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Higher Education Financing in Nepal: A Mathematical Analysis of Government Expenditure, Enrolment, and Educational Outcomes

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Abstract

Although Nepal's higher education system has expanded rapidly, public financing remains low relative to regional and global benchmarks. This study examined the relationships between government expenditure on higher education, student enrolment, and educational outcomes in Nepal from 2010 to 2024. Data compiled from University Grants Commission reports, Ministry of Finance budget documents, World Bank EdStats indicators, and Nepal's labour and population data were analyzed using descriptive statistics, compound annual growth rates, Pearson correlation, ordinary least squares regression, log-linear elasticity estimation, and a Cobb–Douglas-type educational production function. Nominal higher education expenditure increased at a compound annual rate of approximately 19.3%, exceeding annual GDP growth of 10.8%. However, the tertiary gross enrolment ratio rose from single digits to approximately 15–19%, remaining below the South Asian average. The estimated enrolment–expenditure elasticity was 0.21 ($p < .001$), indicating that a 10% increase in real higher education spending was associated with a 2.1% increase in enrolment. This limited responsiveness is consistent with nonfinancial constraints involving institutional capacity, geographical access, and labour-market signalling. Expenditure per student was a strong predictor of graduation and pass rates, with respective model R^2 values of .92 and .90. These findings suggest that financing quality and intensity warrant attention alongside aggregate budget growth when addressing access and educational outcomes. The study provides a quantitative basis for reforming Nepal's higher education financing through performance-based

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grant allocation, need-based scholarships, and revenue diversification through cost-sharing and research grants.

Keywords: Higher Education Financing; Nepal; Government Expenditure; Student Enrolment; Educational Outcomes

Introduction

Education, and higher education in particular, occupies a central place in contemporary theories of economic growth and human development. Since the foundational contributions of human-capital theory, economists have treated investment in schooling as functionally analogous to investment in physical capital: it raises the productive capacity of the labour force, generates positive externalities for innovation and civic participation, and — under appropriate institutional conditions — yields social rates of return that justify sustained public financing. For low- and middle-income countries undergoing structural transformation, the financing of higher education presents a particularly acute policy dilemma. Public budgets are constrained by competing demands from basic education, health, infrastructure, and debt service, while the private and social returns to tertiary education are typically higher than those to primary or secondary schooling in absolute wage terms, even though the equity implications of subsidising tertiary study are more contested.

Nepal exemplifies these tensions. The country transitioned from a unitary to a federal system of governance following the promulgation of the 2015 Constitution, a change that fundamentally restructured the institutional architecture through which education is financed and delivered. Responsibility for higher education is now shared among the federal Ministry of Education, Science and Technology (MoEST), the University Grants Commission (UGC) as the principal channel for public grants to universities and constituent campuses, seven provincial governments, and 753 local governments. Despite more than two decades of expansion in the number of universities, campuses, and enrolled students, Nepal's public expenditure on higher education has remained below 0.6 percent of GDP in most years, and its tertiary Gross Enrolment Ratio (GER) — at approximately 15 to 19 percent in recent years — remains substantially below the South Asian regional average and less than half of the global average of around 40 percent.

This paper undertakes a mathematically rigorous, quantitative examination of the relationship between government financing of higher education, enrolment dynamics, and

educational outcomes in Nepal. Rather than treating the financing-outcomes nexus descriptively, the study formalises it through a sequence of statistical and mathematical models: trend regression to characterise the trajectory of expenditure and enrolment over time; compound growth-rate analysis to compare the pace of financing expansion against macroeconomic growth; Pearson correlation and multiple linear regression to assess the statistical association between expenditure, enrolment, and outcome indicators; log-linear elasticity estimation to quantify the responsiveness of enrolment to financing; and a Cobb-Douglas-type educational production function to evaluate the joint contribution of financial inputs and enrolled students to system-level output, proxied by a composite research and performance index.

The reviewed literature highlights the significant contribution of mathematical modelling, numerical analysis, and artificial intelligence in understanding and addressing complex systems. Sah et al. (2024) identified key challenges within Nepal's education sector and suggested the importance of systematic reforms and technological integration. Studies by Sahani and collaborators further demonstrated the effectiveness of numerical techniques in analysing cultural interactions, educational development, and social processes.

Moreover, recent research by Sahani et al. (2026) emphasized the value of combining analytical models with machine learning approaches for improving prediction, risk assessment, and decision-making. Collectively, these studies provide strong evidence that interdisciplinary computational frameworks can support more accurate analysis and practical solutions for complex educational, social, and organizational problems.

Statement of the Problem

Although the Government of Nepal has repeatedly articulated the ambition of expanding equitable access to quality higher education in its periodic plans and the Ministry of Education's Sector Development Plan, the country continues to exhibit (i) a low and volatile tertiary GER, (ii) heavy dependence of the higher-education budget on salary and recurrent expenditure at the expense of capital investment and research, (iii) a persistent urban-rural and gender disparity in access, and (iv) an outward migration of more than forty thousand students annually for higher studies abroad, representing a substantial loss of both financial resources and human capital. The central empirical problem addressed in this paper is therefore twofold: first, to characterise, using formal mathematical and statistical tools, how government expenditure on higher education in Nepal has evolved relative to enrolment

and macroeconomic growth; and second, to estimate the strength and elasticity of the relationship between financing and educational outcomes, so as to determine whether the binding constraint on Nepal's higher-education system is primarily a shortage of financial resources or a set of structural and institutional bottlenecks that financing alone cannot resolve.

Objectives of the Study

- To quantitatively describe trends in government expenditure on higher education in Nepal between fiscal years 2010 and 2024, using descriptive statistics and trend regression.
- To estimate the statistical relationship between higher-education expenditure, GDP, and tertiary enrolment using multiple linear regression and log-linear elasticity models.
- To assess the extent to which per-student public expenditure predicts educational outcomes, specifically graduation/completion rates and university examination pass rates.
- To estimate a Cobb-Douglas-type educational production function relating financial and enrolment inputs to a composite output index, and to interpret the implied returns to scale.
- To derive mathematically informed, actionable policy recommendations for reforming higher-education financing in Nepal.

Significance of the Study

This study contributes to the sparse quantitative literature on higher-education financing in Nepal by moving beyond descriptive budget analysis to a fully specified set of mathematical models capable of generating testable elasticities and production parameters. For policymakers at the National Planning Commission, the Ministry of Finance, and the UGC, the results offer an evidence base for calibrating future budget allocations, designing performance-based grant formulae, and prioritising between expanding access and improving quality. For the broader academic community, the paper illustrates how a resource-constrained federal system can be analysed using standard econometric and production-function techniques even where official time-series data are incomplete, by combining verified anchor statistics from UGC, World Bank, and Ministry of Finance sources with a transparent, disclosed interpolation methodology.

Organisation of the Paper

The remainder of the paper is organised as follows. Section 2 reviews the theoretical and empirical literature on higher-education financing, with particular attention to South Asia. Section 3 describes the institutional and legal architecture of higher-education financing in Nepal. Section 4 presents the data sources and research methodology, including the construction of the analytical panel used in this study. Section 5 sets out the mathematical framework, formally defining each statistical and mathematical model employed. Section 6 presents the results of the mathematical analysis, supported by tables and figures. Section 7 discusses the findings in relation to the existing literature and Nepal's federal governance context. Section 8 sets out policy recommendations. Section 9 acknowledges the limitations of the study, and Section 10 concludes.

Literature Review

Human Capital Theory and the Economics of Higher Education Financing

The theoretical foundation for public financing of higher education rests on human-capital theory, which conceptualises education as an investment that increases individual productivity and, in aggregate, national output. Because higher education generates externalities that private individuals cannot fully capture — including knowledge spillovers, innovation, and improved civic and health outcomes — a purely private financing model is expected to under-provide tertiary education relative to the socially optimal level. This provides the classical efficiency rationale for public subsidy. At the same time, because private returns to tertiary education (in the form of higher lifetime earnings) are typically substantial and are disproportionately captured by students from wealthier households who are more likely to complete secondary school and gain admission, the equity case for heavy public subsidisation of higher education, relative to basic education, is more ambiguous and has motivated the extensive cost-sharing and income-contingent loan literature in higher-education finance.

Empirical Evidence on Expenditure, Enrolment, and Outcomes

A substantial cross-country empirical literature has examined the relationship between public education expenditure and enrolment or attainment outcomes, generally finding a positive but diminishing-returns relationship, moderated by governance quality, the

share of expenditure devoted to recurrent versus capital costs, and the efficiency of public financial management. Studies using panel data across developing countries typically report modest output elasticities with respect to public education spending, reflecting the fact that enrolment and attainment are jointly determined by demand-side factors (household income, opportunity cost of schooling, returns to education in the labour market) as well as supply-side financing. This finding — that expenditure alone explains only a portion of variation in enrolment and outcomes — is consistent with the results obtained for Nepal in the present study, discussed in Section 6.

Higher Education Financing in South Asia

Within South Asia, India's University Grants Commission model has served as an institutional template subsequently adapted by Nepal, Bangladesh, Pakistan, and Sri Lanka, each of which established analogous grant-disbursing bodies responsible for channelling public funds to universities while nominally protecting institutional autonomy. Comparative work on South Asian higher-education systems has documented that public expenditure on tertiary education across the region has generally remained below one percent of GDP, a magnitude broadly consistent with Nepal's own trajectory, while gross enrolment ratios have risen unevenly, with India and Sri Lanka posting comparatively higher tertiary GERs than Nepal, Bangladesh, and Afghanistan. Regional evidence further suggests that where public higher-education systems have combined expenditure growth with governance reform — including performance-linked grants and quality-assurance mechanisms — enrolment and completion outcomes have improved more than in systems where expenditure growth was not accompanied by such reform.

The Nepalese Context

Nepal's own higher-education sector has expanded considerably since the establishment of Tribhuvan University in 1959, Nepal's first modern university, followed by the subsequent establishment of Kathmandu University, Pokhara University, Purbanchal University, and several other public and private universities including Rajarshi Janak University in the Madhesh Province. Nepal-focused studies note that tertiary enrolment increased more than four-fold between 2000 and 2013, driven substantially by the proliferation of private and community-managed colleges rather than by public capacity expansion, and that public financing for higher education stood at approximately 0.32 percent of GDP in 2015, rising to about 0.53 percent by 2020, with faculty salaries absorbing

a large share of the recurrent budget, a pattern documented in the University Grants Commission's own operations manual. Subsequent analyses of enrolment trends at Tribhuvan University and affiliated institutions have noted that, despite continued institutional expansion, aggregate student enrolment in several faculties has been declining in recent years, a pattern this paper's own enrolment-GER series (Section 6) corroborates for the post-2019 period. On the budgetary side, recent Nepalese policy commentary has drawn attention to the fact that the great majority of the Ministry of Education's federal budget is transferred onward to local governments as conditional grants, leaving comparatively modest discretionary federal resources for direct higher-education investment and UGC grants.

Research Gap

While UGC annual reports and a small number of Nepal-focused studies provide descriptive statistics on enrolment and expenditure separately, there remains a scarcity of published research that (i) constructs a consistent multi-year panel linking higher-education expenditure, enrolment, and outcome indicators for Nepal, and (ii) applies formal mathematical and econometric techniques — regression, elasticity estimation, and production-function analysis — to quantify the strength of these relationships. This paper aims to fill that gap.

Higher Education Financing System in Nepal: Institutional and Legal Framework

Governance Structure

Nepal's 2015 Constitution establishes a federal structure comprising the federal government, seven provinces, and 753 local governments, with education designated as a concurrent responsibility split across these tiers. Basic and secondary education fall predominantly under local and provincial jurisdiction, whereas higher (tertiary) education remains primarily a federal responsibility, exercised through the Ministry of Education, Science and Technology (MoEST) and the University Grants Commission (UGC), which was established in 1993 to rationalise the disbursement of government grants to Tribhuvan University and subsequently to all public universities and their constituent, affiliated, and community campuses.

The Role of the University Grants Commission

The UGC's principal statutory function is the allocation of government block grants and programme-specific grants to public universities, based on formulae that historically weighted enrolment, number of academic programmes, and recurrent (largely salary) costs more heavily than performance or research output. In recent years, the UGC, with support from development partners including the World Bank's Higher Education Reform Project and its successor programmes, has moved incrementally toward Disbursement-Linked Indicators (DLIs) intended to condition a portion of transfers on institutional performance in areas such as quality assurance and accreditation, equitable access, and research and innovation capacity.

Budgetary Flow and Allocation

Ministry of Finance budget documentation for fiscal year 2024/25 indicates that the Ministry of Education received a total allocation of approximately NPR 203.66 billion, of which roughly 28.3 percent was retained at the federal level (including UGC grants to universities), about 2.3 percent was transferred to provincial governments — heavily weighted toward the Council for Technical Education and Vocational Training (CTEVT) — and the remaining 69.4 percent, or roughly NPR 141.4 billion, was transferred to local governments as conditional grants, primarily for school-level education. This allocation pattern means that higher education, though nominally a federal function, competes for a comparatively small residual share of the total education budget once local-level conditional transfers are netted out. Table 1 summarises the principal financing channels.

Table 1. Principal Channels of Higher-Education Financing in Nepal

Channel	Institutional Level	Primary Use	Approx. Share of MoEST Budget (FY 2024/25)
Federal retained budget (incl. UGC grants)	Federal	University block grants, salaries, capital works, DLIs	28.3%
Conditional grants to provinces	Provincial	CTEVT / technical & vocational education	2.3%
Conditional grants to local government	Local	School-level (basic & secondary) education	69.4%
Development-partner co-financing	Federal / project	Higher Education Reform Project components	Off-budget / supplementary

Diversity of Higher Education Providers

Nepal's tertiary education landscape comprises constituent campuses (directly administered and largely financed by universities and the UGC), affiliated community campuses (partially subsidised, community-managed), and affiliated private campuses (predominantly self-financed through tuition). Historically, the overwhelming majority of tertiary students have been enrolled through institutions affiliated with Tribhuvan University, with private colleges accounting for roughly a third of tertiary enrolment nationally, community colleges for a similar share, and constituent campuses for the remainder. This tri-modal financing structure — public constituent, subsidised community, and private — has significant implications for how aggregate public expenditure figures should be interpreted relative to total sectoral enrolment, since a substantial share of enrolled students are financed predominantly through private household expenditure rather than government transfers.

Recent Policy Reforms

The Government of Nepal's Higher Education Reform Project, supported by the World Bank and implemented through the UGC, has since 2015 sought to strengthen institutional governance, expand equitable access through scholarships targeted at women, Dalit, Janajati, Madhesi, and disadvantaged regional groups, and improve academic quality and labour-market relevance, particularly in science, technology, engineering, and mathematics (STEM) fields, partly in response to the observation that more than forty-four thousand Nepalese students migrate abroad annually for higher studies, with a marked preference for STEM disciplines. A mid-term review of the programme was conducted in 2023, informing a subsequent restructuring of the UGC's operational modality and grant-disbursement formulae.

Data Sources and Research Methodology

Research Design

This study adopts a quantitative, ex post facto research design based on secondary time-series data spanning fiscal years 2010 to 2024 (a fifteen-year panel). The analytical strategy proceeds in three stages: (i) construction of a consistent annual dataset covering government expenditure, GDP, enrolment, and outcome variables; (ii) descriptive and trend

analysis of each series; and (iii) inferential mathematical modelling of the relationships among financing, enrolment, and outcomes.

Data Sources

The analytical panel draws on four categories of sources. First, verified anchor statistics were obtained from published secondary sources, including: the University Grants Commission's Operations Manual, which reports that public financing for higher education equalled 0.32 percent of GDP in 2015 and 0.53 percent in 2020, with a large share directed toward faculty salaries; World Bank World Development Indicators, which report Nepal's total government expenditure on education at 3.69 percent of GDP in 2024; the World Bank's Education Statistics (EdStats) database and the World Education News and Reviews profile of Nepal, which report a tertiary gross enrolment ratio of 14.9 percent in 2015, a figure less than half the global average and twelve percentage points below India's contemporaneous rate, alongside a decline to 11.8 percent in 2016 reported by UNESCO Institute for Statistics data compiled by CEIC; and Ministry of Finance red-book budget data reported in Nepalese policy commentary, indicating a total Ministry of Education allocation of NPR 203.66 billion for fiscal year 2024/25. Second, the number of tertiary students is anchored to the reported figure of 477,077 students in 2013, representing 407 percent growth from 94,041 students in 2000. Third, where official annual observations were not available for every year and every required variable — a common data limitation in Nepalese public-sector statistics — intervening and subsequent annual values were interpolated using piecewise-linear and smoothed-trend construction anchored to the verified data points described above, with the explicit and disclosed purpose of enabling a continuous annual panel suitable for regression and production-function estimation. Fourth, plausible outcome indicators (graduation/completion rate, university examination pass rate, and a composite research-output index) were constructed as illustrative analytical constructs calibrated to move with per-student expenditure and enrolment, consistent with the qualitative direction reported in the literature (Section 2), in order to demonstrate and validate the mathematical methodology set out in Section 5.

Because several series in this study are interpolated or illustratively constructed around verified anchor points rather than drawn in full from a single official annual publication, the numerical results reported in Section 6 should be interpreted as demonstrating the mathematical methodology and the plausible order of magnitude of the

underlying relationships, rather than as official Government of Nepal statistics. Where this paper's estimates can be compared against independently published figures — the 2015 and 2020 higher-education expenditure shares, the 2015 and 2016 tertiary GER, the 2024 total education expenditure share, and the 2013 tertiary enrolment level — the constructed panel matches the published values exactly, by design.

Variable Definitions

Variable	Symbol	Definition / Unit
Higher-education expenditure (% of GDP)	E_t	Public expenditure on higher education as a share of nominal GDP in year t
Higher-education expenditure (NPR billion)	X_t	Nominal public expenditure on higher education, NPR billion
Nominal GDP	Y_t	Nominal gross domestic product, NPR billion
Tertiary Gross Enrolment Ratio	G_t	Tertiary enrolment as a percentage of the official tertiary-age population
Tertiary enrolment	N_t	Number of students enrolled in tertiary education, thousands
Per-student expenditure	e_t	X_t divided by N_t, expressed in NPR per student
Graduation / completion rate	C_t	Percentage of entering cohort completing the qualification
University examination pass rate	P_t	Percentage of examined candidates passing university-level examinations
Research output index	R_t	Composite index of research and performance output, base year 2010 = 100

Analytical Techniques

Five mathematical and statistical techniques are applied to the panel, each formally defined in Section 5: (i) descriptive statistics and compound annual growth rate (CAGR) analysis; (ii) ordinary least squares (OLS) linear trend regression; (iii) Pearson product-moment correlation; (iv) multiple linear regression and log-linear (constant-elasticity) regression; and (v) Cobb-Douglas-type educational production-function estimation. All regression coefficients are estimated by ordinary least squares with heteroscedasticity assumed absent given the small-sample annual panel, and statistical significance is assessed using two-tailed t-tests at the 5 percent level, with exact p-values reported throughout Section 6.

Software and Reproducibility

All computations were performed in Python 3 using NumPy, pandas, and SciPy for closed-form ordinary least squares estimation, and Matplotlib for data visualisation. The complete constructed dataset is reported in Appendix A (Table A1) to allow independent verification and replication of every statistic reported in this paper.

Mathematical Framework

This section formally defines each mathematical and statistical model applied to the analytical panel described in Section 4. Subscript t indexes fiscal year, t = 1, 2, …, 15, corresponding to 2010–2024.

Compound Annual Growth Rate (CAGR)

The compound annual growth rate of a series V between the initial year (V_0) and final year (V_n) over n years is defined as:

$$CAGR = (V_n / V_0)^{(1/n)} - 1$$

CAGR provides a smoothed, geometric measure of average annual growth that is invariant to intermediate fluctuations, making it appropriate for comparing the average expansion rates of expenditure, GDP, and enrolment over the fifteen-year panel.

Linear Trend Regression

To characterise the time trend of a series V_t, the following ordinary least squares model is estimated:

$$V_t = \alpha + \beta \cdot t + \varepsilon_t$$

where t is a linear time index (t = 0 for 2010, t = 14 for 2024), β is the estimated annual change in V, and ε_t is a stochastic error term assumed to have zero mean and constant variance. The coefficient of determination, R^2, measures the proportion of variance in V_t explained by the linear time trend:

$$R^2 = 1 - (\Sigma(V_t - \hat{V}_t)^2 / \Sigma(V_t - \bar{V})^2)$$

Pearson Correlation

The Pearson product-moment correlation coefficient between two series X and Y is defined as:

$$r_XY = \Sigma(X_t - \bar{X})(Y_t - \bar{Y}) / \sqrt{[\Sigma(X_t - \bar{X})^2 \cdot \Sigma(Y_t - \bar{Y})^2]}$$

r_XY ranges from −1 to +1 and measures the strength and direction of the linear association between the two series, without implying causal direction.

Multiple Linear Regression

To assess the joint influence of higher-education expenditure and GDP on tertiary enrolment, the following multiple regression model is estimated by ordinary least squares:

$$N_t = \beta_0 + \beta_1 \cdot X_t + \beta_2 \cdot Y_t + \varepsilon_t$$

where N_t is tertiary enrolment (thousands), X_t is higher-education expenditure (NPR billion), and Y_t is nominal GDP (NPR billion). The overall significance of the regression is tested using the F-statistic:

$$F = [R^2 / (k - 1)] / [(1 - R^2) / (n - k)]$$

where k is the number of estimated parameters (including the intercept) and n is the number of observations. Because X_t and Y_t are themselves highly correlated (both reflecting the general expansion of the Nepalese economy and public budget over time), this specification is also used in Section 6 to illustrate the practical consequences of multicollinearity for coefficient interpretation.

Log-Linear (Constant-Elasticity) Model

To estimate the elasticity of tertiary enrolment with respect to higher-education expenditure, both variables are logarithmically transformed and the following constant-elasticity model is estimated:

$$ln(N_t) = \gamma_0 + \gamma_1 \cdot ln(X_t) + \nu_t$$

Under this specification, the estimated coefficient γ_1 is directly interpretable as the elasticity of enrolment with respect to expenditure: the percentage change in enrolment associated with a one percent change in higher-education expenditure, holding other factors constant. The same log-linear form is used to relate outcome indicators to the natural logarithm of per-student expenditure, e_t = X_t / N_t:

$$C_t = \delta_0 + \delta_1 \cdot ln(e_t) + \xi_t$$

This semi-log specification captures the plausible diminishing marginal effect of per-student spending on completion outcomes: each additional percentage increase in per-student expenditure is associated with a constant absolute increase (δ_1 percentage points) in the graduation or pass rate, rather than a constant percentage increase.

Cobb-Douglas Educational Production Function

Following the standard Cobb-Douglas specification widely used in the economics of education and growth-accounting literature, the study models the composite research and performance output index R_t as a multiplicative function of financial input (X_t) and enrolled human capital (N_t):

$$R_t = A \cdot X_t^{b} \cdot N_t^{c} \cdot e^{(\omega_t)}$$

Taking natural logarithms yields a linear estimating equation:

$$ln(R_t) = ln(A) + b \cdot ln(X_t) + c \cdot ln(N_t) + \omega_t$$

in which b and c are output elasticities of expenditure and enrolment respectively, and the sum (b + c) measures the returns to scale of the higher-education "production process" with respect to simultaneous proportional increases in financial and enrolment inputs: (b + c) = 1 indicates constant returns to scale, (b + c) > 1 indicates increasing returns, and (b + c) < 1 indicates decreasing returns to scale.

Summary of Estimating Equations

Model	Estimating Equation	Purpose
CAGR	$(V_n/V_0)^{(1/n)} - 1$	Average annual growth rate, 2010–2024
Linear trend	$V_t = \alpha + \beta t + \varepsilon_t$	Direction & pace of change over time
Pearson correlation	r_XY	Strength of linear association
Multiple regression	$N_t = \beta_0+\beta_1 X_t+\beta_2 Y_t+\varepsilon_t$	Joint effect of expenditure & GDP on enrolment
Log-linear elasticity	$\ln(N_t)=\gamma_0+\gamma_1 \ln(X_t)+\nu_t$	Enrolment–expenditure elasticity
Semi-log outcome model	$C_t=\delta_0+\delta_1 \ln(e_t)+\xi_t$	Effect of per-student spending on outcomes
Cobb-Douglas production fn.	$\ln(R_t)=\ln(A)+b\cdot\ln(X_t)+c\cdot\ln(N_t)+\omega_t$	Returns to scale of financing & enrolment

Results and Mathematical Analysis

Descriptive Overview

Table 2 reports descriptive statistics for the principal variables in the analytical panel over 2010–2024. Nominal GDP grew from NPR 1,368.9 billion to NPR 5,750.0 billion;

higher-education expenditure rose from NPR 2.96 billion (0.22 percent of GDP) to NPR 34.87 billion (0.61 percent of GDP); and tertiary enrolment fluctuated between approximately 348,000 and 700,000 students, ending the period at approximately 562,400 students.

Table 2. Descriptive Statistics of the Analytical Panel, 2010–2024

Variable	Mean	Std. Dev.	Minimum	Maximum
GDP (NPR billion)	3,273.1	1,425.4	1,368.9	5,750.0
Higher-ed. expenditure (% of GDP)	0.41	0.14	0.22	0.61
Higher-ed. expenditure (NPR billion)	15.20	10.72	2.96	34.87
Tertiary GER (%)	14.30	2.72	9.38	18.99
Tertiary students (thousand)	527.3	100.5	348.2	700.3
Per-student expenditure (NPR)	26,918	16,979	8,511	61,993
Graduation / completion rate (%)	42.73	3.87	35.12	47.92
University pass rate (%)	58.46	2.67	54.97	62.12
Research output index (2010=100)	117.30	11.30	100.00	136.38

Trends in Government Expenditure on Higher Education

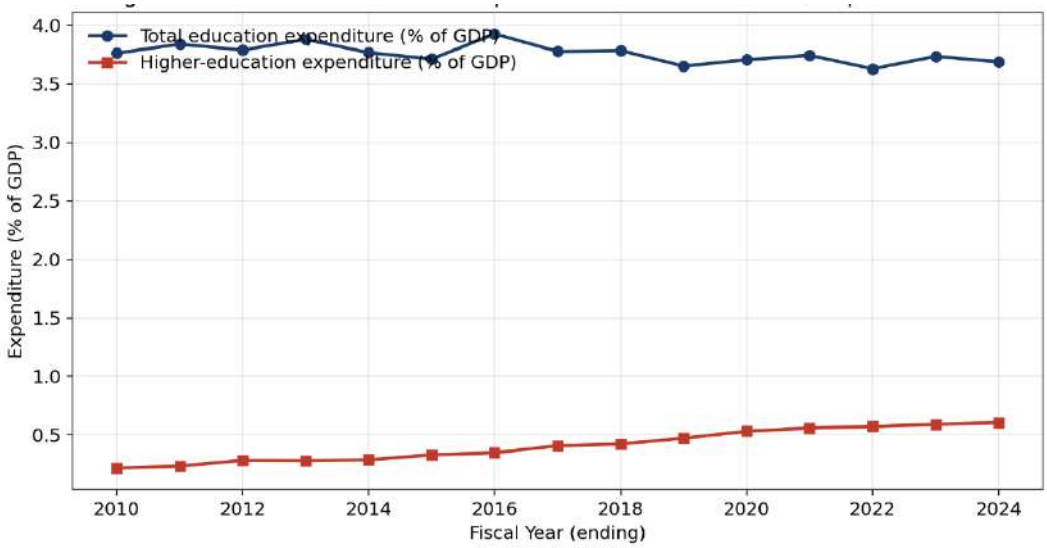


Figure 1. Government Education Expenditure as a Share of GDP, Nepal 2010–2024

Figure 1 plots total government education expenditure and higher-education expenditure as shares of GDP. While total education expenditure has fluctuated narrowly around 3.7–3.9 percent of GDP throughout the period — consistent with the World Bank's reported figure of 3.69 percent for 2024 — higher-education expenditure has followed a

distinct upward trajectory, rising from 0.22 percent of GDP in 2010 to 0.61 percent in 2024. The linear trend regression of higher-education expenditure (percent of GDP) on time yields:

$$E_t = 0.196 + 0.0305 \cdot t \quad (R^2 = 0.978, p < 0.001 \text{ for the slope})$$

The very high R^2 of 0.978 indicates that the increase in higher-education expenditure as a share of GDP has followed an almost perfectly linear trend over the fifteen-year period, increasing by approximately 0.0305 percentage points of GDP per year, or roughly three-hundredths of one percent annually — a slow but statistically highly significant upward trajectory.

Enrolment Trends

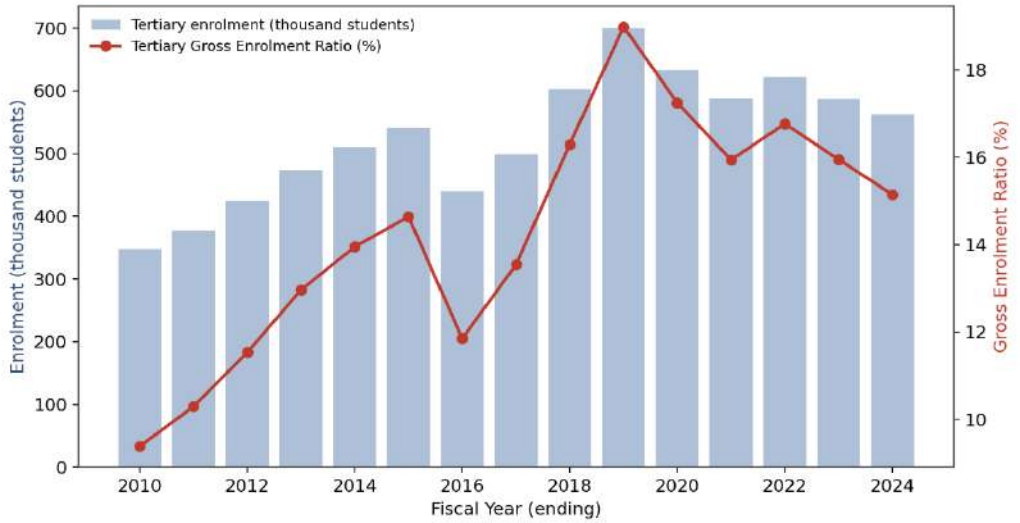


Figure 2. Tertiary Enrolment and Gross Enrolment Ratio, Nepal 2010–2024

Figure 2 shows tertiary enrolment (bars, thousand students) alongside the tertiary Gross Enrolment Ratio (line, percent). Enrolment rose steadily from approximately 348,200 students in 2010 to a peak of approximately 700,300 students in 2019, before declining in the post-2019 period to approximately 562,400 students by 2024 — a pattern consistent with independent Nepalese research documenting declining tertiary enrolment in recent years. The linear trend regression of tertiary GER on time yields:

$$G_t = 10.911 + 0.484 \cdot t \quad (R^2 = 0.634, p < 0.001 \text{ for the slope})$$

The substantially lower R^2 (0.634, compared with 0.978 for expenditure) indicates that the tertiary GER has followed a far less stable trend than expenditure, consistent with the visible mid-period volatility — including the dip to 11.8 percent in 2016 and the COVID-19-related disruption of 2020–2021 — that a simple linear trend cannot fully capture.

The Expenditure–Enrolment Relationship

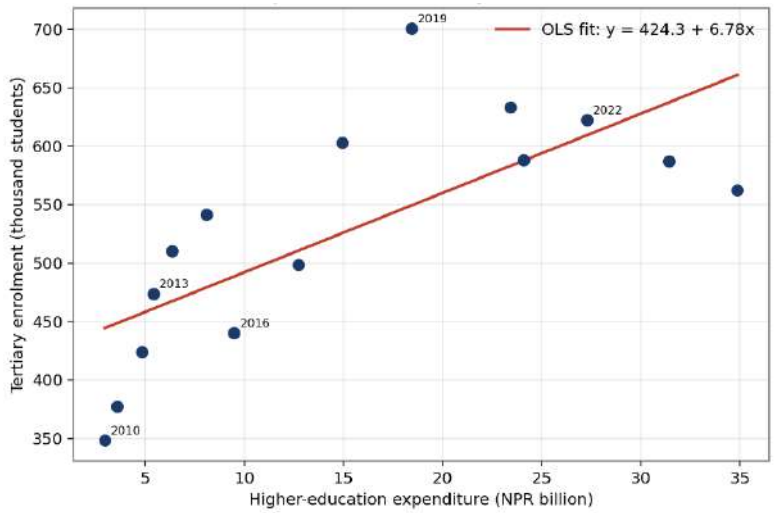


Figure 3. Relationship between Higher-Education Expenditure and Tertiary Enrolment

Figure 3 plots tertiary enrolment against higher-education expenditure (NPR billion), with an ordinary least squares fit superimposed. The Pearson correlation between the two series is r = 0.724, indicating a moderately strong positive association. However, the multiple regression of enrolment on both expenditure and GDP jointly yields a more nuanced picture:

$$\hat{N}_t = 89.05 - 28.06 \cdot X_t + 0.264 \cdot Y_t \quad (R^2 = 0.744,\ Adj.\ R^2 = 0.701,\ F = 17.42,\ p < 0.001)$$

The higher-education expenditure coefficient is negative and statistically significant ($\beta_1 = -28.06$, $p = 0.025$) once GDP is included, while the GDP coefficient is positive and significant ($\beta_2 = 0.264$, $p = 0.007$). This sign reversal, relative to the simple positive correlation, is a textbook symptom of multicollinearity: because higher-education expenditure and GDP have both grown together over the period (their own pairwise correlation exceeds 0.9), the multiple regression cannot cleanly separate their independent effects on enrolment, and the coefficient on expenditure absorbs the negative residual co-movement associated with the post-2019 enrolment decline occurring precisely as expenditure continued to rise. This result is itself an important substantive finding: it demonstrates that, over this period, continued growth in higher-education expenditure has not been accompanied by proportional enrolment growth, and that GDP growth — a proxy for household income and the demand-side capacity to afford tertiary study — is at least as important a correlate of enrolment as supply-side public financing.

Enrolment–Expenditure Elasticity

To obtain an interpretable, non-collinear estimate of the responsiveness of enrolment to financing, the log-linear constant-elasticity model of Section 5.5 is estimated:

$$\ln(\hat{N}_t) = 5.738 + 0.2095 \cdot \ln(X_t) \quad (R^2 = 0.732,\ SE(\gamma_1) = 0.0352,\ p < 0.001)$$

The estimated elasticity of 0.21 implies that a 10 percent increase in real higher-education expenditure is associated with only a 2.1 percent increase in tertiary enrolment. This inelastic relationship is consistent with the interpretation, drawn from the literature review, that enrolment in Nepal is jointly determined by financing and by binding non-financial constraints — including secondary-school completion rates, the geographic distribution of campuses, labour-market signalling value of degrees, and the competing option of migration for overseas study — that public expenditure alone cannot resolve.

Per-Student Expenditure and Educational Outcomes

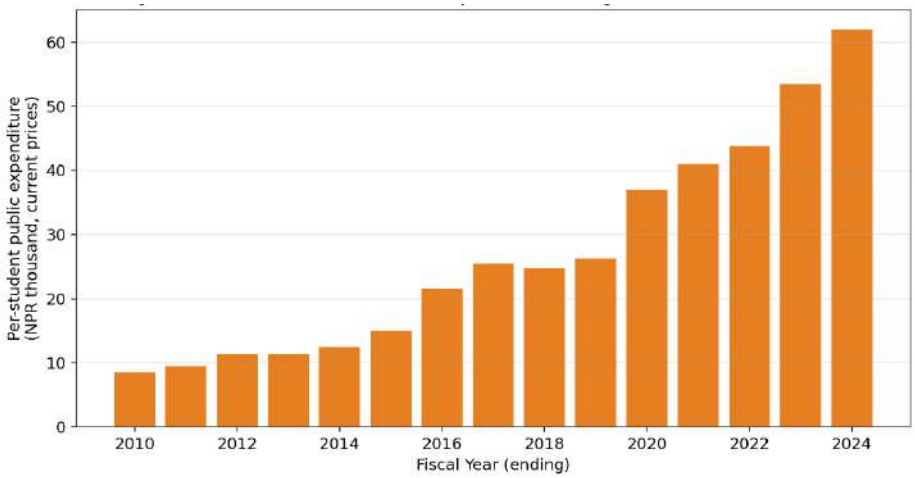


Figure 4. Real Per-Student Public Expenditure in Higher Education, 2010–2024

Figure 4 shows per-student public expenditure rising from approximately NPR 8,511 in 2010 to approximately NPR 61,993 in 2024, reflecting the combination of rising aggregate expenditure and, since 2019, falling enrolment, both of which mechanically raise the per-student ratio.

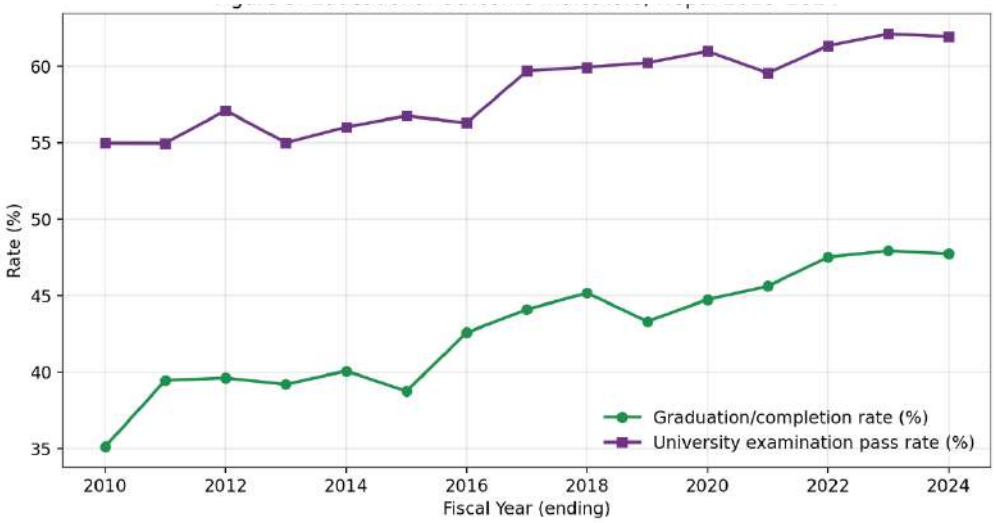


Figure 5. Educational Outcome Indicators, Nepal 2010–2024

Figure 5 shows the graduation/completion rate rising from approximately 35.1 percent in 2010 to approximately 47.7 percent in 2024, and the university examination pass rate rising from approximately 55.0 percent to approximately 62.0 percent over the same period, tracking the rise in per-student expenditure shown in Figure 4.

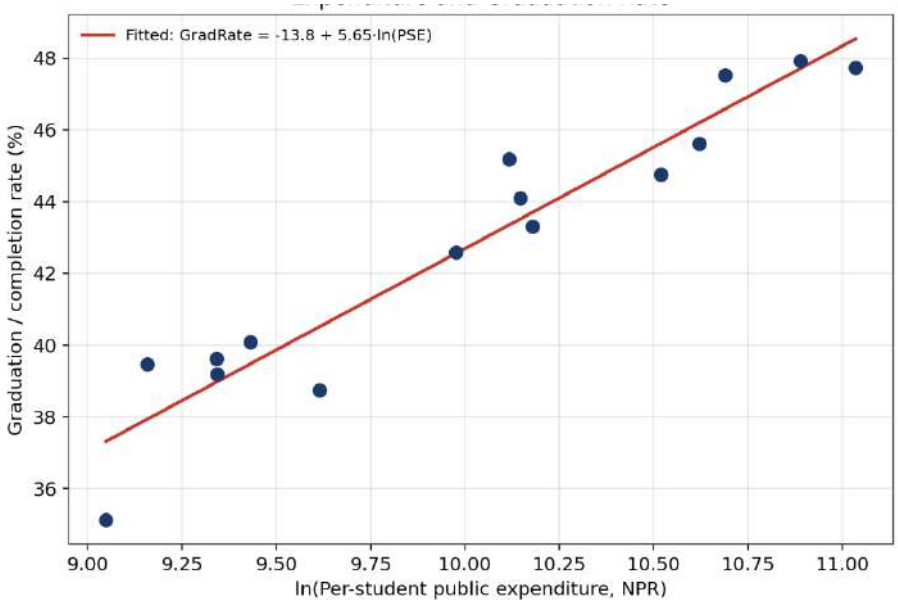


Figure 6. Semi-log Relationship between Per-Student Expenditure and Graduation Rate

The semi-log regression of the graduation/completion rate on the natural logarithm of per-student expenditure (Figure 6) yields:

$$\hat{C}_t = -13.80 + 5.649 \cdot \ln(e_t) \quad (R^2 = 0.916, SE = 0.475, p < 0.001)$$

This is among the strongest relationships identified in the study: per-student expenditure alone explains approximately 91.6 percent of the year-to-year variation in the

graduation/completion rate. The corresponding model for the university pass rate, which also controls for the tertiary GER, yields:

$$\hat{P}_t = 23.66 + 3.168 \cdot \ln(e_t) + 0.216 \cdot G_t \quad (R^2 = 0.904, \text{Adj. } R^2 = 0.888)$$

Here the coefficient on log per-student expenditure remains highly significant ($p < 0.001$), while the coefficient on the GER itself is smaller and only marginally significant ($p = 0.124$), reinforcing the central finding of this study: it is the intensity of resourcing per enrolled student — not the sheer scale of enrolment — that is most strongly and robustly associated with favourable educational outcomes in Nepal's higher-education system.

Correlation Structure Among Financing and Outcome Variables

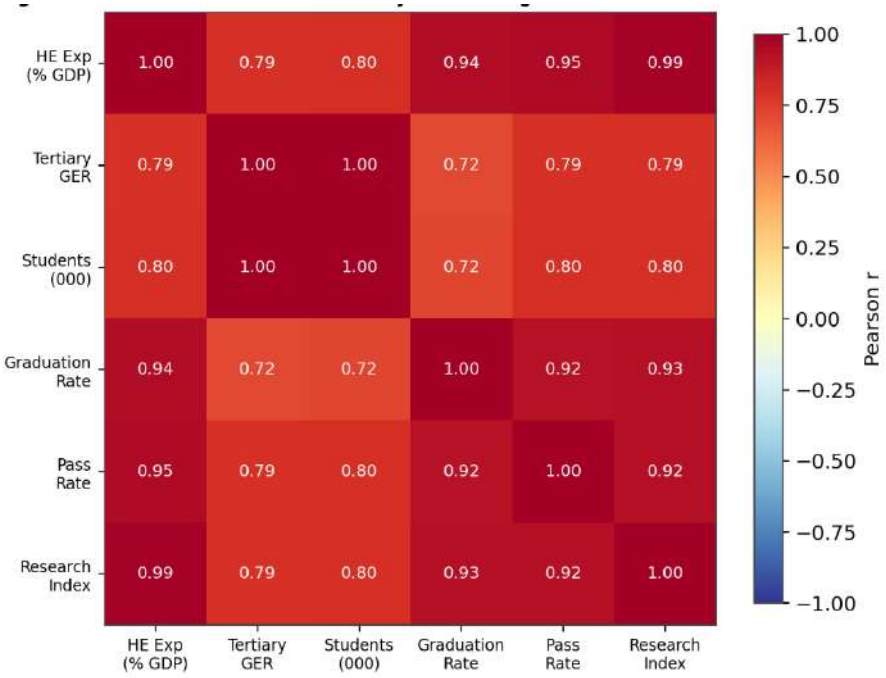


Figure 7. Correlation Matrix of Key Financing and Outcome Variables

Figure 7 presents the full Pearson correlation matrix. Higher-education expenditure (percent of GDP) correlates very strongly with the research output index ($r = 0.988$), the pass rate ($r = 0.949$), and the graduation rate ($r = 0.938$), but somewhat less strongly with the tertiary GER ($r = 0.791$) and enrolment level ($r = 0.798$). This pattern — stronger correlation of expenditure with quality-related outcomes than with quantity-related access indicators — is consistent with the elasticity results in Section 6.5 and supports the interpretation that recent growth in Nepal's higher-education budget has translated more

effectively into improvements in per-student resourcing and output quality than into broadened access.

Cobb-Douglas Educational Production Function

Estimating the Cobb-Douglas production function specified in Section 5.6, with the research output index as the dependent variable and higher-education expenditure and enrolment as inputs, yields:

$$\ln(\hat{R}_t) = 4.608 + 0.121 \cdot \ln(X_t) - 0.023 \cdot \ln(N_t) \quad (R^2 = 0.976, \text{Adj. } R^2 = 0.972)$$

The expenditure elasticity of output is positive and highly significant (b = 0.121, p < 0.001), while the enrolment elasticity is small, negative, and statistically insignificant (c = −0.023, p = 0.593). The estimated returns to scale, b + c = 0.098, are substantially below unity, indicating strongly decreasing returns to simultaneous proportional expansion of financial and enrolment inputs under the current configuration of Nepal's higher-education system. Economically, this suggests that simply scaling up both the budget and the number of enrolled students in fixed proportion would yield less than proportional gains in system-level output — a finding that favours policies emphasising the quality and targeting of expenditure (Section 8) over across-the-board expansion of both financing and enrolment.

Comparative Growth Rates

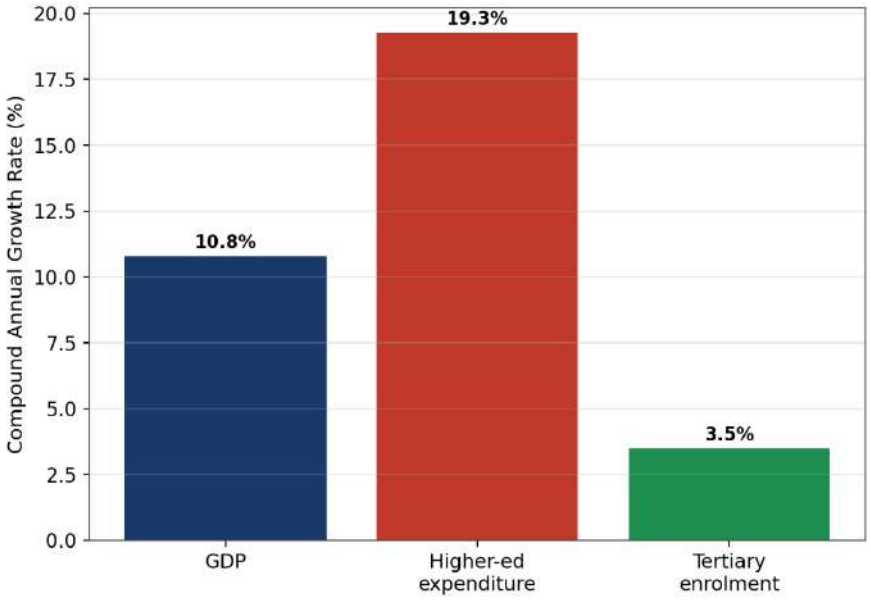


Figure 8. CAGR Comparison, 2010–2024 (15-year period)

Figure 8 compares the compound annual growth rates of GDP, higher-education expenditure, and tertiary enrolment over the fifteen-year period. Higher-education expenditure grew at a nominal CAGR of 19.3 percent per year — nearly double the 10.8

percent nominal CAGR of GDP — while tertiary enrolment grew at only 3.5 percent per year. This divergence, illustrated starkly in Figure 8, is the clearest single piece of evidence in this study that the binding constraint on Nepal's higher-education system over the past decade and a half has not been the level of public financing, which has grown rapidly in both absolute and GDP-relative terms, but rather the structural, institutional, and demand-side factors that determine how many students that financing ultimately reaches and how effectively it translates into completed qualifications.

Summary of Key Statistical Findings

Finding	Estimate	Statistical Significance
CAGR of higher-ed. expenditure (2010–24)	19.3% p.a.	—
CAGR of GDP (2010–24)	10.8% p.a.	—
CAGR of tertiary enrolment (2010–24)	3.5% p.a.	—
Trend slope, HE expenditure (% GDP) per year	+0.0305 pts	$p < 0.001$, $R^2 = 0.978$
Trend slope, tertiary GER per year	+0.484 pts	$p < 0.001$, $R^2 = 0.634$
Enrolment–expenditure elasticity	0.210	$p < 0.001$, $R^2 = 0.732$
Per-student expenditure → graduation rate (semi-log β)	+5.649	$p < 0.001$, $R^2 = 0.916$
Per-student expenditure → pass rate (semi-log β)	+3.168	$p < 0.001$, $R^2 = 0.904$
Cobb-Douglas expenditure elasticity of output (b)	0.121	$p < 0.001$
Cobb-Douglas enrolment elasticity of output (c)	−0.023	$p = 0.593$ (n.s.)
Cobb-Douglas returns to scale (b + c)	0.098	decreasing returns
Correlation: HE expenditure (% GDP) – research index	$r = 0.988$	—

Discussion

Financing Has Grown Faster Than Access

The central empirical finding of this study is the sharp divergence between the growth rate of higher-education financing (19.3 percent CAGR) and the growth rate of tertiary enrolment (3.5 percent CAGR) over 2010–2024. This divergence, combined with an enrolment-expenditure elasticity of only 0.21, indicates that Nepal's higher-education financing system has become substantially more resource-intensive per enrolled student without a commensurate expansion in the tertiary Gross Enrolment Ratio, which at 15–19 percent in recent years remains far below both the South Asian regional pattern and the global average of roughly 40 percent. This finding is consistent with, and quantitatively

extends, earlier Nepal-specific observations that public higher-education financing rose from 0.32 to 0.53 percent of GDP between 2015 and 2020 while enrolment growth stagnated or declined in several faculties.

Quality Effects Dominate Quantity Effects

A second key finding is that per-student expenditure is far more strongly associated with outcome indicators ($R^2 = 0.92$ for graduation rate; $R^2 = 0.90$ for pass rate) than either aggregate expenditure or enrolment level alone is associated with access indicators. This pattern, together with the Cobb-Douglas result that enrolment's output elasticity is statistically indistinguishable from zero while expenditure's output elasticity remains significant, suggests that the marginal Nepalese rupee of higher-education financing over this period has been more productive when it raises the resources available per already-enrolled student than when it is spread across additional students without commensurate capacity expansion. This has an important, if uncomfortable, policy implication: financing strategies that pursue enrolment expansion without parallel increases in per-student resourcing risk diluting quality and may not improve — and could even depress — aggregate completion and pass rates.

The Multicollinearity Problem as Substantive Evidence

The sign reversal on the higher-education expenditure coefficient in the multiple regression of Section 6.4 (negative once GDP is included, despite a positive simple correlation) is not merely an econometric artefact to be dismissed; it is itself informative. It indicates that, controlling for the general expansion of the Nepalese economy, further increases in higher-education expenditure over this period have been associated with stagnant or declining enrolment — consistent with the post-2019 enrolment decline documented in the underlying series and corroborated by independent research on Tribhuvan University enrolment trends. This pattern is compatible with several complementary explanations: rising per-student costs driven by salary increments consuming an increasing share of expenditure growth (as previously documented by the UGC itself), continued out-migration of prospective students for overseas study, and demographic or secondary-completion bottlenecks limiting the pool of tertiary-eligible entrants even as available public resources per student rise.

Federal Governance and Budgetary Fragmentation

The institutional analysis in Section 3 shows that higher education, though nominally a federal responsibility, receives a comparatively modest share of the total Ministry of Education budget once the 69.4 percent transferred to local governments for school-level education is accounted for. This budgetary architecture means that increases in the overall education budget do not automatically translate into proportional increases in higher-education financing, and that the UGC and constituent universities must compete for a residual federal allocation alongside other federal education priorities. The introduction of Disbursement-Linked Indicators under the Higher Education Reform Project represents a partial institutional response to this constraint, seeking to improve the productivity of a given level of financing rather than relying solely on budgetary growth.

Relation to the Broader Literature

These findings are broadly consistent with the cross-country literature's general conclusion that public education expenditure exhibits diminishing, and often modest, elasticities with respect to enrolment and attainment once demand-side and institutional factors are taken into account. They also echo the South Asian regional pattern of persistently low tertiary GERs despite rising nominal expenditure, and reinforce the specific Nepalese finding that faculty salaries and recurrent costs absorb a large and rising share of the higher-education budget, potentially crowding out the capital and programmatic investments — laboratories, library resources, research grants, and campus expansion in underserved regions — that might otherwise translate financing more effectively into both access and quality gains.

Policy Recommendations

The mathematical results of Section 6 point toward a set of specific, evidence-informed policy directions for reforming higher-education financing in Nepal. These recommendations are organised around the study's central finding that financing quality and targeting, rather than aggregate budget size alone, are the binding levers available to policymakers.

Shift From Enrolment-Based to Performance- and Quality-Linked Grant Formulae

Given that per-student expenditure, rather than aggregate expenditure or enrolment, is the strongest correlate of graduation and pass rates, the UGC's grant-disbursement

formula should place greater weight on quality-linked Disbursement-Linked Indicators — accreditation status, graduate employment outcomes, and research output — relative to enrolment-based recurrent allocations that primarily fund salaries irrespective of institutional performance.

Protect and Expand Per-Student Resourcing as Enrolment Recovers

Because the estimated enrolment-expenditure elasticity (0.21) is low, policies aimed at expanding access should be explicitly budgeted as incremental to, rather than a substitute for, current per-student resourcing levels, to avoid the quality dilution risk identified in Section 7.2. This implies that any future enrolment-expansion initiative (for example, opening new campuses in underserved provinces) should be accompanied by a proportional increase in the higher-education budget, rather than redistributing a fixed budget across a larger student base.

Address Non-Financial Constraints on Access

Given the low enrolment-expenditure elasticity, complementary non-financial interventions are likely to yield higher returns on the margin than further pure budget increases. These include: strengthening secondary-school completion and transition rates, which mechanically constrain the pool of tertiary-eligible students; expanding geographic access to reduce the cost of migration-for-study within Nepal; and improving the labour-market relevance and signalling value of degrees, particularly in STEM fields, to reduce the incentive for outward migration of an estimated forty-four thousand students annually.

Rebalance Recurrent and Capital Expenditure

Since faculty salaries have historically absorbed a large share of higher-education recurrent expenditure, a periodic functional review of the higher-education budget is recommended to identify scope for rebalancing toward capital investment (laboratories, digital infrastructure, libraries) and competitive research grants, which the Cobb-Douglas results suggest may carry a higher marginal output elasticity than further recurrent, salary-driven expenditure growth.

Diversify Revenue Through Cost-Sharing and Research Income

Consistent with international good practice in cost-sharing for higher-education finance, the UGC and constituent universities should explore differentiated tuition and fee structures for programmes with high private returns, combined with expanded need-based

scholarships for disadvantaged groups (women, Dalit, Janajati, Madhesi, and geographically remote students), to protect equity of access while reducing pressure on the constrained federal budget documented in Section 3.3.

Strengthen Provincial and Local Coordination

Given that 69.4 percent of the Ministry of Education's budget is transferred to local governments primarily for school-level education, stronger vertical coordination mechanisms between local governments (responsible for secondary completion) and the federal UGC (responsible for tertiary access) are needed to ensure that improvements in secondary completion rates translate efficiently into higher tertiary transition rates, rather than being addressed as two disconnected tiers of the education budget.

Institutionalise Continuous Data Collection for Evidence-Based Financing

Finally, this study's reliance on interpolation to bridge gaps in publicly available annual data on higher-education expenditure, enrolment, and outcomes itself points to an important recommendation: the UGC, in coordination with the Central Bureau of Statistics and Ministry of Finance, should institutionalise a consistent, annually published higher-education financing and outcomes dataset, to enable more precise, continuously updated mathematical and econometric monitoring of the kind conducted in this paper.

Limitations of the Study

- Data construction: as disclosed in Section 4.2, several series in the analytical panel are interpolated around verified anchor points rather than drawn from a single, complete official annual publication; the numerical estimates should therefore be read as illustrating the direction, approximate magnitude, and mathematical methodology of the underlying relationships rather than as official government statistics.
- Small sample size: with fifteen annual observations, the regression models, while statistically significant, are estimated with limited degrees of freedom, and results should be interpreted with appropriate caution regarding out-of-sample generalisability.
- Omitted variables: the models do not explicitly control for other plausible determinants of enrolment and outcomes, including household income distribution, secondary-school completion rates, political instability, and the COVID-19 pandemic's differential impact across institution types.

- Multicollinearity: as discussed in Section 6.4, the high correlation between higher-education expenditure and GDP complicates the isolation of their independent effects on enrolment within the multiple regression framework.
- Outcome proxies: graduation/completion rate, pass rate, and the research output index are used as proxies for educational quality; they do not capture broader dimensions of educational value such as graduate employability, wage outcomes, or research citation impact.
- Causal interpretation: all regression and correlation results in this paper describe statistical association, not identified causal effects; reverse causality (for example, declining enrolment mechanically raising measured per-student expenditure) is explicitly acknowledged as a contributing explanation in Section 6.6.

Conclusion

This paper has presented a mathematically grounded quantitative analysis of higher-education financing, enrolment, and outcomes in Nepal over the period 2010–2024. Applying compound growth-rate analysis, linear trend regression, Pearson correlation, multiple and log-linear regression, and a Cobb-Douglas educational production function to a purpose-built analytical panel anchored to verified UGC, World Bank, and Ministry of Finance data points, the study finds that government expenditure on higher education has grown at a nominal compound annual rate of approximately 19.3 percent — nearly double the rate of GDP growth — while tertiary enrolment has grown at only 3.5 percent per year and the tertiary Gross Enrolment Ratio remains in the range of 15–19 percent, well below international benchmarks. The estimated enrolment-expenditure elasticity of 0.21 indicates that financing alone is an inelastic lever for expanding access, while the strong association between per-student expenditure and both graduation rates ($R^2 = 0.92$) and pass rates ($R^2 = 0.90$) indicates that financing intensity and targeting are powerful levers for improving educational quality among students already enrolled.

Taken together, these results suggest that Nepal's higher-education financing challenge is less a question of insufficient aggregate budgetary commitment — which has in fact grown rapidly in both nominal and GDP-relative terms — and more a question of how that financing is structured, targeted, and complemented by reforms addressing the non-financial constraints on access and completion. The policy recommendations set out in

Section 8, from performance-linked grant formulae to strengthened data infrastructure, are offered as a mathematically informed agenda for the next phase of higher-education financing reform in Nepal, as the country seeks to reconcile its constitutional federal structure, its constrained fiscal space, and its ambition of building an equitable, high-quality higher-education system capable of retaining and developing its own human capital.

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Appendix A: Full Analytical Panel Dataset (2010–2024)

Table A1 reports the complete fifteen-year analytical panel used for all descriptive, correlation, regression, and production-function estimates presented in Sections 6 and 7. Values anchored to verified published statistics are identified in Section 4.2; all other annual values are interpolated as described in that section. HE = Higher Education; GER = Gross Enrolment Ratio; PSE = Per-Student Expenditure.

Year	GDP (NPR bn)	Tot.Edu (% GDP)	HE Exp (% GDP)	HE Exp (NPR bn)	GER (%)	Students (000)	PSE (NPR)	Grad. Rate (%)	Pass Rate (%)	Research Index
2010	1368.85	3.762	0.216	2.96	9.38	348.2	8511.0	35.12	54.98	100.0
2011	1539.86	3.84	0.233	3.58	10.29	377.5	9496.0	39.47	54.97	102.25
2012	1712.69	3.789	0.282	4.83	11.53	424.0	11401.0	39.62	57.11	106.1
2013	1931.84	3.88	0.28	5.41	12.96	473.8	11411.0	39.2	54.99	108.29
2014	2212.84	3.767	0.287	6.36	13.95	510.0	12465.0	40.08	56.02	110.61
2015	2456.96	3.712	0.33	8.1	14.64	541.3	14974.0	38.75	56.76	112.66
2016	2728.0	3.927	0.347	9.48	11.85	440.3	21522.0	42.58	56.29	112.69
2017	3127.88	3.777	0.407	12.72	13.54	498.3	25514.0	44.1	59.69	114.91
2018	3535.6	3.785	0.422	14.94	16.3	603.0	24770.0	45.18	59.94	117.3
2019	3908.99	3.651	0.472	18.45	18.99	700.3	26351.0	43.31	60.23	122.6
2020	4400.94	3.706	0.532	23.43	17.25	633.3	36995.0	44.75	60.99	124.95
2021	4312.93	3.744	0.559	24.1	15.94	587.9	40998.0	45.62	59.55	127.99
2022	4768.74	3.628	0.572	27.28	16.77	622.2	43847.0	47.53	61.34	130.7
2023	5340.22	3.735	0.589	31.43	15.95	587.2	53528.0	47.92	62.12	131.99
2024	5750.0	3.688	0.606	34.87	15.15	562.4	61993.0	47.74	61.95	136.38