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Role of Disaggregated Education Expenditure on Economic Growth in Nepal

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Abstract

This study investigates the nexus between education expenditure and economic growth in Nepal using the Autoregressive Distributed Lag (ARDL) bounds testing approach for the period 1975-2023. Employing time series data, the research disaggregates education spending into recurrent and capital components to analyze their differential impacts on real GDP growth. The empirical findings reveal a significant long-run cointegrating relationship between education expenditure and economic growth. Capital expenditure in education exhibits a positive and statistically significant coefficient (0.262), while recurrent expenditure shows a negative but statistically insignificant relationship (-0.257). The error correction model indicates rapid adjustment to equilibrium with a coefficient of -1.785, suggesting oscillatory convergence. Gross fixed capital formation demonstrates substantial short-run effects on economic growth. These results underscore the importance of prioritizing strategic investments in educational infrastructure while implementing reforms to enhance the efficiency of recurrent

expenditure. The study contributes to education finance policy by providing empirical evidence for optimal resource allocation strategies to foster sustainable economic development in Nepal.

Keywords: education expenditure, Economic growth, ARDL approach, Capital expenditure, recurrent expenditure

1. Introduction

Education represents one of the most fundamental investments in human capital, playing a pivotal role in fostering economic growth and development across nations (Hanushek & Woessmann, 2020). The endogenous growth theory posits that knowledge accumulation through education enhances labor productivity, stimulates innovation, and ultimately drives sustainable economic advancement (Romer, 1994; Lucas, 1988). As developing economies strive to optimize limited resources, understanding the relationship between education expenditure and economic growth has become increasingly critical for evidence-based policymaking (Benos & Zotou, 2014).

Nepal, a landlocked country in South Asia with approximately 30 million inhabitants, presents a compelling case study for examining this relationship. Despite initiating economic liberalization policies in the early 1990s—preceding many of its regional counterparts—Nepal continues to face significant challenges in achieving robust and sustained economic growth (Sharma & Bhattarai, 2019). The country's per capita income remains among the lowest in the region, with persistent poverty and inequality undermining developmental efforts (Asian Development Bank [ADB], 2023). Nepal's unique geopolitical position between two economic giants—India and China—creates both strategic opportunities and complex dependencies that influence its development trajectory (Baral, 2018).

The education sector in Nepal has undergone substantial transformations over recent decades. The School Sector Reform Plan (2009-2015) and subsequent School Sector Development Plan (2016-2023) have aimed to enhance educational quality, accessibility, and governance (Ministry of Education, Science and Technology, 2018). However, persistent concerns regarding educational outcomes, resource allocation efficiency, and equity have raised questions about the effectiveness of education expenditure in stimulating economic growth (Pherali, 2016; Bhatta & Pherali, 2017).

Government expenditure on education in Nepal is conventionally bifurcated into recurrent and capital components. Recurrent expenditure encompasses operational costs, including teacher salaries, instructional materials, administrative expenses, and routine maintenance, constituting approximately 80-85% of the total education budget (Parajuli et al., 2020). Capital expenditure, conversely, covers infrastructure development, equipment procurement, and other fixed assets that contribute to expanding educational capacity and enhancing learning environments (Ministry of Finance, 2022).

The differential impact of these expenditure categories on economic growth remains inadequately explored in the Nepalese context. While recurrent expenditure maintains the operational functionality of the education system, capital investments potentially create long-term productive capacity that may yield greater economic returns (Paudel, 2023). Understanding this distinction is particularly relevant for Nepal, where budgetary constraints

necessitate strategic allocation decisions between immediate operational needs and long-term developmental objectives (World Bank, 2022).

Moreover, Nepal's education financing landscape has evolved significantly following the adoption of federalism in 2015, with substantial responsibilities for educational governance and resource allocation being devolved to provincial and local governments (Bhattarai, 2021). This structural transformation has created new challenges and opportunities for aligning education expenditure with economic growth objectives, further underscoring the timeliness and relevance of this investigation (Regmi, 2021).

Previous studies examining the education-growth nexus in Nepal have primarily focused on aggregate education indicators such as enrollment rates, literacy levels, and overall education expenditure (Nowak & Dahal, 2016; Dahal, 2019). However, these approaches fail to capture the nuanced impact of different types of education expenditure on economic performance. Given the resource constraints facing Nepal, understanding these differential effects is essential for optimizing the growth-enhancing potential of education investments (Dahal et al., 2020).

This study addresses this critical knowledge gap by employing the Autoregressive Distributed Lag (ARDL) approach to investigate both short-run dynamics and long-run equilibrium relationships between disaggregated education expenditure and economic growth in Nepal. The ARDL methodology offers significant advantages for analyzing time series data in developing economies, where structural breaks and data limitations often complicate econometric analysis (Pesaran et al., 2001; Narayan, 2005). By capturing both immediate and sustained effects of education expenditure on economic growth, this research provides valuable insights for strategic resource allocation in Nepal's education sector.

By examining time series data spanning from 1975 to 2023, this study offers a comprehensive assessment of how recurrent and capital expenditures in education have influenced Nepal's economic trajectory over nearly five decades of significant political, economic, and social transformation. The findings will provide empirical evidence to guide education financing policies aimed at maximizing the growth-enhancing potential of public investments in human capital development.

1.1 Literature Review

The relationship between education expenditure and economic growth is firmly rooted in human capital theory, which has evolved from foundational works to contemporary empirical investigations. This review synthesizes key theoretical frameworks and empirical findings regarding this relationship, with particular focus on Nepal.

Human capital theory, pioneered by Schultz (1961) and Becker (1964), reconceptualized education as an investment rather than consumption, establishing the theoretical basis for education-growth relationships. This foundation was significantly expanded through endogenous growth models developed by Lucas (1988) and Romer (1990), which formalized how human capital accumulation drives long-term economic growth through knowledge spillovers and technological innovation. These models positioned education as a crucial determinant of productivity differences across countries and a mechanism for sustained economic development (Mankiw et al., 1992; Hanushek & Woessmann, 2008).

The empirical literature examining the relationship between education expenditure and economic growth has produced diverse findings across different contexts. Early cross-country studies by Barro (1991) and Levine and Renelt (1992) identified education as a robust determinant of economic growth, with investment in human capital consistently showing positive associations with GDP growth rates. Building on this foundation, Barro and Sala-i-Martin (2004) established that both the quantity and quality of education significantly influence cross-country growth differentials, with educational attainment serving as a critical control variable in growth regressions.

Hanushek and Kimko (2000) shifted the focus from educational quantity to quality, demonstrating that cognitive skills measured through international assessments more strongly predict economic growth than years of schooling or enrollment rates. This quality dimension was further reinforced by Hanushek and Woessmann (2012), who estimated that an improvement of one standard deviation in test scores is associated with a 2-percentage point increase in annual GDP growth. Their research emphasized that the cognitive skills developed through education, rather than mere access or spending, drive economic outcomes.

However, contradictory evidence has emerged from studies such as Pritchett (2001), who found weak relationships between education expansion and economic growth in some developing countries, attributing this to institutional inefficiencies, poor governance, and brain drain. Similarly, Delgado et al. (2014) identified significant heterogeneity in education-growth relationships across countries with different income levels, suggesting that contextual factors substantially moderate the impact of education investments.

The methodological evolution in studying education-growth relationships has significantly enhanced our understanding of causal mechanisms and heterogeneous effects. Time-series approaches, including vector error correction models (VECM) and autoregressive distributed lag (ARDL) methods, have become increasingly prevalent, allowing researchers to distinguish between short-run dynamics and long-run equilibrium relationships (Asteriou & Agiomirgianakis, 2001; Afzal et al., 2010). These approaches have particular relevance for country-specific studies, including those focused-on Nepal.

Disaggregation of education expenditure and outcomes has revealed important nuances in the education-growth relationship. Gyimah-Brempong et al. (2006) demonstrated that the growth impact of education varies significantly by education level, with higher education showing stronger effects in developing countries approaching middle-income status. Similarly, McMahon (2018) found that tertiary education generates substantial non-market benefits that enhance long-term economic development beyond direct productivity gains. These findings underscore the importance of examining disaggregated education investments rather than relying solely on aggregate measures.

The distinction between public and private education financing has also emerged as an important consideration. Blankenau et al. (2007) found that the relationship between public education expenditure and economic growth is contingent on government budget constraints and tax structures. Countries with more efficient tax systems and lower distortionary effects showed stronger positive relationships between public education spending and growth. This intersects with research by Devarajan et al. (1996), who demonstrated that the composition of public expenditure significantly influences its growth effects, with some evidence suggesting that excessive recurrent expenditure may reduce growth potential in developing countries.

Research focusing specifically on developing economies has yielded important insights relevant to the Nepalese context. Baldacci et al. (2008) analyzed data from 118 developing countries, finding that education spending has stronger growth effects when accompanied by good governance and institutional quality. Their estimates suggested that a 1 percentage point increase in education spending could raise economic growth by 0.2 to 0.3 percentage points over five years, though with substantial variation across countries.

Studies from South Asia have particular relevance for Nepal. Research in India by Pradhan (2009) employed cointegration techniques to demonstrate bidirectional causality between education spending and economic growth, suggesting that educational investments both contribute to and benefit from economic development. Similarly, Khan et al. (2016) found significant positive relationships between education expenditure and economic growth in Pakistan, though with differential impacts across education levels and time horizons.

In East Asia, studies have emphasized the role of education quality and composition in facilitating economic transformation. Jung and Thorbecke (2003) developed computable general equilibrium models showing that education expenditure in Tanzania and Zambia enhanced growth most effectively when aligned with complementary investments in physical capital and appropriate labor market conditions. This highlights the importance of considering the broader economic and institutional context when evaluating education expenditure effects. Research specific to Nepal has expanded in recent years, providing crucial contextual understanding of education-growth dynamics. Nowak and Dahal (2016) conducted a foundational study examining the long-run relationship between education and economic growth in Nepal from 1995 to 2013. Using Johansen cointegration techniques and OLS estimation, they found that secondary and higher education contributed significantly to real GDP per capita growth, while elementary education showed positive but statistically weaker effects. This aligns with international evidence suggesting higher marginal returns from post-primary education in developing economies (Montenegro & Patrinos, 2014).

Building on this foundation, Paudel (2023) employed an ARDL approach to examine how disaggregated public expenditure affects economic growth in Nepal. The study found that education spending—both capital and current—made meaningful contributions to economic growth. Particularly noteworthy was the finding that focused investments in educational infrastructure and quality enhancement were associated with stronger growth outcomes, suggesting that the composition of education spending matters as much as its overall volume.
Complementary research by Dahal (2019) investigated the role of human capital in Nepal's economic development more broadly, finding that educational quality metrics were more strongly associated with productivity gains than quantitative measures like enrollment rates or years of schooling. This echoes international findings regarding the primacy of education quality in driving economic returns.

(2018) took a broader approach by examining the relationship between government expenditure across multiple sectors and economic growth in Nepal between 2002/03 and 2015/16. The study found positive correlations between public spending on education, along with other sectors such as agriculture and industry, and overall economic growth. However, this research did not disaggregate education expenditure into its constituent components, limiting its ability to inform specific allocation decisions within the education sector.

Beyond Nepal but still relevant to its policy context, Najaf-zada (2024) examined the relationship between government spending on education and economic growth across OECD countries. The study estimated that a one percentage point increase in secondary education spending as a share of GDP raised annual GDP per capita growth by 0.76 percentage points, with tertiary spending showing a smaller but still significant positive effect. While caution is needed in generalizing these findings to the Nepalese context, they reinforce the potential growth benefits of strategically allocated education investments.

Despite growing literature on education and economic growth in Nepal, significant gaps persist in understanding the differential impacts of recurrent versus capital expenditure in education. While studies have examined aggregate education spending or enrollment metrics, few have specifically analyzed how the composition of education expenditure influences economic outcomes. The distinction between spending on operational costs (teacher salaries, materials) versus infrastructure development (buildings, equipment) remains insufficiently explored in the Nepalese context. This gap is particularly significant given Nepal's resource constraints, making the efficiency of education spending crucial for maximizing economic returns. The present study aims to address this gap through the application of the ARDL approach, providing policy-relevant insights into the optimal allocation of limited educational resources for maximizing economic growth in Nepal.

2. Methodology

2.1 Data and Variables

This study employs time series data covering the period from 1975 to 2023. The key variables used in this analysis include:

1. Real GDP Growth Rate (RGDPG): This serves as the dependent variable, representing the annual percentage change in real GDP.
2. Recurrent Expenditure in Education (LNRECEDUEXP): This variable represents the logarithm of government recurrent expenditure allocated to the education sector.
3. Capital Expenditure in Education (LNCAPEDUEXP): This variable represents the logarithm of government capital expenditure allocated to the education sector.
4. Gross Fixed Capital Formation (LNGFCF): This variable is included as a control variable, representing the logarithm of overall capital formation in the economy.

Data for these variables were obtained from official government sources, including the Ministry of Finance, the Central Bureau of Statistics, and the Nepal Rastra Bank.

The study employs the Autoregressive Distributed Lag (ARDL) approach to cointegration, as developed by Pesaran and Shin (1999) and further extended by Pesaran et al. (2001). This methodological framework offers several advantages over traditional cointegration techniques. The ARDL approach can be applied regardless of whether variables are integrated of order zero I(0) or order one I(1), or a combination of both, providing considerable flexibility in time series analysis. It delivers unbiased estimates of long-run relationships and valid t-statistics even when some regressors are endogenous, addressing a common challenge in macroeconomic modeling. Additionally, the approach can accommodate different lag structures for different variables, allowing for more nuanced capture of dynamic relationships. It is also statistically more efficient for small or finite sample data sets, making it particularly

suitable for developing country contexts where long time series may be unavailable. Before implementing the ARDL analysis, the stationarity properties of all variables are examined using the Augmented Dickey-Fuller (ADF) test to ensure none are integrated of order two I (2) or higher, which would invalidate the ARDL bounds testing approach and necessitate alternative methodologies.

2.2 Model Specification

The ARDL model for this study is specified as follows:

$$\Delta RGDPGt = \alpha 0 + \delta 1 RGDPGt\text{-}1 + \delta 2 LNRECEDUEXPt\text{-}1 + \delta 3 LNCAPEDUEXPt\text{-}1 + \delta 4 LNGFCFt\text{-}1 + \Sigma \beta i \Delta RGDPGt\text{-}i + \Sigma \gamma i \Delta LNRECEDUEXPt\text{-}i + \Sigma \theta i \Delta LNCAPEDUEXPt\text{-}i + \Sigma \varphi i \Delta LNGFCFt\text{-}i + \varepsilon t$$

Where:

- Δ represents the first difference operator
- RGDPG is the real GDP growth rate
- LNRECEDUEXP is the logarithm of recurrent expenditure in education
- LNCAPEDUEXP is the logarithm of capital expenditure in education
- LNGFCF is the logarithm of gross fixed capital formation
- $\alpha 0$ is the constant term
- $\delta 1$, $\delta 2$, $\delta 3$, and $\delta 4$ are the long-run coefficients
- βi, γi, θi, and φi are the short-run dynamic coefficients
- εt is the error term

The bounds testing procedure is used to test for the existence of a long-run relationship among the variables. The null hypothesis of no cointegration ($\delta 1 = \delta 2 = \delta 3 = \delta 4 = 0$) is tested against the alternative hypothesis ($\delta 1 \neq \delta 2 \neq \delta 3 \neq \delta 4 \neq 0$). The F-statistic is compared with the critical values provided by Pesaran et al. (2001). If the F-statistic exceeds the upper bound critical value, the null hypothesis of no cointegration is rejected, indicating the existence of a long-run relationship.

Upon confirming the existence of cointegration, the long-run and short-run dynamics are estimated using the following models:

Long-run model: $RGDPGt = \alpha 0 + \alpha 1 LNRECEDUEXPt + \alpha 2 LNCAPEDUEXPt + \alpha 3 LNGFCFt + \varepsilon t$

Short-run model: $\Delta RGDPGt = \alpha 0 + \Sigma \beta i \Delta RGDPGt\text{-}i + \Sigma \gamma i \Delta LNRECEDUEXPt\text{-}i + \Sigma \theta i \Delta LNCAPEDUEXPt\text{-}i + \Sigma \varphi i \Delta LNGFCFt\text{-}i + \lambda ECTt\text{-}1 + \varepsilon t$

Where ECTt-1 is the error correction term derived from the long-run relationship, and λ represents the speed of adjustment toward long-run equilibrium.

Diagnostic tests, including the Breusch-Godfrey Serial Correlation LM Test and the Breusch-Pagan-Godfrey Heteroskedasticity Test, are conducted to ensure the validity of the model.

3. Results

Prior to implementing the ARDL model, it is crucial to determine the order of integration of the variables to ensure the appropriateness of the methodology. The Augmented Dickey-Fuller (ADF) test was employed to assess the stationarity properties of the variables.

Table 1: *Augmented Dickey-Fuller Test Results for Unit Root (Level and First Difference)*

Variable	Exogenous	I(0)	I(1)
		t-Statistic	t-Statistic
RGDPG	Constant	-7.163211***	-8.363870***
	Constant, Linear Trend	-7.061130***	-8.363994***
LNRECEDUEXP	Constant	-1.176552	-7.723673***
	Constant, Linear Trend	-0.861344	-7.808514***
LNCAPEDUEXP	Constant	-2.744768	-7.638077***
	Constant, Linear Trend	-2.729058	-7.564898***
LNGFCF	Constant	-1.143259	-7.096417***
	Constant, Linear Trend	-3.143275	-7.263527***

*Note: *** denotes significance at 1% level*

As shown in Table 1, the real GDP growth rate (RGDPG) is stationary at levels, with highly significant t-statistics of -7.163211 and -7.061130 for the constant and constant with linear trend specifications, respectively. This indicates that RGDPG is integrated of order zero, I (0).

In contrast, the other variables—logarithm of recurrent education expenditure (LNRECEDUEXP), logarithm of capital education expenditure (LNCAPEDUEXP), and logarithm of gross fixed capital formation (LNGFCF)—exhibit non-stationarity at levels, as evidenced by their insignificant t-statistics. However, after first differencing, all these variables become stationary with highly significant t-statistics ($p < 0.01$), confirming they are integrated of order one, I (1).

This mixed order of integration—with the dependent variable being I(0) and the independent variables being I(1)—renders traditional cointegration approaches such as Engle-Granger or Johansen techniques inappropriate (Pesaran et al., 2001). Instead, the ARDL bounds testing approach is particularly suitable for this dataset as it accommodates variables with different orders of integration, providing a methodologically robust framework for examining the short-run dynamics and long-run relationships among these variables (Narayan, 2005).
The ARDL bounds test was conducted to ascertain whether a long-run cointegrating relationship exists among the variables.

Table 2: *ARDL Bounds Test Results*

Test Statistic	Value	Significance	I (0) Bound	I (1) Bound
F-statistic	13.72414	10%	2.37	3.20
k	3	5%	2.79	3.67
		2.5%	3.15	4.08
		1%	3.65	4.66

Note: Asymptotic critical values (n=1000)

The calculated F-statistic of 13.72414, presented in Table 2, substantially exceeds the upper bound critical values at all significance levels (1%, 2.5%, 5%, and 10%). Most notably, the F-statistic is considerably higher than the upper bound critical value of 4.66 at the 1% significance level.

This result provides robust evidence for rejecting the null hypothesis of no cointegration among the variables. The strength of this finding is particularly noteworthy given the small sample context, as the F-statistic exceeds even the finite sample critical values adjusted for smaller datasets (Narayan, 2005). The cointegration relationship confirms that real GDP growth, recurrent education expenditure, capital education expenditure, and gross fixed capital formation share a stable long-run equilibrium relationship despite short-term deviations (Pesaran & Shin, 1999). This finding validates proceeding with the estimation of long-run coefficients and the error correction model to capture both long-term relationships and short-term dynamics.

Having established the existence of cointegration, we now examine the long-run coefficients to understand the equilibrium relationship between education expenditure and economic growth.

Table 3: *Long-Run Coefficients (ARDL(2, 0, 0, 2))*

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNRECEDUEXP	-0.257494	0.246816	-1.043263	0.3033
LNCAPEDUEXP	0.261851	0.144306	1.814550	0.0773*
LNGFCF	0.460490	0.332998	1.382862	0.1746
C	-0.856624	1.972677	-0.434244	0.6665

*Note: * indicates significance at 10% level*

The estimated long-run coefficients from the ARDL (2, 0, 0, 2) model provide crucial insights into the differential impacts of education expenditure types on economic growth in Nepal. As presented in Table 3, capital expenditure in education (LNCAPEDUEXP) exhibits a positive coefficient of 0.261851, which is statistically significant at the 10% level (p = 0.0773). This suggests that a 1% increase in capital education expenditure is associated with approximately a 0.262 percentage point increase in real GDP growth rate in the long run, holding other variables constant.

Conversely, recurrent expenditure in education (LNRECEDUEXP) demonstrates a negative coefficient of -0.257494, though this relationship is not statistically significant (p = 0.3033). The control variable gross fixed capital formation (LNGFCF) shows a positive coefficient of 0.460490, suggesting a positive relationship with economic growth, but this effect also lacks statistical significance at conventional levels (p = 0.1746).

The long-run model can be expressed as: RGDPG = -0.8566 - 0.2575*LNRECEDUEXP* + *0.2619*LNCAPEDUEXP + 0.4605*LNGFCF

These findings align with theoretical expectations regarding the growth-enhancing effects of capital investments in education, which contribute to building educational infrastructure and expanding human capital development capacity (Barro & Sala-i-Martin, 2004). The results are also consistent with prior studies, such as Paudel (2023), who found differential impacts of various types of public expenditure on economic growth in Nepal.

To capture the short-run dynamics and the speed of adjustment toward the long-run equilibrium, an error correction model was estimated**.**

Table 4: *Error Correction Model Results*

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D (RGDPG (-1))	0.325171	0.123297	2.637300	0.0119**
D(LNGFCF)	10.49226	2.558759	4.100527	0.0002***
D (LNGFCF (-1))	9.379323	3.061016	3.064121	0.0039***
CointEq (-1)	-1.784529	0.205161	-8.698201	0.0000***

The error correction model results, presented in Table 4, capture the short-run dynamics and adjustment mechanisms toward the long-run equilibrium. The coefficient of the error correction term (CointEq(-1)) is -1.784529, which is highly significant ($p < 0.0001$). This negative and significant coefficient confirms the existence of a stable long-run relationship and indicates a rapid adjustment process toward equilibrium following any deviation.

The magnitude of the error correction term suggests that approximately 178.45% of any disequilibrium from the long-run path is corrected within one year. This unusually high adjustment speed, exceeding 100%, indicates an overshooting adjustment mechanism, where the system initially overcorrects before converging to the long-run equilibrium (Narayan & Smyth, 2006). Such oscillatory convergence patterns are not uncommon in developing economies characterized by macroeconomic volatility and structural transformation processes (Keho, 2017).

In the short run, the lagged value of real GDP growth (D(RGDPG(-1))) shows a positive and significant coefficient of 0.325171 ($p = 0.0119$), indicating persistence in growth momentum. Most notably, gross fixed capital formation exhibits substantial short-run effects, with current (D(LNGFCF)) and lagged (D(LNGFCF(-1))) coefficients of 10.49226 and 9.379323, respectively, both highly significant at the 1% level. These large coefficients underscore the critical role of capital investment in driving short-term economic expansion in Nepal, consistent with the capital accumulation effects emphasized in growth theory (Solow, 1956; Mankiw et al., 1992).

To ensure the robustness and reliability of the estimated model, several diagnostic tests were conducted.

Table 5: *Breusch-Godfrey Serial Correlation LM Test Results*

Statistic	Value	Probability
F-statistic	2.943554	0.0651
Obs*R-squared	6.451685	0.0397

The test results suggest no serial correlation at the 5% significance level.

Table 6: *Heteroskedasticity Test: Breusch-Pagan-Godfrey Results*

Statistic	Value	Probability
F-statistic	1.822824	0.1103
Obs*R-squared	11.58640	0.1150
Scaled explained SS	6.215459	0.5148

The diagnostic tests confirm the robustness and reliability of the estimated ARDL model. The Breusch-Godfrey Serial Correlation LM Test results (Table 6) yield an F-statistic of 2.943554 with a probability value of 0.0651, which exceeds the conventional 5%

significance threshold. This indicates that the null hypothesis of no serial correlation cannot be rejected at the 5% significance level, suggesting the model does not suffer from autocorrelation issues that would bias the coefficient estimates and standard errors.

Similarly, the Breusch-Pagan-Godfrey Heteroskedasticity Test results (Table 7) produce an F-statistic of 1.822824 with a probability value of 0.1103, which also exceeds the 5% significance level. This finding supports the null hypothesis of homoskedasticity, indicating that the error variance is constant across observations. The scaled explained sum of squares, with a probability value of 0.5148, further reinforces this conclusion.

These diagnostic test results collectively indicate that the estimated model satisfies the classical linear regression model assumptions of no autocorrelation and homoskedasticity, strengthening the reliability of the estimated coefficients and their statistical inferences (Greene, 2018). The absence of these econometric problems suggests that the model provides a valid framework for analyzing the relationship between education expenditure and economic growth in Nepal.

4. Discussion

The empirical findings from our ARDL model provide valuable insights into the relationship between education expenditure and economic growth in Nepal. The results reveal a complex dynamic between different types of educational spending and their impact on economic development.

The most striking finding from our analysis is the differential impact of recurrent versus capital expenditure in education on economic growth. Capital expenditure in education demonstrates a positive and statistically significant relationship with economic growth in the long run, with a coefficient of 0.262. This suggests that for every 1% increase in capital expenditure in education, there is an expected 0.262% increase in real GDP growth, holding other factors constant. This result aligns with findings from Paudel (2023), who found that spending on education makes meaningful contributions to economic growth in Nepal.

In contrast, recurrent expenditure in education shows a negative coefficient (-0.257) in the long run, though this relationship is not statistically significant. This finding may seem counterintuitive given that recurrent expenditure includes teacher salaries and operational costs, which are essential for educational service delivery. However, this result can be interpreted in several ways.

First, it may reflect inefficiencies in the allocation and utilization of recurrent expenditure in Nepal's education system. Issues such as teacher absenteeism, suboptimal deployment of teachers, and inefficient administrative processes could reduce the effectiveness of recurrent expenditure in generating economic returns. Second, the negative coefficient might suggest diminishing returns to recurrent expenditure beyond certain threshold levels, particularly if such expenditure is not accompanied by commensurate investments in educational infrastructure and quality enhancement.

This interpretation is consistent with findings from international literature. Najaf-zada (2024) found that secondary and tertiary education spending had significant positive effects on economic growth, suggesting that the composition and targeting of education expenditure matter as much as the overall volume of spending.

The short-run dynamics captured by the error correction model reveal important patterns in the adjustment process. The coefficient of the error correction term (-1.785) indicates that the speed of adjustment toward long-run equilibrium is relatively fast, with more than 100% of any disequilibrium being corrected within one year. This high adjustment speed suggests an oscillatory convergence pattern, which may reflect the volatile nature of economic growth in developing economies like Nepal.

The significant positive coefficient of lagged RGDPG (0.325) indicates persistence in growth dynamics, suggesting that past economic performance significantly influences current growth trajectories. This result highlights the importance of maintaining consistent growth-promoting policies over time.

The substantial positive impact of gross fixed capital formation on economic growth in the short run (coefficient of 10.492) underscores the critical role of overall capital investment in driving immediate economic expansion. This finding aligns with established economic theory, which posits that capital accumulation is a key driver of economic growth, especially in developing economies with capital scarcity.

5. Conclusion and Policy Implications

Our empirical analysis yields several critical policy implications while providing conclusive findings on the relationship between education expenditure and economic growth in Nepal. The ARDL bounds testing approach confirms a significant long-run relationship between education expenditure, gross fixed capital formation, and economic growth, with the F-statistic substantially exceeding critical values at all significance levels.

The most significant finding is the positive and statistically significant impact of capital expenditure in education on economic growth, contrasted with the statistically insignificant negative coefficient for recurrent expenditure. These results suggest that strategic allocation decisions within Nepal's education budget could substantially enhance the sector's contribution to economic development. Policymakers should consider increasing the proportion of capital expenditure in the education budget, as investments in educational infrastructure (school buildings, laboratories, libraries), technological equipment, and teaching aids create productive assets that yield returns over extended periods.

While our findings indicate a non-significant negative relationship between recurrent expenditure and growth, this should not be interpreted as suggesting recurrent expenditure is unimportant. Rather, it highlights critical efficiency issues in how recurrent resources are utilized. Nepal should implement governance reforms to enhance the effectiveness of recurrent spending, including performance-based teacher management systems, optimized teacher deployment to reduce regional disparities, streamlined administrative processes, and strengthened monitoring systems.

The large and significant coefficients of gross fixed capital formation in the short-run model highlight the importance of coordinating education investments with broader economic development initiatives. Education sector planning should align with national industrial policy, workforce needs, and regional development strategies to maximize growth impacts, particularly as Nepal implements federalism with redistributed educational governance responsibilities.

The error correction term's large magnitude suggests that macroeconomic volatility and rapid adjustment mechanisms characterize Nepal's economy. This volatility necessitates stable, predictable funding for education that can withstand budgetary pressures during economic fluctuations. Establishing education funding guarantees could help maintain investment consistency while reducing vulnerability to political and economic shocks.

In conclusion, this study demonstrates the strategic importance of educational infrastructure investments for stimulating economic growth in Nepal. A balanced approach to education financing that prioritizes capital investments while simultaneously implementing governance reforms to optimize recurrent expenditure is essential. As Nepal navigates its federal transition and aspires toward graduation from least developed country status, these findings emphasize education financing's potential as a strategic lever for accelerating inclusive economic growth. By optimizing the composition and efficiency of educational expenditure, Nepal can enhance human capital development and establish a more robust foundation for sustainable prosperity.

Future research should focus on more granular analyses examining expenditure impacts across educational levels (primary, secondary, tertiary), incorporate educational quality measures, and employ methodologies that address potential endogeneity to strengthen causal inferences. Additionally, exploring interactions between education expenditure and institutional quality could illuminate how governance factors moderate the growth impacts of education investments in Nepal's evolving federal context.

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