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Modeling the Production Function of General Higher Education in Rajasthan: An ARDL Approach

Sheena Choudhary[1]*, Prof. J N Sharma[2]

[1]Research Scholar, IIS Deemed to be University, Jaipur
[2]Professor, IIS Deemed to be University, Jaipur

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***Corresponding author:** Sheena Choudhary
Research Scholar, IIS Deemed to be University, Jaipur

Abstract

General higher education plays a critical role in human capital formation, economic development, and social mobility. In India, state-level higher education systems display significant variation in institutional capacity, enrollment growth, and resource allocation. Rajasthan has experienced rapid extension in general higher education institutions over the past few decades; however, the relationship between educational inputs and outputs remains deficiently studied. This study models the production function of general higher education in Rajasthan using the Autoregressive Distributed Lag (ARDL) approach. The study examines the impression of key inputs such as the number of institutions, faculty strength, government expenditure, and infrastructure capacity on educational output measured through student enrollment and graduates. The ARDL bounds testing framework is in work to analyze both short-run dynamics and long-run equilibrium relationships among variables. The findings points that faculty strength and government expenditure significantly power higher education output in the long run, while infrastructure capacity subscribe to short-run adjustments. The study finds that effective resource allocation and institutional strengthening are important to improve the productivity and efficiency of general higher education in Rajasthan.

Keywords: Higher Education, Production Function, ARDL Model, Human Capital, Rajasthan.

1. INTRODUCTION

Higher education is widely called as a fundamental driver of economic development and human capital formation. Universities and colleges provide to knowledge creation, skill development, and technological innovation. As economies increasingly rely on knowledge-based industries, the role of higher education institutions becomes even more critical.

General higher education, including disciplines such as arts, science, and commerce, provides a wide intellectual foundation and supports the development of analytical and crucial thinking skills. In India, higher education has extended significantly over the past three decades due to increasing demand, population growth, and policy steps goaled at improving access and equity.

Rajasthan, one of the largest states in India, has affirmed substantial growth in the number of universities and colleges offering general higher education programs. However, extension alone does not assert improved educational outcomes. Understanding how different educational inputs affect output is important for calculating the efficiency of higher education systems.

The concept of the education production function provides a useful framework for analyzing the relationship between educational inputs and outputs. The model distinguishes between inputs such as teachers, infrastructure, and financial resources and outcomes such as student enrollment, academic performance, or graduation rates. Economist Eric Hanushek introduced influential work on educational production functions, emphasizing the role of resources and institutional factors in determining educational outcomes.

This study applies the Autoregressive Distributed Lag (ARDL) model to estimate the production function of general higher education in Rajasthan. The ARDL approach is particularly useful for analyzing time-series data and capturing both short-run and long-run relationships among variables.

2. OBJECTIVES OF THE STUDY

The main objective of the study is to find the productivity of general higher education in Rajasthan using an econometric approach.

The objectives are:

1. To model the production function of general higher education in Rajasthan.
2. To identify the major determinants influencing the output of general higher education.
3. To examine the short-run and long-run relationships between educational inputs and outputs using the ARDL model.
4. To provide policy recommendations for improving the efficiency and productivity of general higher education institutions in Rajasthan.

3. REVIEW OF LITERATURE

Nelson and Hevert (1992) examined the impact of class size on economies of scale and marginal costs in higher education. A multiproduct trans log cost function is estimated using data from a single university. The results indicate that failure to control for class size may lead to biased estimates of economies of scale and relative marginal costs. It is founded that evidence of constant returns to scale for schools that expand output holding class size is constant and increasing returns to scale if class size is allowed to expand. And also found that the marginal cost of graduate students is to be 4.3 to 8.98 times that of undergraduates.

Harris and Kaine (1994) explored the relationship between individual productivity in research, as measured by an index of publications produced, and their preferences and perceptions about research-related issues. A sample of 134 Australian university economists were classified as low, average and high in respect of their publication performance using cluster analysis. Discriminant analysis was then used to see whether membership of these groups was associated with items representing individuals' preferred research approach, their involvement in a range of research-related activities, the things which they felt constrained their research and their perceptions of the benefits of their position which might be conducive to research. Results shows that there was a relationship between these items and group membership, and therefore productivity. Highly productive researchers made deliberate choices about the type of research undertook in order to enhance their career advancement; and were heavily involved in a number of areas of research activity; felt relatively few constraints on their research by comparison with low producers; and enjoyed the freedom and challenge of their positions. These results imply that research performance is more a function of individual motivation than resource support.

Lenton (2008) examined the cost of the increased provision of higher education courses within further education colleges in England. And believed that this to be the first attempt to fit a cost function specifically to the further education sector. Cost functions for a sample of 96 colleges over a 2-year period, from 2000 to 2002, are fitted using a panel data methodology as well as stochastic frontier analysis. Comparison and contrasted the findings with a sample of 959 US colleges. Total operating costs, as in the vast majority of empirical analyses of costs in higher education, are treated as the dependent variable. Findings indicates that most further education colleges are able to benefit from economies of scale. Results from both methodologies suggest the presence of product-specific economies of scale, substantial ray economies of scale and indicate that higher education classroom-based courses, such as business studies, as well as vocational courses display substantial economies of scope.

Johns J and Johnes G. (2009) estimated a multiproduct cost function for English higher education institutions by using a panel of data from recent years. The panel approach allows estimation by means of a random parameter stochastic frontier model which provides considerable new insights in that it allows the impact on costs of inter-institutional differences in the cost function itself to be distinguished from inter-institutional differences in efficiency. The approach used here therefore resembles in some respects the non-parametric methods of efficiency evaluation. Measures of average incremental cost of provision and returns to scale and scope also reported.

Quimbo and Sulabo (2014) analyzed the research productivity of selected higher education institutions by responding to the Commission on Higher Education's development plan of enhancing research culture among higher education institutions. It covered five state universities in the Philippines where a total of 377 randomly selected faculty members served as research participants. Path analysis shows that educational attainment, research benefits and incentive system are important predictors of both research self-efficacy and research productivity. Self-efficacy has also been found to be a significant determinant of productivity. Findings suggested a number of policy implications for institutions of higher learning including the need to have a strong faculty development program, enhanced research collaboration, improved research productivity, and good incentive system in order to promote and enhance the research culture in higher education institutions.

Agasisti (2016) analyzed the cost structure of the Italian higher education system for the decade between 2001 and 2011, by means of a stochastic trans log cost function. And suggested that the judgment about the optimal configuration of the sector is strongly dependent upon the policy priorities set by decision makers. When assuming that the universities' output is the number of students, scale economies are exhausted, and marginal costs are relatively low; when considering graduates as outputs instead, there is opportunity for increasing the scale of operations. In a sensible manner inefficiency affects production, especially when assuming that the target output is the number of graduates. Moreover, efficiency contributes to explaining a relevant portion of the productivity increases in the period. No significant scope economies between teaching and research emerge, suggesting that a higher degree of universities' specialization can be a direction for improving the sector's efficiency and productivity.

Titus (2016) provided an overview of the theoretical and conceptual underpinnings of stochastic frontier analysis (SFA) and its application to degree production efficiency in higher education. And discussed the theoretical background, conceptual basis, statistical properties, and application of different types of SFA models that are used to generate measures of production efficiency. True fixed-effects (TFE), true random-effects (TRE), random parameter (RP), and latent class (LC) are among the SFA models introduced and discussed. Using cross-sectional and panel data and various models, this chapter demonstrates how SFA can be employed to examine bachelor's degree productivity of master's comprehensive universities. Differences in estimates of the technical efficiency of degree production across TFE, TRE, RP, and LC models of SFA, with different distributional assumptions of technical efficiency are discussed. The chapter also provides an example of the utility of a SFA model and how it is used to rank institutions based on their technical efficiency of degree production. It concludes with recommendations for future applications of SFA models in higher education.

Martinez, Vazquez and Alberto (2018) analyzed the efficiency of Argentinean public universities and its determinants over a 10-year period (2004–2013). It is quantified that the effect on the efficiency scores of a set of institutional variables, i.e., policy decisions under the control of universities. Efficiency scores are determined on a first stage using nonparametric Data Envelopment Analysis and then second stage is conducted to study through parametric modelling. The results reveal the existence of a positive and significant effect on efficiency levels of those variables related to high-ranked professors and full-time positions, while those variables associated with budget allocation do not significantly affect the efficiency. Empirical findings help identifying the characteristics that explain differences in the efficiency of public universities, providing new elements in studying the higher education system in Argentina.

4. DATA, VARIABLES AND METHODOLOGY

This section introduces the data used in the analysis and provides a brief description of each variable and the sources of the data. The time-series data of Rajasthan for the period of 1981 to 2023. The data used in the study has all been sourced from the EPWRF. The dataset consists of the dependent variable which is Total enrollment of General education (TEGE), number of institutions of general education (INGE), Gross state domestic product (GSDP), male faculty in General education (MFGE), female faculty in General education (FFGE), pupil teacher ratio of General education (PTRGE)and per capita expenditure in General higher education (PCEGE).

Table 1: Variables – Description, Definition, Specification and Data Source

Variable	Description	Definition	Data Source	Specification
LNTEGE	Total enrollment of General Education	Total count of students registered in general educational programs	EPWRF	Dependent Variable
LNINGE	No. of Institutions of General Education	Total count of schools, colleges and universities that provide broad and non- specialized education to students.	Statistical abstract of Rajasthan	Independent Variable
LNGSDP	Goods state domestic product	total money value of all final goods and services produced within a state's geographical boundaries during a specific period, usually a year.	Statistical abstract of Rajasthan	Independent Variable
LNMFGE	Male Faculty in General Education	Male individuals who are part of the teaching and academic staff within the broad field of general educational institutions ranging from elementary/secondary schools to universities.	EPERF	Independent Variable
LNFFGE	Female Faculty in General Education	Female individuals who are part of the teaching and academic staff within the broad field of general educational institutions ranging from elementary/secondary schools to universities.	EPWRF	Independent Variable

Variable	Description	Definition	Data Source	Specification
LNPTRGE	Pupil Teacher Ratio of General Education	The average number of students per teacher at a specific educational level.	EPWRF	Independent Variable
LNPCEGE	Per Capita Expenditure in General Education	The average amount spent on each person in a given population on non-technical education during a specific period.	EPWRF	Independent Variable

RESEARCH METHODOLOGY

Different aspects of research tools applied in the study have been described as below:

Unit Root Test

For testing the stationarity of the series unit root tests have been applied. Augmented Dicky Fuller (ADF) and PP tests have been applied as the unit root tests. LNTEGNED, LNGSDP, LNMFGNED, LNFFGNED, LNPTRGNED and LNPCEGNED are the variables for which unit root tests have been applied.

Optimum Lag Length

Time series models consider lagged values of the dependent and independent variables so selection of optimum lg length becomes the essential part of the times series models. Many different criteria are available for deciding the optimum lag length in the analysis. This study uses LR: sequential modified LR test statistic (each test at 5% level), FPE: Final prediction error, AIC: Akaike information criterion, SC: Schwarz information criterion, HQ: Hannan- Quinn information criterion and decides the optimum lag length.

ARDL Model

As the choice of econometric modelling the ARDL model of Pesaran et al. (2001) has been employed. In comparison with other cointegration methods the ARDL cointegration approach has many advantages. Unlike other cointegration techniques, the ARDL does not impose a restrictive assumption that all the variables under study must be integrated of the same order.

In other words, the ARDL approach can be applied regardless of whether the underlying regressors are integrated of order I (1), order zero I (0) or are fractionally integrated. Secondly, the ARDL test is suitable even if the sample size is small while other cointegration techniques are sensitive to the size of the sample. Thirdly, the ARDL technique generally provides unbiased estimates of the long-run model and valid *t*-statistics even when some of the regressors are endogenous.

In formulating our ARDL empirical specifications, we firstly specify the model as below:

TEGE = f (INGE, GSDP, MFGE, FFGE, PTRGE, PCEGE) (1)

Above models can be respecified in the log linear form as below:

$\ln TEGE_t = \beta_0 + \beta_1 \ln INGE_t + \beta_2 \ln GSDP + \beta_3 \ln MFGE_t + \beta_4 \ln FFGE_t + \beta_5 \ln PTRGNE_t + \beta_6 \ln PCEGE_t + \mu_t$ (2)

where β_0, t and μ signify intercept, the time (in years) and stochastic error term respectively.

β_0 to β_6 are the parameters to be estimated.

The long run aspect of the ARDL model is expressed as given below:

$\Delta \ln TEGE_t = \alpha_0 + \delta_1 \ln TEGE_{t-1} + \delta_2 \ln INGE_{t-1} + \delta_3 \ln GSDP_{t-1} + \delta_4 \ln MFGE_{t-1} + \delta_5 \ln FFGE_{t-1} + \delta_6 \ln PTRGE_{t-1} + \delta 7 \ln PCEGE_{t-1} + \sum_{i=1}^{p-1} \theta_i \Delta \ln TEGE_{t-i} + \sum_{j=0}^{q_1-1} \beta_{1j} \Delta \ln INGE_{t-j} + \sum_{j=0}^{q_2-1} \beta_{2j} \Delta \ln GSDP_{t-j} + \sum_{j=0}^{q_3-1} \beta_{3j} \Delta \ln MFGE_{t-j} + \sum_{j=0}^{q_4-1} \beta_{4j} \Delta \ln FFGE_{t-j} + \sum_{j=0}^{q_5-1} \beta_{5j} \Delta \ln PTRGE_{t-j} + \sum qj=6-01\ \beta 6j \Delta \ln PCEGE_{t-j} + et$ (3)

Here, p, q_1, q_2, q_3, q_4, q_5, q_6 indicate the number of lags considered for log values of Total enrollment of General education, number of institutions of general education, Gross state domestic product, male faculty in General education, female faculty in General education, pupil teacher ratio of General education and per capita expenditure in General higher education respectively.

The short run aspect of the ARDL model is expressed as given below:

$\Delta \ln TEGE_t = \alpha_0 + \sum_{i=1}^{p-1} \theta_i \Delta \ln TEGE_{t-i} + \sum_{j=0}^{q_1-1} \beta_{1j} \Delta \ln INGE_{t-j} + \sum_{j=0}^{q_2-1} \beta_{2j} \Delta \ln GSDP_{t-j} + \sum_{j=0}^{q_3-1} \beta_{3j} \Delta \ln MFGE_{t-j} + \sum_{j=0}^{q_4-1} \beta_{4j} \Delta \ln FFGE_{t-j} + \sum_{j=0}^{q_5-1} \beta_{5j} \Delta \ln PTRGE_{t-j} + \sum_{j=0}^{q_6-1} \beta_{6j} \Delta \ln PCEGE_{t-j} + \gamma\, ECT_{t-1} + _t$ (4)

Where φ_i's are the short-run coefficients, βi's are the long-run regression coefficients and ECT's are the error correction terms which measure the speed of adjustment back to steady-state equilibrium in the face of external shocks to the economy. The error correction terms are assumed to lie within an interval (0, −1) although the coefficient can be allowed to be lie between −1 and −2 as an exceptional case. Incidentally, significant negative error correction terms indicate long-run causality from the regressor to the regress and variable. However, it is imperative that one tests for cointegration effect to his end, prior to estimating our

ARDL models the study uses the bounds test for cointegration effects which tests the joint null hypothesis as:
H0: β1=β2=…=βi =0
And this is tested against the alternative hypothesis of significant ARDL cointegration effects i.e.
H0: β1≠β2≠…≠βi≠0

With an F-statistic the test is tested which is compared to the non-standard critical bound's values reported in Pesaran *et al.,* (2001). The null hypothesis of no cointegration is rejected if the computed f statistic exceeds the critical upper bounds value. And the null hypothesis of no cointegration is not rejected if the computed φ-statistic falls below the critical lower bounds value. And the test is considered as being inconclusive if the computed F-statistic falls between the critical lower and upper bounds values.

To capture the objective of the study ARDL Co-integration Approach used. The study employed ARDL Co-integration analysis to explore the contribution of higher education development on economic growth. To estimate the short-run and the long-run analysis of this study ARDL method is used.

Diagnostic Tests

After estimated empirical ARDL model, on the estimated regressions the final stage of the empirical analysis is to perform diagnostic test. In particular, the Jarque-Bera test for residual normality, the Breusch-Godfrey LM test for serial correlation, the Breusch-Pagan-Godfrey test for heteroscedasticity as well as Ramsey's RESET test for specification error are conducted. To study the stability of the models the CUSUM and CUSUM of squares tests have been applied.

ANALYSIS OF RESULTS

Descriptive Statistics

Table 2: Displays information about descriptive statistics regarding the variables of the study

Variable	LNTEGE	LNPTRGE	LNPCEGE	LNMFGE	LNINGE	LNGSDP	LNFFGE
Mean	12.49616	3.685037	-1.143736	8.361930	6.142571	10.68285	7.743748
Median	12.41177	3.561108	-1.711925	8.356085	5.676754	10.95042	7.909480
Maximum	14.01359	4.906166	1.352231	8.530109	7.788626	14.12040	8.283241
Minimum	11.41850	2.926982	-4.511040	8.043342	4.828314	6.375025	6.736967
Std. Dev.	0.906804	0.682789	1.838599	0.115278	1.099494	2.516244	0.513425
Skewness	0.328584	0.552714	-0.027946	-0.722191	0.226152	-0.246042	-0.472554
Kurtosis	1.762262	2.004441	1.538377	3.418392	1.363726	1.657918	1.655876
JarqueBara	3.518595	3.965155	3.833208	4.051484	5.163533	3.660969	4.837320
Probability	0.172166	0.137714	0.147106	0.131896	0.075640	0.160336	0.089041
Observations	43	43	43	43	43	43	43

Table 2: Descriptive Statistics

It can be stated that all the variables are normally distributed. Other than female faculty in general education, male faculty in general education and per capita expenditure of general education and Gross state domestic product all the rest variables are positively skewed. All variables have positive coefficient of kurtosis, with male faculty in general education and pupil teacher ratio corresponding to a leptokurtic curve while all the other variables represent platykurtic curve.

CORRELATION MATRIX

Correlation coefficients existing between different pairs of the variables are displayed in Table 3 in a matrix form which states the degree of association among variables.

Table 3: Correlation Matrix

	lnTEGE	lnPTRGE	lnPCEGE	lnMFGE	lnINGE	lnGSDP	lnFFGE
lnTEGE	1						
lnPTRGE	0.992	1					
lnPCEGE	0.935	0.901	1				
lnMFGE	0.905	0.857	0.934	1			
lnINGE	0.971	0.953	0.958	0.896	1		
lnGSDP	0.962	0.925	0.960	0.947	0.958	1	
lnFFGE	0.922	0.870	0.932	0.927	0.923	0.981	1

Source: Calculated by author
Note: values in parenthesis are the prob. Values

Presence of a strong positive correlation coefficient can be easily noticed among the variables with the coefficient of correlation ranging approximately to 0.8 and 0.9 specifying high degree of positive association existing among all the variables. It makes the study interesting to carry out the time-series analysis further to check and understand in depth the long run dynamics of the relationship of the variables.

UNIT ROOT TEST

Table 4: ADF Test and PP Test Results for stationarity check

Variable	ADF				PP			
	Level		First differences		Level		First differences	
	Intercept	Trend & Intercept	Intercept	Trend & Intercept	Intercept	Trend & Intercept	Intercept	Trend & Intercept
LNTEGE	1.69111 (0.9995)	-3.3188 (0.0782)	-2.6443 (0.0932)	-2.5282 (0.3136)	0.9899 (0.9958)	-2.5682 (0.2960)	-4.016 (0.0033)	-4.2160 (0.0096)
LNINGE	0.0424 (0.9571)	-2.03 (0.5652)	-6.65 (0.000)	-6.62 (0.00)	0.07 (0.9599)	-2.03 (0.5652)	-6.65 (0.000)	-6.62 (0.000)
LNGSDP	-2.356 (0.1600)	0.2832 (0.9979)	-1.898 (0.3297)	-5.783 (0.0001)	-2.0198 (0.2775)	0.3016 (0.9980)	-5.556 (0.000)	-5.902 (0.0001)
LNMFGE	-3.983 (0.0035)	-5.60 (0.0002)	-5.35 (0.0001)	-5.88 (0.0001)	-3.43 (0.0153)	-6.34 (0.000)	-5.45 (0.000)	-6.06 (0.0001)
LNFFGE	-2.60 (0.1007)	-0.55 (0.9768)	-4.30 (0.0015)	-3.74 (0.0312)	-2.38 (0.1527)	-0.65 (0.9702)	-4.95 (0.0002)	-5.56 (0.0002)
LNPTRGE	2.11 (0.9999)	-2.44 (0.3517)	-4.25 (0.0017)	-4.88 (0.0016)	1.29 (0.9982)	-3.06 (0.1285)	-4.36 (0.0012)	-5.10 (0.0009)
LNPCEGE	-1.29 (0.6234)	-2.95 (0.1553)	-7.51 (0.000)	7.44 (0.000)	-1.27 (0.6320)	-2.95 (0.1553)	-8.41 (0.000)	-8.38 (0.000)

Source: Calculated by author

Note: values in parenthesis are the prob. Values

The results of ADF and PP test as mentioned in Table 4 state that all the variables are found to be nonstationary at level except male faculty in general education which is stationary at level. All the rest variables are found to be stationary at first difference i.e. no problem of unit root exist at first difference for these variables.

As the order of integration of all the variables is a mix of I(0) and I(1), hence it is feasible to make use of ARDL approach for the time-series analysis.

OPTIMAL LAG LENGTH

The decision regarding the appropriate number of lags to be consider has to be taken before ARDL model estimation. The outcomes of the different criteria are displayed in Table 5.

Table 5: Lag Length Selection Criterion

Lag	LogL	LR	FPE	AIC	SC	HQ
0	213.8379	NA	7.61e-14	-10.34189	-10.04634	-10.23503
1	552.6889	542.1616	4.02e-20	-24.83444	-22.47001*	-23.97954*
2	614.8674	77.72314*	2.62e-20*	-25.49337*	-21.06006	-23.89042
3	663.2655	43.55834	5.37e-20*	-25.46328	-18.96109	-23.11229

Source: Calculated by author

Note: values in parenthesis are the prob. Values. * indicates lag order selected by the respective criterions.

Since four of the six given criteria results, consider 2 as the suitable lag length, hence for the current analysis, optimal lag length of 2 is considered for the study.

Model Selection

The order of the ARDL model selected for model estimation is (1,1,1,1,2,1,2). The decision regarding selection of this order is based on Automatic Lag Selection as per which among all the possible models, the model having least AIC is considered to be the most appropriate model. Figure 1, displays top 20 models having lesser values of AIC out of all the total models.

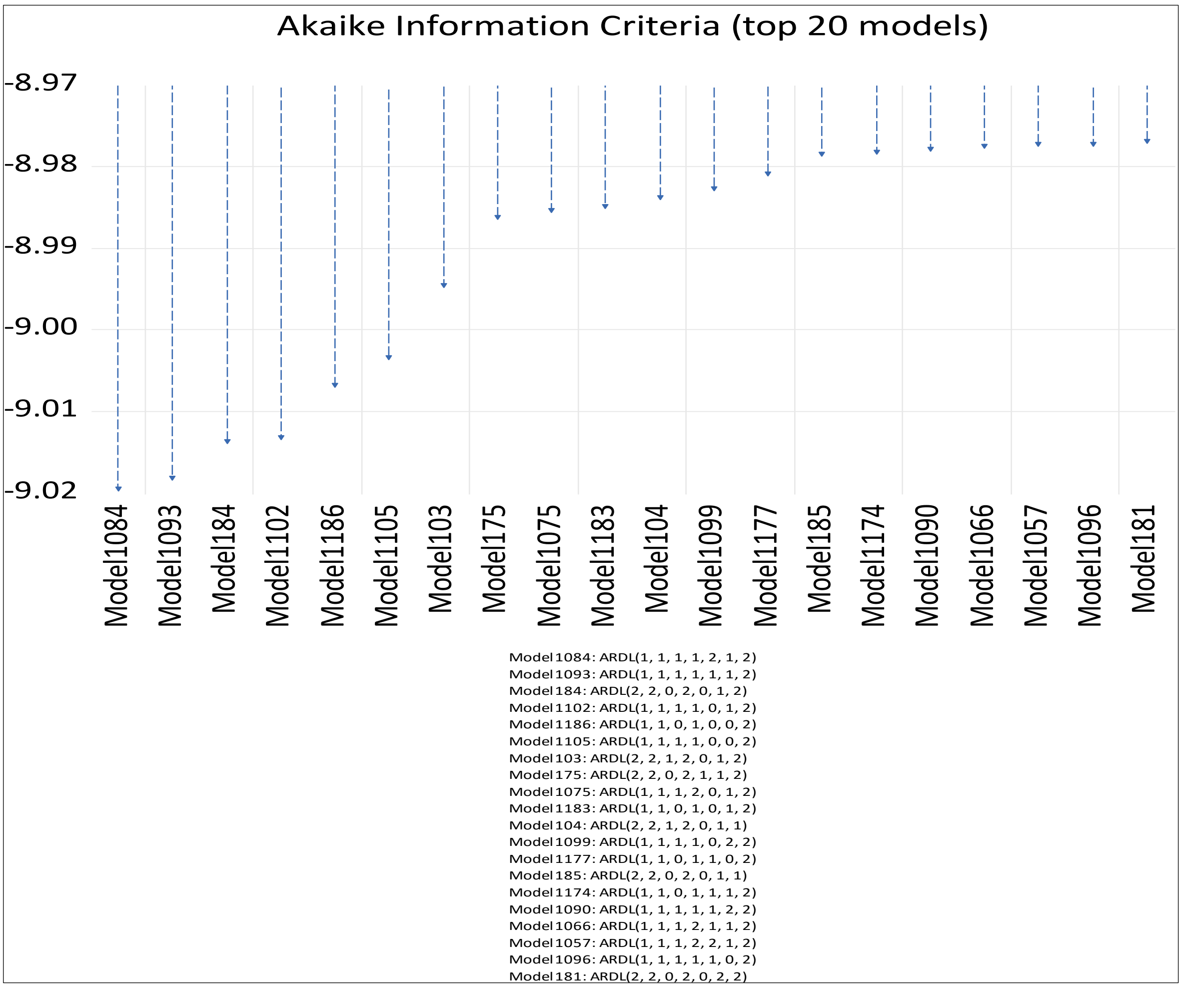


Figure 1: ARDL Model Selection Graph

ARDL BOUNDS TEST

ARDL Bounds test has been applied to inspect the presence or absence of a long-run relationship between expenditure on general education and all the independent variables. Table 6 contains the result of the test.

Table 6: Results of Bounds Test

Test Statistic	Value	K
F-Statistic	6.863986	6
Critical Value Bound		
Significance	I(0)	I(1)
10%	2.12	3.23
5%	2.45	3.61
2.5%	2.75	3.99
1%	3.15	4.43

Source: Calculated by author

Note: values in parenthesis are the prob. Values

The null hypothesis of no long run relationship among the variables is rejected as the magnitude of F statistic (6.863986) surpasses the upper bound values at 1%, 2.5%, 5% and 10% level of significance. It confirms that the concerned independent variables are cointegrated with the expenditure on general higher education in the long run.

ARDL LONG RUN FORM ESTIMATION

Once being ensured of the long run association among the concerned variables, the long and short run dynamics of the relationship are studied. Conditional error correction regression has been used to estimate the long run coefficients of the relationship which reflect the direction and the degree of association the independent variables have with economic growth of India. Table 7 possesses the outcomes of the ARDL long run model.

Table 7: Long Run Coefficient

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.072448	0.242549	-0.298693	0.7676
lnPTRGE	0.999561	0.005121	195.1930	0.0000
lnPCEGE	-0.000489	0.002673	-0.182781	0.8564
lnMFGE	0.736693	0.049814	14.78889	0.0000
lnINGE	0.024535	0.005174	4.742388	0.0001
lnGSDP	-0.018395	0.004254	-4.324258	0.0002
lnFFGE	0.365191	0.014224	25.67386	0.0000

Source: Calculated by author
Note: values in parenthesis are the prob. Values

It can be noticed evidently from the Table-7 that the long run coefficients of female faculty, male faculty and pupil teacher ratio of general education has statistically significant at 5% level of significance. All these variables possess positive relationship with enrollment in general education. Number of institutes have positive but insignificant association with enrollment in general education. The long run relationship existing among the variables is presented in the following equation:

$lnTEGE_t$ = -0.072448 - ($0.9996*lnPTRGE_{t-1}$ - $0.0005*lnPCEGE_{t-1}$ + $0.7367*lnMFGE_{t-1}$ + $0.0245*lnINGE$ - $0.0184*lnGSDP_{t-1}$ + $0.3652lnFFGE_{t-1}$) (5)

ERROR CORRECTION MODEL ESTIMATION

The short run dynamics of the estimated model is checked by the ECM. The final results of the same are given in Table 8.

Table 8: Results of ECM

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.072448	0.009448	-7.668060	0.000
D(lnPTRGE)	0.997645	0.006330	157.6005	0.000
D(lnPCEGE)	0.001928	0.000842	2.288705	0.0308
D(lnMFGE)	0.689586	0.023557	29.27255	0.000
D(lnINGE)	0.007046	0.002381	2.959553	0.0067
D(lnGSDP)	-0.001166	0.003570	-0.326476	0.7468
D(lnFFGE)	0.324865	0.007299	44.50835	0.000
CointEq(-1)*	-0.558777	0.072392	-7.718770	0.000
R-squared - 0.998931				
Adjusted R squared - 0.998620 F-statistic - 3218.067 Prob (F- statistic) - 0.000 Durbin-Watson stat 2.044643				

Source: Calculated by author
Note: values in parenthesis are the prob. Values

The negative and significant value of the Error Correction Term ensures the restoration of the long run equilibrium with the speed of adjustment being around 24.1%. In the short run, all the independent variables seem to be quite effective in influencing enrollment in general education which is reflected by the positive and statistically significant coefficient of these variables.

Diagnostic Tests

To test the strength and robustness of the estimated model, four diagnostic tests have been performed, results of these tests are mentioned in the Table-9.

Table 9

Test	Test Statistic Value	Probability	Results
Jarque- Bera test (normality test)	JB = 0.567318	0.753023	Residuals are normally distributed
Breusch-Godfrey Serial Correlation LM test	F = 0.172602	0.8426	No serial correlation exists
Breusch-Pagan-Godfrey (Heteroskedasticity)	F = 2.575065	0.0577	No Presence of Heteroscedasticity
Ramsey RESET Test	F = 0.923553	0.3649	No specification error

Source: Calculated by author
Note: values in parenthesis are the prob. Values

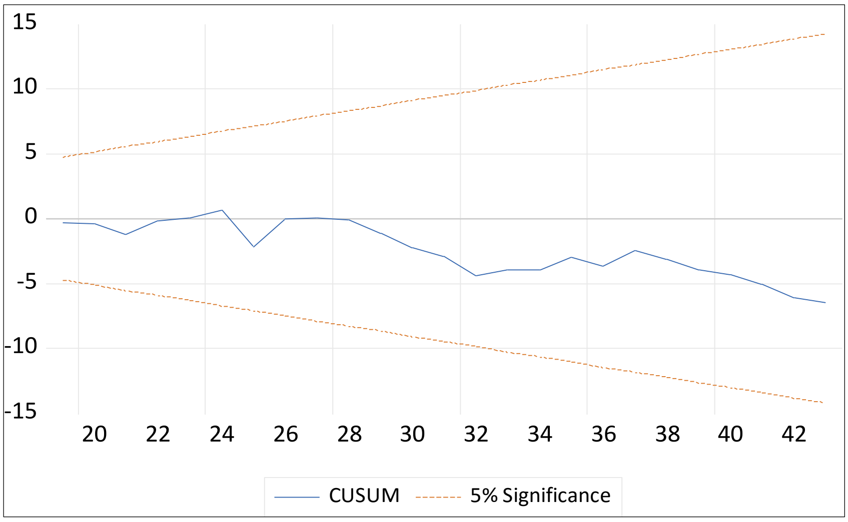
Jarque- Bera Normality test of distribution shows the null hypotheses states that the residuals are normally distributed at 5% level of significance. As the p-value exceeds 0.05, the null hypothesis is accepted here.

Breusch-Godfrey Serial Correlation LM test shows the null hypothesis states that there is no serial correlation. The probability value is greater than 0.05, that means the null hypothesis cannot be rejected, which shows the absence of serial correlation.

Also, Breusch-Pagan-Godfrey (Heteroskedasticity) shows the null hypothesis assumes homoscedasticity (constant variance) that is there is no presence of heteroscedasticity as the probability value is greater than 0.05.

The p-value for Ramsey RESET test is also found to be greater than 0.05 confirming that there is no specification bias in the model or that the model is free of specification errors. Here, the null hypothesis states that the model is correctly specified.

To check if the ARDL model estimated is stable or not, CUSUM and CUSUMSQ tests have been utilized that have been displayed in Figure 5.



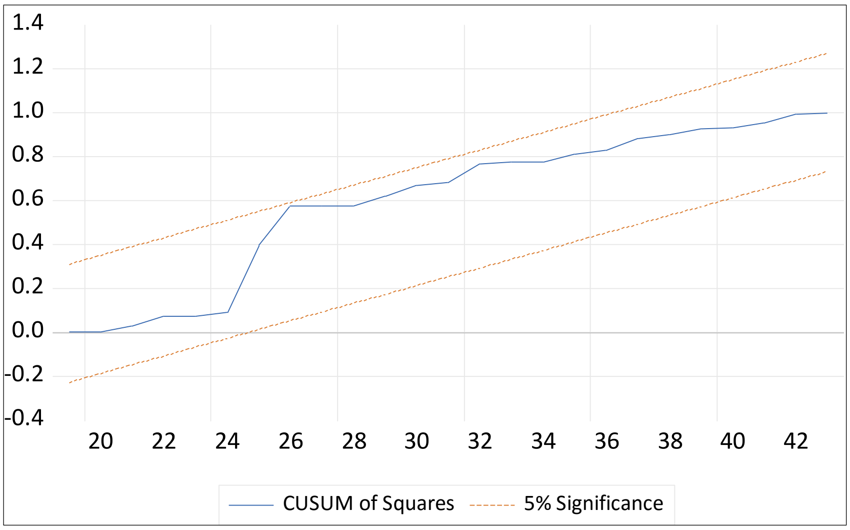


Figure 2: CUSUM and CUSUMSQ Tests

Source: Calculated by author

Note: values in parenthesis are the prob. Values

Based on the displayed curves of CUSUM and CUSUMSQ tests, the stability of the model is ensured as both the curves are found to be lying within the critical bound of 5% significance level. Hence we can say that the model is perfectly stable.

5. Policy Implications

The findings suggest several policy implications for improving general higher education in Rajasthan:

1. Increasing investment in faculty development and recruitment.

2. Strengthening infrastructure and academic facilities in universities and colleges.
3. Enhancing public funding for higher education institutions.
4. Improving governance and management of higher education institutions.

Strategic resource allocation and quality improvement initiatives are necessary to enhance the productivity of higher education institutions in the state.

6. CONCLUSION

This study examined the production function of general higher education in Rajasthan using the ARDL econometric approach. The results reveal that educational inputs such as faculty strength, pupil teacher ratio strongly affect enrollment. The ARDL analysis confirms both short-run and long-run relationships between these variables. The findings emphasize that improving educational quality requires not only expanding institutional capacity but also strengthening the resources and governance of higher education institutions.

Future research may incorporate additional variables such as research output, employability outcomes, and digital learning infrastructure to provide a more comprehensive analysis of higher education productivity.

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