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Ekonomikalia Journal of Economics

Vol. 2, No. 2, 2024



Government Expenditure on Education, Educational Index, and Economic Growth in Nepal: An ARDL-ECM Approach

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Article History

Received 3 June 2024
Revised 6 August 2024
Accepted 11 August 2024
Available Online 20 August 2024

Keywords:

Economic growth
Government expenditure on education
Educational index
ARDL
ECM
Nepal

Abstract

Education is a key priority in economic development, significantly impacting growth and society through its role in enhancing human capital and advancing technological knowledge. Government spending on education is crucial for providing equitable access to quality education and is widely believed to stimulate economic growth. This study examines the relationship between education, government expenditure on education, and economic growth in Nepal from 1990 to 2022, using the Autoregressive Distributed Lag (ARDL) model and the Error Correction Model (ECM) to assess long-run and short-run impacts. The findings reveal that the educational index, gross capital formation, and population have a positive and significant impact on economic growth. In contrast, government expenditure on education, domestic credit to the private sector, and trade openness have negative and insignificant effects on long-run economic growth. Additionally, the educational index shows a negative and significant impact on economic growth in the short run. The study's policy recommendations emphasize the need to increase government spending on education, implement effective mechanisms for spending, and enhance credit availability and trade openness to boost economic growth.



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1. Introduction

Public expenditure by central, state, and local governments should aim to meet collective needs and promote economic and social welfare. In the 19th century, such spending was limited to justice, police, and arms. Today, it plays a significant role in reducing regional disparities, developing social infrastructure, and advancing development agendas. Investment in education benefits both the labor force and the economy [1–5]. Two key mechanisms through which education influences economic growth have been highlighted by Hanushek & Woessmann [6]. First, education enhances

human capital, thereby boosting labor productivity and output levels. Second, according to endogenous growth theories, education stimulates economic innovation capacity and enhances advanced technological knowledge [6–8]. These dynamics underscore the critical role of education in economic growth. Furthermore, economists argue that increases in government spending, particularly on education, have a positive and significant impact on economic growth [9, 10]. The general consensus is that government spending on education ensures equitable access to quality education, which is essential for social mobility and reducing income inequality [11]. Many empirical studies, such as

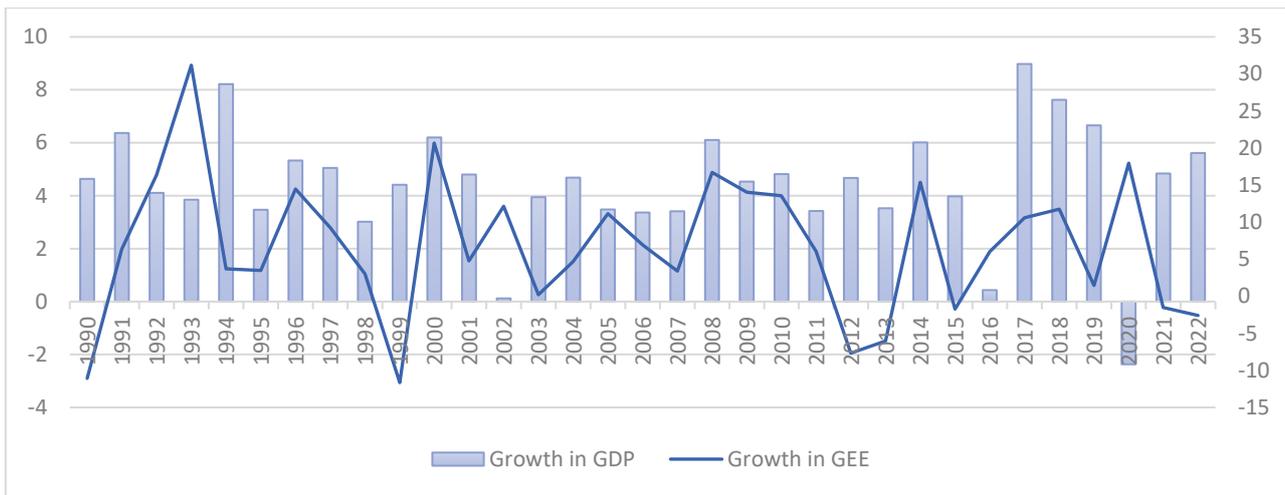


Figure 1. Growth in GDP and growth in government expenditure on education (GEE) from 1990 to 2022 in Nepal.

Mukhtarov et al. [12], Nuru [13], Nowak & Dahal [14], Rambeli et al. [15], Okerekeoti [16], Njong [17], Coman et al. [18], Sasongko & Wibowo [19], and Suwandaru et al. [20], have revealed that education and government spending on education foster economic growth in both developing and developed countries.

Nepal is a developing country that has made progress toward sustainable economic growth since the 1950s [21]. Figure 1 shows the annual growth in gross domestic product (GDP) and government expenditure on education (GEE) from 1990 to 2022 in Nepal, based on World Development Indicators (WDI) from the World Bank. Following the establishment of democracy in Nepal, both economic growth and government spending on education increased. However, despite political, economic, and social turmoil disrupting the country's well-being, Nepal has struggled to achieve sustained economic growth. In 2002 and 2016, GDP growth was minimal due to changes in political systems and devastating earthquakes, respectively. In 2020, GDP growth was negative due to the COVID-19 pandemic.

Similarly, the growth of government expenditure on education (GEE) was negative in 1990, but it rose by nearly 9% in 1993. After that, GEE growth declined and became negative again in 1999. In 2012 and 2013, GEE growth was once again negative. Overall, the trends in both GDP growth and GEE were found to be increasing at a decreasing rate. In line with the constitutional mandate and the objectives outlined in SDG 4: Education 2030, the Government of Nepal views education as a public good and is committed to assuming the role of the primary entity responsible for education. It aims to ensure inclusive access to quality education, promote lifelong learning, foster a culture of peace, and strengthen ICT applications, while also focusing on enhancing the institutional capacity of the education sector.

Additionally, the Nepalese government asserts that the global initiative of the Sustainable Development Goals (SDGs) presents an opportunity for Nepal to revive its aspiration of achieving the goal of a "Prosperous Nepal, Happy Nepali" by 2043. Though the federal budget of Nepal continues to prioritize education, several organizations have complained that only 10.94% of the total budget has been allocated to the education sector. These organizations argue that the government should allocate at least 25% of the budget and at least 10% of GDP to education. To expedite progress and effectively reduce poverty, Nepal must prioritize investments in its human capital. By allocating resources to develop the skills and abilities of its people, Nepal can enhance individual earning capacities, thereby contributing to overall economic growth [22].

The relationship between education and economic growth has garnered increased interest from proponents of endogenous growth theory [1, 2]. Emerging and developing economies are increasingly investing in education with the primary objective of enhancing the level, quantity, and quality of their human capital [23]. Additionally, economic growth can be driven by the expansion of financial volume and trade openness in both developing and developed countries [24–26]. The educational index, which captures the mean years of schooling and the expected years of schooling, serves as a proxy for education and plays a similar role in promoting economic growth [27, 28].

Research on the relationship between the educational index, government expenditure on education, and economic growth in Nepal is limited. To address this gap, this study aims to investigate the impact of gross capital formation, total population, government expenditure on education, the education index, domestic credit to the private sector, and trade openness on Nepal's economic

growth. By employing ARDL and ECM, this study seeks to provide insights into both the long run and the short run. The empirical findings of this study will offer policymakers insights into stimulating economic growth by leveraging the impact of education, credit availability, and trade openness.

2. Literature Review

2.1. Role of Education on Economic Growth

Economists and policymakers have consistently focused on policy measures related to a country's economic growth, often employing decomposition analysis of gross domestic product (GDP). Among the key figures in this field, Robert Lucas, Paul Romer, and Robert Barro—proponents of the endogenous growth model—have underscored the importance of education in fostering economic growth.

The relationship between education and economic growth has been a central topic of academic inquiry. Theodore Schultz, a pioneer of Human Capital Theory, argued that investments in education and skills development significantly enhance individual productivity, which, in turn, drives the economic growth of a nation [29]. Human capital, which encompasses education and skills, is a critical factor in economic development [1, 2, 30, 31]. Numerous studies have established a strong correlation between higher levels of education and increased rates of economic growth [3, 6]. Additionally, education has been shown to be a powerful tool for poverty alleviation. For example, a study conducted in Cameroon using household survey data from the National Institute of Statistics employed a sample selectivity corrected logistic regression model. The results indicated that improvements in educational attainment reduce poverty and, consequently, stimulate economic growth in Cameroon. Moreover, the study concluded that the educational level of males had a more pronounced impact on poverty reduction than that of females [17].

While there is limited literature on the specific role of education in Nepal's economic growth, Nowak & Dahal [14] investigated the impact of education on the country's economic growth. Their findings indicated that secondary and tertiary education contribute positively and significantly to real GDP per capita. Although primary education also had a positive impact, it was not statistically significant. Another study examined the linkage between higher education and real GDP in Nepal from 1975 to 2009, finding a causal relationship between enrollment in higher education and real GDP [32]. However, in contrast, a time series analysis from 1986 to 2022 revealed that secondary school enrollment has a

negative and insignificant relationship with GDP growth [33].

2.2. Role of Government Expenditure in Education on Economic Growth

Governments worldwide are investing in education to improve human capital and, consequently, stimulate economic growth. The Indian government, for example, has been increasing its spending on education to enhance growth prospects. A study examined the effect of education expenditure on economic growth in India using time series data from 1951 to 2012. The analysis, conducted using a bi-variate VAR model, cointegration, Granger causality, variance decomposition, and impulse response, revealed a long-run equilibrium relationship between education expenditure and economic growth. The results indicated that while economic growth influenced government spending, education expenditure also impacted economic growth. The study recommended prioritizing public spending on education to achieve better outcomes in human development [34].

In Nigeria, a study conducted from 1999 to 2020 measured the impact of government expenditure on education on economic growth. The findings showed a significant and positive relationship between education and real GDP, emphasizing that without education, economic growth would be unlikely [16]. Similar positive impacts of public spending on education were observed in studies from Azerbaijan [12], Ethiopia [13], and various European countries [18]. These studies concluded that public investments in education contribute significantly to accelerating economic prosperity and have a statistically significant long-run impact on economic development [12].

Research in Indonesia explored the dynamics of local government spending on education, healthcare, and infrastructure across 464 districts/cities from 2016 to 2018. Although there was a positive relationship between healthcare spending and improvements in the Human Development Index (HDI) and community welfare, spending on education did not significantly affect economic growth in Indonesia [19]. In Bangladesh, public expenditure on education showed a positive and significant association with economic growth for the period from 1995 to 2009 [35]. However, Suwandaru et al. [20] found an insignificant relationship between government expenditure on education and economic growth in both the long and short run. Despite this, they noted a positive relationship in the long run and a negative relationship in the short run.

In Nepal, the literature on the role of government spending on education in economic growth is limited.

However, it has been observed that the Nepalese government has increased its education spending over time. A study examining the relationship between government expenditure and economic growth in Nepal from 1990 to 2019 found a positive relationship between government expenditure on education and economic growth [36]. Another study using Autoregressive Distributed Lag (ARDL) bound test on annual data from 1975 to 2016 also identified a long-run relationship between government expenditure and economic growth, with government spending significantly influencing Nepal's economic growth [37].

Conversely, some studies have found that public funding for education in Nepal negatively impacts long-run economic growth. In the short-run, the enrollment of technical students in universities also showed a negative association with economic growth. One such study, utilizing the ARDL and Error Correction Model (ECM) from 1982 to 2018, highlighted this negative relationship [38]. Similarly, another study found an insignificant and negative relationship between government spending on education and GDP growth for the period from 1986 to 2022 [33]. Giri [39] argued that while education expenditure negatively impacts GDP growth, public funds should be strategically allocated to infrastructure development and social services.

2.3. Role of Economic Factors on Economic Growth

Theoretical knowledge and empirical studies indicate that labor force, capital formation, credit facilities, and trade openness are key economic factors influencing a country's production and productivity. Among these, labor is one of the most indispensable factors driving economic growth. Population growth is often used as a proxy for labor contribution. However, rapid population growth can strain resources and hinder economic development. For instance, a statistical analysis of population and economic growth in Ghana, using time series data, revealed an inverse relationship between population growth and economic growth, which was statistically significant [40]. Similar findings have been observed in the economies of the Indonesia [41, 42] and Brazil [43].

A study by Suwandaru et al. [20] in Indonesia, using time series data from 1988 to 2018 and the Cobb-Douglas production function with an ARDL Bound Test, identified a complex relationship between labor and economic growth. The analysis revealed a positive long-run relationship but a negative short-run relationship between labor and economic growth. In contrast, gross fixed capital formation consistently showed a positive relationship with economic growth, a finding also

confirmed by Hardi et al. [44] and Idroes et al. [45]. Similarly, a study in Nepal using an ARDL model and data from 1986 to 2022 found a positive long-run relationship between gross fixed capital formation and economic growth [33].

In developing countries, the private sector's ability to secure funding, often facilitated by government policies, plays a critical role in achieving national macroeconomic goals [46, 47]. Domestic credit to the private sector enhances confidence among economic agents and fosters economic growth. Empirical studies by Shapoval [25], Ekanayake & Thaver [48] and Raj Kharel et al. [49] have generally found a positive impact of domestic credit to the private sector on economic growth. However, some studies by Asteriou & Spanos [50], Bamba et al. [51], and Shah et al. [52] have reported a negative impact of domestic credit on the private sector's contribution to economic growth.

Trade openness, defined as the ease and accessibility of international trade for foreign investors, is another crucial factor that can stimulate economic growth [53–56]. Despite its importance, the relationship between trade openness and economic growth remains a subject of debate in the literature. Several studies conducted by Silajdzic & Mehic [26], Abdi et al. [57], Keho [53], Kong et al. [58], and Udeagha & Ngepah [59] have provided evidence of the positive impact of trade openness on economic growth. Conversely, research conducted by Eris & Ulasan [60] and Neupane [61] has found the role of trade openness in economic growth to be insignificant, while some studies by Menyah et al. [62] and Malefane & Odhiambo [63] have even reported a negative effect of trade openness on economic growth.

3. Materials and Methods

3.1. Data Source and Description of Variables

The study uses secondary data from the World Development Indicators (WDI) [22] for 1990-2022. Key variables—economic growth, capital formation, population, government expenditure on education, domestic credit to the private sector, and trade openness—are proxied by LNGDP, LNGCF, LNPOP, LNGEE, LNDGPS, and LNT, respectively. These variables are converted to natural logarithms to linearize relationships, stabilize variances, and handle data range effectively. Table 1 offers a detailed overview of the data types used in this study, including their definitions and relevance. It outlines each variable and its expected interactions, providing a clear understanding of their roles and impact on the analysis.

Table 1. Description of the Variables.

Variable	Symbol	Explanation (Expected Sign)	Source
Dependent	GDP	Gross domestic product is at a constant price in Nepalese currency, the base year 2001.	WDI [22]
Independent	GCF	Gross capital formation is at a constant price in Nepalese currency, the base year 2001 (+).	WDI [22]
	POP	Total Population of Nepal (+).	WDI [22]
	GEE	Government Expenditure on Education (+/-).	WDI [22]
	EI	Education Index measures the adult literacy rate and the combined primary, secondary and tertiary gross enrollment ratio ranging from 0 to 1 (+/-).	WDI [22]
	DCPS	Domestic Credit to the private sector, the base year 2001 (+/-).	WDI [22]
	T	Trade represents the total sum of exports and imports of goods and services between countries (+/-).	WDI [22]

Note: (+) indicates an increase, and (-) indicates a decrease in relation to the dependent variable.

LNGDP, the dependent variable, represents GDP at constant prices (base year 2001, Nepalese currency). Key independent variables include LNGCF, which covers outlays on fixed assets and inventory changes critical for economic growth; LNPOP, the total population (midyear estimates) used as a labor proxy; and LNGEE, reflecting real government expenditure on education at constant prices (base year 2001). The educational index (EI), part of the Human Development Index, is measured by literacy rates and enrollment ratios, with expected years of schooling (EYS) and mean years of schooling (MYS) as its components, ranging from 0 to 1 and positively impacting output. Additionally, LNDPCS measures domestic credit to the private sector as a percentage of GDP, indicating financial depth and its effect on economic growth, while LNT represents trade openness as the sum of exports and imports as a percentage of GDP, positively related to GDP growth.

3.2. Theoretical Framework

The theoretical framework for analyzing the impact of education expenditure on economic growth is based on the endogenous growth model developed by Lucas [1] and Romer [2]. This model extends the classical production function theory of labor and capital, as presented in Equation 1.

$$Q = f(K, L) \tag{1}$$

Where L and K represent the units of labor and capital used to produce Q units of output in the economy, as shown in Equation 1. Furthermore, education, denoted by H , is included in the model because it enhances the economy's human capital stock. Therefore, the aggregate production function, incorporating education as a factor, is presented in Equation 2.

$$Q = f(K, L, H) \tag{2}$$

In the present study, education is considered a function of production or growth due to its significant role in

economic growth by enhancing the skills and knowledge of human capital. It should be noted that various studies measure the quantity of education using different proxies. For instance, education quantity is assessed through schooling enrollment ratios [3, 64, 65], adult literacy rates [1, 66], and education spending [67]. Furthermore, the function model used to investigate the relationship between education and economic growth is presented in Equation 3.

$$GDP = f(GCF, POP, GEE, EI, DCPS, T) \tag{3}$$

Where GDP represents Gross Domestic Product, GCF stands for Gross Capital Formation, POP denotes Total Population, GEE is Government Expenditure on Education, EI is the Education Index, DCPS stands for Domestic Credit to the Private Sector, and T refers to Trade Openness. The econometric model used in this study is expressed in Equation 4.

$$LNGDP_t = \beta_0 + \beta_1 LNGCF_t + \beta_2 LNPOP_t + \beta_3 LNGEE_t + \beta_4 EI_t + \beta_5 LNDPCS_t + \beta_6 LNT_t + \varepsilon_t \tag{4}$$

Where LN in each variable denotes the natural logarithm transformation, β_0 is the intercept, β_1 through β_6 are the coefficients, and ε is the error term.

3.3. ARDL and ECM Estimation Models

Analyzing the long-run impact in an econometric model is crucial for understanding the sustained effects of variables and guiding long-run policy decisions [68, 69]. This study conducted an Autoregressive Distributed Lag (ARDL) and Error Correction Model (ECM) approach to examine the relationship between education and economic growth in Nepal. The ARDL-ECM model was chosen for its flexibility and robustness in handling data and their relationships. It is particularly useful for dealing with various types of data, including those that are stationary at different levels or first differences, thus

circumventing the pretesting problem associated with unit roots [70–72].

The study employed the ARDL/bound testing cointegration procedure, as proposed by Pesaran et al. [73], to estimate both long-run and short-run relationships and dynamic interactions between variables [74, 75]. The ARDL model allows for different lag lengths for different variables, offering a more tailored fit for the data. Additionally, it provides insights into the speed of adjustment back to long-run equilibrium

$$\Delta LNGDP_t = \beta_0 + \sum_{i=1}^k \beta_1 \Delta LNGDP_{t-1} + \sum_{i=1}^k \beta_2 \Delta LNGCF_{t-1} + \sum_{i=1}^k \beta_3 \Delta LNPOP_{t-1} + \sum_{i=1}^k \beta_4 \Delta LNGEE_{t-1} + \sum_{i=1}^k \beta_5 \Delta EI_{t-1} + \sum_{i=1}^k \beta_6 \Delta LNDPCS_{t-1} + \sum_{i=1}^k \beta_7 \Delta LNT_{t-1} + \varphi ECT_{t-1} + \delta_1 LNGDP_{t-1} + \delta_2 LNGCF_{t-1} + \delta_3 LNPOP_{t-1} + \delta_4 LNGEE_{t-1} + \delta_5 EI_{t-1} + \delta_6 LNDPCS_{t-1} + \delta_7 LNT_{t-1} + \varepsilon_t \tag{6}$$

Where Δ represents the first difference, β_1 through β_7 are the short-run coefficients, and δ_1 through δ_7 are the long-run coefficients.

3.4. The Stages of the Analysis Process

The analysis process in this study consists of several stages, starting with Descriptive Statistics to summarize the data, followed by Unit Root Tests to assess stationarity. Next, we use the Cointegration with Bound Test to examine long-run relationships and then estimate the ARDL model to include both short-run and long-run dynamics. The ECM Estimation follows to adjust short-run disequilibrium to long-run equilibrium. Finally, the results are discussed in detail, and conclusions, along with policy implications, are drawn. All the processes are visualized in Figure 2.

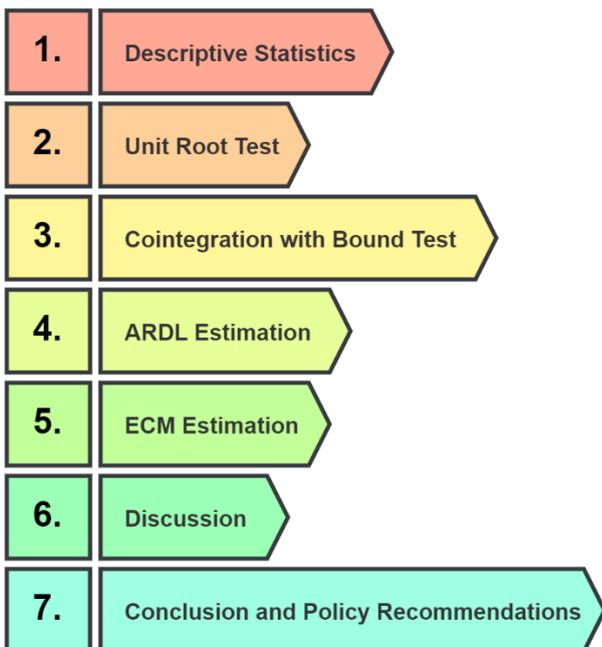


Figure 2. The workflow of the study.

following short-run shocks using ECM. The model used in this study is presented in Equation 5.

$$\Delta Y_t = \delta_{01} + \sum_{i=1}^k \alpha_1 \Delta Y_{t-1} + \sum_{i=1}^k \alpha_2 \Delta X_{t-1} \dots + \varphi ECT_t \tag{5}$$

Where φ represents the speed of adjustment parameter and ECT is the error correction term. It is expected that the coefficient of φ will be negative and statistically significant, confirming a cointegrated relationship. If no long-run relationship is found, the analysis will focus on short-run dynamics. The ARDL regression model is presented in Equation 6.

4. Results and Discussion

4.1. Descriptive Statistics

Table 2 presents the descriptive statistics for the selected variables. LNGDP shows a nearly symmetric distribution with a mean of 27.88, a median of 27.86, low variability (standard deviation: 0.41), a skewness of 0.01, and a kurtosis of 1.89, indicating lighter tails than a normal distribution. LNGCF also displays symmetry with a mean of 21.97, a median of 21.94, moderate variability (standard deviation: 0.61), a skewness of 0.06, and a kurtosis of 1.93. LNPOP has a mean of 17.05, a median of 17.09, low variability (standard deviation: 0.12), a slightly left-skewed distribution (-0.69), and a kurtosis of 2.54, suggesting a near-normal distribution. LNGEE is symmetric with a mean of 24.34, a median of 23.35, left-skewness (-0.24), and a kurtosis of 1.99, indicating lighter tails. EI shows low variability (standard deviation: 0.09), slight right-skewness (0.27), and lighter tails (kurtosis: 1.46). LNDPCS exhibits higher variability (standard deviation: 1.00) but remains symmetric with a mean of 26.88, a median of 26.75, near-zero skewness (-0.04), and a kurtosis of 1.97. Lastly, LNT has a mean of 27.11, a median of 27.08, low variability (standard deviation: 0.42), is left-skewed (-0.55), and has heavier tails than normal (kurtosis: 3.41).

4.2. Unit Root Test

This study first assesses the presence of trends and intercepts in the data to determine the nature of the series, select the appropriate test, and ensure accurate and reliable model selection. The results of the tests are presented in Table 3. The examination revealed that all variables (LNGDP, LNGCF, LNPOP, LNGEE, EI, LNDPCS, and LNT) exhibit both trends and intercepts. Consequently, a unit root test was performed using both

Table 2. Descriptive statistics.

Variable	Mean	Median	Max.	Min.	Std. Dev.	Skewness	Kurtosis
LNGDP	27.88	27.86	28.56	27.17	0.41	0.01	1.89
LNGCF	21.97	21.94	22.99	20.86	0.61	0.06	1.93
LNPOP	17.05	17.09	17.23	16.79	0.12	-0.69	2.54
LNGEE	24.34	24.35	25.29	23.10	0.64	-0.24	1.99
EI	0.40	0.37	0.54	0.28	0.09	0.27	1.46
LNDCPS	26.88	26.75	28.54	25.12	1.00	-0.04	1.97
LNT	27.11	27.08	27.85	26.04	0.42	-0.55	3.41

Table 3. The results of the unit root test.

Variable	ADF		PP		Remarks
	Level	1 st Diff.	Level	1 st Diff.	
	Prob.	Prob.	Prob.	Prob.	
LNGDP	0.0673*	0.0036***	0.0732*	0.0000***	I (1)
LNGCF	0.0251**	0.0036***	0.0287**	0.0000***	I (0)
LNPOP	0.6734	0.0621*	0.2096	0.0319**	I (1)
LNGEE	0.1721	0.0003***	0.2381	0.0002***	I (1)
EI	0.1695	0.0190**	0.6670	0.0142**	I (1)
LNDCPS	0.3880	0.0067***	0.2854	0.0078***	I (1)
LNT	0.1893	0.0839*	0.1123	0.0069***	I (1)

Note: *, **, and *** indicate 10%, 5%, and 1% significance levels, respectively.

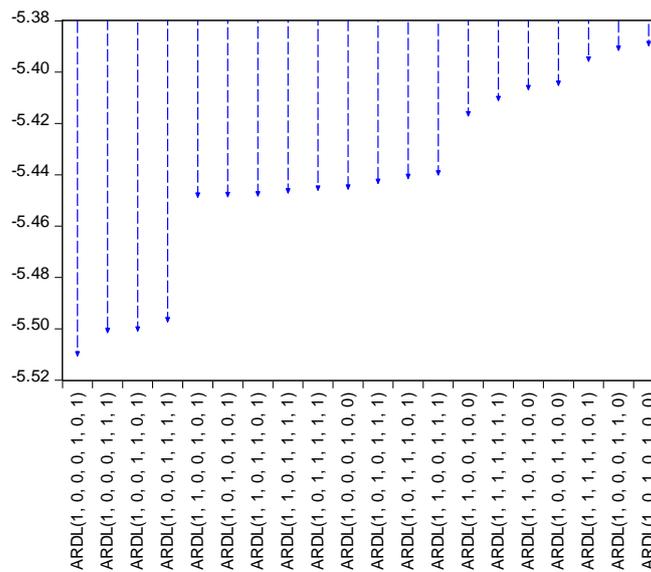


Figure 3. Akaike Information Criteria for top 20 models.

the Augmented Dickey-Fuller (ADF) test and the Phillips-Perron (PP) test to evaluate the stationarity of these variables. The null hypothesis for these tests is that the variables contain a unit root. From [Table 3](#), it is found that all variables, including LNGDP, LNGCF, LNPOP, LNGEE, EI, LNDCPS, and LNT, are stationary at the 1st difference in both the ADF and PP tests. Therefore, based on the unit root test results, the ARDL model is the most suitable model for estimating the study's results.

4.3. Determining the Optimal Lag Structure in the ARDL Model

The optimal lag structure for the model is determined using the Akaike Information Criterion (AIC). According to

the AIC, the ARDL model should include a maximum lag of 1 for the dependent variable and a maximum lag of 1 for the fixed regressors. The chosen lag structure for the variables is (1, 0, 0, 0, 1, 0, 1) for LNGDP, LNGCF, LNPOP, LNGEE, EI, LNDCPS, and LNT, respectively. [Figure 3](#) presents the AIC values for the top 20 models, with the best model lag having an AIC value of -5.51.

4.4. ARDL Bound Test

For coefficient diagnostics, the bound test was conducted, as shown in [Table 4](#). This test is used for cointegration analysis to determine whether a long-run association exists among the variables in the specified ARDL model. The F-statistic value is 13.45, which exceeds

Table 4. Bound test for cointegration analysis.

Test Statistic	Value	Significance Level	I (0)	I (1)
F - statistics	13.4452	10%	2.254	3.388
k	6	5%	2.685	3.960
		1%	3.713	5.326

Table 5. Estimated long-run coefficients of the model.

<i>Dependent Variable: LNGDP</i>				
Variable	Coeff.	Std. Err.	t-stat.	Prob.
LNGCF	0.3648**	0.1525	2.3919	0.0257
LNPOP	1.3606***	0.4262	3.1925	0.0042
LNGEE	-0.1181	0.1535	-0.7698	0.4496
EI	1.2420**	0.5682	2.1857	0.0398
LNDPCS	0.0344	0.0783	0.4395	0.6646
LNT	-0.0697	0.0967	-0.7205	0.4788
C	0.1304	5.1020	0.0256	0.9798

Note: *, **, and *** indicate 10%, 5%, and 1% significance levels, respectively.

Table 6. Error correction model results.

<i>Dependent Variable: LNGDP</i>				
Variable	Coeff.	Std. Err.	t-stat.	Prob.
D(EI)	-0.6367**	0.2977	-2.1385	0.0438
D(LNT)	0.0413*	0.0227	1.8199	0.0824
ECT(-1)	-0.2768***	0.0232	-11.9074	0.0000
R-squared	0.7194			
Adjusted R-squared	0.7000			

Note: *, **, and *** indicate 10%, 5%, and 1% significance levels, respectively.

all corresponding lower and upper bound critical values at the 1%, 5%, and 10% significance levels. Therefore, the null hypothesis is rejected, indicating that a long-run cointegration relationship exists among the variables.

4.5. Long-run Analysis of the ARDL Model

The estimated long-run coefficients of the model are presented in Table 5. The results indicate that LNGCF, LNPOP, and EI are statistically significant at the 5% level in the long run. Specifically, there is a positive and significant relationship between capital formation, population, and the educational index with economic growth in Nepal. A 1% increase in LNGCF is associated with a 0.3648% increase in LNGDP, while a 1% increase in LNPOP results in a 1.3606% increase in LNGDP. Additionally, a 1-unit increase in EI leads to a 1.2420% rise in LNGDP.

On the other hand, government expenditure on education, although statistically insignificant, shows a negative relationship with economic growth. A 1% increase in LNGEE decreases LNGDP by 0.1181%. Similarly, trade openness has a negative but statistically insignificant impact on economic growth, where a 1% increase in LNT reduces LNGDP by 0.0697%. Conversely, domestic credit to the private sector is positively related to economic growth, though this relationship is not statistically significant.

4.6. Short-run Dynamics of the Model

In the short run, the dynamics of the variables are explained by ECM, which evaluates the speed of adjustment toward long-run equilibrium. The ECM regression results are presented in Table 6, where several key findings are highlighted. Specifically, EI is found to be statistically significant with a negative relationship at the 5% significance level (p-value of 0.04), indicating that a 1-unit increase in EI reduces LNGDP by 0.6367%. On the other hand, LNT is significant at the 10% level, demonstrating a positive relationship with LNGDP, where a 1% increase in LNT raises LNGDP by 0.0413%. The coefficient on the lagged ECT, which represents the speed of adjustment toward long-run equilibrium, is statistically significant at the 1% level. This significance suggests a strong presence of cointegration between the variables in the long run. Additionally, the model's R-squared value of 0.7194 indicates that approximately 71.94% of the variability in the dependent variable is explained by the model, with the adjusted R-squared value closely supporting this by explaining nearly 70% of the variability.

4.7. Diagnostic Tests

To ensure the reliability of the estimated ARDL approach, several diagnostic tests were conducted, focusing on normality, heteroscedasticity, serial correlation, and model stability. Specifically, the Jarque-Bera normality

Table 7. Diagnostic tests for the ARDL approach.

Diagnostic Test	Coeff.	Prob.	Conclusion
Jarque-Bera	0.7195	0.6979	Residuals are normally distributed
Breusch-Pagan-Godfrey Test	0.3793	0.8907	No heteroscedasticity exists
Breusch-Godfrey Serial Correlation LM Test	0.3942	0.2914	No serial correlation exists

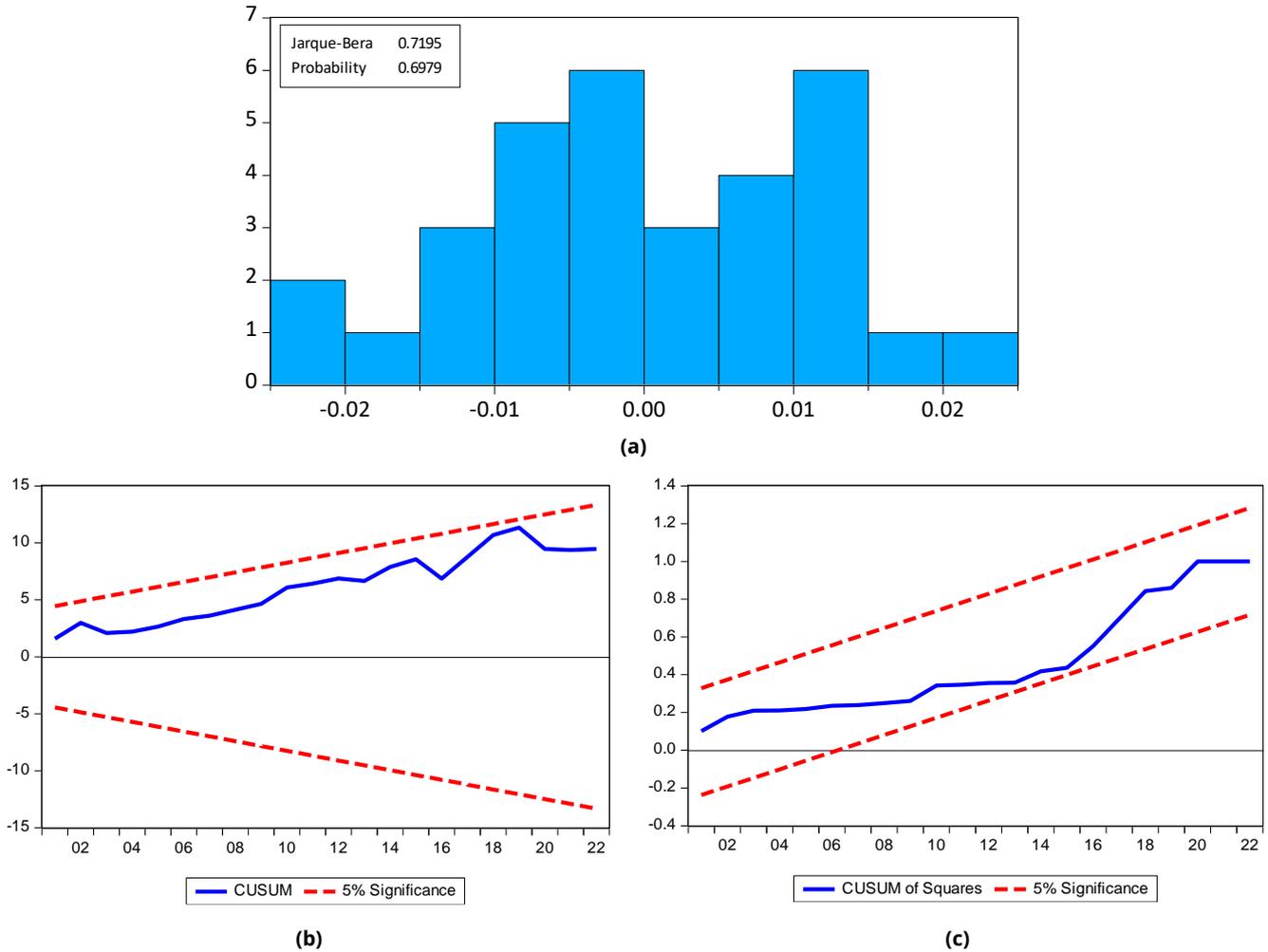


Figure 4. Results of the normality test (a), CUSUM test (b), and CUSUM squared test (c).

test, Breusch-Pagan-Godfrey heteroscedasticity test, Breusch-Godfrey serial correlation LM test, and the recursive CUSUM test were employed, as detailed in Table 7. The results indicate that the model is not affected by heteroscedasticity or serial correlation, as evidenced by F-statistics and Chi-square p-values greater than 0.05. The Jarque-Bera statistic of 0.79 with a p-value of 0.69 suggests that the residuals follow a normal distribution, confirming that the ARDL model is statistically significant and reliable.

The model's long-run stability was further validated using the Jarque-Bera test, CUSUM test, and CUSUM square test, as shown in Figure 4a-c. The Jarque-Bera test results are above the 5% significance level, and the plots for both the CUSUM and CUSUM square tests remain within the critical boundary lines at the 5% significance level. These

findings confirm the model's stability throughout the study period, supporting its use for measuring causality and long-run relationships.

4.8. Discussion

Government expenditure is a crucial component of national income [76], reflecting the social responsibility of governments to allocate public resources efficiently for societal benefit. In resource-constrained economies like Nepal, strategic allocation of public funds, especially towards education, aims to develop high-quality human capital essential for economic growth [77]. Funding for these expenditures primarily comes from domestic taxes on businesses and individuals, with additional support from external sources like debt and grants, while the distribution of public goods arises from a complex

interplay between collective action and top-down processes [78].

Education is widely recognized as a crucial factor in enhancing human productivity and fostering long-run economic growth [1–3, 29]. Numerous empirical studies support this view, with research by Coman et al. [18], Mukhtarov et al. [12], Kharel et al. [36], Shah et al. [37] affirming the positive impact of government expenditure on education on economic growth. However, some studies, such as those by Duwal & Acharya [33], Dangal & Gajurel [38], and Giri [39], present contrasting findings, including insignificantly negative results, highlighting the complexity of this relationship.

In our study, government expenditure on education showed a negative but statistically insignificant relationship with economic growth. Conversely, the educational index, which includes expected years of schooling and mean years of schooling, exhibited a positive and statistically significant relationship with economic growth. This aligns with findings from Delgado et al. [27], who note that mean years of schooling positively correlate with economic growth.

The educational index enhances human capital by improving knowledge, skills, and technical expertise, thereby boosting productivity and efficiency in the long run. Although there is a short-run negative relationship between the educational index and economic growth, the long-run benefits of increased knowledge and skills are anticipated to drive labor force growth and economic development. This finding is consistent with previous studies by Mukhtarov et al. [12], Nuru [13], Nowak & Dahal [14], Rambeli et al. [15], Okerekeoti [16], Njong [17], Coman et al. [18], Sasongko & Wibowo [19], and Suwandaru et al. [20], which indicate a positive and significant influence of educational attainment on economic growth, despite the short-run negative association.

Empirical studies examining the relationship between economic growth, government expenditure, and gross capital formation consistently find a positive correlation between gross capital formation and economic growth, particularly through government expenditure in Nepal [14, 32–34]. The labor force, encompassing both employed and unemployed populations, significantly impacts national income, with population growth directly influencing GDP [40, 79]. This study also identifies a positive and statistically significant correlation between total population and GDP.

Financial depth and innovation are recognized as strong predictors of economic growth [25]. However, this study reveals a contradictory finding of a negative effect of

financial depth on economic growth, despite Levine & Renelt [65] supporting the idea that financial development enhances economic growth. The study also found a statistically insignificant positive relation between domestic credit to the private sector and economic growth, suggesting a weak contribution rate. Empirical studies conducted by Silajdzic & Mehic [26] found positive and significant effects of trade openness with lagged values on economic growth. While Nepal's trade openness is relatively high in manufacturing (20%) and service sectors (14%), the study found a low sensitivity of per capita income growth to trade openness [61]. Despite theoretical support for a positive relationship between trade openness and economic growth, this study found a negative and statistically insignificant effect of trade openness on economic growth in Nepal. The nuanced relationship between trade openness and economic growth in Nepal contrasts with theoretical expectations and previous empirical findings by Silajdzic & Mehic [26] and Neupane [61].

Prioritizing the education sector in government expenditures emerges as a crucial policy measure for nurturing skilled human capital essential for sustained economic development. The findings also highlight the need for nuanced policy considerations regarding the impact of financial indicators and trade openness on economic growth within specific national contexts like Nepal.

5. Conclusions and Policy Recommendations

This study investigates the effects of gross capital formation, total population, government expenditure on education, the education index, domestic credit to the private sector, and trade openness on Nepal's economic growth, utilizing time series data spanning from 1990 to 2022. The ARDL and ECM models were employed to estimate these dynamics, revealing several critical insights. In the long run, gross capital formation, total population, and the education index were found to be statistically significant and positively related to economic growth in Nepal. The study primarily focused on the relationship between government expenditure in education on economic growth, finding that government expenditure on education has a negative, though statistically insignificant, impact on economic growth. Additionally, while an increase in the education index promotes economic growth in Nepal in the long run, it has a detrimental effect in the short run.

The analysis highlights a persistent contradiction: there remains a significant need for increased investment in education to meet social objectives and facilitate development. Domestic credit to the private sector and

trade openness exhibit an insignificant relationship with economic growth in Nepal. Policymakers should be mindful of the underlying capitalist interests of influential powers and aid agencies when formulating education policies related to trade openness, and should prioritize integrating local knowledge with global relevance. The education index contributes to economic growth in the short run and has a more substantial impact in the long run. The findings suggest that current government expenditure on education has yet to be effective in advancing the educational sector in Nepal or significantly enhancing economic growth. Despite the absence of a direct, significant effect on economic growth, there is a clear need for additional resources and improved management within the education sector to achieve social goals and promote development. Policymakers and stakeholders should focus on well-structured programs with robust monitoring mechanisms. This underscores that, although government spending on education may not directly drive immediate economic growth, it remains essential for societal development and the enhancement of human capital.

This study highlights the complexity of factors influencing economic growth in Nepal, emphasizing the diverse nature of development. Economic policies are complex and require consideration of broader socio-political contexts and stakeholder interests, extending beyond mere statistical analysis. While variables such as capital formation, population growth, and educational improvements demonstrate positive impacts on long-run economic growth, others—such as government expenditure on education and trade openness—necessitate more nuanced policy approaches to fully realize their potential benefits. The study also underscores the importance of accounting for local contexts and the possible hidden agendas of international aid agencies and capitalist interests when formulating education policies related to trade openness. This calls for balanced policies that integrate global and local priorities.

Author Contributions: Conceptualization, N.D. and S.S.; methodology, N.D.; software, N.D.; validation, N.D. and S.S.; formal analysis, N.D.; investigation, N.D.; resources, N.D.; data curation, N.D.; writing—original draft preparation, N.D. and S.S.; writing—review and editing, N.D. and S.S.; visualization, N.D. and S.S.; supervision, N.D. and S.S.; project administration, N.D.; All authors have read and agreed to the published version of the manuscript.

Funding: This study does not receive external funding.

Data Availability Statement: The data is available by request.

Acknowledgments: The authors express their gratitude to their institutions and universities.

Conflicts of Interest: All the authors declare that there are no conflicts of interest.

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