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ASSESSING EFFICIENCY OF PUBLIC SPENDING ON ELEMENTARY EDUCATION IN INDIA: A COMPARATIVE ANALYSIS POST-IMPLEMENTATION OF THE RIGHT TO EDUCATION (RTE) ACT

Nikita Pahwa[1], Bojan Georgievski[2], Indira M.[3], Dadi Chen[4] & Abdul Rauf[5]

[1*]Assistant Professor, Wittenborg University of Applied Sciences, Netherlands.
[2]Associate Professor, Wittenborg University of Applied Sciences, Netherlands.
[3]Professor of Economics (Retired), University of Mysore, Karnataka, India.
[4]Associate Professor, Wittenborg University of Applied Sciences, Netherlands.
[5]Head of School of Business, Wittenborg University of Applied Sciences, Netherlands.

Abstract
This study aims to evaluate the efficiency of public sector spending on elementary education in India. Adopting a positivist philosophy, the research focuses on observable phenomena and employs a mono-method approach using quantitative analysis. It follows a deductive approach, aiming to test established theories and variables widely discussed in the existing literature. Given the strong correlation between public spending and educational outcomes, along with the varied educational achievements across Indian states, the study analyzes spending efficiency in sixteen major states.
To achieve this, the study applies Data Envelopment Analysis (DEA) and the Malmquist Index to assess the efficiency of educational spending during the five years preceding and following the implementation of the Right to Education Act (RTE), 2010. The analysis compares DEA efficiency scores and Malmquist Index-based growth efficiency scores across the pre- and post-RTE periods. The findings indicate an overall improvement in spending efficiency, which rose from 83% to 93%. However, the Malmquist Index reveals a decline in the growth rate of efficiency—from 7.1% to 2.3%—suggesting that although efficiency improved, the rate of improvement has slowed.
The primary objective of enhancing spending efficiency is to maximize educational outcomes. In the second part of the study, the influence of other variables—such as governance quality, maternal education, and school location (rural vs. urban)—on educational outcomes is examined. Regression analysis confirms the significant impact of governance, school location, and maternal education on educational performance in the Indian context.
This study fills a critical research gap in several ways. It not only provides efficiency estimates for elementary education in India but also compares efficiency before and after the implementation of the RTE Act. It contributes to the existing literature by applying the Malmquist Index in conjunction with DEA, thereby capturing not just static efficiency levels but also the rate of change in efficiency over time. The use of the Malmquist Index represents a novel contribution to the Indian context, as earlier studies have not employed this method to estimate efficiency growth rates.
Moreover, the study offers a practical framework for policymakers to assess spending from an efficiency standpoint. It further highlights the need to focus on governance quality, school location, and maternal education when analysing the reasons behind inter-state differences and below-par performance in educational outcomes.

Keywords: Public Expenditure, Education, Data Envelopment Analysis, Malmquist Index, India, Return to Education, Econometric and Input-Output Models, Regional Government.

Introduction

Education is a public merit good, which attracts significant funding from national and state governments all around the world. India allocates 4.1% of its GDP to education, out of which 1.5% is dispersed towards elementary education. India's commitment towards education has been a long standing effort since its independence. The constitutional commitment to provide free and compulsory education to children below the age of 14 years was further strengthened with various national policies in 1986 and 1992. The last three decades noted a strong commitment towards the initiative of Universalization of Elementary Education (UEE). Universalization of elementary education at school level means universal access to schools, universal enrolments and retention, along with reduction of gender and social gaps at elementary level. The past three decade witnessed the advent of various schemes, and initiatives targeting UEE. Some of the most prominent ones include Sarva Shiksha Abhiyan

(SSA), District Primary Education Programme (DPEP), Kasturba Gandhi Balika Vidyalaya (KGBY) Scheme, and the Right to Education Act (RTE). Among these initiatives, the Right to Education (RTE) Act, 2009 (implemented in 2010) reinforced the universalization of education by making it a Right for children under the age of 14 years to receive free and compulsory education. Despite various efforts, the education enrolments for elementary education, for children below 14 years of age have not universalized, yet. This study is a special attempt to analyze the efficiency of education spending on elementary education in India, before and after the implementation of RTE. The decadal analysis focuses on five years data pre-RTE and five years data post-RTE implementation between 2007-16.
Contemporary challenges in educational access remain significant, with Nwoke, Oyiga and Cochrane (2024) highlighting the persistent issue of out-of-school children in developing nations, while Asante (2024) demonstrated that cost elimination can significantly impact secondary school enrollment in Sub-Saharan Africa.

Apart from lacking universalization, a large gap among states has been prevalent in outcomes. A detailed interstate comparison of education spending i.e. inputs and the overall education outcomes (enrolments, dropouts, etc.), indicate wide disparities among states, which points to underlying inefficiencies of funds usage (Indira and Pahwa, 2020). A wide variation in inter-state spending and educational outcomes can be noted in Table 1.The various states of India present diverse outcomes in education, with some attaining better outcomes with less spending, while others are unable to attain good outcomes, with significant spending. For example, Jharkhand spends (more than all state average) Rs 10,116 on elementary education per student, but it has one of the highest dropout rates at 9 percent. The states of Maharashtra, Tamil Nadu and Chhattisgarh, though spending moderately on elementary education per student (Rs 5,000 -Rs 6,500), have attained nearly 100 percent enrolments in elementary education, with lower dropout rates (1 to 5 percent). Meanwhile, Karnataka spends the highest on elementary education at Rs 19,719 per student, but still has gross enrolment rates standing at 92%, indicating a need to focus on outcomes. The states in Table 1 can be divided in four categories. The first two categories of high spending have better outcomes, with low spending having lower outcomes, these being the expected scenarios. However, a lower spending leading to good outcomes, along with high spending creating lower outcomes, makes an intriguing case for further analysis. An investigation into the factors that causes these varied differences in educational outcomes with regard to spending is essential. Given the intricate and strong relationship between spending and outcomes, it is essential to delve deeper into the efficiency of public spending (Mohanty and Bhanumurthy, 2020).

Table 1. Status of Key Elements of Elementary Education in India 2007-16

States	**Elementary Education Spending per student[1]**	**Dropout rates**	**Gross Enrolment Rates (GER) Elementary Education**
	2007-11	2007-16	2007-16
Andhra Pradesh	6649	5.6	89
Bihar	3307	9.2	89.375
Chhattisgarh	6518	4.9	103.45

[1] The study uses INR as the currency, as it focuses on expenditure efficiency within the Indian context. The average education spending by all states would convert to approximately $90, based on exchange rates as of May 2025.

Gujarat	10524	2.5	89.7
Haryana	4973	4.45	85.85
Jharkhand	10116	9.2	105.225
Karnataka	19719	3.2	92.675
Kerala	4881	0.45	88.9
Madhya Pradesh	12311	7.45	110.325
Maharashtra	5699	2.15	97.075
Odisha	4456	6.6	95.9
Punjab	7610	2.7	90.375
Rajasthan	10234	9	94.775
Tamil Nadu	5830	1.4	109.625
Uttar Pradesh	3802	10.95	83.275
West Bengal	6903	5.9	102.475
All States	7702	6.35	94.55

Source: Analysis of Budgeted Expenditure, Various Years, MHRD.

Measuring expenditure efficiency of public sector funds has been widely studied in the international contexts. Technical efficiency denotes the ability of the government to produce maximum possible outcomes with the given set of inputs and technology. The governments can be considered producers who invest in teachers, books, and other educational resources (inputs) to reduce illiteracy (outputs), increase enrolments, improve educational quality, and attain gender parity (outputs), among others. Therefore, governments that can maximize output attainment given the existing resources are considered efficient.
The analysis of input efficiency has been widely examined in the international context; however, limited studies have focused on this in the Indian context. The various studies that have examined the efficiency of inputs in the Indian context have either used Data Envelopment Analysis (DEA) or Stochastic Frontier Analysis (SFA) techniques for efficiency estimations. Furthermore, most studies have focused on only primary or upper primary education separately (Purohit, 2015; Purohit, 2015; Ghose, 2017; Ghose and Bhanja, 2014), but very few have analyzed the efficiencies of overall elementary education (Dutta, 2012; Rosario and Shanmugam 2024).

Provision of education is crucial for a country, especially one the size of India given its vast and growing population, as it builds human capital and drives economic growth that may reduce inequality by equipping millions with essential skills for participation in a disruptive economic environment. Compulsory basic education not only addresses internal challenges like poverty, social disparities, and unemployment, and perhaps can help enhance India's global competitiveness by preparing a skilled workforce that can contribute to international industries and innovation. With India's demographic dividend, ensuring universal access to quality elementary education is vital for sustainable development and for the country to realize its potential as a major global player.

This study fills the research gap in various aspects. It not only attempts to provide efficiency estimates for overall elementary education in India, but it does so to compare the performance of efficiency estimates post the implementation of the Right to Education Act (RTE), 2010. It contributes to the existing literature by estimating Malmquist Index for elementary education

spending along with DEA estimates of efficiency, which not only provides efficiency estimates of inputs, but also captures the rate of growth of change. The estimation of the Malmquist Index can be considered a contribution to the literature in the Indian context, as previous studies have not employed this technique to estimate the growth rate of efficiency. The importance of efficient spending is to facilitate better educational attainment. The study further seeks to identify the role and impact of other factors (apart from spending and its efficiency) on educational outcomes. It tests the role of governance, mother's education, per capita income and school location on educational outcomes in elementary education.

Literature Review

Numerous international studies have explored the efficiency of educational spending. The study by Koku (2015) analyzed the data for 15 African countries and found that education spending efficiency does not impact the enrolments in primary and secondary education. The findings highlighted a significant role of per capita GDP on school enrolments. The study by Miningou (2019), developed a learning-adjusted school year index, as a measure for educational outcomes, and analyzed 130 countries. The study found a positive association between spending and outcomes, but the impact of public spending pointed to diminishing returns of educational spending over the years.

The studies in the literature have used both DEA and Stochastic Frontier Approach (SFA) as techniques for efficiency estimations. Some studies favor DEA over SFA, based on its capacity to handle multiple inputs and outputs at the same time. The study by Campoli et al. (2019) examined the efficiency of 27 Brazilian federative units and also provided estimates of Malmquist index for the period of analysis. Efficiency score improvements for different regions were further suggested by this study. Dufrechou (2016), compared the efficiency scores between 11 Latin American countries with 24 high income countries, using DEA. The findings highlighted the expansion of output without much increase in input. Many cross-country and country-specific studies have utilized the Program for International Students Assessment (PISA) surveys for learning outcomes and estimated the efficiency scores (Salas-Velasco, (2020); Ciro and Garcia (2018); Cuellar (2014)). The study by Delprato and Antequera (2021), analyzed the efficiency of public and private schools in Latin American countries, and compared the PISA scores. The study found private schools to be more efficient than public schools by a small difference.

Recent studies have continued to explore educational efficiency across different regions. Ulkhaq, Oggioni and Riccardi (2024) developed a two-stage super-efficiency model for measuring education efficiency in South-East Asia, while Nguyen and Do (2024) analyzed governmental expenditure efficiency on education across ASEAN countries for the period 2015-2021, finding significant variations in spending effectiveness across the region.

The literature on expenditure efficiency estimation in India is scarce; however, some studies have provided detailed accounts in this area. The study by Sankar (2007), measured efficiency of public spending for 27 states of India. The study examined the role of various inputs namely infrastructure and teacher pupil ratio on enrolment and completion rates. The overall results highlighted inefficiency of utilization of funds in some states. The states of Chhattisgarh, Assam, and Gujarat were found to be least efficient among their counterparts. Dutta (2012), analyzed the efficiency of elementary education by using inputs on school access and teacher availability and output variables on enrolment. The study found that during 2007-08, Delhi, Kerala, and Tamil Nadu excelled not only in educational outcomes but also in input efficiency.

On the other hand, Bihar, Rajasthan, Madhya Pradesh, Odisha, and Uttar Pradesh struggled with lower outcomes and inefficiency of inputs.

Purohit (2016), studied the efficiency of primary and upper primary schools in 2012-13 for 19 Indian states. The study utilized average instruction hours, infrastructure variables and school grants as inputs and enrolments as output indicator. The results highlighted the inefficiency of inputs in Goa and Uttarakhand, while Andhra Pradesh, Maharashtra, and West Bengal were found to be the most efficient states. Ghose(2017) estimated efficiency scores for 28 states and 7 Union Territories, and examined Net Enrolments and student passing as output indicators. The study analyzed a number of schools, classroom student ratio as input variables. The study found Karnataka and Tripura to be most efficient at primary level, and Andhra Pradesh and Kerala to be efficient at upper primary level. The states of Bihar, Gujarat, Maharashtra, Tamil Nadu, and West Bengal exhibited higher efficiency during the period of analysis. Purohit (2015), and Ghose and Bhanja (2014) analyzed district level efficiency in enrolments at primary and upper primary education, in Rajasthan and West Bengal, respectively. Both studies considered net enrolments for the outcome variable. The variables on infrastructure and pupil teacher ratio were considered as indicators of inputs in this study.

Rosario and Shanmugam (2024), applied the techniques of Stochastic Frontier Analysis (SFA), on 28 major states of India, focusing on efficiency of elementary education in its entirety. Many studies earlier focused on primary or upper primary education, and did not consider the possibility of measuring the combined impact for elementary education in India. The study measured the impact of public spending, infrastructure, and availability of teachers impact on outcomes, during 2009-10 and 2020-21. The study noted Goa, Haryana, and Kerala to be more efficient states, while Arunachal Pradesh, Meghalaya and Manipur ranked lowest in efficiency outcomes.

Many of these studies also measured the reasons for inefficiencies among states and found female literacy, income, and urbanization to play a crucial part (Purohit, 2015). Meanwhile, other studies emphasized the role of economic growth, governance and mothers education in explaining variation among efficiencies (Mohanty and Bhanumurthy, 2020). Infrastructure facilities including access to water, availability of electricity, teacher availability, social indicators, state level factors, and income inequality have been used in various analysis, as explanatory factors for efficiency differences, thereby impacting educational outcomes.

The relationship between educational expenditure and broader sustainable development outcomes has gained increasing attention in recent literature. Khan, Khan and Rahman (2024) examined the role of education in pursuing sustainable development through evidence from Malaysia, Indonesia and Pakistan, demonstrating that efficient educational investments contribute not only to immediate learning outcomes but also to long-term sustainable development goals. This perspective reinforces the importance of measuring not just spending efficiency but also the broader developmental impact of educational investments

Research Design

Data Collection

The main aim of this analysis is to measure the efficiency of elementary education spending among Indian states. The analysis period is divided into two, based on the Right to Education (RTE) Act implemented in 2010. One of the main objectives of RTE is to provide compulsory, free and quality education to children aged between 6-14 years. This study seeks to understand

the performance of education spending among Indian states, before and after the introduction of RTE. In this study, the period of analysis is divided into two: pre-RTE (2007-11) and post-RTE (2012-16). The longitudinal decadal analysis pre and post RTE implementation is strictly a choice based on data availability. The CAG accounts, which provide a detailed overview of elementary education spending, are available for 5 years prior to the implementation of RTE. For this reason, the analysis has been conducted for an overall 10 years, given the availability of five years of data before the implementation of RTE. To facilitate a balanced comparison, the study compares 5 years of data before and after the implementation of the Right to Education Act.

A positivist and deductive research approach has been employed in this analysis. The present analysis uses mono methods of quantitative research, where three inputs of education spending and two outputs of education performance to estimate the expenditure efficiency of elementary education have been considered for this analysis. The choice of input and output variables has been validated from extensive literature review of national and international studies. The two output variables that capture educational outcomes are the Net Enrolment Rate (NER) and learning outcomes in Mathematics and English[2]. The data on student performance in English and Mathematics was obtained from the Annual Status of Education Report (ASER), whereas NER data was obtained from U-DISE statistics.[3]

The input data for this study on education spending has been collected from the Controller and Auditor General of India (CAG). In India, the funds for elementary education are allocated via both the center and the states. For the purpose of this study, the total spending has been rearranged into these three categories of qualitative spending (spending on teacher training, textbooks etc), quantitative spending (spending on infrastructure, and administration, etc.) and spending via decentralized bodies, including spending through Sarva Shiksha Abhiyan (SSA). Introduced in 2001-2002, SSA is a centrally sponsored flagship scheme by the Indian government, which focuses on universalization of elementary education, community participation, decentralized planning and quality of education with improvement of educational outcomes. It is essential to include spending from SSA when assessing elementary education spending in India, as it has been one of the biggest flagship schemes in elementary education since its inception.

This study focuses on major general category states, namely, Andhra Pradesh, Bihar, Chhattisgarh, Jharkhand, Karnataka, Kerala, Maharashtra, Punjab, Tamil Nadu, Haryana, West Bengal, Gujarat, Odisha, Rajasthan, Uttar Pradesh, and Madhya Pradesh. The general category states have been chosen due to a similarity of devolution of funds from the center.

Data Analysis

The study uses Data Envelopment Analysis (DEA) and the Malmquist Index approach to measure technical efficiency in education spending and growth in technical efficiency, respectively. The efficiency models for the pre- and post-RTE period have used a one-year lag in between input and output data. This study assumes variable returns to scale while running

[2] The Net Enrolment Rate (NER) is considered a better measure of enrolment than the Gross Enrolment Rate (GER) since GER includes non-attendance and dropped-out children in the school-going population.

[3] The competency in English and Math is captured by the percentage of government school students of class V who can read the text of class II and the percentage of students of class V who can do division.

the DEA, as states are expected to have increasing, constant or decreasing returns of education spending, as supported by the literature[4].

Apart from standard efficiency scores, this analysis further examines the same data from the approach of multi-stage DEA. The first step of a multi-stage DEA requires estimation of efficiency scores, which in its second stage are then utilized in the regression analysis. This study uses output-oriented efficiency scores for multi-stage DEA.

The regressions test the role of per capita income, governance, mother's education, and the role of school location (rural/urban) on educational outcomes. The first two equations below (equation 1 & 2), try to measure the impact of a mother's education, per capita income, and location (rural/urban) on output efficiency. Overall, mother's education, per capita income, and urban population are hypothesized to have a positive impact on educational outcomes (Tilak, 2006) (Anand & Ravallion, 1993; Musgrove, 1996).

$Eff_i = \beta_0 + \beta_1\, MOTHEDU + \beta_2\, PCI + \beta_3\, URBANPOP + u_i$ - Eq 1.

$Eff_i = \beta_0 + \beta_1\, MOTHEDU + \beta_2\, PCI + \beta_3\, RURALPOP + u_i$ - Eq 2.

The next two equations (equation 3 and 4) aim to capture the impact of the role of governance, along with mother's education and school location on educational outcomes.

$Eff_i = \beta_0 + \beta_1\, MOTHEDU * GOVINDEX + \beta_2\, PCI + \beta_3\, URABNPOP + u_i$ - Eq 3

$Eff_i = \beta_0 + \beta_1\, MOTHEDU * GOVINDEX + \beta_2\, PCI + \beta_3\, RURALPOP + u_i$ - Eq 4

The second set of equations includes an interaction term for mother's education and governance, to capture the dual impact of better governance and educated parents on the efficiency of educational outcomes. This study uses governance index as a proxy for institutional factors, created by the Public Affairs Centre (PAC), Bengaluru. The Public Affairs Index (PAI) is a good proxy of governance as it is based on ten broad themes of essential infrastructure, support to human development, social protection, women and children, crime, law and order, delivery of justice, environment, transparency and accountability, fiscal management, and economic freedom across major states of India. Better governance is expected to have a positive impact on elementary education outcomes in general (Mohanty & Bhanumurthy, 2020).

Data Envelopment Analysis (DEA)

The method of Data Envelopment Analysis (DEA) has been conventionally used in literature to analyze the efficiency of spending in various national and international studies. The alternative method to measure efficiency is the Stochastic Frontier Approach (SFA). The technique of SFA is considered to be more stable in response to shocks and inefficiencies of production function (Rosario and Shanmugam, 2024). On the other hand, DEA is considered advantageous as it allows efficiency estimates via inclusion of multiple inputs and outputs. The method of DEA is considered advantageous as it does not assume any functional relationships between variables considered for the analysis (Dutta, 2012).

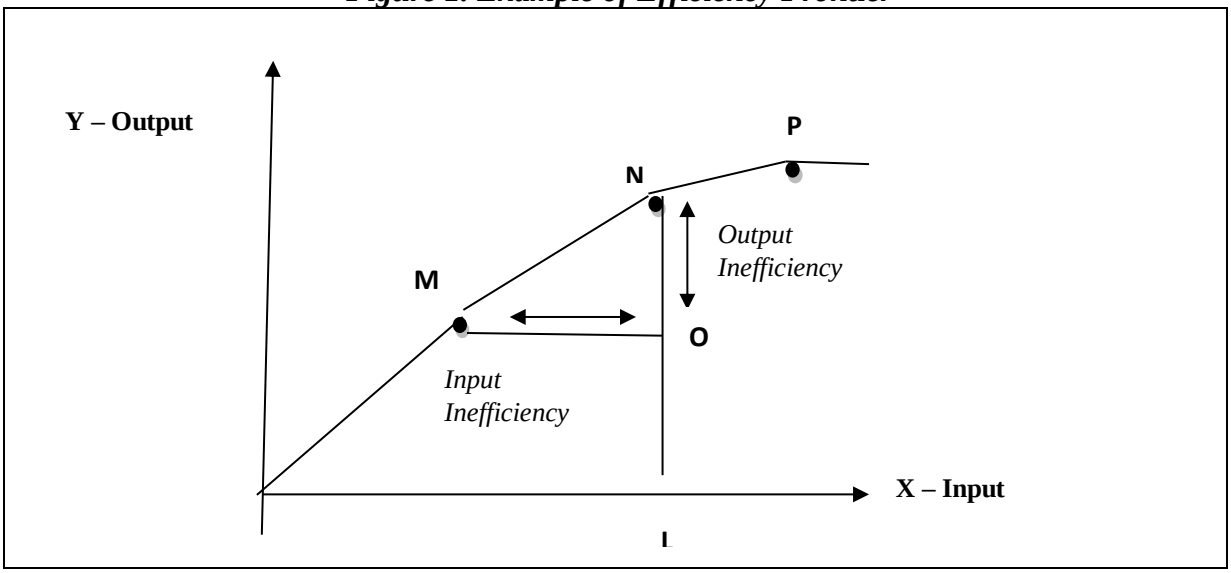
To measure spending efficiency, this study employs the technique of DEA. Efficiency in DEA is defined as obtaining the maximum possible performance with given resources. A maximization in efficiency can be either obtained by input minimization or output

[4] A rule of thumb for Data Envelopment Analysis (DEA), established by Golany and Roll (1989), states that the number of Decision-Making Units (DMUs) should be at least twice the total number of inputs and outputs. This analysis satisfies that criterion, as it includes 16 DMUs (states) with 5 inputs and 2 outputs, resulting in a minimum requirement of 10 DMUs (2 × (5 + 2) = 14, though 10 is often cited as a minimum threshold). Therefore, the study meets the necessary condition for conducting efficiency analysis.

maximization. The formula for efficiency is output divided by inputs as conceptualized by (Farell, 1957), and further developed by various authors (Boles, 1966; Afriat, 1972; Charnes et al., 1978).

The technique of DEA is based on an efficiency frontier, which further helps to explain input and output-oriented efficiencies. The details of input and output-oriented efficiency models can be understood in Figure 1. The efficiency frontier in Figure 1 illustrates inputs on the X-axis and output on the Y-axis. The various points on the efficiency frontier (namely M, N and P) are called Decision Making Units (DMUs). A Decision-Making Unit (DMU) is the entity/state/organization for which efficiency calculation is desired. A DMU is considered efficient if it operates or positioned on the frontier and inefficient when it is far away from the frontier. The DEA has potential to provide two sets of efficiency scores, input and output-oriented efficiency. The input-oriented efficiency depicts possible reduction in inputs, without changing the output. The output-oriented efficiencies on the other hand, depict maximization possibilities of output without varying the inputs. The efficiency generally ranges between 0 to 1, and all other efficient DMU are assigned a value of one if they are efficient.

Figure 1. Example of Efficiency Frontier



Source: Author

Malmquist Index

This study further uses the Malmquist Index technique of capturing growth in efficiency units. Mostly applied in the context of panel data, the Malmquist Index was developed by Caves et al. (1982), Berg et al. (1992) and Farell et al. (1992, 1994a, 1994b). The Malmquist index captures the change in the efficiency of DMUs over a period of time. The approach requires calculation of geometric means of the two TFP indices, with one evaluated based on the technology efficiency frontier in period t+1 and the other in period t. This calculation uses the non-parametric techniques and the distance function provided by Coelli et al. (2005). The index depicts the productivity change in each DMU, which is further decomposed into two effects. A change in total efficiency can be broken down into a change in technical efficiency and technological change. The productivity change via Malmquist Index can be visualized by equation 1.

$$M_o^{t+1}(y_t, x_t, y_{t+1}, x_{t+1}) = EC * TC = \frac{D_o^{t+1}(y_{t+1}, x_{t+1})}{D_o^t(y_t, x_t)} \left[\frac{D_o^t(y_{t+1}, x_{t+1})}{D_o^{t+1}(y_{t+1}, x_{t+1})} \times \frac{D_o^t(y_t, x_t)}{D_o^{t+1}(y_t, x_t)} \right]^{1/2}$$

Eq.1

The first component of this equation reflects the technical efficiency change (EC), and it captures the improvement or deterioration in the period (t+1). A value greater than one depicts improvement in technical efficiency, a value less than one represents deterioration in technical efficiency and a value equal to one depicts no change in efficiency.

Results and Analysis

Technical Efficiency Scores Pre- and Post-RTE

The results of technical efficiency scores via DEA are presented in Table 2. The scores were calculated for each year for the sixteen major states of India and an average of 2007-11 was estimated for pre-RTE period. A similar estimation exercise was conducted for 2012-16 and an average post-RTE score was created for the states. The table also presents the ranks for each state, with rank one meaning highest efficiency among peers and sixteen indicating lowest efficiency among states.

The overall efficiency scores can be further divided into three sub-categories. These divisions have been created based on the efficiency scores obtained via the DEA analysis in this study. The states with efficiency scores value one are on the efficiency frontier indicating the highest expenditure efficiency, the second category states are those who obtained a value between .90 to .99, and the last category of states are those which obtained values less than .90.

During 2007-11, the states in the first category with highest spending efficiency in elementary education were Kerala, Tamil Nadu and Maharashtra (Table 2). An efficiency score of one implies the best possible attainment in enrolment and learning levels with existing education spending. It also means best performance of these states in utilizing their inputs in comparison to their peers. The states which obtained the high efficiency scores between .90 and .99 were Madhya Pradesh, Karnataka, Haryana, Odisha, Andhra Pradesh, Punjab, and Chhattisgarh. This score implies that these states can attain their educational outcomes by spending 90-99% of the current input/spending on education. The states which had lowest efficiency scores among their peers were Bihar, West Bengal, Rajasthan, Gujarat, Jharkhand and Uttar Pradesh. Among these states, Uttar Pradesh (.67) and Jharkhand (.76) recorded the lowest efficiency scores. In other words, Uttar Pradesh and Jharkhand can attain their current educational outcomes by using only 67 percent and 76 percent of the current spending, respectively.

During 2007-11, the average efficiency score for all states was .89, which highlights that overall, the 16 major states could spend 89% of their existing funds to attain similar levels of educational outcomes.

The post-RTE (2012-16) period, noted an improvement for most states. While the states who scored a rank of one on the efficiency frontier declined from three to one, the overall number of states in the second category increased from seven to eleven. The states which obtained an efficiency score between .90 and .99 were Kerala, Maharashtra, Karnataka, Chhattisgarh, Andhra Pradesh, Tamil Nadu, Jharkhand, West Bengal, Bihar and Haryana. The states with values less than .90 at the efficiency frontier were Gujarat, Odisha, Madhya Pradesh, Uttar Pradesh and Rajasthan. Among these states, the lowest scores were obtained by Rajasthan (.79) and Uttar Pradesh (.83). These states could have attained the same level of educational outcomes in elementary education with 79% and 83% of their existing spending, respectively.

Table 2. Technical Efficiency Scores Pre- and Post-RTE

States	Pre-RTE		Post-RTE	
	2007-11	Rank	2012-16	Rank
Andhra Pradesh	0.92	8	0.98	6
Bihar	0.88	11	0.93	10
Chhattisgarh	0.90	10	0.99	2
Gujarat	0.80	14	0.89	12
Haryana	0.93	6	0.92	11
Jharkhand	0.76	15	0.96	8
Karnataka	0.94	5	0.99	2
Kerala	1.00	1	0.99	2
Madhya Pradesh	0.95	4	0.84	14
Maharashtra	1.00	1	0.99	2
Odisha	0.93	6	0.88	13
Punjab	0.91	9	1.00	1
Rajasthan	0.84	13	0.79	16
Tamil Nadu	1.00	1	0.97	7
Uttar Pradesh	0.67	16	0.83	15
West Bengal	0.86	12	0.94	9
All States	0.89		0.93	

Source: Author's Calculation based on DEA Analysis

Comparative Analysis Pre- and Post-RTE.

The average efficiency score of all states increased from .83 to .93 between pre- and post-RTE. The state-wise performance of efficiency scores shows promising trends, with nine out of sixteen states noting an increase in efficiency during the two periods. These states are Andhra Pradesh, Bihar, Chhattisgarh, Gujarat, Jharkhand, Karnataka, Punjab, Uttar Pradesh, and West Bengal. On the other hand, spending efficiency deteriorated for Haryana, Kerala, Madhya Pradesh, Maharashtra, Odisha, Rajasthan, and Tamil Nadu.

Overall, Bihar, Madhya Pradesh, Rajasthan, Odisha, and Uttar Pradesh (BIMAROU) remained among the least-performing states in spending efficiency. During the pre-RTE period, four out of the six least-performing states remained Uttar Pradesh, Rajasthan, Bihar, and Jharkhand. Similarly, post-RTE, four out of the six least-performing states remained Odisha, Madhya Pradesh, Uttar Pradesh, and Rajasthan. It is to be noted that the lower spending of BIMAROU states is consistent with their abysmal performance in educational outcomes (Indira & Pahwa, 2020; Dutta, 2012).

Malmquist Index Analysis

The results of Malmquist Index for all states, during the two periods are presented in Table 3 below. Malmquist index captures the rate of change in technical efficiency over a period of time. The total change in technical efficiency for this index is captured via Total Factor Productivity Change (TFPCH). An overall change in technical efficiency is due to two reasons. The first reason can be a technological change denoted by Technological Change (TECH), which causes the efficiency frontier to shift outwards or inwards. In context of education expenditure, a shift in efficiency frontier signifies an increase/decrease in education spending for a state. The second change in overall efficiency is due to Technical Efficiency Change

(TECCH), which indicates a change in spending efficiency of a particular state. In general, an index value greater than one denotes an improvement in efficiency, and a value less than one denotes a decline in efficiency. An index value equal to one implies no change in performance.

Table 3. Malmquist Index Pre- and Post-RTE

	States	TFPCH (Total Factor Productivity Change)	TECH (Technological Change)	TECCH (Technical Efficiency change)	TFPCH (Total Factor Productivity Change)	TECH (Technological Change)	TECCH (Technical Efficiency change)
		2009-11	2009-11	2009-11	2012-16	2012-16	2012-16
1	Andhra Pradesh	1.02	1.01	1.01	1.00	1.00	1.00
2	Bihar	0.95	0.96	0.99	1.02	1.33	1.02
3	Chhattisgarh	1.07	1.02	1.04	0.98	1.00	0.97
4	Gujarat	0.99	0.98	1.00	1.01	1.01	1.00
5	Haryana	0.97	1.00	0.98	0.95	0.97	0.98
6	Jharkhand	1.04	1.05	0.99	1.03	1.00	1.03
7	Karnataka	1.50	1.00	1.50	1.38	1.00	1.38
8	Kerala	1.03	1.00	1.03	0.92	1.00	0.92
9	Madhya Pradesh	0.98	0.97	1.00	1.01	0.97	1.04
10	Maharashtra	1.05	1.00	1.05	1.05	1.00	1.05
11	Odisha	1.02	1.02	1.00	1.05	1.01	1.03
12	Punjab	1.32	1.03	1.20	1.02	1.00	1.02
13	Rajasthan	1.08	1.02	1.03	1.02	0.99	1.03
14	Tamil Nadu	1.00	1.00	1.00	0.98	1.00	0.98
15	Uttar Pradesh	1.19	1.18	1.01	1.00	1.00	1.03
16	West Bengal	0.95	0.96	0.99	1.06	1.02	1.04
	All States	1.07	1.01	1.05	1.03	1.02	1.03

Source: Author's Calculation based on DEA Analysis

The overall Malmquist Index for the pre-RTE period (TFPCH) noted an increase in overall technical efficiency by 7 percentage points, as presented in Table 3. An increase in growth rate of technical efficiency indicates an increase in elementary education spending in general. This increase in overall efficiency can be attributed to a shift in efficiency frontier (TECH) by 1.3%

and an improvement in efficiency (TECCH) by 5% during 2009-11[5]. It is to be highlighted that the pre-RTE period improvement in efficiency of elementary education for all states can be attributed to an increase in efficiency rather than an increase in spending itself. The overall index of spending efficiency (TFPCH) points to an improvement in average technical efficiency in eleven out of sixteen states of India. The most significant increase is noted in Karnataka (50.2%), Punjab (32%), Uttar Pradesh (18%), Jharkhand (3.5%), Maharashtra (5.3%), Chhattisgarh (6.7%) and Rajasthan (7.5%). A marginal increase between 0-2% is noted in the states of Tamil Nadu, Kerala, Odisha, and Andhra Pradesh.
An improvement in state-specific efficiencies does not mean that the states have reached the maximum productivity in elementary education spending. A larger change in TFPCH implies an increase in the productivity of inputs in these states, as compared to other states, over a period of time. All the states that noted an increase in spending efficiency during 2009-11 and witnessed a change in both TECH and TECCH, except Jharkhand and Odisha. In other words, an increase in elementary education spending is not only due to an increase in spending but also to an improvement in the efficiency of spending. Jharkhand and Odisha noted an improvement in efficiency only due to a shift in the efficiency frontier (TECH) via increased spending.

The states that noted a decline in efficiency are Bihar (-5.2%), West Bengal (-4.5%), Haryana (– 2.7%), Madhya Pradesh (-2.2%), and Gujarat (-1.4%). The decline in the states of West Bengal, Haryana, and Bihar is due to a decline in both technical efficiencies as well as technological change. However, a decline in Madhya Pradesh and Gujarat is due to a decline in expenditure. Among the BIMAROU states, the efficiency changes remained positive for Uttar Pradesh, Jharkhand, and Rajasthan. It remained the same for Odisha and declined for Madhya Pradesh and Bihar.

The post-RTE index on total productivity indicated by TFPCH saw an improvement in efficiency by 2.8 percent. In the state-wise analysis, eleven out of sixteen states noted an improvement. The states with the most significant increase are Karnataka (37%), Odisha (4.6%), Maharashtra (5.1%), and West Bengal (5.9%). A marginal increase of 0-2% is noted in Andhra Pradesh, Madhya Pradesh, Gujarat, Rajasthan, Punjab, Bihar, and Jharkhand. A decline in spending efficiency is noted in Kerala (-8.3%), Haryana (-5.5%), Chhattisgarh (-2.4%), Tamil Nadu (-2.2%), and Uttar Pradesh (-0.5%). These states moved from higher growth in spending efficiency to the lowest growth between the two periods.

The overall index value of Malmquist Index indicated a decline in efficiency growth between pre- and post-RTE period from 7.1% to 2.8%. Among the sixteen states, Haryana and Karnataka were the least- and best-performing states, respectively. Among the BIMAROU states, progress in performance was noted for Bihar, Jharkhand, Madhya Pradesh, Rajasthan, and Odisha, but not Uttar Pradesh.

Multistage DEA

The process of multistage DEA requires estimation of efficiency scores, which are then used in regression analysis. This study estimated the output-oriented efficiency scores for all sixteen states, and the results of output-oriented efficiency are presented in Table 4. A higher output efficiency score indicates the state's efficiency in utilising its current resources on education

[5]An increase in technical efficiency is calculated by subtracting 1 from the Malmquist Index value and multiplying the result by 100. For example, in Karnataka's case, the increase is calculated as $(1.502 - 1) \times 100 = 50.2\%$.

spending to attain educational outcomes of learning and enrolments. The states at the frontier with the highest efficiency score (Value being 1) are Andhra Pradesh, Chhattisgarh, Haryana, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Rajasthan, and Uttar Pradesh. The highest efficiency score depicts efficient utilization of elementary education spending without wasting resources.

Table 4. Output Oriented Efficiency Scores

States	Technical Efficiency (TE)	Rank
Andhra Pradesh	1.00	1
Bihar	0.75	16
Chhattisgarh	1.00	1
Gujarat	0.99	11
Haryana	1.00	1
Jharkhand	0.99	10
Karnataka	1.00	1
Kerala	1.00	1
Madhya Pradesh	1.00	1
Maharashtra	1.00	1
Odisha	0.88	13
Punjab	0.83	14
Rajasthan	1.00	1
Tamil Nadu	0.96	12
Uttar Pradesh	1.00	1
West Bengal	0.81	15

Source: Author's Calculation based on DEA Analysis.

The states away from the frontier with efficiency scores between 0.90 to 0.99 are Jharkhand (.99), Gujarat (.98), and Tamil Nadu (.96). A higher efficiency score near the frontier implies attaining 99%, 98%, and 96% of the educational outcomes with the existing resources, but with scope for improvement of 0.2% 1.3% and 3.7% respectively. The scope for improvement in output attainment is largest for Bihar, with an efficiency score of .75 (75% utilization). Bihar's educational outcomes could increase by 25% by using its existing educational spending. The remaining states which can improve educational outcomes with existing educational spending are West Bengal (18%), Punjab (17%), and Odisha (11%).

Regression Results

The regression analysis for the multistage DEA uses output-oriented efficiency scores from the first step as the dependent variable and aims to identify the factors impacting educational outcomes. In India, educational outcomes vary significantly across major states, and one possible reason for this is the differing spending capacities of state governments and the devolution of funds based on Finance Commission recommendations. However, differences in outcomes may also arise from a broader range of factors.

While government spending and its efficiency do play a role, educational outcomes are also influenced by institutional capacity, the extent of leakages in public spending, and poor

resource management. Existing literature highlights the importance of governance in shaping human development outcomes (Bhanumurthy, Prasad, & Jain, 2018; Rajkumar & Swaroop, 2008). Better governance is believed to improve these outcomes by enhancing both the level and efficiency of public spending. Additionally, higher levels of economic development are positively correlated with improved delivery of educational services, underscoring the importance of economic development in achieving better outcomes (Afonso et al., 2010; Anand & Ravallion, 1993).

The literature identifies three major factors affecting educational outcomes: resources, institutions, and endowments (Mohanty & Bhanumurthy, 2020). In this analysis, GDP per capita is used as a proxy for resources, the governance index represents institutions, and mother's education serves as a proxy for endowments. Furthermore, the rural or urban location of schools is considered a proxy for both resources and institutional factors, as the availability of resources and the quality of institutional support can vary significantly based on location.

The results for equation 1 and 2 are presented in Table 5. The result from equation 1 indicates mother's education and urban location of school positively and significantly impact educational outcomes for schools in India. The result from equation 2 points to similar findings. The mother's education positively and significantly impacts educational outcomes and rural location of the school can be considered as a disadvantage when it comes to attainment of educational outcomes. The per-capita income, even though positive, has obtained an insignificant p value in both the regression results. The two equations have an R square of 53% each, with an F value less than 0.05, indicating a decent fit of the regression equation.

Table 5. Factors Affecting Educational Outcomes

Variables	Model 1	Model 2
Mother's Education	.195*** (3.44)	.195*** (3.44)
Per Capita Income	.0498 (1.02)	.0498 (1.02)
Urban Location	.2168** (2.30)	-
Rural Location	-	-.409** (-2.30)
Constant	.489*** (3.29)	1.115*** (6.96)
R Square	.528	.527
F- Statistics	0.02	0.02

Note: Values in the Parenthesis are t values. The star with p value denotes significance at one percent, five percent and ten percent respectively (*** p < 0.01, ** p < .05, p *< .10)

The results of equations 3 and 4 are presented in Table 6. An interaction term of mother's education with governance index has been added in equation 3 and 4. The impact of the interaction term of mother's education with governance was found to be positive and significant in both the models. It suggests that the educational outcomes in states are impacted by better governance and educated mothers. The results from equation 3 point to significance of urban location, highlighting the role of school location and its impact on attaining outcomes. Similarly, the results from equation 4 point to negative impact of rural location on attainment

of educational outcomes. The results could not emphasize the importance of per capita GDP on educational outcomes with significance. The R square value of 53% each, with F-statistics of both the models less than 0.05, indicates a decent fit.

Table 6. Factors Affecting Public Spending Efficiency (Output-Oriented)

Variables	Model 3	Model 4
Mother's education *	.179***	.179***
Governance Index	(3.29)	(3.29)
Per Capita Income	.0125	0.012
	(.20)	(.20)
Urban Location	.207**	
	(2.24)	
Rural Location	-	-0.39**
		(-2.24)
Constant	.551***	1.15 ***
	(4.24)	(6.09)
R Square	.533	.533
F-Statistics	0.04	0.04

Note: Values in the Parenthesis are t values. The star with p value denotes significance at one percent, five percent and ten percent respectively (*** p < 0.01, ** p < .05, p *< .10)

Conclusion

This study aimed to measure the efficiency of public spending on elementary education in India. The growing importance of elementary education is underscored by the Sustainable Development Goals (SDGs), which highlight the role of inclusive and quality education in achieving a sustainable and equitable world. Given the strong correlation between education spending and educational outcomes (Indira & Pahwa, 2020), improvements in outcomes cannot be expected unless the spending is efficient (*ceteris paribus*). Educational outcomes are influenced not only by spending but also by various other factors identified in the literature.
The study had two main objectives: first, to estimate the efficiency of inputs in elementary education from a comparative perspective between the pre- and post-RTE (Right to Education) periods; and second, to understand the factors that influence educational outcomes beyond public spending.

The first part of the analysis focused on estimating the efficiency of public sector spending on elementary education from 2007 to 2016. Efficiency scores were calculated to enable a comparison between the pre- and post-RTE periods. The overall results showed an increase in average efficiency from 83% to 93%. At the state level, efficiency improved in nine out of sixteen states: Andhra Pradesh, Bihar, Chhattisgarh, Gujarat, Jharkhand, Karnataka, Punjab, Uttar Pradesh, and West Bengal. Conversely, efficiency declined in Haryana, Kerala, Madhya Pradesh, Maharashtra, Odisha, Rajasthan, and Tamil Nadu.
Overall, Bihar, Madhya Pradesh, Rajasthan, Odisha, and Uttar Pradesh (BIMAROU states) remained among the least efficient in terms of spending. Before the RTE period, four of the six least-performing states were Uttar Pradesh, Rajasthan, Bihar, and Jharkhand. After the RTE, the lowest performers included Odisha, Madhya Pradesh, Uttar Pradesh, and Rajasthan. Notably, the lower public spending by BIMAROU states aligns with their historically abysmal educational outcomes (Indira & Pahwa, 2020; Dutta, 2012).

The study also estimated the growth rate of technical efficiency between the two periods using the Malmquist Index. The overall technical efficiency declined from 7.1% to 2.8%. Among the sixteen states, Karnataka emerged as the best performer, while Haryana was the least efficient. Within the BIMAROU group, performance improved in Bihar, Jharkhand, Madhya Pradesh, Rajasthan, and Odisha, with the exception of Uttar Pradesh. This suggests that improvements in educational outcomes stem not just from increased spending, but from more efficient use of resources. Thus, while increasing expenditure is important, the effective utilization of resources is crucial to enhancing outcomes.

The Malmquist Index results further illustrated a decline in efficiency growth post-RTE. This metric helps decompose the decline into components attributable to either reduced spending or declining efficiency, offering a useful diagnostic tool for policymakers seeking to understand underperformance across states or countries.

The second part of the analysis estimated output-oriented efficiency for the year 2015–16 using similar inputs and outputs. This cross-sectional analysis adopted a two-stage DEA approach, with efficiency scores subsequently used in regression analysis. The regression results highlight the significance of governance, mother's education, and school location (rural vs. urban) in explaining the variation in educational outcomes. These findings are consistent with those of Mohanty and Bhanumurthy (2020), who emphasized the roles of maternal education, per capita income, and governance in spending efficiency. The results of this study reinforce the importance not only of efficient public funding, but also of governance quality, school location, and parental education in shaping educational outcomes.

The findings offer a comprehensive overview of the performance of sixteen major states in terms of spending efficiency and its relationship with educational outcomes. These insights can guide policymakers in identifying states that need to improve efficiency. The trends captured through the Malmquist Index provide deeper insight into the causes of declining efficiency, and can serve as an important starting point for national and sub-national governments to identify areas for improvement.

This study also serves as a practical framework for regional, provincial, and international comparisons of spending efficiency. The techniques and models used here can be adapted by researchers to assess public spending efficiency across various sectors. This analysis offers a foundation for enhancing the accountability of public funds at sub-national, national, and international levels.

However, the study has certain limitations that future research could address. While this analysis employed DEA and the Malmquist Index, future studies could conduct comparative assessments using both DEA and Stochastic Frontier Analysis (SFA) to estimate efficiency scores. Additionally, a broader range of input and output variables could be incorporated, and further analysis could explore the differential impact of various factors on educational outcomes in rural and urban contexts separately.

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