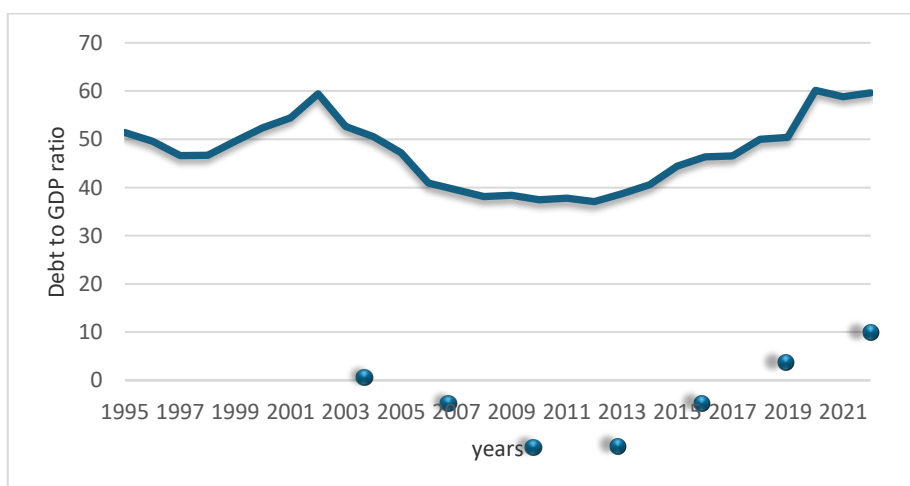


Fig. 1. Debt to GDP ratio for the 15 countries
 Source: Author's Compilation Using World Development Indicators Database

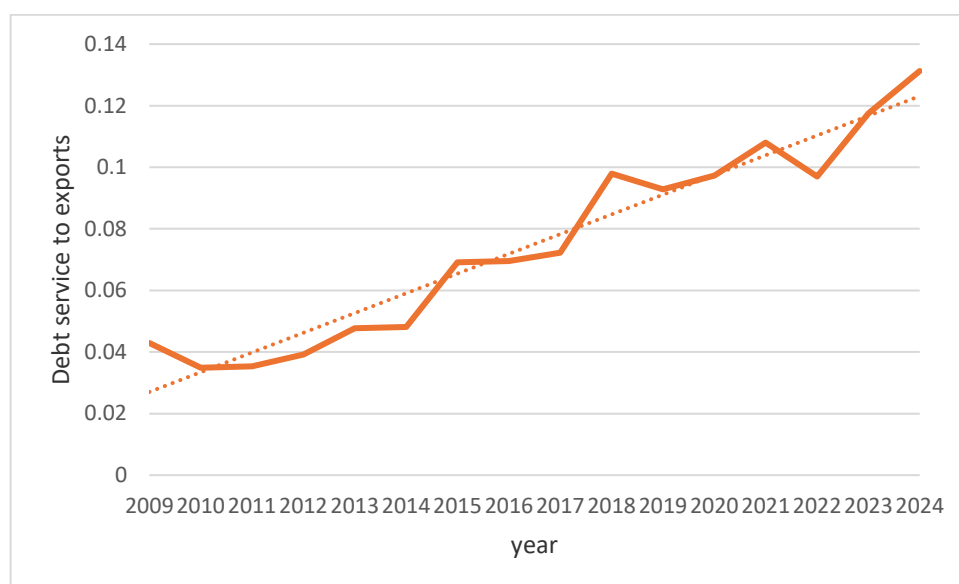


Fig. 2. Debt to export ratio for African countries (2009-2024)
 Source: Author's Compilation Using World Development Indicators Database

As more challenges come, governments resort to borrowing more from both domestic and external lenders. Consequently, debts continue to accumulate and that affects the ability of the government to spend in other sectors. One of the crucial sectors that has fallen victim to this is the education sector. Due to rising levels of debts, governments are forced to restructure spending on vital services such as education [2]. Studies have disclosed that high debt levels lower spending in the education sector because more resources from the budget are being used to service loans [5-7]. While other studies finding that public debt adversely affects education spending, others have argued that it doesn't Liyambo & Kaulihowa, [8]. Based on this background, this paper empirically investigates how public debt is connected to education expenditure in selected developing countries in the context of the rising debt accumulation and debt service obligations.

This paper's contribution are threefold. First, this study adds to the ongoing debt on how public debt affects education expenditure. Literature examining the effect of public debt service on education expenditure is limited and is still inconclusive. As such there is a need for more evidence on this issue. In addition, literature has largely focused on the effect of debt servicing on social sector expenditure in general (Tasleem, [9], Hälg et al., [10], Abu et al., [11]. This study adopts a more specific approach by examining

how public debt service affects education expenditure. Thirdly, the study also utilizes Pooled Mean Group (PMG) which to the best of my knowledge has not been utilized to analyse the link between public debt service and education expenditure in the context of Sub-Saharan countries. PMG estimator was devised by Pesaran, Shin, and Smith [12]. PMG helps to solve the problem of heterogeneity in empirical research since it assumes that long run coefficients are homogenous while letting the error variances and short run coefficients to vary across countries [12]. PMG is beneficial because unlike methods like General Method of Moments (GMM) it allows researchers to simultaneously estimate both short and long run association between variables. This study assumes that the countries under study will exhibit such behaviour. The study also provides essential information and evidence to researchers and policy makers to formulate policies that can develop education sector.

The segments that follow are organised as follows: Section 2 examines relevant literature; Section 3 outlines data and variables; Section 4 details preliminary tests; Section 5 presents the econometric methodology that has been used; Section 6 presents and analyses results. The paper concludes with Section 7, summarizing key findings and implications.

2. LITERATURE REVIEW

2.1 Theoretical Foundation

One of the theories developed to understand debt levels and how it affects other economic factors is debt overhang theory. This theory suggests that when the government accumulates high levels of debt, it reduces its investment [13]. This happens because of the debt burden and potential crowding effect on private investment. The crowding effect of debt affects government spending by reducing government investments. The government eventually diverts its attention to servicing public debt thereby reducing investment. The concerns about high debt and the associated risks influence government decisions on expenditure [13]. This study attempts to investigate how debt overhang affects government spending priorities in the context of education spending in selected developing countries.

2.2 Empirical Literature

Research on how public debt affects education expenditure is limited. A lot of research work on effect of public debt, has concentrated on how external debt affects economic growth (Yamin et al., [14], Panizza & Presbitero, [15], Afonso & Alves, [16], Matthew & Mordecai, [17] and much focus has not been given to how education expenditure is affected by public debt. Studies investigating the connection between public debt and education expenditure have come up with inconclusive results; others have found that public debt positively affects education spending (Buchanan and Wagner, [18], Liyambo & Kaulihowa, [8] while many have found public debt is detrimental (Fosu, [5], Buthelezi & Nyatanga, [6], Miningou, [7].

In support of research that has found the detrimental effects of debt, Stephens [19] using data for twenty-four African HIPC, found that the rise in debt servicing negatively influenced education and health expenditure. Governments most often find it easier to reduce their spending in social sectors such as education than other sectors [20]. Similarly, Mahdavi [21] supports the view that external debt crowds out investment in other sectors. He analysed the impact of debt on different types of government expenditure in forty-seven developing countries and he established that external debt had negative impact on expenditure.

Study utilising 50 Latin American countries (1985–2003), by Lora, [22] aiming at investigating whether a rise in public debt affects social expenditures showed that a higher debt stock cuts down public expenditure and reduces social expenditure in health and education. Similarly, study by Fosu [23] focusing on the influence of external debt servicing burden on public expenditure in African economies revealed that debt service burden negatively affected social sector spending with similar effects on education and health. That study did not use recent data as it used data from 1990 to 1994, a period prior to HIPC initiatives, using seemingly unrelated regression.

Quattri & Fosu, [24] utilising 40 Sub Saharan Africa countries (1995-2009) which included HIPC, revealed that debt servicing negatively affects education expenditure. The study compared the influence of debt on both education and health expenditures before and after the HIPC initiative.

A more recent study in Nigeria by Bulus [25] aiming at analysing the effect of external debt on education financing, established that a long run association between external debt and education funding exists. The study used Johansen cointegration and vector error correction model (VECM). Research work by Miningou [7] examining the link between debt, fiscal consolidation and public expenditure on education showed that external debt is a good predictor of fiscal consolidation. The results of GMM showed that higher debt to reserve ratio is associated with lower education spending. Study by Ekaette et al. [26] using OLS showed evidence of a significant relationship between public debt (external) and financing education. Studies in Europe have also shown that public debt has detrimental effects on public spending [27]. Shabbir & Yasin [28] concur with the above-mentioned study. In their study which analyzed the influence of public debt on social spending revealed that external debt servicing has detrimental impact on public spending.

Khundadze and Alvarez [29] stated that external public debt can be beneficial for developing nations, enabling them to access resources for development initiatives. However, they caution that escalating external public debt leads to increased debt servicing costs, which subsequently constrains public expenditure.

In his research on South Asian nations, Tasleem [9] examined how servicing external debt affects expenditure on health and education. His findings revealed that among various factors, debt servicing had huge influence on both education and healthcare sectors. Tasleem [9] suggested that South Asian nations would benefit from more efficient use of their domestic resources and reduced reliance on external borrowing.

Despite the popular opinion that public debt is detrimental in so far as education expenditure is concerned, other studies have found that the impact is positive or insignificant (Ouattara, 2006; Ukwueze, 2015; Abu et al., [11], IYAMBO & Kaulihowa, [8], Del Monte & Pennacchio, 2020). Buchanan and Wagner [18] and Del Monte & Pennacchio (2000) found that public debt produces higher levels of education spending. Liyambo & Kaulihowa, [8] recently studied how government expenditure is affected by public debt in Namibia using data from 1980 to 2018 and he found that rise in public debt stimulates government expenditure. Study by Ouattara (2006) found that debt affected social sector spending insignificantly. Furthermore, Fosu [5] studied 35 African countries using dataset from 1975–94 which was a period preceding the HIPC initiative and he found that debt service is not a good predictor of sector expenditure. The harmful effect of debt on the social sector was particularly strong among all factors that were being studied. The findings of Nurudeen et al [30] revealed that public debt and public expenditure nexus is not linear in that further increases in public debt are linked with a decrease in government spending.

From the literature review, there is evidence of contradictions among researchers, and they have not used panel ARDL approach in examining the link between public debt and education expenditure in the context of the chosen Sub-Saharan African countries. In this study, I analyze the effect of public debt on education expenditure in selected developing countries where some of the countries have unsustainable debt.

In equation (1) dependent variable is denoted by y_{it} , while x_{it} represents the $(k \times 1)$ vector of explanatory variables for a given country i , the fixed effects are symbolised by u_i , λ_{ij} 's signifies scalar coefficients of the lagged dependent variables, γ'_{ij} 's denotes $k \times 1$ coefficient vectors. Through reparameterization of eq. (1), eq (1) becomes:

$$\Delta y_{it} = \phi_i (y_{i,t-1} - \theta_1 d_{i,t-1} - \theta_2 x_{i,t-1}) + \sum_{l=1}^{p-1} \lambda_{i,t-1} \Delta y_{i,t-1} + \sum_{l=0}^{q-1} \lambda'_{i,t-1} \Delta d_{i,t-1} + \sum_{l=0}^{q-1} \lambda''_{il} + u_i + \varepsilon_{it} \quad (2)$$

3. METHODOLOGY

3.1 Data and Variables Description

This study used a panel data set from 1995 to 2022, which includes 15 developing countries from South America and Africa (Benin, Togo, Eswatini, Madagascar, Ghana, Lesotho, Côte d'Ivoire, Kenya, Colombia, Argentina, Costa Rica, El Salvador, Guatemala, Jamaica and Peru). The study selected the period and countries based on data availability and data was obtained from the databases of World Bank and International Monetary Fund (IMF).

The dependent variable for the study is education expenditure while public debt service is the independent variable. The control variables include GDP per capita, inflation rate, government final consumption expenditure and population growth rate. The choice of the control variables is based on their use by other scholars such as Quattri & Fosu, [24], Tasleem, [9]. A detailed overview of the variables utilized in this study is presented in Table 1.

The log of total education expenditure per student has a mean of 3.39 with a standard deviation of 1.00, indicating variability in education spending across the dataset. The log of the debt-to-GDP ratio averages 3.71, reflecting moderate variability in public debt levels relative to GDP.

3.2 Econometric Methods

The study uses ARDL method to estimate the model parameters. The ARDL model has been employed to estimate both long-term and short-term relationships between the dependent variable and its regressors. Pesaran and Shin (1999) demonstrated that the panel ARDL approach can be applied to models incorporating variables with differing orders of integration. The model can also be where is possible endogeneity problem. A general ARDL model for time periods $t = 1, 2, \dots, T$ and groups $i = 1, 2, \dots, N$; and the dependent variable y is as follows:

$$y_{it} = \sum_{j=1}^p \lambda_{ij} y_{i,t-1} + \sum_{j=0}^q \gamma'_{ij} x_{i,t-j} + u_i + \varepsilon_{it} \quad (1)$$

Table 1. Description of the variables and data sources

Variable	Description	Source
Education expenditure	Government expenditure per student (% of GDP per capita).	WDI
Public debt service	Central government public debt to GDP ratio.	IMF
Inflation rate	Annual percentage of consumer prices	WDI
Economic growth	GDP per capita (current US\$)	WDI
Government expenditure	Government final consumption expenditure (% of GDP)	WDI
Population	Population growth (annual %)	WDI

Source: Author

In this model, i and t denote country and time respectively, y represents education expenditure, while d stands for public debt service, x_{it} ($k \times 1$) denote a vector of control variables (inflation, GDP per capita, government expenditure and population). $\lambda\lambda'$ and λ'' signifies the short-run coefficients of the lagged dependent variable, debt, and other control variables. Long-run coefficients are denoted by θ_1 and θ_2 while ϕ_1 illustrates the speed of adjustment.

The study utilises PMG estimator. This method permits the intercepts, short-run coefficients, and error variances to diverge freely across groups (Peseran et al, 1998). Aside from PMG there are other estimators namely Mean Group (MG) and Dynamic Fixed Estimator (DFE). PMG is an intermediate model since it involves pooling and averaging. While the MG estimator produces consistent estimates of the average of the parameters, it fails to account for the potential homogeneity of certain parameters across all

groups, thus potentially compromising efficiency in scenarios where common parameters exist (Shin et al., 1998). Another advantage of PMG is that despite constraining long-run results for different countries, it also estimates different short-run coefficients for different countries, thereby allowing a country-by-country comparison of regression results.

PMG has advantages over MG and DFE as it is not too sensitive to outliers, and it manages the serial autocorrelation problem and can deal with the problem of endogeneity through including lags of all variables (Pesaran et al. 1999). Hausman test is utilised to verify the validity of PMG. PMG allows for the estimation of long-run homogeneity while permitting short-run parameter heterogeneity (Shin et al., 1998). PMG model for the effect of public debt service on education expenditure is specified in form as follows:

$$\Delta LNEDU_EXP_{it} = \phi_i(LNEDU_EXP_{i,t-1} - \beta_1 LNPUB_DEB_SER_{it} - \beta_2 LNGDP_CAP_{it} - \beta_3 INFLAT_{it} - GOV_EXP_{it} + POP_GROW_{it} - \beta_0) + \lambda_1 LNPUB_DEB_SER_{it} + \lambda_2 LNGDP_CAP_{it} + \lambda_3 INFLAT_{it} + \lambda_4 GOV_EXP_{it} + POP_GROW_{it} + \lambda_i + u_{it} \tag{3}$$

Where LNEDU_EXP is log of education expenditure per student LNPUB_DEB_SER is log of public debt service, LNGDP_CAP is log of GDP per capita, INFLA is inflation, LNGOV_EXP is log of Government final consumption expenditure and POP is population growth.

$\beta_i = 1,2 \dots n$ denotes the long run coefficients. $\lambda_i = 1,2 \dots n$ is representing the short run coefficients. u_{it} are the regression residuals, while ϕ_i denotes Error Correction Term (ECT) and measures the rate at which short-term deviations adjust towards long-run equilibrium. This study expects this coefficient to be negatively signed.

4. RESULTS AND DISCUSSION

4.1 Descriptive Statistics Analysis

The summary of the variables used in the current study is presented in Table 2.

4.2 Multicollinearity Test

The variables were tested if they have high multicollinearity using the pairwise correlation matrix. Correlation coefficient that is greater than 0.8 indicates severe multicollinearity Wooldridge (2020). Pairwise correlation test for this study showed that multicollinearity is at a good level. Table 3 shows the results.

Table 2. Descriptive statistics

Variables	Obs	Mean	Std. Dev.	Min	Max
LNEDU_EXP	420	3.385723	1.001905	-3.38996	6.041083
LNPUB_DEB_SER	420	3.712157	0.544781	2.12419	4.991813
LNGDP__CAP	420	7.562671	1.015798	5.53489	9.589666
LNGOVT_EXP	420	4.49274	0.125939	4.257193	4.93325
INFLA	420	7.741426	9.363294	-16.8597	94.8
POP_GRO	420	3.731115	7.511513	-0.05601	39.9862

Source: Author

Note: Missing values in the dataset have been substituted with mean

Table 3. Correlation analysis

Variables	1	2	3	4	5	6
1. LNEDU_EXP	1.0000					
2. LNPUB_DEB	0.1828	1.0000				
3. LNGDP_CAP	-0.3986	-0.1151	1.0000			
4. LNGOVT_EX	0.3578	0.1086	-0.3326	1.0000		
5. INFLAT	0.0291	0.1758	-0.0053	-0.0443	1.0000	
6. POP_GROW	0.4821	0.1187	-0.3088	0.7202	-0.0663	1.000

Source: Author

4.3 Unit Root Test

It is needed to find the order of integration before using co-integration techniques. In panel ARDL approach, unit root test is applied to eliminate variables of I (2) (Pesaran et al., 2001). The study conducted tests by Levin, Lin, and Chu (LLC) (2002) followed by test by Im Pesaran and Shin (IPS), (2003) and the null hypothesis in both tests is that all panels have unit roots. IPS is less

restrictive and more suitable in comparison to LCC which does not allow heterogeneity in the autoregressive coefficient.

Test of Unit root indicated a mixture of stationary and non-stationary variables. All the variables were stationary at level except public debt and government expenditure but became stationary after first difference. Table 4 presents all the unit root results:

Table 4. Results of Unit root test

IPS	LLC			
	AT LEVEL		With both trend and intercept	
	Statistic	Probability	Statistic	Probability
LNEDU_EXP	-5.8091	0.0000	-5.4492	0.0000
PUB_DEBT_SER	-0.5846	0.2794	-2.9617	0.0015
INFLA	-7.8875	0.0000	-7.2158	0.0000
LNGDP_CAP	-8.9509	0.0000		0.0000
POP_GROW	-8.2313	0.0000	-9.3625	0.0000
LNGOV_EXP	-2.3993	0.0082	0.6114	0.7295
PUB_DEB_SER after first difference	-8.2536	0.0000		
GOV_EXP after first difference			-4.3133	0.0000

Source: Author

4.4 Cointegration Results

After conducting unit root test, cointegration test was conducted. The null hypothesis is that cointegration does not exist. Cointegration test of the variables showed that there was cointegration. Three different tests were employed to assess cointegration: Pedroni [31], Kao [32] and Westerlund [33]. The Pedroni test results were mixed. While the Modified Phillips-Perron t statistic did not reject the null hypothesis of no cointegration, both the Phillips-Perron t and Augmented Dickey-Fuller t statistics strongly rejected the null hypothesis, indicating cointegration across the panels. The Kao test provided strong evidence of cointegration. The Westerlund test also rejected the null hypothesis of no cointegration. The combined results from

these tests confirm the presence of a stable long-term relationship among the variables studied. This implies that despite short-term fluctuations, the variables tend to move together over time. Tables 5, 6 and 7 presents detailed results:

4.5 PMG Estimation Results and Discussion

After confirming cointegration, PMG estimator was applied to analyze the long-run and short-run relationships between the variables. The Hausman test showed that PMG is the most efficient and valid estimator and as such discussion will focus on the results of PMG. Table 4 presents the empirical results:

Table 5. Pedroni Cointegration test result

	Statistic	p-value
Modified Phillips-Perron t	0.5499	0.2912
Phillips-Perron t	-7.4763	0
Augmented Dickey-Fuller t	-7.4946	0

Table 6. Kao cointegration test results

	Statistic	p-value
Modified Dickey-Fuller t	-8.7922	0
Dickey-Fuller t	-8.5629	0
Augmented Dickey-Fuller t	-7.3689	0
Unadjusted modified Dickey	-18.0838	0
Unadjusted Dickey-Fuller t	-10.7418	0

Table 7. Westlund cointegration test results

	Statistic	p-value
Variance ratio	-2.1197	0.017

Source: Author

Table 8. PMG results

VARIABLES	Short Run	Long Run
ec	-0.756***(0.0836)	
PUB_DEB_SER	-0.00372 (0.367)	-0.0688** (0.0305)
GDP_CAP	-0.186 (0.440)	0.113*** (0.0230)
GOVT_EXP	-1.008 (1.174)	1.112*** (0.266)
INFLA	-0.0104* (0.00563)	0.000485 (0.00128)
POP_GROW	0.676 (0.587)	-0.0469** (0.0182)
Constant		-1.388*** (0.242)
Hausman test p value	0.7452	
Observations	405	

Standard errors (in parentheses) *** p<0.01, ** p<0.05, * p<0.1

Source: Author

Table 9. Robustness results

VARIABLES	SR	LR
_ec	-0.780*** (0.0782)	
Debt_Stock	-0.00690 (0.0742)	-0.203* (0.104)

Source: Author

The long-run estimates from the PMG regression reveal significant relationships between the dependent variable and other key economic indicators. Specifically, a 1% increase in the debt-to-GDP ratio is associated with a 0.069% decrease in education expenditure per student. This suggests that higher public debt levels may constrain fiscal resources available for education. The negative impact of public debt service on education expenditure can be attributed to several factors. When governments allocate a significant portion of their budgets to servicing debt, it leaves fewer resources available for other priorities like education. This result aligns with existing literature, which argues that increased debt obligations divert financial resources away from essential public services, including education (Miningou, [7], Tasleem, 2021; Fosu, [23]).

On the other hand, a 1% increase in GDP per capita is associated with a 0.113% increase in education spending, highlighting the role of economic growth in supporting educational investments. Additionally, final consumption expenditure has a strong positive effect, with a 1% increase leading to a 1.112%. Population growth is negatively associated with education expenditure, with a 1% increase in population growth leading to a 0.047% decrease in spending per student.

In the short run, the PMG regression results indicate public debt service does not have statistically significant impact on education expenditure per student. However, the error correction term is highly significant and negative (-0.7562 (0.000)), indicating a robust adjustment mechanism. This suggests that deviations from the long-term equilibrium are corrected by approximately 75.6% each period, underscoring the model's ability to return to equilibrium after short-term shocks.

The findings of this study support the empirical evidence of negative impact of debt service on education expenditure (Miningou, [7], Tasleem, [9], Fosu, [5], Abu et al., [11], Idenyi et al., [34]). These studies have argued that increase in public debt services results in reduced education

expenditure since more resources are used to service debt obligations [35,36]. The findings of this study also show that debt service diverts financial resources that could have been allocated to education consequently constraining education budget. Therefore, countries should take necessary steps to reduce debt levels consequently that will reduce debt service burden [37].

4.6 Robustness Check

Robustness check using debt stock as another proxy for public debt service confirms the stability of the findings. The empirical analysis confirms the negative impact of public debt on education in the long run [38,39]. The results highlight the need for prudent debt management and strategic fiscal policies so that education expenditure is not constrained by excessive levels of debt. Table 9 shows the robustness results.

5. CONCLUSION

This study examined the relationship between public debt service and education expenditure using the ARDL approach, focusing on a panel of 15 developing countries. The empirical analysis revealed that there is a statistically significant long-term relationship, indicating that public debt service negatively affects education expenditure. Specifically, the findings suggest that as public debt levels rise, the resources available for education reduce, which aligns with previous studies highlighting the detrimental impact of debt service on educational funding.

Given these results, it is imperative for governments to adopt effective fiscal policies aimed at maintaining manageable debt levels. Additionally, international partners should consider providing debt relief to developing countries, enabling them to allocate more resources toward education.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

The author hereby declare that NO generative AI technologies such as Large Language Models

(ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

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COMPETING INTERESTS

Author has declared that no competing interests exist.

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