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Public Spending and Primary School Enrollment: An Autoregressive Distributed Lag Approach[1]

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Abstract: This paper delves into the effects of public investment on primary school enrollment in low- and middle-income countries (LMICs) across three decades, from 1990 to 2020. Autoregressive distributed lag models are employed to evaluate their long-term relationship for the whole sample and four distinct sub-samples while also probing the potential non-linear nature of the relationship. Results reveal that public expenditure has a significant, positive impact on enrollment across LMICs, including low-income (LICs), lower-

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middle-income (LMCs), and sub-Saharan African (SSA) countries in the long run. These effects persist under non-linear model specifications. The study provides fresh empirical insights by adopting a long-term viewpoint on the nexus between educational funding and enrollment trends in LMICs. The findings highlight the critical role of sustained and efficient funding in achieving enrollment goals, a cornerstone for advancing sustainable development. Beyond conventional revenues and expenditures in the education finance literature, the study also discusses alternative policy approaches that can enhance the efficient use of allocated resources.
Keywords: public spending; government expenditure; school enrollment; access to education; SDG4

Gasto público y matrícula en la escuela primaria: Un enfoque de rezagos distribuidos autorregresivos

Resumen: Este artículo explora los efectos de la inversión pública en la matrícula de la escuela primaria en países de ingresos bajos y medianos (PIBM) durante tres décadas, de 1990 a 2020. Se emplean modelos de rezagos distribuidos autorregresivos para evaluar su relación a largo plazo en toda la muestra y en cuatro submuestras distintas, al tiempo que se examina la posible naturaleza no lineal de la relación. Los resultados revelan que el gasto público tiene un impacto positivo y significativo en la matrícula en los PIBM, incluidos los países de ingresos bajos (PIB), de ingresos medianos bajos (PIMB) y de África subsahariana (ASS) a largo plazo. Estos efectos persisten bajo especificaciones de modelos no lineales. El estudio aporta nuevas perspectivas empíricas al adoptar un enfoque a largo plazo sobre la relación entre el financiamiento educativo y las tendencias de matrícula en los PIBM. Los hallazgos subrayan el papel fundamental de una financiación sostenida y eficiente para lograr los objetivos de matrícula, un pilar clave para el avance del desarrollo sostenible. Más allá de los ingresos y gastos convencionales en la literatura sobre financiamiento educativo, el estudio también analiza enfoques de políticas alternativas que pueden mejorar el uso eficiente de los recursos asignados.
Palabras-clave: gasto público; gasto gubernamental; matrícula escolar; acceso a la educación; ODS4

Gasto público e matrícula no ensino primário: Uma abordagem de defasagem distribuída autorregressiva

Resumo: Este artigo investiga os efeitos do investimento público na matrícula no ensino primário em países de baixa e média renda (PBMR) ao longo de três décadas, de 1990 a 2020. Modelos de defasagem distribuída autorregressiva são empregados para avaliar a relação de longo prazo para toda a amostra e quatro subamostras distintas, além de explorar a possível natureza não linear dessa relação. Os resultados revelam que o gasto público tem um impacto positivo e significativo na matrícula nos PBMR, incluindo países de baixa renda (PBR), de renda média-baixa (PRMB) e da África Subsaariana (ASS) a longo prazo. Esses efeitos persistem sob especificações de modelos não lineares. O estudo oferece novas percepções empíricas ao adotar uma perspectiva de longo prazo sobre a relação entre financiamento educacional e tendências de matrícula nos PBMR. Os achados destacam o papel essencial de um financiamento contínuo e eficiente para atingir as metas de matrícula, um elemento fundamental para o avanço do desenvolvimento sustentável. Além das receitas e despesas convencionais na literatura sobre financiamento educacional, o estudo também discute

abordagens de políticas alternativas que podem aprimorar o uso eficiente dos recursos alocados.
Palavras-chave: gasto público; despesa governamental; matrícula escolar; acesso à educação; ODS4

Public Spending and Primary School Enrollment: An Autoregressive Distributed Lag Approach

At the World Conference on Education for All in 1990, the objective of universalizing access to basic education was adopted, with an aim of achieving this goal 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 enrollments at primary and secondary levels. Many low and 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-quality educational opportunities for children.

Since then, the role of public investment and its efficacy has remained a prominent topic within educational policy discussions, and specifically as a means to realize the goal of universal education access (Ferber & Baten, 2024; Kyei et al., 2025; Mingat & Tan, 1999). This strategic emphasis aligns with the Sustainable Development Goals' (SDG) 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 that are foundational for fostering an effective learning environment (Vegas & Coffin, 2015).

However, increased fiscal allocation to educational systems may not invariably correspond to the anticipated advancements in learning, particularly in LMICs wherein there may be system challenges that require transformation different than scaling via increased financing (Azevedo et al., 2019). In fact, there is a vigorous debate in education finance literature regarding whether money really matters. Some scholars assert that public spending has a negligible impact on outcomes (Glewwe et al., 2011; Hanushek & Kimko, 2000; Hanushek & Woessmann, 2017; McEwan, 2015), attributing their findings to the pervasive inefficiencies, misallocation of resources, inadequate accountability, exacerbating inequality between well-funded and underfunded schools, and diminishing returns across some education systems (Hanushek, 1986; Trostel, 2005; Vegas & Coffin, 2015). Conversely, another body of the literature finds that increased funding significantly influences educational outcomes (Gustafsson, 2003; Hanushek, 1994; Jackson et al., 2016; Jacques & Brorsen, 2002; Kremer, 1995; Lee & Barro, 2001).

These debates have yielded profound insights regarding the theoretical and empirical dynamics of educational participation. Studies, including those that employ quasi-experimental methods have, at times, presented an array of mixed or inconclusive findings (Berlinski et al., 2008; Gustafsson, 2003; Hanushek, 1995; Hanushek & Woessmann, 2017). Many of the existing studies implicitly assume a linear relationship, while some have documented significant nonlinearities in the spending-schooling nexus (Trostel, 2005; Vegas & Coffin, 2015). 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 responsiveness (Ferber & Baten, 2024; Oseni et al., 2020; Rajkumar & Swaroop, 2008; Vegas & Coffin, 2015).

This study examines the interplay between public expenditure and primary school enrollment over an extended period (1990–2020). Recognizing the complexity of the enrollment and financing relationship in practical settings, we note that while government spending may fluctuate unpredictably in the short term, it could tend 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; Rajkumar & Swaroop, 2008; Vegas & Coffin, 2015).This long-term perspective is essential to develop a more nuanced understanding of how sustained public investment impacts educational enrollment.

The 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 as it allows 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 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 LMICs. We examine an extensive dataset spanning three decades (1990–2020) across 72 LMICs, yielding over 2,000 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 enrollment, 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 that, to our knowledge, is distinctly rare in existing literature and provides unique insights about the sensitivity of public spending for policymakers, donors and international financial institutions. Our approach also helps address potential heterogeneity between these groups of countries, ensuring that the results are robust to individual country differences. The outcomes indicate a positive and sustained correlation between public investment in education and primary school enrollment rates, except in landlocked countries.

Lastly, prevailing research often operates on the assumption that the benefits of public spending on school enrollment are constant, relying on linear models that may not fully capture the relationship's complexity (Oseni et al., 2020; Rajkumar & Swaroop, 2008; Trostel, 2005). 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. The literature appears to uncover critical thresholds of expenditures; surpassing this threshold can lead to a marked decline in school enrollment. Our study contributes to this discourse by probing the possibility of a non-linear relationship between government spending and enrollment rates. Our

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

By providing empirical data on how public expenditure correlates with primary school enrollment, this research can guide decision makers in their budgeting and resource allocation efforts to advance the goal of equitable, high-quality education for all with a view on the long term. 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 early childhood education within LMICs. Although the findings generally support the need for increased funding to education, bureaucratic red tape, inefficiency, and misallocation of resources typify the education system in developing countries. Increased funding may also create opportunities for corruption and mismanagement, and Rajkumar and Swaroop (2008) and Ferraz et al. (2012) have attributed differences in school performance to a prevailing level of corruption. Finally, increased public funding may disincentivize local communities from exploring alternative sources of financing schools, which could have unintended consequences in the long run, especially when such funding is reduced or unavailable. Therefore, it is of crucial importance for governments in these economies to also explore alternative policy pathways such as performance-based financing of schools and community involvement in the decision-making process to ensure the most efficient use of allocated resources for the benefit of all.

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 on education finance, particularly arguments for and against increased public spending. The estimation strategy and data are described in Section 4, while Section 5 presents and discusses the results of the analyses. Based on the results, the policy implications are presented in Section 6. Section 7 concludes the paper, proposing directions for future research, while Section 8 discusses limitations of our analysis and alternative policy approaches.

Public Spending and Enrollment: Stylized Facts

The Sustainable Development Goals (SDGs) have established a comprehensive educational agenda, with a particular focus on low and 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, youth, and adolescents around the world were still out of school in 2018 (UIS, 2023; UNESCO, 2020). This figure amounts to 20% of the global school-age population. Breaking it down, primary schools account for 23% (59 million) of this group. According to reports by UNESCO in 2020 and the UIS in 2023, LMICs were home to more than 86% (51 million) of these primary level out-of-school children (UIS, 2023; UNESCO, 2020). A substantial number of these out-of-school 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 quality and inclusive 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.

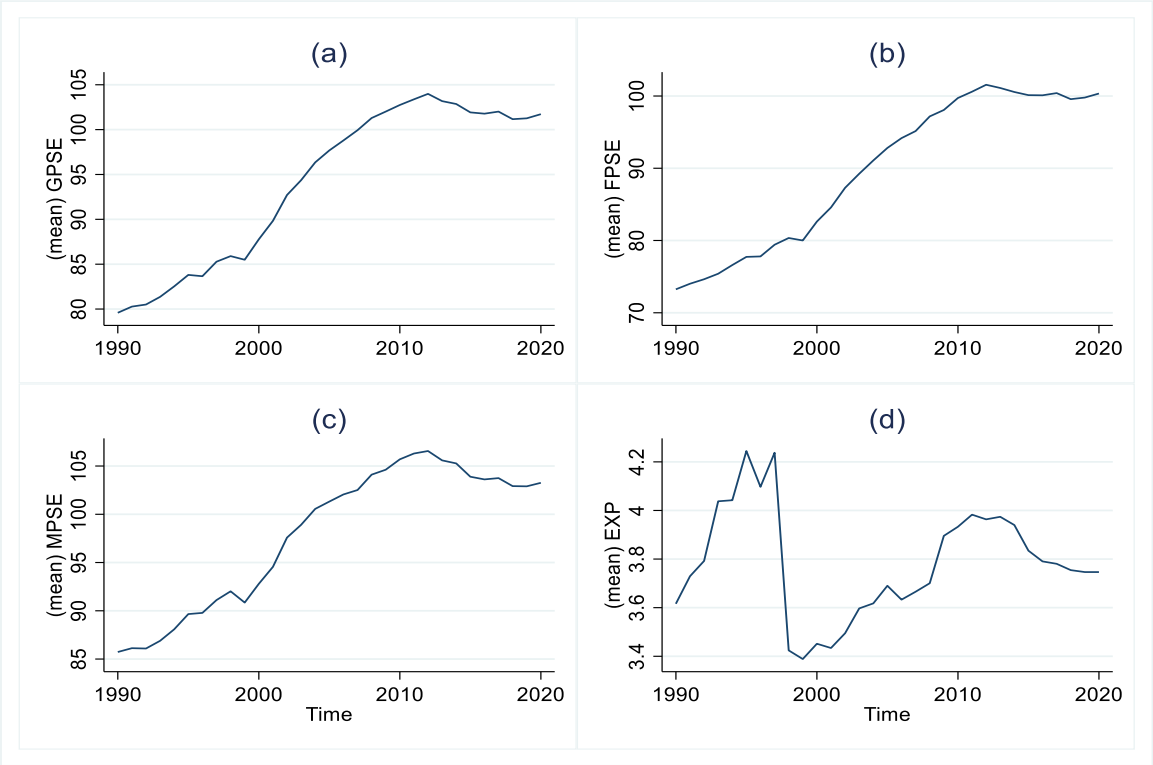
In response to these issues, governments of developing countries have emphasized the importance of investing in education. This prioritization is grounded in recognizing education as a fundamental human right, a tool to mitigate inequalities, enhance access and quality, and leverage its economic advantages. According to reports by the World Bank and UNESCO Institute for Statistics in 2023, 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.

This analysis prompts further exploration into how LMICs have managed to achieve 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. However, Kyei et al. (2025) reported that greater access had a cost on quality in Ghana, although that is beyond the scope of this study. Additionally, the growing popularity of education has led to economies of scale, effectively reducing the per-unit cost of educational resources (Sciiultz, 1988). Parent teacher associations (PTAs) have also 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. These elements collectively contribute to the evolving landscape of educational enrollment and funding in LMICs, as observed in Sciiultz's 1988 study.

Analysis of Figure 1A from the supplementary file reveals that the proportion of government expenditure dedicated to education within 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 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. Our approach emphasizes the need for a strategic, long-term approach to education policy and resource allocation.

Figure 1

School Enrollment and Public Spending



Notes: GPSE in Figure 1a represents total primary school enrollment. Figures 1 (a)–(c) show a remarkable increase in school enrollment from 1990 to 2020. Female primary school enrollment (FPSE) has increased substantially, but remains lower than male primary school enrollment (MPSE) across all years. In Figure 1(d), government expenditure on education (EXP) has largely been less than the recommended 4% of the gross national product to achieve universal access to education since 2000.

Literature Review

During the past decades, numerous theoretical and empirical 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 & Baten, 2024; Glewwe & Kremer, 2006; Trostel, 2005). According to the 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 (Angrist et al., 2025). Moreover, many of these studies 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's (1958) and Musgrave's (1959) theories suggest that as a country's economy expands, the demand for public services, such as education, increases and that leads 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, 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, 1995; Hanushek & Woessmann, 2017).

The 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 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.

Empirical research on the link between public spending and educational outcomes presents a spectrum of findings. On the one hand, some studies identify a clear positive correlation between increased educational resources and student achievement (Ferber & Baten, 2024; Hanushek, 2003, 1994; Jackson et al., 2016; Jacques & Brorsen, 2002; Oseni et al., 2020; Velez et al., 1993). Others challenge this, arguing that more spending does not necessarily yield better results (Amin & Ntembe, 2021; Blankenau & Camera, 2009; Hanushek, 1995, 2003, 1994; Hanushek & Kimko, 2000; Hanushek & Woessmann, 2017; Harbison & Hanushek, 1992; Mingat & Tan, 1999).

At the heart of the debate is a famous survey of 147 studies by Hanushek (1986), which concluded that money might not always matter for education outcomes. The paper provoked a series of responses from Hedges et al. (1994), Kremer (1995) and others, who found a weakness in Hanushek's vote counting methodology, and another counter response by Hanushek (1994). An updated review with 91 studies by Hanushek (1997) concluded that only 9% of studies found a positive and significant relationship between school resources and students' performance, with 5% finding a negative and significant relationship. Hanushek (1997) concluded that simply basing education policy on resource distribution and incentives was neither necessary nor sufficient in enhancing school outcomes. A wealth of other influential studies, including randomized controlled trials, also support the conclusion that simply allocating more financial resources to schools does not correlate with increased outcomes (Glewwe et al., 2011; Hanushek, 1995, 2003; Hanushek & Kimko, 2000; Hanushek & Woessmann, 2017; Harbison & Hanushek, 1992; McEwan, 2015; Mingat & Tan, 1999). Kyei et al. (2025) studied the evolution of literacy and numeracy in Ghana after three decades of basic education and concluded that the expansion in gross enrollment at primary and lower secondary schools was associated with a long-term decline in the quality of education. As an alternative policy pathway, these studies viewed performance-based education funding to have a higher likelihood of driving school performance rather than centralized decision-making processes that failed to recognize differences between schools, teachers, and students.

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 (Rajkumar & Swaroop, 2008; Trostel, 2005; Vegas & Coffin, 2015). Additionally, factors like teacher quality and economic growth are also highlighted as influential for educational outcomes (Glewwe et al., 2011; Glewwe & Muralidharan, 2016). However, there is a noted gap in long-term analysis, which this

study aims to address, since such an analysis offers a comprehensive review of how public spending affects educational success across extended periods.

Estimation Strategies and Data

Estimation Procedure

This paper examines the dynamics of public spending and primary school enrollment in low- and middle-income countries (LMICs). Many previous studies have considered this relationship by using simple correlation analysis or static regression procedures, typically the OLS, fixed/random effects, and two-stage least squares models, and often with either cross-sectional or panel datasets with limited countries or time periods (Hanushek, 2020; Hanushek & Woessmann, 2017; Jacques & Brorsen, 2002; Lee & Barro, 2001; Simões, 2011; Vegas & Coffin, 2015). A limitation 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 in LMICs, this assumption is noted to have become more challenging to justify (Martínez-Zarzoso & Bengochea-Morancho, 2004).

We reconsider the interrelationship between these variables with panel data spanning 72 countries and 30 years (1990 to 2020) and with more than 2,000 observations. To the best of our knowledge, no previous study has covered a similar number of countries and years within the same framework; in comparison, Rajkumar and Swaroop (2008) covered only three years, albeit with 91 countries.

Our dataset has two distinguishing characteristics: (i) the number of panels (N) and years (T) are both relatively large and (ii), the variables are nonstationary and the panels have diverse features (Blackburne & Frank, 2007). Stationary series are often predictable and do not change much over time. For instance, if public spending on education and enrollments is both stationary, it would be easier to forecast future spending and how it affects enrollment. However, public spending sometimes increases, especially during election years, and decreases during recessions. Likewise, school enrollment might rise when more resources are available or decrease due to societal changes that affect education. In both cases, the data could follow an upward or downward trend or a combination of both, a pattern often described as nonstationary that is difficult to model over time, especially with traditional fixed/random effects and OLS procedures. This also becomes pronounced when the dataset is heterogenous.

Pesaran et al. (1999) and Pesaran and Smith (1995) have offered innovative ways of estimating the parameters of such nonstationary dynamic panels via the autoregressive distributed lag (ARDL) models. The ARDL model explores how past and current values of the explanatory variable (public spending on education in our case) and a host of other control variables influence the outcome variable (school enrollment). In such models (depending on the lag order), current enrollment is a function of past enrollments, current and past public expenditures in education, and other control variables. The model allows for varying intercepts, short run fluctuations and errors across cross-sections, while maintaining similarity in the long-run coefficients of explanatory variables across these cross-sections (Pesaran et al., 1999). As a result, the method provides comprehensive insights on how explanatory variables influence school enrollment over time.

Two techniques often used in the literature to estimate such models include the mean-group (MG) and pooled mean-group (PMG) estimators. The MG estimates regression parameters for all countries in the panel and average the coefficients of all variables in the series, while the PMG pools and averages the coefficients, thereby restricting all cross-sections to have common parameters. According to Pesaran et al. (1999), PMG provides consistent and asymptotically normal estimates

even when the explanatory variables are both stationary I (0) and non-stationary I (1). In our analysis, we employ the PMG procedure to estimate the coefficients of our variables because it has been shown to have superior performance in Monte Carlo experiments (Asteriou & Monastiriotis, 2004). PMG also allows for both balanced and unbalanced panels, with the flexibility to accommodate variations in the number of observations across different cross-sections within the study.

To begin the modelling, we follow Blackburne and Frank (2007) by assuming a typical ARDL $(m, n_1, \dots, n_k)$ dynamic panel specification of the form:

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

Where m and n represent the number of lags or past values of the dependent and independent variables, respectively; $PSE_{i,t}$ is primary school enrollment[2]; $X_{i,t}$ is a $k \times 1$ vector of explanatory variables, including public education spending($EXP_{i,t}$)[3]; δ'_{ij} is the $K \times 1$ vector of parameters to be estimated; $i = 1, 2, \dots, N$ is the number of groups; $t = 1, 2, \dots, T$ is the number of periods; μ_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; ε_{it} is the white noise. In essence, the ARDL model in Eq. (1) captures how past values of school enrollment, public spending, and other control variables jointly determine current school enrollment.

Since all variables in Eq. (1) are stationary after first differencing (I (1)) and cointegrated, we reparametrize the equation in an error-correction (EC) form to disentangle the long run relationship from the overlain short run dynamics by specifying Eq. (2) (Blackburne & Frank, 2007; Kripfganz & Schneider, 2023).

$$\Delta PSE_{i,t} = \phi_i \left(PSE_{i,t-1} - \beta'_i EXP_{i,t-j} \right) + \sum_{j=1}^{m-1} \gamma_{ij} \Delta PSE_{i,t-j} + \sum_{j=0}^{n-1} \gamma'_{ij} EXP_{i,t-j} + \mu_i + \varepsilon_{i,t} \quad (2)$$

where:

Δ in Eq. (2) is the difference operator; β_is are the long-run coefficients, γ'_{ij} are the short run elasticities, and ϕ_is are the speeds of adjustments or error correction parameters (theoretically negative) from short run disequilibria to long run equilibria. The speeds of adjustments typically show how fast the effects of any short-term changes (temporary shocks to primary school enrollment) are corrected for the system to return to its long-term relationship with the variables. The model is estimated via the maximum likelihood method, and requires selecting a suitable lag length. Using the Schwarz Bayesian Criterion, the general form of the ARDL (1,0,0,0,0,0) is specified in Eq. (3).

[2] It is possible for school enrolment to exceed 100%, this is because over-aged and under-aged students can be included as well as those who have entered early or late as well as those repeating grades.

[3] "Education expenditure refers to the current operating expenditures in education, including wages and salaries and excluding capital investments in buildings and equipment" (UNESCO Institute for Statistics, 2023). It is expressed as a share of gross national income.

$$\Delta PSE_{it} = \phi_i\left(PSE_{i,t-1} - \beta_i'(EXP_{i,t}, HDI_{i,t}, POP_{i,t}, NPT_{it}, GDPC_{it}, GoE_{it}\right)' + \sum_{j=1}^{m-1} \gamma_{ij}\Delta PSE_{i,t-j} + \sum_{j=0}^{n-1} \gamma_{ij}'\Delta EXP_{i,t-j} + \sum_{j=0}^{n-1} \gamma_{ij}'\Delta HDI_{i,t-j} + \sum_{j=0}^{n-1} \gamma_{ij}'\Delta POP_{i,t-j} + \sum_{j=0}^{n-1} \gamma_{ij}'\Delta NPT_{i,t-j} + \sum_{j=0}^{n-1} \gamma_{ij}'\Delta GDPC_{i,t-j} + \sum_{j=0}^{n-1} \gamma_{ij}'\Delta GoE_{i,t-j} + \mu_i + \varepsilon_{it} \quad \cdots (3)$$

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 Eq. (3) is correctly specified by following the procedure in Martínez-Zarzoso and Bengochea-Morancho (2004) to specify its non-linear or quadratic form.

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

where:

$EXP_{i,t}{}^2$ is public spending squared or its non-linear form. The relationship is assumed to follow an inverted U-shaped pattern. In a sense, we are assuming the possibility that the effects of public spending on school enrollment may increase up to a certain threshold, beyond which it starts declining thereafter (Vegas & Coffin, 2015). This more sophisticated form of the model ensures that our results are robust to model misspecification, and can also capture potential diminishing returns or threshold effects from increasing public expenditures on education.

Data

Our main dependent variable is gross primary school enrollment (GPSE), which is consistent with previous studies (Amin & Ntembe, 2021; Oseni et al., 2020). GPSE is the number of children, regardless of age, enrolled in primary school (expressed as a percentage of the official

[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).

primary school-age population). We run regressions for gross primary school enrollment, female primary school enrollment (FPSE), and male primary school enrollment (MPSE) to gain further insights into whether enrolment is sensitive to gender differences.

Our main independent variable is public spending, measured with education expenditure as a percent of GDP. This has been used in several studies, including Sequeira and Robalo (2008) and Sciiultz (1988). Although some studies use public spending at specific levels of education (Rajkumar & Swaroop, 2008) or spending per pupil (Jackson et al., 2016; Lee & Barro, 2001), there were many missing observations with these alternatives that could have substantially reduced our sample size. We expect public spending to have a positive and long run significant impact on school enrollment.

We incorporate a set of control variables sourced from existing literature that are known to influence enrollment rates. These include the Human Development Index (HDI), the population of children between 0 and 14 years old as a measure of population growth (POP) (Glewwe & Muralidharan, 2016; Oseni et al., 2020), the number of teachers (NPT) (Glewwe et al., 2011), economic development as proxied by GDP per capita (GDPC) (Amin & Ntembe, 2021), and governance effectiveness (GoE) (Rajkumar & Swaroop, 2008). Generally, we expect countries with better human development, a larger population size, more trained teachers, faster level of economic development, and better governance quality to be positively correlated with primary school enrollment. Data analyzed during the current study was collected from the World Development Indicators of the World Bank, except for the Human Development Index, which was gathered from the database of the United Nations Development Program.

To maintain consistency in our variables despite some 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 inverse hyperbolic sine transformation function was applied to transform the data from actual to logarithmic values. Log transformation makes the data to closely follow a normal distribution, which is critical in econometric analysis as it improves model convergence. It also stabilizes the variance, which is crucial in this study where the data spans several orders of magnitudes and has large ranges. Finally, converting the data to logarithmic form simplifies the analysis and allows us to interpret coefficients as elasticities. 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, confirmed via the mean (t) and variance comparisons tests between the original and the transformed dataset.

Results and Discussions

Descriptive Analysis

Table 1 presents the summary statistics and the pairwise correlation matrix. Across LMICs, the average school enrollment rate in our sample 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. Therefore, in addition to studying the public spending-schooling nexus in the full sample of LMICs, it is also important to analyze the data at the regional and sub-regional levels to capture its true characteristics and potential heterogeneities.

Table 1
Descriptive Statistics

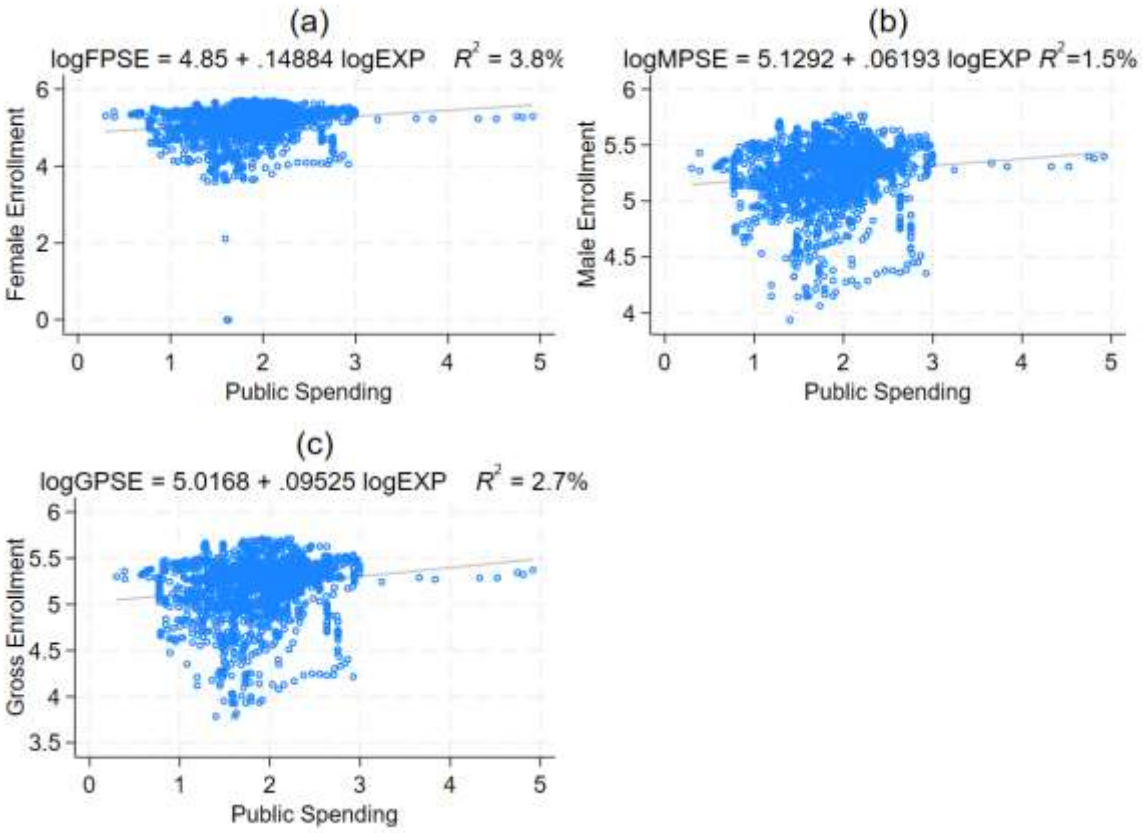
Variable	Gross enrollment	Female enrollment	Male enrollment	Public spending	GDP per capita	Population	Human development	Number of teachers	Governance
Mean	94.32	90.16	98.21	3.78	1473.28	40.28	51.48	122333.5	-0.737
Std. Dev.	23.23	25.6	21.95	3.12	1036.64	6.77	11.89	378670.1	0.51
Min	22.07	0	25.7	0.3	189.28	14.086	21.6	460	-2.17
Max	151.57	154.03	159.66	68.15	5450.93	51.18	78.9	4600165	0.707
Pairwise Correlation Matrix									
Gross enrollment	1								
Female enrollment	0.942	1							
Male enrollment	0.977	0.88	1						
Public spending	0.148	0.184	0.104	1					
GDP per capita	0.355	0.365	0.315	0.3	1				
Population	-0.299	-0.326	-0.242	-0.2	-0.426	1			
Human development	0.625	0.635	0.552	0.306	0.623	-0.659	1		
Number of teachers	0.184	0.171	0.19	-0.198	0.076	-0.239	0.201	1	
Governance	0.176	0.215	0.13	0.331	0.329	-0.314	0.355	0.008	1

The second part of Table 1 presents the pairwise correlation matrix, and we are particularly interested in magnitudes of the correlations between the explanatory variables. Typically, when two or more explanatory variables have a correlation coefficient of 0.8 and higher, it often indicates potential multi-collinearity. Such situations complicate regression analysis, as it means that one predictor variable can be used to predict another variable in the RHS of the model, which makes it difficult to disentangle their true relationship with the dependent variable or to determine which actually influences the outcome variable. Such higher correlations between two or more RHS variables also indicate multi-collinearity, which is a fundamental problem in econometric analysis. In our case, the correlations between the explanatory variables were largely less than 0.8, suggesting no risk of multi-collinearity. We followed this up by testing for the variance inflation factor, which is a formal test for multicollinearity, and the results rejected the null hypothesis. Therefore, we retain all variables for analysis as they are without need of any further adjustments.

We now turn to the graphical presentation of the relationship between school enrollment and public spending on education. 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).

Figure 2

Public Spending and School Enrollment



Note: Fixed effects regressions with country-level data.

Before conducting our main estimations, we conducted several preliminary checks to ensure the suitability of our data for the econometric analysis and reliability of results. In addition to pairwise correlations, we conducted unit root tests and determined that all variables were stationary either at the level or after first differencing. Furthermore, we tested for cointegration using Pedroni and Kao's procedures (Kao, 1999; Pedroni, 1999), uncovering 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.

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 LMICs.

The initial findings in Table 2 highlight the adjustment speeds from short-term discrepancies to long-term equilibrium (ECT (ϕ_i)), 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%, which implies that it takes a little more than five years for all short-term disturbances to be stabilized. Analysis of short-term coefficients reveals that only human development and the number of teachers exhibit a positive and significant association with primary school enrollment. The statistically insignificant effects of public spending on primary school enrollment seem to support a part of the literature arguing that money does not matter, since a majority of those studies were based on short run analysis (Glewwe et al., 2011; Hanushek, 1986, 1997; Hanushek & Woessmann, 2017; Rajkumar & Swaroop, 2008). Therefore, focusing on those short-term elasticities can mask important insights from the data.

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 LMICs, we have divided 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 in column (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 of human development and the number of teachers is positive and significant in the short term, although their significance levels and directions vary over the long term. Overall, these econometric findings support the hypotheses that public spending significantly influences primary school enrollment in LMICs.

Table 2

Long Run Impact of Public Spending on School Enrollment

VARIABLES	(1) GPSE	(2) GPSE	(3) GPSE	(4) FPSE	(5) MPSE	(6) LICs	(7) LMCs	(8) SSA	(9) Landlocked
SR Coefficients									
ECT (ϕ_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 presented in parenthesis. GPSE, FPSE and MPSE are total, female, and male primary school enrollments, 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

Robustness Check

The previous findings assume a linear relationship between public spending and enrollment in low and middle-income countries. This assumption could lead to model misspecification, however, 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 findings by Vegas and Coffin (2015) 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 above. 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). Also, worthy of note is the lack of evidence supporting any threshold effects of public spending. 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.

Discussion of Results

The study investigated the relationship between public spending dynamics and primary school enrollment in low and middle-income countries, utilizing data spanning from 1990 to 2020 and employing the PMG technique. Findings strongly support the central hypothesis: 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 theoretical predictions and statistical expectations (Jackson et al., 2016; Oseni et al., 2020; Vegas & Coffin, 2015).

However, our findings diverge from those reported by Amin and Ntembe (2021), who found 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. Kyei et al.'s (2025) finding that increased enrollment compromised quality in Ghana is beyond the scope of this paper. Thus, our study confirms the hypothesis that public spending has a lasting causal effect on primary school enrollment in low and middle-income countries (LMICs).

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 (ϕ_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.

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; 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 and 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 (1958), Musgrave (1959), and human capital theories (Becker, 1975; Jimenez & Patrinos, 2008; Schultz, 1961) in demonstrating how public investment significantly influences enrollment trends.

Secondly, our findings that public spending is not associated with school enrollment in the short run are consistent with a cross-section of the literature (Hanushek, 1995; Hanushek & Kimko, 2000; Hanushek & Woessmann, 2017; Harbison & Hanushek, 1992; Mingat & Tan, 1999; 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; Jackson et al., 2016; Oseni et al., 2020; Vegas & Coffin, 2015; Velez et al., 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.

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. There can be a reduction in learning poverty if countries are willing to be ambitious. Reports from projection studies indicate that through the application of reasonable targets and implementation plans, we should be able to significantly reduce learning poverty, as noted within Sobral, Brazil (Vivekanandan, 2023). In order to do so, it is imperative to raise awareness, ensure data and findings are accessible and understandable to stakeholders that are involved in education (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 et al., 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, 2001). Consequently, governments in low and middle-income countries 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 that regular evaluation mechanisms are to be put in place to ensure progress. Within this framework, reaching the 4% mark as outlined in SDG4 should be a top priority across all low-and-medium income countries.

There is also a need for policy recalibration towards enhancing the quality of basic education. Policymakers in the East Asia and Pacific (EAP) region significantly underestimate 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 policymakers 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, 2021; Hanushek & Woessmann, 2017), 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. The trickle-down effects from improvements in the Human Development Index and governance effectiveness on access to education at primary schools cannot be overemphasized, and as such, overall human development should be prioritized in government policy.

Conclusion

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

This work extends beyond previous research that primarily assessed the short-term correlation between public spending and educational outcomes (Oseni et al., 2020; Rajkumar & Swaroop, 2008; Vegas & Coffin, 2015). Our study also identifies other key factors that impact school enrollment, 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 organizations 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 as documented in Kyei et al. (2025).

Although our findings generally support the need for increased funding, there are counterarguments, as presented in the literature, which have prompted alternative policy approaches. These contrasting views towards increased funding can be explained with a highly simplified model. Schools have several resources that are both simple and complex in nature. These resources include teachers with different qualities and teaching approaches, head teachers with different leadership skills, and schools with different kinds of curricular and extracurricular resources that collectively determine the supportive learning environment. These varying resources influence school outcomes in different ways. Money can buy some of these resources (class size, digital learning tools and other instructional materials, and extracurricular facilities). Others are more complex and cannot be bought, including quality of teachers and leadership (Grubb & Allen, 2011). Understanding these differences may provide potential insights into why many studies tend to find a weak relationship between money and school outcomes. While most of the inputs that money can buy are crucial for access to schools, several of those that money may not buy are essential for learning or quality education.

This complex interrelationship between inputs and the multifaceted outputs prompted researchers and policymakers to explore alternative policy pathways, aside from revenues and expenditures in traditional education finance literature. For example, the need for efficiency in schools. Led to the development of performance-based funding (PBF) as an alternative pathway to education finance, wherein funding to schools is tied to the attainment of specified goals or contingent on achieving certain measures, such as teaching or outputs (Dougherty et al., 2016). Architects of PBF believe that it is the most effective way to hold the public sector accountable for its use of taxpayers' money. Typically, metrics used to determine the allocation of funds may include enrollment rates, retention rates, completion, and graduation rates. Other researchers suggest outcome-based funding (OBF) and metrics that rely on student learning outcomes, income levels of graduates, societal impact, and post-graduation employment rates in allocating funds. Unlike in conventional school finance where governments pay upfront for education or interventions that may or may not be achieved, the OBF model pays agreed upon amounts upon achievement of the outcome. If well implemented, both methods can result in a consistent positive correlation between spending and school outcomes and developing countries may consider these as alternative policy approaches for resource distribution.

Limitations

This study has some limitations that should be acknowledged. First, the general conclusion from our empirical analyses is that money matters for school enrollment in low- and middle-income countries. This conclusion relies on our 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, several studies particularly from the United States and some developing countries provide little confidence linking educational outcomes to money (Hanushek & Woessmann, 2017; Rajkumar & Swaroop, 2008), hence the saying that money does not educate children. In fact, the connection has been found to be weak in general, including in specific randomized cases where governments increased funding but improved were limited (Grubb & Allen, 2011). Creating a balance between quality and quantity is also important as numerous studies have documented evidence of decreasing quality amidst rising enrollment (Angrist et al., 2025; Kyei et al., 2025). Although the issue of quality is beyond the scope of our current analysis, it is of crucial importance to consider country-specific analyses in low- and middle-income countries to ascertain the robustness of these findings.

Second, the pooled mean group (PMG) approach used in our empirical analyses 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, especially developed countries, is essential to confirm our findings.

Third, 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 (Kyei et al., 2025). 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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