# Public spending and primary school enrolment: An Autoregressive distributed lag approach

Beri, Parfait and Cochrane, Logan and Syed Fazlullah, Sarah

Triple Helix Foundation, Hamd Bin Khalifa University, Hamad Bin Khalifa University

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Parfait Beri
parfaitberi@gmail.com
Triple Helix Foundation, Simbock-Yaounde
Cameroon

Logan Cochrane
lcochrane@hbku.edu.qa
Hamad Bin Khalifa University, College of Public Policy, Doha, Ad Dawhah
Qatar

Sarah Syed Fazlullah
safa68196@hbku.edu.qa
Hamad Bin Khalifa University, College of Public Policy, Doha, Ad Dawhah
Qatar

Correspondence: Parfait Beri, parfaitberi@gmail.com, Triple Helix Foundation, Simbock-Yaounde, Cameroon

## Abstract

This paper delves into the effects of public investment on primary school enrollment in low- and lower-middle-income countries (LMICs) over three decades, from 1990 to 2020. Autoregressive distributed lag models are employed to evaluate the long-term influence of public spending on enrollment for the whole sample and four distinct sub-samples, while also probing the potential non-linear nature of this relationship. Findings reveal that public expenditure has a significant, positive impact on enrollment across LMICs, including low-income countries (LICs), lower-middle-income countries (LMCs), and sub-Saharan Africa (SSA) in the long run. These effects persist under non-linear model specifications. This research provides fresh empirical insights by adopting a long-term viewpoint on the nexus between educational funding and enrollment trends in LMICs. These findings highlight the critical role of sustained and efficient funding for achieving enrollment goals, a cornerstone for the advancement of sustainable development.

**Keywords**: Public spending, government expenditure, school enrolment, education, SDG4.
JEL Classification: A21, H52, I22

## 1. **Introduction**

In March 1990, the World Conference on Education for All in Jomtien, Thailand, pledged to universalise access to basic education by the year 2000. This was an ambitious and unprecedented goal that aimed to transform the lives of millions globally. In response, nations across the globe initiated substantial expansions in educational provisions, resulting in increased enrolments at primary and secondary levels. Many low and lower-middle-income countries (LMICs) went a step further to alleviate economic barriers by eliminating school fees, aiming to ease the financial burden on underprivileged households (Oseni et al., 2020). However, by the early 21st century, it became apparent that the Jomtien Conference's ambitious goals would not be met within the projected timeline, due primarily to an intricate nexus of economic, social, and political challenges (Hossain & Hickey, 2019). A significant hindrance was the pervasive debt crises that imposed stringent fiscal limitations on developing nations, thereby undermining their capacities to invest in and provide high-caliber educational opportunities to children.

The role of public investment and its efficacy remains a prominent topic within educational policy discussions as a means to realize the goal of universal education access (Ferber & Baten, 2024; Schultz, 1988; Mingat & Tan, 1992, 1998; Harbison & Hanushek, 1992). This strategic emphasis aligns with the Sustainable Development Goals' mandate to offer free, equitable, and high-quality primary and secondary education to all by 2030. The theory posits that sufficient public funding equips educational institutions with the essential resources — infrastructure, educators, and instructional materials — that are foundational for fostering an effective learning environment (Vegas & Coffin, 2015). Nonetheless, increased fiscal allocation to educational systems does not invariably correspond to the anticipated advancements in learning, particularly within LMICs that are often characterized by systemically flawed educational structures (Azevedo et al., 2019; Hanushek & Woessmann, 2017).

The exploration of factors influencing school enrollment has been a subject of extensive research over the past several decades, yielding profound insights into the theoretical and

empirical dynamics between public spending and educational participation. Studies employing quasi-experimental methods have, at times, presented an array of mixed or inconclusive findings (Hanushek & Woessmann, 2017; Berlinski et al., 2008; Gustafsson, 2003; Hanushek, 1995). Concurrently, a substantial portion of existing research, predominantly rooted in microeconomics, is often constrained by its focus on limited temporal scopes and a tendency to analyze immediate, short-term elasticities (Ferber & Baten, 2024; Oseni et al., 2020; Vegas & Coffin, 2015; Rajkumar & Swaroop, 2008).

Our study enhances the current body of literature by examining the interplay between public expenditure and primary school enrollment over an extended period. Recognizing the complexity of this relationship in practical settings, we note that while government spending may fluctuate unpredictably in the short term, it tends to correlate more consistently with enrollment figures over the long term. It is therefore crucial to discern the enduring connection between these variables, distinguishing it from the short-term volatility documented in prior research (Kripfganz & Schneider, 2023; Oseni et al., 2020; Vegas & Coffin, 2015; Rajkumar & Swaroop, 2008). This long-term perspective is therefore essential to develop a more nuanced understanding of how sustained public investment impacts educational enrollment.

This paper presents three significant contributions to educational research. First, it explores the short- and long-term impact of public investment on school enrollment in low and middle-income countries (LMICs). It does this by using a sophisticated analytical approach known as the pooled mean group (PMG) model, originally developed by Pesaran and colleagues in 1999. Unlike earlier studies which primarily indicated a general positive correlation without addressing causality between public spending and school enrollment rates, this paper delves into the cause-and-effect nature of this relationship. The PMG model effectively handles the issue of heterogeneity in panel studies by allowing short-run coefficients and error variances to differ across countries, yet it assumes that over a longer period, these variations will align uniformly across all countries (Simões, 2011). Through this approach, our research offers new insights into

how educational funding affects student enrollment patterns over time, especially highlighting the lasting impact of investment decisions in education.

Secondly, our research addresses a notable scarcity of long-term, cross-country analysis in the context of low and lower-middle-income countries (LMICs). We examine an extensive dataset spanning three decades (1990–2020) across 72 LMICs, yielding over 2000 individual data points. This longitudinal approach allows us to draw more definitive conclusions about the enduring influence of public expenditure on education and other control variables. LMICs present a particularly relevant study group due to their consistent trends in school enrolment, high numbers of out-of-school children, and generally lower educational spending compared to more developed regions. However, these countries are diverse, necessitating a nuanced analysis to ensure broad applicability of the findings. Our study categorizes the 72 LMICs into sub-groups: 21 are classified as low-income, 51 as lower-middle-income, 38 are located in sub-Saharan Africa, and 23 are landlocked nations. By dissecting the data into these subsets, we can extend the relevance of our results across different LMIC contexts, a methodological choice which to our knowledge, is distinctly rare in existing literature. The outcomes indicate a positive and sustained correlation between public investment in education and primary school enrolment rates, except for in landlocked countries.

Lastly, prevailing research often operates on the assumption that the benefits of public spending on school enrolment are constant, relying on linear models which may not fully capture the relationship's complexity (Oseni et al., 2020; Rajkumar & Swaroop, 2008). Such an approach risks oversimplification, as evidenced by Vegas and Coffin (2015), who found that the impact of public expenditure on educational outcomes varies at different spending levels. There appears to be a critical threshold of expenditure; surpassing this threshold can lead to a marked decline in school enrolment. Our study contributes to this discourse by probing the possibility of a non-linear relationship between government spending and enrolment rates. Our findings indicate that

in LMICs, the effect of public expenditure on school enrolment remains positive and statistically significant, when accounting for potential non-linearities.

This study's findings hold valuable implications for policymakers, educators, and advocates. By providing empirical data on how public expenditure correlates with primary school enrollment, this research can guide policymakers in their budgeting and resource allocation efforts to advance the goal of equitable, high-quality education for all. Understanding the effect of government investment on school accessibility allows policymakers to tailor their strategies appropriately and set realistic expectations for different timelines. Such insights are essential for addressing disparities in school enrollment or for advocating heightened investment in primary education within LMICs.

The remaining structure of this paper is as follows: Section 2 provides an overview of public spending on education within LMICs. Section 3 reviews the literature. Section 4 documents the estimation strategy and data, while Section 5 presents and discusses the results. Section 6 concludes the paper, proposing directions for future research.

## 2. **Public spending and primary school enrolment**

The Sustainable Development Goals (SDGs) have established a comprehensive educational agenda, with a particular focus on low- and lower-middle-income countries (LMICs), committing to prioritize the progress of those who are furthest behind. At the forefront of SDG 4 is the aim to "ensure inclusive and equitable quality education and promote lifelong learning opportunities for all." This target stipulates that all children, regardless of their background, should have access to at least nine years of free and compulsory education, leading to meaningful and productive learning outcomes, thereby eliminating any discriminatory barriers that could impede this fundamental right.

Despite significant advancements in public investment for education and a notable rise in school enrollment rates in recent decades, about 258 million children, youths, and adolescents

around the world were still out of school in 2018. This figure amounts to 20% of the global school-age population. Breaking it down, primary schools were the most affected, with 23% (59 million) of this group. Furthermore, low and middle-income countries (LMICs) were home to more than 86% (51 million) of these out-of-school children, according to reports by UNESCO in 2020 and the UIS in 2023 (UNESCO, 2020; UIS, 2023). A substantial number of these children are found in sub-Saharan Africa and developing regions of Asia. The reasons for their absence from school are multifaceted: some attend only intermittently or drop out early, others never enroll or enroll late. Financial constraints, a lack of sufficient or qualified teachers, the impact of violent conflicts, and the poor quality of education resulting in minimal learning gains are among the key challenges these children face (Berlinski et al., 2008; Hossain & Hickey, 2019).

In addressing the ongoing concerns regarding educational access disparities, it was noted in 2022 by UN-WOMEN that closing certain gender gaps to achieve universal, high-quality education for all girls could take approximately 286 years (Frola et al., 2024). This projection emphasizes the complex challenges faced in ensuring all children, particularly in developing countries, receive education. The dialogue surrounding these issues touches on critical policy questions concerning the means of enrolling all children in schools, the role of public spending, and other systemic factors that influence educational outcomes once enrollment is achieved.

In response to these issues, governments of developing countries have emphasized the importance of investing in education. This prioritization is grounded in recognizing education as a fundamental human right, a tool to mitigate inequalities, enhance access and quality, and leverage its economic advantages. According to reports by the World Bank and UNESCO in 2023, Low- and Lower-Middle-Income Countries (LMICs) increased their expenditure on education from $305 billion in 2012 to $454 billion in 2021. However, a study covering the period from 2014 to 2018 across 141 countries revealed that 41 of these nations failed to meet the recommended benchmarks of allocating either 4% of their GDP or 15% of their total public expenditure towards education, as outlined in the Sustainable Development Goal 4 (SDG4)

framework (UNESCO, 2020). It's important to note that the heightened investment has not adequately reached the most marginalized groups. Furthermore, this increased spending has been largely insufficient in bridging the educational disparities between developed and developing nations, as well as between wealthier and poorer sectors within developing countries. A concerning trend illustrated in Figure 1(d) is the stagnation, or in some cases, the decline in government education spending when measured as a percentage of gross national production (GNP). This lack of prioritization further exacerbates existing inequalities between the rich and the poor and the differentiated opportunities that income inequality affords.

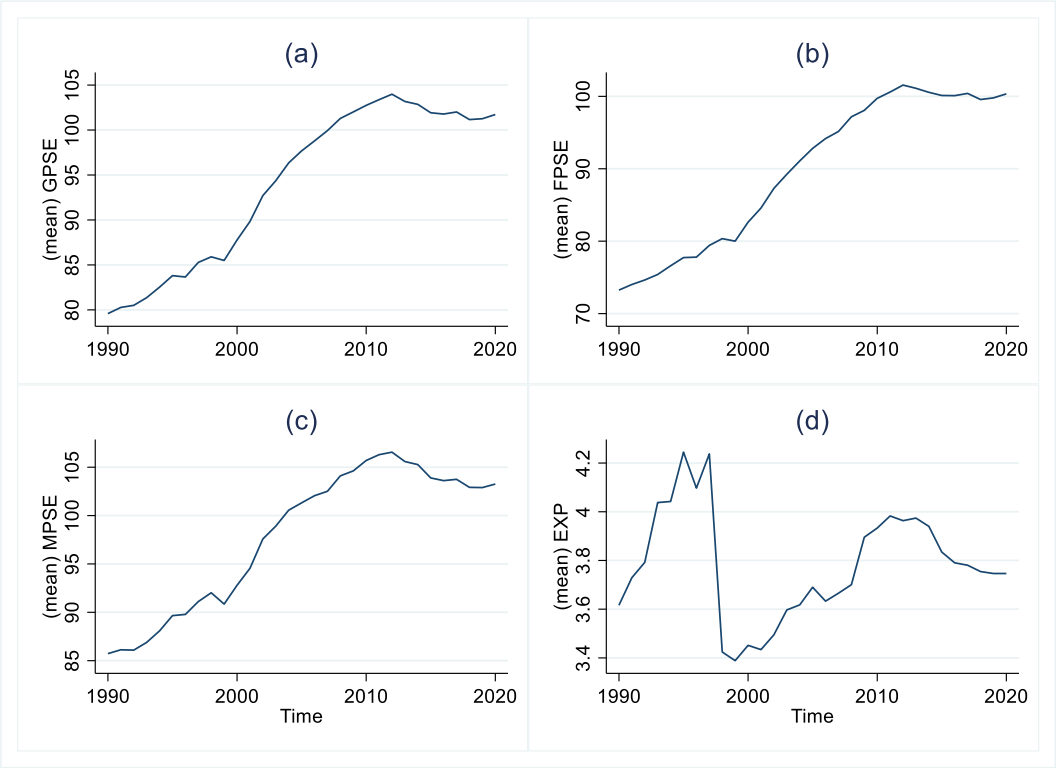



Figure 1: School enrolment and public spending

*Notes*: Figures 1 (a)–(c) show a remarkable increase in school enrolment from 1990 to 2020. Female enrolment has increased, but it is still lower than their male counterparts across all years. In Figure 1(d), government expenditure has largely been less than 4% of the gross national product since 2000.

This analysis prompts further exploration into how Low- and Lower-Middle-Income Countries (LMICs) have managed to achieve consistent increases in school enrollment despite a general trend of decreasing government expenditures on education. One notable strategy includes the elimination of tuition fees for many public schools across LMICs, making education

more accessible. Additionally, the growing popularity of education has led to economies of scale, effectively reducing the per-unit cost of educational resources. Parent Teacher Associations (PTAs) have emerged as pivotal contributors to the educational infrastructure in numerous economically disadvantaged nations. They have taken proactive steps by constructing classrooms, hiring part-time teachers, and covering various school-related expenses, thereby playing a crucial role in supplementing educational provisions. Moreover, there has been a noticeable uptick in both expenditure on and enrollment in private schools over recent years. This trend can be attributed to a confluence of factors, including economic growth, urbanization, population increases, and the influences of globalization. These elements collectively contribute to the evolving landscape of educational enrollment and funding in LMICs, as observed in Schultz's 1988 study (Schultz, 1988).

Analysis of Figure 1A from the supplementary file reveals that the proportion of government expenditure dedicated to education within Low- and Lower-Middle-Income Countries (LMICs) fluctuated between 14.5% and 16.5% from 1990 to 2021. During the same timeframe, the allocation of government spending on primary education as a percentage of total education expenditure varied from 35% to 48%. Notably, public investment in education peaked in the early 2000s, only to experience a subsequent decline. This reduction in funding for primary education highlights significant policy challenges, particularly concerning its impact on Sustainable Development Goal 4 (SDG4), which emphasizes inclusive and equitable quality education for all. Addressing these challenges necessitates a critical reassessment of the relationship between financial investment in education and enrollment rates, emphasizing the need for a strategic, long-term approach to education policy and resource allocation.

## 3. **Literature review**

Over the past decades, numerous studies have explored the impact of various factors on school performance, aiming to guide policymakers in optimizing resource allocation to enhance

educational outcomes. A foundational concept in this research is the Education Production Function (EPF) (Ferber & Jörg Baten, 2024; Glewwe & Kremer, 2006; Trostel, 2005). According to this framework, school outcomes are influenced by a multitude of variables, including the quality of schools and teachers, levels of funding, socio-economic backgrounds of students, household income, and innate abilities among others. These studies assert that the effectiveness of the education system is contingent upon both the quantity and quality of its inputs. Moreover, many of these investigations have employed a quasi-experimental design to delineate the specific contribution of each factor to educational outputs (Glewwe & Kremer, 2006; McEwan, 2015). The insights garnered from this body of research continues to significantly inform and direct governmental strategies for investment in education in developing nations.

Wagner and Musgrave's theories suggest that as a country's economy expands, the demand for public services, such as education, increases, leading to greater public investment in these areas. Wagner's hypothesis also indicates that democracies are predisposed to invest more in education compared to autocracies, while Musgrave emphasizes the essential role of government in educational funding to ensure that quality education is accessible to all members of society (Musgrave, 1959; Wagner, 1883, 1958). The hypothesis proposes that countries with high-quality educational systems tend to see higher rates of student enrollment and better overall educational outcomes (Hanushek & Woessmann, 2017; Hanushek, 1995).

Human Capital Theory (HCT), as proposed by Schultz in 1961 and expanded by Becker in 1975, suggests that education is an investment in human capital, with the decision to pursue education based on a cost-benefit analysis (Jimenez & Patrinos, 2008). This theory, however, has been critiqued for its narrow perspective that often frames education as a series of individual choices without adequately considering the broader systemic factors at play. This reductionist view fails to recognize the complex dynamics that contribute to the provision of education and the resulting disparities in educational outcomes. It incorrectly attributes these disparities to personal choices while ignoring the underlying systemic factors that shape these decisions (Mejía-Rodríguez

& Kyriakides, 2022). We hypothesize that insufficient investment in education negatively impacts enrollment, suggesting that increased public expenditure is essential for addressing this issue and promoting educational advancement over time.

Recent research on the link between public spending and educational outcomes presents a spectrum of findings. Some studies identify a clear positive correlation between increased educational resources and student achievement (Ferber & Baten, 2024; Oseni et al., 2020; Jackson et al., 2016; Hanushek, 2003, 1994; Velez et al., 1993; Jacques & Brorsen, 2002). Others challenge this, arguing that more spending does not necessarily yield better results (Amin & Ntembe, 2021; Hanushek & Woessmann, 2017; Blankenau & Camera, 2009; Hanushek & Kimko, 2000; Mingat & Tan, 1998; Hanushek, 1994, 1995, 2003; Harbison & Hanushek, 1992). Further research indicates that the impact of investment on education may depend on broader socio-economic factors, such as a country's level of development and stability (Vegas & Coffin, 2015; Rajkumar & Swaroop, 2008; Trostel, 2005). Additionally, factors like teacher quality and economic growth are also highlighted as influential for educational outcomes (Glewwe & Muralidharan, 2016; Glewwe et al., 2011). However, there is a noted gap in long-term analysis, which this study aims to address, offering a comprehensive review of how public spending affects educational success over extended periods.

## 4. **Estimation strategies and data**

This study explores the dynamic effects of public spending on primary school enrolment[1] (PSE) in 72 low- and lower-middle-income countries (LMICs) over the period from 1990 to 2020. Drawing on the foundational works of Amin and Ntembe (2021), Hanushek (2020), Hanushek and Woessmann (2017), Vegas and Coffin (2015), Jacques and Brorsen (2002), Simões (2011), and Rajkumar and Swaroop (2008), our analytical framework is structured around a pooled mean

[1] "Gross enrolment ratio is the ratio of total enrolment, regardless of age, to the population of the age group that officially corresponds to the level of education shown", that is, primary schools (UNESCO Institute for Statistics (UIS)).

group (PMG) application of the autoregressive-distributed lag (ARDL) model, as established by Pesaran and Smith (1995), and further developed by Pesaran et al. (1999).

The panel structure of the model can be specified in $ARDL\ (m, n, \dots, n)$ form for period $t = 1, 2, 3, \dots T$ and cross-sections $i = 1, 2, 3 \dots N$ of the dependent variable ($PSE_{i,t}$) in equation (2):

$$PSE_{i,t} = \sum_{j=1}^{m} \lambda_{ij} PSE_{i,t-j} + \sum_{j=0}^{n} \delta'_{ij} EXP_{i,t-j} + \mu_i + \varepsilon_{i,t} \quad \dots (2)$$

where:

$PSE$ is primary school enrolment[2] and we estimate models for gross primary school enrolment (GPSE), female primary school enrolment (FPSE), and male primary school enrolment (MPSE). $EXP$ is public education spending[3], $\mu_i$ accounts for the effects of diverse cultural settings, such as linguistic norms, orientations, rules, and other country specific factors that affect enrollment but are not directly observable (Fuller & Clarke, 1994), while $\varepsilon_{it}$ is the white noise.

We reparameterize equation (2) in an error-correction (EC) form to disentangle the long run relationship from the overlaid short run dynamics (Kripfganz & Schneider, 2023).

$$\Delta PSE_{i,t} = \phi_i \left( PSE_{i,t-1} - \beta'_i EXP_{i,t-j} \right) + \sum_{j=1}^{m-1} \gamma_{ij} \Delta PSE_{i,t-j} + \sum_{j=0}^{n-1} \gamma'_{ij} EXP_{i,t-j} + \mu_i + \varepsilon_{i,t} \quad \dots (3)$$

where:

$\Delta$ in (3) is the difference operator, $\beta_i$s are the long-run coefficients and $\phi_i$s are the speeds of adjustments (theoretically negative and statistically significant) from short run disequilibria to long run equilibria or the error correction parameters.

[2] School enrolment can exceed 100% due to the inclusion of over-aged and under-aged students, early or late school entrance, and grade repetition.

[3] "Education expenditure refers to the current operating expenditures in education, including wages and salaries and excluding capital investments in buildings and equipment" (UIS). It is expressed as a share of gross national income.

The PMG restricts all cross-sections to have common $\beta_i$s. According to Pesaran et al. (1999), these parameters are consistent and asymptotically normal even when the regressors are both stationary, I (0) and non-stationary, I (1). The model is estimated via the maximum likelihood method. It also requires selecting a suitable lag length. Using the Schwarz Bayesian Criterion, the general form of the ARDL (1,0,0,0,0,0) is given by (4).

$$\Delta PSE_{it} = \phi_i\left(PSE_{i,t-1} - \beta_i'(EXP_{i,t}, HDI_{i,t}, POP_{i,t}, NPT_{it}, GDPC_{it}, GoE_{it}\right)' \quad \cdots \quad (4)$$
$$+ \sum_{j=1}^{m-1} \gamma_{ij}\Delta PSE_{i,t-j}$$
$$+ \sum_{j=0}^{n-1} \gamma_{ij}'\Delta EXP_{i,t-j}$$
$$+ \sum_{j=0}^{n-1} \gamma_{ij}'\Delta HDI_{i,t-j}$$
$$+ \sum_{j=0}^{n-1} \gamma_{ij}'\Delta POP_{i,t-j}$$
$$+ \sum_{j=0}^{n-1} \gamma_{ij}'\Delta NPT_{i,t-j}$$
$$+ \sum_{j=0}^{n-1} \gamma_{ij}'\Delta GDPC_{i,t-j} + \sum_{j=0}^{n-1} \gamma_{ij}'\Delta GoE_{i,t-j} + \mu_i + \varepsilon_{it}$$

We further split the study sample into LICs, LMCs, SSAs, and landlocked countries to account for the heterogeneity across LMICs[4]. To ensure that our results are robust, we also investigate whether the EPF in (4) is correctly specified by following the procedure in Martınez-Zarzoso and Bengochea-Morancho (2004) to estimate its non-linear or quadratic form.

[4] The classification of countries into LMICs and landlocked developing countries followed the World Bank list (https://datahelpdesk.worldbank.org/knowledgebase/articles/906519-world-bank-country-and-lending-groups), and the UNCTAD (https://unctad.org/topic/landlocked-developing-countries/list-of-LLDCs).

$$\Delta PSE_{i,t} = \phi_i\left[PSE_{i,t-1} - \beta_{1i}(EXP_{i,t})^2 - \beta_{2i}(x_{i,t})\right] - \gamma_{ij}\Delta\left(EXP_{i,t-1}\right)^2 - \gamma_{ij}\Delta(x_{i,t-1}) + \mu_i + \varepsilon_{i,t} \quad \ldots(5)$$

Where:

$EXP_{i,t}{}^2$ is the non-linear form of public spending, with the relationship assumed to follow an inverted U-shaped pattern. In a sense, we are assuming that the effect of public spending increases up to a certain point and starts declining thereafter.

A limitation present in estimating static or dynamic fixed effect models is their imposition of slope homogeneity, permitting only intercept variations across countries in estimations. Given the diverse nature of public spending in education across countries, especially in Low- and Lower-Middle-Income Countries (LMICs), this assumption is noted to have become more challenging to justify (Martínez-Zarzoso & Bengochea-Morancho, 2004). In response to this challenge, Pesaran et al. (1999) extended the Autoregressive Distributed Lag (ARDL) framework to allow for varying intercepts, short-run coefficients, and errors across cross-sections, while maintaining similarity in the long-run coefficients of explanatory variables across these cross-sections. Additionally, the choice of the Pooled Mean Group (PMG) approach was made due to its superior performance in Monte Carlo experiments (Asteriou & Monastiriotis, 2004). The PMG model accommodates both balanced and unbalanced panels, with the flexibility to accommodate variations in the number of observations ($m$ and $n$) across different cross-sections within the study.

We incorporate a set of control variables sourced from existing literature that are known to influence enrollment rates. These variables include the human development index (HDI), the population of children between 0 and 14 years old as a measure of population growth (POP) (Oseni et al., 2020; Glewwe & Muralidharan, 2016), the number of teachers[5](NPT) (Glewwe et

[5] Primary education teachers include the number of full-time and part-time teachers (UIS).

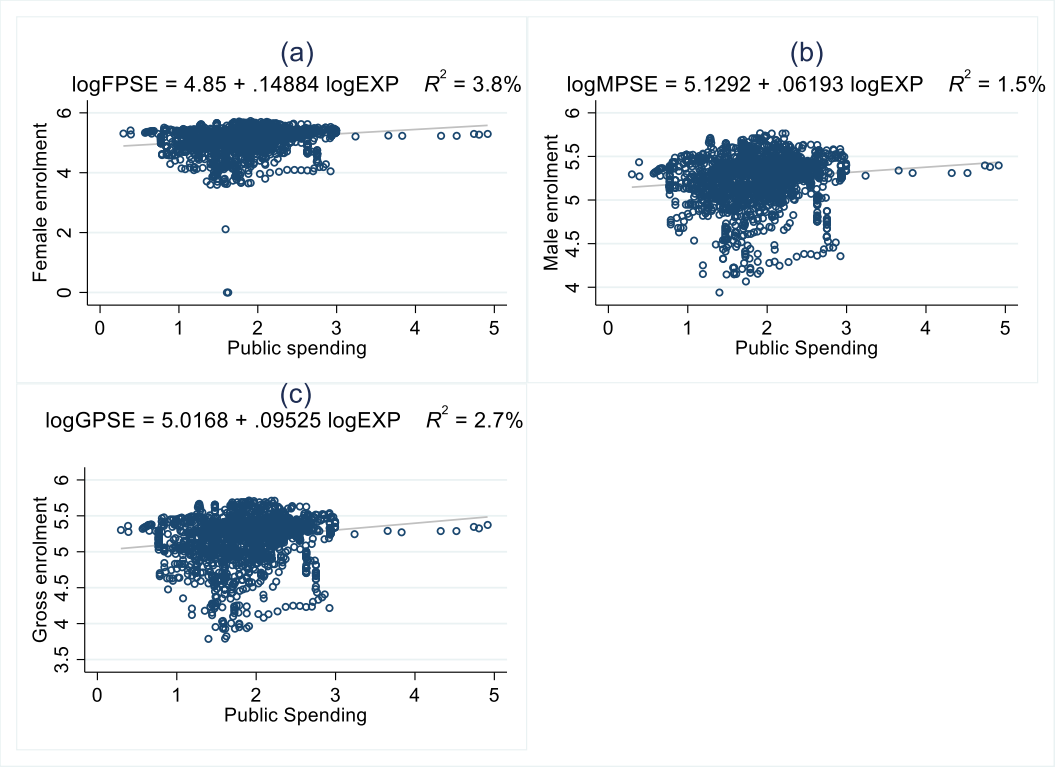
al., 2011), economic development as proxied by GDP per capita (GDPC) (Amin & Ntembe, 2021), and governance effectiveness[6] (GoE) (Rajkumar & Swaroop, 2008).

To maintain consistency in our variables despite missing observations, we employed various techniques. Missing observations in school enrollment data were replaced with nearby non-missing values within the panel. Linear interpolation was utilized to estimate missing values for variables such as GDP per capita (GDPC) and government effectiveness. Additionally, the hyperbolic sine transformation function was applied to linearize the data. These adjustments were made with care to preserve the fundamental characteristics of the data, and they did not lead to significant alterations in its underlying structure.

[6] "Government effectiveness captures perceptions of the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies. Estimate gives the country's score on the aggregate indicator, in units of a standard normal distribution, i.e. ranging from approximately -2.5 to 2.5" with higher scores indicating better governance (www.govindicators.org).

# 5. Results and discussion

## 5.1 Descriptive results




This section presents the findings of our analysis, with summary statistics displayed in Table 1. Across Low- and Lower-Middle-Income Countries (LMICs), the average school enrollment rate during the studied period is 94.32%. Notably, male enrollment rates are higher at 98.21% compared to females at 90.16%. Enrollment rates vary significantly across countries, ranging from a minimum of 44.34% to a maximum of 131.43%. On average, LMICs allocate 3.78% of their Gross National Product (GNP) to education, slightly below the 4% commitment outlined in SDG4. However, spending on education varies widely among countries, ranging from as low as 0.86% to as high as 12.95% of GNP. A visual examination of the scatter plots in Figure 2 reveals a positive linear relationship between public spending and enrollment rates, both for females (a) and males (b), as well as gross primary enrollment (c).

Table 1
*Descriptive Statistics*

| Variable | Mean | Std. Dev. | Min | Max | |
|---|---|---|---|---|---|
| Gross enrolment | 94.32 | 23.23 | 22.07 | 151.57 | N = 2211 |
| Between | | 17.55 | 44.34 | 131.43 | n = 72 |
| Within | | 15.34 | 33.54 | 156.00 | T-bar= 30.7 |
| Female enrolment | 90.16 | 25.60 | 0.00 | 154.03 | N = 2196 |
| Between | | 19.59 | 40.12 | 128.74 | n = 72 |
| Within | | 16.58 | 26.38 | 160.72 | T-bar =30.5 |
| Male enrolment | 98.21 | 21.95 | 25.70 | 159.66 | N = 2196 |
| Between | | 16.52 | 48.40 | 134.69 | n = 72 |
| Within | | 14.56 | 39.85 | 155.20 | T-bar = 30.5 |
| Public spending | 3.78 | 3.12 | 0.30 | 68.15 | N = 2232 |
| Between | | 2.00 | 0.86 | 12.95 | n = 72 |
| Within | | 2.41 | -7.25 | 58.98 | T-bar = 31 |
| GDP per capita | 1473.28 | 1036.64 | 189.28 | 5450.93 | N = 2181 |
| Between | | 960.45 | 322.74 | 4524.82 | n = 72 |
| Within | | 402.10 | -35.43 | 3393.77 | T-bar =30.3 |
| Population | 40.28 | 6.77 | 14.086 | 51.18 | N = 2232 |
| Between | | 6.07 | 16.76 | 49.26 | n = 72 |
| Within | | 3.08 | 30.09 | 53.83 | T-bar = 31 |
| Human development | 51.48 | 11.89 | 21.60 | 78.90 | N = 2046 |
| Between | | 10.59 | 30.37 | 73.93 | n = 72 |
| Within | | 5.38 | 36.59 | 65.1298 | T-bar = 28.4 |
| Number of teachers | 122333.5 | 378670.14 | 460 | 4600165 | N = 2137 |
| Between | | 429121.20 | 625.29 | 3576401 | n = 71 |
| Within | | 81403.98 | -679420.9 | 1146097 | T-bar = 30.1 |
| Governance | -0.737 | 0.51 | -2.17 | 0.707 | N = 1770 |
| Between | | 0.46 | -1.66 | 0.473 | n = 72 |
| Within | | 0.21 | -1.48 | 0.066 | T-bar = 24.5 |

*Note*: N= number of observations; n=number of countries; T-bar=average number of years for which data is available.

Before conducting our estimation, we conducted several preliminary tests to ensure the reliability of our results. Firstly, we examined pairwise correlations and calculated the variance inflation factor to assess multicollinearity, finding no significant evidence of it. We also conducted unit root tests and determined that all variables were stationary either at the level or after first differencing (Im et al., 2003). Furthermore, we tested for cointegration using Pedroni's (1999) and Kao's procedures, revealing evidence of a long-run linear relationship among the variables in our models. The presence of unit root and cointegration supports the suitability of our chosen estimation approach.

## 5.2 **Econometric results**

This section presents the outcomes regarding both short- and long-term dynamics of public spending and primary school enrollment. Table 2 showcases various analyses: Column (1) displays baseline results, while (2) factors in economic development (GDPC), (3) considers governance effectiveness, and (4) and (5) delve into the impacts on female and male enrollments, respectively. Furthermore, columns (6) to (9) delve into estimations tailored to sub-groups of countries within Low- and Lower-Middle-Income Countries (LMICs).

The initial findings in Table 2 highlight the adjustment speeds from short-term discrepancies to long-term equilibrium (ECT), all of which are notably negative and statistically significant. These highly significant coefficients suggest that our models are appropriately specified, with public spending on education reverting to its long-term relationship when equilibrium is disrupted. For instance, in column (1), the short-term disequilibrium returns to long-term equilibrium at a rate of 17.4%. Analysis of short-term coefficients reveals that only human development and the number of teachers exhibit a positive and significant association with enrollment.

The long-term results indicate a significant positive impact of public spending on enrollment across columns (1) to (6). This effect persists consistently even after accounting for GDP per capita (GDPC) in column (2) and governance in column (3). Interestingly, while both female and male enrollment rates respond positively to public spending over the long term, males demonstrate a higher tendency to enroll in primary schools compared to females. This observation is supported by their respective long-term elasticities of 0.067 and 0.025. Furthermore, the analysis reveals that factors such as human development, the number of teachers, population size, GDP per capita, and governance quality also contribute positively to enrollment rates over the long term.

Given the diverse nature of Low- and Lower-Middle-Income Countries (LMICs), we have divided our samples to assess the validity of our findings regarding the impact of public

spending on enrollment. In the short term, the coefficient of public spending (0.075) is negative and weakly significant in low-income countries (6), but is insignificant in columns (7) to (9). However, in the long term, the coefficients of public spending are positive and econometrically significant in LICs, LMCs, and SSA (columns (6) to (9)). Additionally, our analysis indicates that the coefficients for human development and the number of teachers are positive and significant in the short term, although their significance levels and directions vary over the long term. Overall, these econometric findings support the hypothesis that public spending significantly influences primary school enrollment in LMICs.

Table 2

*Long run impact of public spending on school enrolment*

| VARIABLES | (1) GPSE | (2) GPSE | (3) GPSE | (4) FPSE | (5) MPSE | (6) LICs | (7) LMCs | (8) SSA | (9) Landlocked |
|---|---|---|---|---|---|---|---|---|---|
| SR Coefficients | | | | | | | | | |
| ECT ($\phi_i$) | -0.174*** | -0.176*** | -0.171*** | -0.173*** | -0.189*** | -0.196*** | -0.195*** | -0.173*** | -0.122*** |
| | (0.022) | (0.029) | (0.022) | (0.025) | (0.020) | (0.039) | (0.034) | (0.026) | (0.026) |
| ΔPublic Spending | 0.013 | 0.057 | 0.021 | -0.030 | 0.022 | -0.075* | 0.041 | -0.010 | 0.020 |
| | (0.033) | (0.070) | (0.032) | (0.043) | (0.038) | (0.041) | (0.041) | (0.024) | (0.057) |
| ΔHuman development | 1.188*** | 1.391*** | 1.102*** | 1.367*** | 1.058*** | 1.882*** | 0.880*** | 1.381*** | 1.564*** |
| | (0.183) | (0.243) | (0.169) | (0.365) | (0.173) | (0.393) | (0.201) | (0.224) | (0.416) |
| ΔPopulation (0-14) | -1.078 | -1.373 | -1.007 | -1.155 | -0.925 | -3.336* | -0.693 | -1.508* | -1.444* |
| | (0.795) | (1.024) | (0.778) | (1.077) | (0.794) | (1.715) | (0.941) | (0.874) | (0.757) |
| ΔNumber of teachers | 0.159*** | 0.135*** | 0.155*** | 0.182*** | 0.163*** | 0.248*** | 0.097*** | 0.239*** | 0.207*** |
| | (0.028) | (0.026) | (0.028) | (0.032) | (0.028) | (0.076) | (0.023) | (0.045) | (0.061) |
| ΔGDP per capita | | -0.074 | | | | | | | |
| | | (0.051) | | | | | | | |
| ΔGovernance | | | 0.013 | | | | | | |
| | | | (0.014) | | | | | | |
| *LR coefficients* | | | | | | | | | |
| Public Spending | 0.043*** | 0.027** | 0.043*** | 0.025** | 0.067*** | 0.185*** | 0.067*** | 0.063** | -0.012 |
| | (0.015) | (0.013) | (0.016) | (0.010) | (0.018) | (0.042) | (0.018) | (0.027) | (0.009) |
| Human development | 0.837*** | -0.176*** | 0.882*** | 0.609*** | 0.767*** | 0.220 | -0.167*** | 0.924*** | -0.671*** |
| | (0.070) | (0.025) | (0.068) | (0.064) | (0.069) | (0.163) | (0.029) | (0.088) | (0.082) |
| Population (0-14) | 0.397*** | -0.121** | 0.455*** | 0.034 | 0.475*** | 1.194*** | -0.089** | 0.302** | -0.103 |
| | (0.055) | (0.049) | (0.056) | (0.051) | (0.046) | (0.396) | (0.043) | (0.141) | (0.089) |
| Number of teachers | 0.034* | 0.130*** | 0.031* | 0.077*** | -0.003 | 0.244*** | 0.168*** | 0.018 | 0.237*** |
| | (0.018) | (0.015) | (0.018) | (0.018) | (0.020) | (0.056) | (0.017) | (0.025) | (0.070) |
| GDP per capita | | 0.131*** | | | | | | | |
| | | (0.020) | | | | | | | |
| Governance | | | 0.022* | | | | | | |
| | | | (0.012) | | | | | | |
| Constant | -0.161*** | 0.715*** | -0.228*** | 0.204*** | -0.100*** | -0.869*** | 0.871*** | -0.128*** | 0.724*** |
| | (0.021) | (0.125) | (0.029) | (0.034) | (0.013) | (0.163) | (0.159) | (0.016) | (0.163) |
| Observations | 2,130 | 2,130 | 2,130 | 2,130 | 2,130 | 600 | 1,530 | 1,110 | 690 |

*Note*: Standard errors in presented in parenthesis. GPSE, FPSE and MPSE are total, female, and male primary school enrolments, respectively. LICs, low-income countries; LMCs, lower-middle-income countries; SSA, sub-Saharan Africa; Landlocked, Landlocked countries.

* Significant at the 10% level, ** Significant at the 5% level, *** Significant at the 1% level

### 5.3 **Robustness check**

The previous findings assume a linear relationship between public spending and enrollment in Low- and Lower-Middle-Income Countries (LMICs). However, this assumption could lead to model misspecification, as discerning the true nature of the relationship between two or more variables can be challenging. To ensure the robustness of our results, we explored the possibility of a non-linear relationship, specifically a quadratic form, in line with Vegas and Coffin's (2015) findings of threshold effects of education spending on school outcomes. Trostel (2005) also estimated non-linear models in his examination of the Education Production Function (EPF). To assess this non-linearity, we squared public spending and re-estimated the models. Table 3 presents the outcomes of this quadratic specification. Once again, the speeds of adjustment (ECT) across columns (1) to (9) affirm the adequacy of our models, with all coefficients of public spending proving positive and statistically significant in the long term, except for the model concerning female enrollment in column (4). Additionally, the control variables exhibit varying effects in the short and long terms. However, GDP per capita and governance consistently demonstrate positive and significant associations with enrollment over the long term.

Lastly, Table 3 showcases findings from the non-linear specification across all sub-samples analyzed in our study. Once more, the impact of public spending remains positive and statistically significant in the long term across all sub-samples. A noteworthy finding from Table 3 is the newfound significance of public spending on enrollment in landlocked countries, emphasizing the importance of allocating additional financial resources towards education within these economies. Furthermore, human development and the number of teachers continue to exert a positive influence on enrollment in the short term, although their effects vary across different models in the long term.

Table 3
*Results from quadratic specification (full sample)*

| Variables | (1) GPSE | (2) GPSE | (3) GPSE | (4) FPSE | (5) MPSE | (6) LICs | (7) LMCs | (8) SSA | (9) Landlocked |
|---|---|---|---|---|---|---|---|---|---|
| SR coefficients | | | | | | | | | |
| ECT ($\phi_i$) | -0.173*** | -0.176*** | -0.170*** | -0.166*** | -0.188*** | -0.153*** | -0.185*** | -0.171*** | -0.142*** |
| | (0.022) | (0.029) | (0.022) | (0.019) | (0.020) | (0.038) | (0.031) | (0.025) | (0.034) |
| ΔPublic spending$^2$ | 0.001 | 0.009 | 0.004 | -0.011 | 0.004 | -0.022* | 0.008 | -0.003 | 0.004 |
| | (0.007) | (0.013) | (0.006) | (0.011) | (0.007) | (0.012) | (0.008) | (0.007) | (0.018) |
| ΔHuman development | 1.182*** | 1.388*** | 1.093*** | 1.300*** | 1.057*** | 1.538*** | 0.886*** | 1.374*** | 1.492*** |
| | (0.183) | (0.242) | (0.169) | (0.365) | (0.174) | (0.379) | (0.201) | (0.224) | (0.410) |
| ΔPopulation (0-14) | -1.042 | -1.359 | -0.960 | -1.452 | -0.871 | -0.683 | -0.450 | -1.451* | -1.461* |
| | (0.793) | (1.020) | (0.778) | (1.100) | (0.803) | (1.636) | (1.019) | (0.860) | (0.853) |
| ΔNumber of teachers | 0.159*** | 0.134*** | 0.154*** | 0.188*** | 0.163*** | 0.336*** | 0.108*** | 0.238*** | 0.209*** |
| | (0.028) | (0.026) | (0.028) | (0.032) | (0.028) | (0.075) | (0.022) | (0.045) | (0.062) |
| ΔGDP per capita | | -0.075 | | | | | | | |
| | | (0.050) | | | | | | | |
| ΔGovernance | | | 0.012 | | | | | | |
| | | | (0.014) | | | | | | |
| *LR coefficients* | | | | | | | | | |
| Public spending$^2$ | 0.009** | 0.006** | 0.008** | -0.003 | 0.012*** | 0.057*** | 0.010*** | 0.012* | 0.018*** |
| | (0.004) | (0.003) | (0.004) | (0.005) | (0.004) | (0.020) | (0.003) | (0.007) | (0.004) |
| Human development | 0.855*** | -0.176*** | 0.909*** | 1.092*** | 0.800*** | 2.264*** | 0.485*** | 0.933*** | -0.101 |
| | (0.071) | (0.025) | (0.069) | (0.062) | (0.071) | (0.134) | (0.083) | (0.090) | (0.068) |
| Population (0-14) | 0.394*** | -0.127** | 0.461*** | 0.930*** | 0.482*** | -0.668 | 0.052 | 0.299** | -0.453*** |
| | (0.057) | (0.050) | (0.058) | (0.048) | (0.047) | (0.584) | (0.066) | (0.147) | (0.093) |
| Number of Teachers | 0.028 | 0.129*** | 0.025 | 0.022 | -0.011 | -0.486*** | 0.046** | 0.014 | 0.047 |
| | (0.018) | (0.015) | (0.018) | (0.015) | (0.020) | (0.060) | (0.018) | (0.025) | (0.048) |
| GDP per capita | | 0.133*** | | | | | | | |
| | | (0.020) | | | | | | | |
| Governance | | | 0.024* | | | | | | |
| | | | (0.013) | | | | | | |
| Constant | -0.153*** | 0.720*** | -0.230*** | -0.710*** | -0.102*** | 0.513*** | 0.399*** | -0.112*** | 0.987*** |
| | (0.020) | (0.126) | (0.029) | (0.082) | (0.013) | (0.129) | (0.069) | (0.014) | (0.243) |
| Observations | 2,130 | 2,130 | 2,130 | 2,130 | 2,130 | 600 | 1,530 | 1,110 | 690 |

*Note*: Standard errors in presented in parenthesis. GPSE, FPSE and MPSE are total, female, and male primary school enrolments, respectively. LICs, low-income countries; LMCs, lower-middle-income countries; SSA, sub-Saharan Africa; Landlocked, Landlocked countries.

* Significant at the 10% level, ** Significant at the 5% level, *** Significant at the 1% level.

## 5.4 **Results and Discussion**

The study investigated the relationship between public spending dynamics and primary school enrollment in low- and lower-middle-income countries, utilizing data spanning from 1990 to 2020 and employing the PMG technique. Findings strongly support the central hypothesis that increased public spending yields a long-term positive impact on enrollment rates. Moreover, gender disparities in enrollment are not found to be statistically significant; however, in the long term the analysis suggests that males tend to have a higher probability of enrolling in primary schools compared to females. Notably, the effects of public spending remain consistent across various analyses, including examinations of the entire sample, sub-regions within LMICs (excluding landlocked countries), and alternative model specifications incorporating non-linear elements. Nevertheless, a closer examination reveals that doubling government expenditure in landlocked countries leads to a significant improvement in enrollment rates over the long term. These findings align with both theoretical predictions and statistical expectations.

However, our findings diverge from those reported by Amin and Ntembe (2021), who concluded that there was no significant relationship between public spending and primary school enrollment (PSE) in Senegal. Contrary to Rajkumar and Swaroop's (2008) assertion that public spending is only impactful in countries with strong governance, our research reveals that an increase in public spending positively influences enrollment regardless of governance effectiveness. Thus, our study confirms the hypothesis that public spending has a lasting causal effect on primary school enrollment in Low- and Lower-Middle-Income Countries (LMICs).

This study contributes to the existing body of literature by expanding our understanding of how government expenditure affects school enrollment. While previous research has predominantly focused on analyzing the short-term dynamics of public spending and its impact on educational outcomes (Blankenau & Camera 2009, Gustafsson, 2003, Oseni et al., 2020, Rajkumar & Swaroop, 2008), there has been limited exploration into the long-term effects of public spending on enrollment. Apart from a study conducted by Amin & Ntembe (2021)

concerning Senegal, little attention has been given to examining the enduring influence of public spending on enrollment. Discovering a positive long-term effect emphasizes the importance for policymakers to prioritize the long-term advantages of investing in education, despite facing short-term challenges. Our findings also highlight the theoretical and practical significance of Wagner, Musgrave, and human capital theories, demonstrating how public investment significantly influences enrollment trends.

Secondly, our findings that public spending is not associated with school enrolment in the short run are consistent with a cross-section of the literature (Harbison & Hanushek, 1992; Hanushek & Kimko, 2000; Hanushek, 1995; Hanushek & Woessmann, 2017; Mingat & Tan, 1998; Rajkumar & Swaroop, 2008). Additionally, the short-run coefficients also lend credence to the mixed and inconsistent pattern of results in the literature, as numerous other studies have highlighted a positive and significant impact of public spending on educational outcomes (Hanushek, 1994, 2003; Vegas & Coffin, 2015; Jackson et al., 2016; Oseni et al., 2020; Velez, Schiefelbein, & Valenzuela, 1993). Therefore, it is important that researchers and policymakers consider the short- and long-term costs and benefits of public spending on school outcomes when making decisions to invest in education.

## 6. **Policy Implications**

Global poverty could be significantly reduced by more than 50% within a generation if all adults achieved secondary school completion (UNESCO, 2017). Addressing the educational disparities as identified in this paper requires a comprehensive and multi-faceted strategy. Learning poverty can be reduced if countries are willing to be ambitious. Reports from projection studies indicate that through application of reasonable targets and implementation plan we should be able to significantly reduce learning poverty such as noted within Sobral, Brazil (Vivekanandan, 2023). In order to do so, it is imperative to raise awareness, ensure data and finding are accessible and understandable to stakeholders that are involved in education (Rythia Afkar et al., 2023), thereby

orchestrating efforts in a manner that produces the wanted results in the specific country contexts.

Investing in education is crucial as it provides children with the foundational skills they need to thrive intellectually, socially, and emotionally in the future. Aligned with the goals of Sustainable Development Goal 4 (SDG4), public expenditure in education helps to broaden access and affordability, particularly for marginalized children, and has been shown to yield significant long-term benefits in terms of educational attainment and poverty alleviation (Jackson, Johnson, & Persico, 2016; Oseni et al., 2020). A well-educated populace not only signifies a pool of skilled labor that can boost economic productivity but also facilitates the adoption of technology from more advanced economies and improves social outcomes (Barro & Lee, 2001). Consequently, governments in Low- and Lower-Middle-Income Countries (LMICs) must maintain their focus on investing in education to meet the targets outlined in the United Nations' 2030 Sustainable Development Goals as well as ensuring regular evaluation mechanisms to be put in place to ensure progress.

There is a need for policy recalibration towards enhancing the quality of base education. Policymakers in the East Asia and Pacific (EAP) region significantly underestimates learning poverty by 27%, while over estimating public funding for education (Yarrow et al., 2023). With the presence of existing over-evaluation of tertiary education among officials, the allocation of disproportionate investments towards higher education comes at the expense of primary sectors which as we have noted is critical for broad based educational development for individuals (Yarrow et al., 2023), thereby raising concerns with regards to misalignment in investment priorities and a need for enhanced realigning of educational strategies by those responsible in the educational sector. By improving awareness not just among policymakers but also civil society, families, as well as other stakeholders, we can establish a greater sense of accountability into the education system and thereby garner a larger, collective effort in attaining the wanted outcomes

as poor knowledge exchange between policy makers and development partners is noted to exacerbate misalignment of objectives (Smith & Benavot, 2019).

We have also identified the enduring positive impact of various factors on enrollment over the long term, including human development, the child population aged 0 to 14, the number of teachers, economic development, and governance. Research has consistently demonstrated that the quality of teachers is a key determinant of academic achievement (Glewwe et al., 2011; Hanushek & Woessmann, 2017; Glewwe et al., 2021), with teacher shortages and absenteeism posing significant challenges in many LMICs. Consequently, policies aimed at bolstering school expenditure should be coupled with initiatives to attract, retain, and motivate teachers through enhancements in salaries, training programs, and working conditions. Furthermore, our findings emphasize the importance of bolstering economic performance across LMICs due to their trickle-down effects on educational outcomes.

## 7. **Conclusion**

In this paper, we analysed the effects of public spending on primary school enrolment in 72 low- and lower-middle-income countries, using data spanning from 1990 to 2020. Our findings indicate that such spending positively affects enrolment over time. This trend holds true universally across nations classified as low-income and lower-middle-income, as well as specifically within sub-Saharan Africa. We also found that public spending had a long-term positive impact on female and male enrolment.

This work extends beyond previous research that primarily assessed the short-term correlation between public spending and educational outcomes (Rajkumar & Swaroop, 2008; Vegas & Coffin, 2015; Oseni et al., 2020). Our study also identifies other key factors that impact school enrolment, including human and economic development, population growth, number of teachers, and the efficacy of governance. Based on our results, we recommend that educators

advocate for more funding and support from the government and non-governmental organisations for education, taking into account the prolonged and widespread benefits of such funding.

The disparity in results from our panel time series approach and some micro-studies suggests that there might be structural differences between economy-wide effects of public expenditure on education and household- or individual-level effects. Therefore, further research, especially in early childhood, secondary, and tertiary education, would undoubtedly be useful in consolidating the findings from this study. Micro-level studies with longitudinal data on student performance can illuminate the impact of spending on education outcomes in LMICs. Recognizing the importance of not just the accessibility of education but also the quality, future research could therefore explore what drives differences in education quality in LMICs, acknowledging the concern that the push to increase school enrollment may inadvertently impact the standard of education provided.

## 8. **Limitations**

This study has some limitations that should be acknowledged. Firstly, our findings rely on cross-country regressions without a detailed examination of any single nation. In-depth country-specific analyses might reveal unique experiences not aligned with our general conclusions. Notably, existing literature provides little confidence that educational outcomes are influenced by financial investments/expenditures (Rajkumar & Swaroop, 2008; Hanushek & Woessmann, 2017). Second of all, the pooled mean group (PMG) approach used here might be subject to inaccuracies due to unobserved heterogeneity, inherent biases, and data measurement errors. Future research, incorporating broader datasets and spanning various geographical regions, is essential to confirm our findings. Third of all, mere enrollment in schools does not guarantee learning. In fact, several studies have shown that LMICs are suffering from a learning

poverty crisis whereby 53% of children enrolled are unable to read and understand a simple passage by the age of 10 (Azevedo et al., 2019) with further exacerbations since the COVID-19 crisis. Prioritizing funding and school attendance may inadvertently detract from the focus on actual learning and graduation rates. Therefore, further research is necessary to evaluate the effectiveness of public expenditure in enhancing actual learning and completion rates throughout the educational lifecycle.

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## Declaration of interest

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## Data availability

The dataset analysed during the current study are publicly available in the World Development Indicators of the World Bank (https://databank.worldbank.org/reports.aspx?source=World-Development-Indicators) and the United Nations Development Program (https://hdr.undp.org/data-center/documentation-and-downloads).