An Economic Study of Performance of Secondary and Higher Secondary Education in India

Thesis submitted for the degree of
Doctor of Philosophy (Arts)
of
Jadavpur University

By

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2024

Certified that the Thesis entitled

An Economic Study of Performance of Secondary and Higher Secondary Education in India submitted by me for the award of the Degree of Doctor of Philosophy in Arts at Jadavpur University is based upon my work carried out under the supervision of Dr. Arpita Ghose, Professor, Department of Economics, Jadavpur University and that neither this thesis nor any part of it has been submitted before for any degree or diploma anywhere/ elsewhere.

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"Statement of Originality"

I SANGITA CHOUDHURY registered on **July 26, 2016** do hereby declare that this thesis entitled **"An Economic Study of Performance of Secondary and Higher Secondary Education in India"** contains literature survey and original research work done by the undersigned candidate as part of Doctoral studies.

All information in this thesis have been obtained and presented in accordance with existing academic rules and ethical conduct. I declare that, as required by these rules and conduct, I have fully cited and referred all materials and results that are not original to this work.

I also declare that this thesis has been checked as per the "Policy on Anti Plagiarism, Jadavpur University, 2019" on January 16, 2024, and the level of similarity as checked by iThenticate software is **6%.**

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Acknowledgements

In gratitude to God, I dedicate this thesis, acknowledging divine guidance and blessings throughout.

I also extend my sincere thanks and gratitude to all those who have played a crucial role during the preparation of this thesis.

Foremost, my heartfelt appreciation goes to Dr. Arpita Ghose, my Ph.D. supervisor at Jadavpur University. Her unwavering guidance, constructive ideas, and continuous support were instrumental in the successful completion of this research. Without her mentorship, this journey would have not been possible.

I extend my gratitude to the State Government Departmental Fellowship Scheme for its invaluable support. I appreciate the Research Section and the Office of the Registrar at Jadavpur University for the prompt disbursement of the fellowship, facilitating the seamless progression of my research.

I express my appreciation to the faculty members of the Department of Economics, Jadavpur University, for their invaluable academic guidance. I am indebted to the Ph.D. Research Committee of the Department for their insightful comments and suggestions. Gratitude is extended to the staff of the Departmental and Central libraries of Jadavpur University for their support and cooperation. Special acknowledgment goes to the Ph.D. Cell of the Faculty Council of Arts for efficiently managing all administrative matters.

I appreciate the continual encouragement from my fellow Ph.D. scholars throughout my research.

I extend my heartfelt gratitude to my colleagues and the administration of Maulana Abul Kalam Azad University of Technology, West Bengal.

I express my sincere gratitude to my parents, elder sister, and all family members for their unwavering support in every possible way throughout my research journey.

Lastly, but certainly not least, I extend my deepest gratitude to my husband, Mr. Abir Das, whose endurance and unwavering support merit heartfelt thanks.

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List of Abbreviations for Thesis

AEF	Allocative efficiency
A&N	Andaman & Nicobar Islands
AP	Andhra Pradesh
ARU	Arunachal Pradesh
AS	Assam
BCC	Banker, Charnes and Cooper
BI	Bihar
BPLM	Breusch–Pagan Lagrange Multiplier
CHAND	Chandigarh
CCR	Charnes, Cooper and Rhodes
CHHAT	Chhattisgarh
CRS	Constant Returns to Scale
D&N	Dadra & Nagar Haveli
D&D	Daman & Diu
DEA	Data Envelopment Analysis
DMU	Decision making unit
DRS	Decreasing Returns to Scale
DEL	Delhi
FE	Fixed effect model
FDH	Free Disposal Hull
GCS	General Category States
GO	Goa
GEXPOE	Government education expenditure
GER	Gross enrolment ratio
GUJ	Gujarat
HAR	Haryana
HM	Headmaster/ Headmistress
H.S.	Higher Secondary
HP	Himachal Pradesh
TEF_{inp}	Input oriented technical efficiency
J&K	Jammu & Kashmir

JHAR	Jharkhand
KAR	Karnataka
KER	Kerala
LAKH	Lakshadweep
MP	Madhya Pradesh
MH	Maharashtra
MAN	Manipur
MEGH	Meghalaya
MIZO	Mizoram
NG	Nagaland
NEP	National Education Policy
NPE	National Policy on Education
ORI	Orissa
TEF_{out}	Output oriented technical efficiency
PCNSDP	Per capita net state domestic product
PWBS	Percentage of 'without building' schools
PBCC	Percentage of "bad" condition classrooms
Prob	Probability
PSCE	Percentage of Scheduled Caste enrolment
PSAPTA	Percentage of Schools arranging Parent–Teacher Association
PSACI	Percentage of schools with absence of computer and internet connection
PSADWF	Percentage of schools with absence of drinking water facility
PSAE	Percentage of schools with absence of electricity
PSAGT	Percentage of schools with absence of girls toilet
PSTE	Percentage of Scheduled Tribe enrolment
PFTMT	Proportion of female teachers to male teachers
PGETB	Proportion of girl's enrolment to boys
PPTEA	Proportion of Para teachers

PSSC	Proportion of schools with single classroom
PSST	Proportion of schools with single teacher
PUD	Puducherry
PN	Punjab
RAJ	Rajasthan
RE	Random effect model
RMSA	Rashtriya Madhyamik Shiksha Abhiyan
SC	Scheduled Class
ST	Scheduled Tribe
SUR	Seemingly unrelated regression
SIK	Sikkim
SCS&UT	Special Category States and Union territories
TN	Tamil Nadu
TEF	Technical efficiency
TP	Tripura
UDISE	Unified District Information System for Education
UP	Uttar Pradesh
UK	Uttarakhand
VRS	Variable Returns to Scale
WB	West Bengal

Chapter 1:

Motivation and Relevance of the Study

1.1 Introduction

Education is regarded as an essential constituent of the foundation of economy across the major nations around the world because of its role in generation of expedited economic growth and equating income distribution. The commonly acknowledged role of education in promoting the living standards of the population is expected to transform the society in the progressive direction. In the era of technological evolution, education works as a key instrument in transforming the work condition and atmosphere. Education can be perceived as both consumption good and capital good since from one angle it is capable of offering the consumer's utility and from a different angle education can be involved as an input for producing other goods & services. In the light of the characteristics of a capital good, education is deployed for forming human capital which in turn can be considered as an indispensable factor for the economic transition due to the fact that skill and knowledge enhancement can be leading to the promotion of productive activities. In this connection, the stock of human capital alongside the physical capital are crucial for the functioning as well as the economic prosperity of a nation.

Education has remained as an area of attention among the general people because of the emergence of immense literature addressing the crucial role of human capital in inducing economic growth. The relevance of education and thereby the human capital is highlighted in various endogenous growth related studies (Lucas (1988), Romer (1990)). Following the assumption of Lucas (1988), a metaphysical variable referred to as human capital exists besides the physical capital. A particular proportion of labour is dedicated for production while its residual proportion is dedicated for human capital accumulation; and the total factor productivity of an economy is decided by the average status of human capital. Though primarily, constant returns to scale (CRS) is existent, the expansion of human capital, therefore, may lead to the increasing returns to scale for the overall economy featuring more than proportionate increase in output because of a certain proportion of increase in factors of production (Romer (1986)). Further, it is considered by Romer (1990) that the prevailing stock of ideas and the number of people engaging time for developing new ideas are determining the productivity growth of the nation. Additionally, according to Romer (1990) productivity

growth rate is affected by the level of human capital and not by its accumulation rate. The basis of such an outcome is, in these models for producing the new ideas, as an input, the human capita is used and hence it determines the speed of the innovations. Specifically, the contribution of human capital towards economic progress through innovation and sharing knowledge with the broader society are crucial for the process of economic growth & development. As a consequence, with more employment of human capital in research, the growth of the economy accelerates. The greater level of steady-state income is expected to be achieved by the country, possessing the greater level of human capital. In this instance, Augmented Solow Model's prediction becomes equivalent to that, formulated by Romer. A positive correlation should be existent between growth and initial extent of human capital. Mankiw, Romer and Weil (1992) extended the Solow model while including human capital as a distinctive input and accordingly the technology of production in this model is referred as 'human-capital augmented Solow model' which predicts that with the greater level of human capital with other things being the same, a country can achieve a greater level of income per capita. The labour productivity differences as well as the overall technological differences are emerging because of education and thereby the formation of human capital (Barro(1991)).

In the light of the established role of human capital in the development of an economy, the relevance of educational expansion is possible to be justified. Education can be considered as an investment for human capital formation. Therefore, a greater proportion of developing countries acknowledged that developing human capital is possible in the nation through the mechanism of developing the system of education. Consequently, the governments of the majority of the nation allocate a certain proportion in the budget for education. Given the context, Indian education expenditure has remained around 3 percent of GDP; and 9.1 percent of the total expenditure incurred by the general government in 2020-21 (Economic Survey 2022-23).

Amongst all the stages of education, Secondary education has always remained the substantial stage of education because of its role as a bridge between elementary education and higher education. In India, in the post-independence period, the Secondary Education Commission was constituted (1952-1953) for reviewing the structure as well as the status of overall Secondary education and depending on the recommendations of the commission relating to the various aspects on Secondary education, several suggestions were implemented. During the last phase of the third 5-year-plan in India, the necessity of a comprehensive review of the system of education and following that educational restructuring with further determination

resulted in the appointment of education commission (1964-1966) for advising the government on national pattern of education and suggesting the policies for the development concerning all aspects in all the levels of education. These policies, documented as National Policy on Education (NPE) -1968 also shed light on the expeditious extension of Secondary education facilities to those areas and classes that had been denied earlier. NPE (1968) recognizing the Secondary (and higher) level of education as the main instrument of social transformation, recommended increasing the opportunities of diversified vocational courses at this stage including the fields like agriculture, medicine and public health, industry, trade and commerce, secretarial training etc. for mitigating the actual employment opportunity requirements in a developing nation like India. Later, NPE-1986 (rectified in 1992) considering Secondary and Higher Secondary (also referred as Senior-Secondary) levels of education as the terminal stages for those students who planned to step into the occupational world after completion of this level, recommended the strategies for the development of the education system under the condition of prevailing socio-economic and cultural changes. Specifically, targeting the improvement of Secondary education facilities on the grounds of unserved areas in India where no schools were found within at least 10 to 20 km areas, NPE (1986) introduced the scheme of Navodaya Vidyalayas to serve each district with the objective of offering good quality education (free of cost) to the exceptionally talented students residing in the unserved (by the education system) backward or rural areas. This scheme also promoted reservation for ST and SC category students and targeted covering girl students. Additionally, NPE (1986) emphasized on the non-formal set up for delivering Secondary and H.S. education through open schools; and also recommended improvement in the curriculum structure & text-materials, evaluation system, in-services training for improving teachers' competencies, providing playground & laboratory facilities, constructing new classrooms, arranging mid-day meal facilities and uniforms for backward class students, promoting three-language-formula etc., for reconstructing the system of school education. The policy of vocationalization was also strengthened in the H.S. education system in NPE (1986). Further, the Kothari Commission recommended maintaining a standard of 3:1 ratio for Secondary and H.S. schools. Subsequently, National Education Policy (NEP) - 2020 (approved by union cabinet), introduced a comprehensive policy for reforming and remodelling the entire education system starting from early childhood education to higher education in India focusing on the reconfiguration of school education structure, incorporation of the practical skill based vocational education into the conventional or general education system (from secondary education onwards), technology-aided teacher training, parity in gender, multilingualism,

multidisciplinary structure of education, flexible curriculum and modification in the evaluation system.

Prioritizing the access as well as the quality upgradation of Secondary education in India, the Ministry of education, Government of India initiated Rashtriya Madhyamik Shiksha Abhiyan (RMSA) in the year 2009. The leading objective of this scheme was providing the opportunity of secondary-level schooling within sensible proximity while other objectives dealt with raising educational quality at Secondary-level through the removal of gender disparity, disability and socio-economic barriers, offering universal access to Secondary education by the end of 2017 and attaining universal retention by the end of 2020. In this connection this scheme provided several physical infrastructural facilities like, (i) further classrooms, (ii) provision of toilets, (iii) drinking water, (iv) library and (v) laboratory etc. The quality interventions performed by this scheme included (i) recruiting more teachers for maintaining the standard proportion of pupil and teacher at 30:1, (ii) prioritizing Mathematics , Science and English education, (iii) upgrading the teaching-learning process, (iv) promoting ICT integrated education, (v) in-service teachers' training (for confirming competencies) and (vi) redesigning the curriculum; while the equity interventions performed by this scheme considered - (i) relatively greater count of female teachers, (ii) separate toilets for girl students and (iii) preference for opening schools in the minority community concentrated areas. At the state-level, this centrally sponsored scheme was implemented by the state government with the partnership from the centre .In 2018, an integrated scheme covering the whole school education was introduced in India as Samagra Shiksha Mission which subsumed the three existing & leading centrally sponsored school development programmes like, Sarva Shiksha Abhiyan, RMSA and centrally sponsored scheme on teacher education. Aiming the holistic perspective towards the school education in India from preschool to H.S. level, Samagra Shiksha Mission was initiated for achieving the major goals of quality, universalization and equality in the school education system in the context of India.

A satisfactory level of educational achievement in India can be reflected in relation to literacy rate and gross enrolment ratio (GER). In particular, the literacy rate reflected an improvement in India, from 12% to 74% over the 1947- 2011 period. Further, the measure of GER improved for Secondary-level from 67.35% to 79.35% between the time span 2012-13 to 2016-17 and for Higher-Secondary (H.S.) level from 31.06% to 55.40% over the time span 2010-11 to 2016-17 (Source: Unified District Information System for Education) respectively. A significant rise of 10% is observed in GER of secondary education over the duration 2012-13 to 2019-20.

On the ground of this noteworthy achievement in the form of GER at Secondary and H.S. levels, the mapping of GER to another performance indicator such as efficiency seems essential. Relevantly, the question arises, whether the Indian education sector is performing efficiently specifically in relation to Secondary and H.S. levels, in the sense that are Indian Secondary and H.S. stages of education capable of generating the maximum extent of output with the given extent of input; or conversely, can these stages of education (individually) produce the given extent of output while utilizing the inputs at the 'minimum required' extent under a certain technology? Since the schools under various Indian states may perform differently in terms of the efficiency aspect, therefore it is relevant to perform the study of efficiency evaluation at Indian-state-level using the data collected from secondary source. In connection to this, the question to deal with would be 'are different Indian states & union territories efficient in producing Secondary-stage as well as H.S. stage of education? Accordingly, a related concern is recognizing the factors causing the variation in efficiency levels of the corresponding stage of education. Indian states & union territories receive diverse proportions of grants and loans in the overall assistance, provided by the centre; for instance, 30% of the assistance received by the general category states (GCS) is allotted as grants and the rest i.e. 70% is allotted as loans while 90% of the assistance to special category states & union territories (SCS&UT) is allotted as grants and remaining 10% is allotted as loans (Planning Commission Government of India, Report of the Working Group on State's Financial Resources for the twelfth five year plan (2012)). Therefore, it is evident that all Indian states & union territories do not function under the homogeneous economic as well as fiscal environment and thus it is essential to segregate and carry out the analysis of efficiency and its determinants separately for the two distinguished state-groups, referred to as GCS and SCS&UT. Review of the prevailing studies relating to the aspect of efficiency in Indian school education, indicated the dearth of the school-level study on efficiency focusing on Secondary and H.S. levels individually involving primary survey data; and hence efficiency analysis at school-level is likely to be performed for shedding a light on this specific aspect. In connection to this, the concern is whether various schools are efficient in production of Secondary and H.S. education levels or not; and relevantly it is also essential to find the determining factors, affecting the level of efficiency.

In this context, the perception about the efficiency of a decision making unit should be discussed and generally, it is distinguished into technical efficiency (TEF) and allocative efficiency (AEF) aspects. Conceptually, TEF is reflected by the capability of a productive unit

either in generating maximum achievable output with the given extent of input involving a particular production technology or in utilizing the smallest extent of input for generating the given extent of output employing a certain technology. On the contrary, AEF signifies the capability of a productive unit in combining the outputs and inputs following optimal ratios in consideration of the existing prices and technology. However, the present study is concerned only with TEF.

Accordingly, in the present study, the efficiency analysis of Indian Secondary and H.S. stages of education is classified into two broader segments: one deals with the state-level analysis of efficiency while segregating Indian states and union territories into two categories for the time span 2010-11 to 2015-16 based on secondary data; and the other deals with the school-level analysis of efficiency based on primary data for the government and government-aided schools located in Kolkata for the year 2019-2020. The study on efficiency is invaluable from the perspective that the existence of inefficiency may lead to the loss of economic growth (Hulten (1996)); and this may be a probable reason why India is underperforming in the aspect of economic growth.

In accordance with the literature, two orientations can be followed for TEF measurement: (i) output oriented efficiency (TEF_{out}) and (ii) input oriented efficiency (TEF_{inp}). Basically, TEF_{out} deals with the comparison of actual output of a productive unit with the highest possible output producible out of the specific extent of input whereas TEF_{inp} deals with the comparison of actual input used by the productive unit with the lowest input requirement for producing the certain extent of output. The present study attempts to measure both TEF_{out} and TEF_{inp} and also identify the corresponding determinative factors.

Exploration of literature indicates the limitedness in the state-level as well as the school-level study relating to TEF estimation and analysis of the determinants considering Secondary and H.S. stages of education in India. Primary survey data based study is even more limited. In addition to this, the study on the state-level comparison between Secondary and H.S. stages' efficiency performance is also lacking. A thorough review of literature is discussed in chapter 2.

The contribution of the present study to the prevailing literature can be noted as below:

(i) The fundamental contribution of present study using secondary data set, is that while analysing TEF it is taken into account that GCS and SCS&UT in India are non-homogeneous

and function in diverse fiscal and economic conditions. Accordingly, estimation of TEF and identifying its determinants are carried out separately- for the GCS and for the SCS&UT. (ii) Post estimation of TEF score, a subsequent step of regression is performed to identify the determinants of TEF at Secondary and H.S. levels of education individually. Secondary data based segment of the thesis, evaluates school-specific infrastructure reflecting variables, social indicators, state-specific macro indicator and policy variable as determinants. The divergence of the present study from the prevailing literature (Sengupta and Pal (2012)) is instead of forming and thereby relating the composite index, reflecting the wider classification of determinants, to TEF estimate, investigating the individual effect of each explanatory variable included in the determinant analysis as it may be beneficial for designing the specific policy for the respective level of education. (iii) For filling the void in literature on TEF analysis at school-level in Indian context, a segment of the present study estimates TEF of Secondary and H.S. stages of the schools based on primary survey data, collected following stratified random sampling method from twenty five government-aided and government schools located in Kolkata for 2019-2020 and also determines the affecting factors of resulting TEF scores at the respective level. (iv) In the process of data collection it was noticed that the majority of the students are dependent on private tuition which possibly can inflate TEF score attainment of the schools at the respective educational stage. Therefore, the concern of the present study is obtaining that extent of TEF variation in these schools which is not explained by private educational assistance. To the best of our knowledge, previously any such attempt has not been executed. (v) The present study contributes by performing the detailed determinant analysis of TEF for the respective stage of education at school-level in Indian context, using primary survey data, incorporating the dimensions like, the contribution of private tuition, government policy, school managerial role of HM, teacher's characteristics, HM's characteristics, school characteristics, socio-economic environment of a student, opinion of students regarding school attributes etc. (vi) As 'Kanyashree Prakalpa' is introduced by West-Bengal government for conditionally transferring cash to girl students with the objective of encouraging the schooling of teenage girls and delaying their marriages till the age of 18, the present study contributes to the literature while investigating the influence of this policy intervention on school-level TEF attainment.

The consideration of the prevailing literature indicates that for estimating TEF of a productive unit, two distinct approaches are existent; referred to as (a) parametric approach and (b) non-parametric data envelopment analysis (DEA). However, for conducting the present study, the

DEA method is adopted. Charnes et al. (CCR (1978)) using linear programming problem and by determining shadow prices in absence of market prices of outputs and inputs of non-profit decision making units (DMU) in multiple-output, multiple-input context (where outputs and inputs are measurable), introduced DEA for estimating TEF. CCR (1981) based on empirical observations of organizations like schools, evaluated efficiency of public programmes using DEA in context of multiple-output and multiple-input and under consideration of CRS in production. In the subsequent period, Banker et al. (BCC (1984)) using actual output and input observations of several DMU and adopting DEA under consideration of variable returns to scale (VRS) assumption, estimated TEF of the DMU. The present study relying upon BCC (1984) estimates TEF of secondary and H.S. levels of education in the Indian context employing DEA under the assumption of VRS. The strength of the non-parametric approach lies in without considering a certain form of production function, it is possible to estimate TEF using linear optimization method on actual output-input data; therefore, the problem of misleading results occurring due to wrong specification of the production function in parametric approach, can be ruled out. The fundamental approach of DEA is primarily constructing the benchmark production frontier, representing perfect efficiency and thereafter comparing the actual performance of the DMU with the postulated standard of efficiency.

In accordance with the literature, the estimation of TEF rests on the production relation between output and input variables. Relevantly, it is essential to point out the following deviations of education production function from the conventional micro-economic idea: (1) the output of education sector is intangible. Therefore, representation of output by appropriate measures is essentially required; and in the state-level analysis segment of the present study, as output variables (i) Retention rate and (ii) Passing Percentage of students are included. The output, revealing 'passing percentage of students' stands for the quality aspect. Likewise, the inputs, included for state-level analysis are : (i) Number of schools for each lakh of population, (ii) Teacher-student ratio, (iii) Classroom-pupil ratio and (iv) Percentage of teachers qualifying post-graduation or higher degree. The quality aspect of input is incorporated while including 'qualification of the teacher'. Contextually, the included output and input variables in the school-level analysis segment of the present study should be pointed out. The output variables, included for analyzing TEF of Secondary-stage of the schools are: (i) Highest score obtained in board examination, (ii) Percentage of students scoring first division marks, (iii) Average scores obtained in language group, (iv) Average scores obtained in mathematics, (v) Average scores obtained in science group. Since most of the surveyed schools for the school-level

analysis have not introduced commerce as a stream, the Science and Arts streams are taken together for considering and analyzing the TEF aspect in the overall sense for the H.S. stage at the school-level. The output variables, included for H.S. stage are similar to that of the above stated school-level output variables, added on the output 'average scores obtained in Arts group'. For the school-level analysis of the present study, the included input variables are: (i) Classroom-pupil ratio, (ii) Teacher-student ratio, (iii) Percentage of teachers qualifying master's or higher degree and (iv) Per student monthly expenditure incurred by the school. Revisiting the aspect of deviation of education production function (from the standard), it is relevant to state that in the education production process, prices of output and inputs are absent and hence shadow prices have to be obtained.

For the state-level TEF analysis of Secondary and H.S. stages of education individually, the state is taken into account as the unit of observation. Acknowledging the across-school dissimilarities in terms of the schooling quality in a specific state due to the varied environmental factors, the overall representation of each of the outputs as well as each of the inputs are regarded for the respective state, encompassing the schools within that state. Relevantly, for Secondary and H.S. levels of analysis, the outputs and inputs are taken into account separately. For the state-level segment of analysis of the present study, the data on output and input variables have been obtained from a secondary data source: State Report Cards, Unified District Information System for Education (UDISE). The thorough discussion relating to the methodology of TEF_{out} and TEF_{inp} estimation are provided in Chapter 3 and Chapter 4 respectively.

In light of this scenario, the following objectives are decided for the present study.

1.2 Objective of the Present Study

Since the present thesis is divided into two parts i.e. the state-level analysis segment and the school-level analysis segment, the objectives are considered accordingly and stated below-

In the first part, measurement and determinant analysis of TEF of Indian Secondary and H.S. level of education is to be carried out at the state-level, based on secondary data sources. The time span for the analysis is 2010-11 to 2015-16 and the data sources are UDISE and handbook of statistics, RBI. At the state-level, since GCS and SCS&UT are non-homogeneous, therefore the objectives can be classified as-

- Measuring the extent of TEF_{out} and analyzing its determinants both for GCS and SCS&UT separately.
- Evaluating the extent of TEF_{inp} and the respective determinant for GCS and SCS&UT respectively.
- While estimating TEF_{inp}, the corresponding input slack values are calculated.

In the second part, the analysis of TEF at school-level is to be carried out, based on primary survey data collected through the stratified random sampling method from the government-aided and government schools in Kolkata.

- In this part, TEF_{out} and TEF_{inp} have been estimated, along with the identification of the respective determinants; and input slack values are also measured.
- During the process of student survey, it was noted that the major proportion of the students depend on private tuition at both Secondary and H.S. levels and thus the concern is examining the strength of the role of private tuition in determining TEF_{out} & TEF_{inp} (individually), and accordingly identifying the extent of variation of both TEF_{out} & TEF_{inp} which is not explained by private educational assistance. For this segment of analysis, the primary survey is conducted for the year 2019-20 considering twenty five government-aided and government schools in Kolkata.

1.3 Chapters of the Present Study

Chapter 1: Motivation and Relevance of the Study

Chapter 2: Review of Literature

Chapter 3: Output Efficiency Analysis of Secondary and Higher Secondary Education: An Inter-state Analysis

Chapter 4: An Inter-state Analysis of Input Efficiency of Secondary and Higher Secondary Education

Chapter 5: Analysis of Output Efficiency of government and government-aided schools based on primary survey data: A case study of Kolkata

Chapter 6: Analysis of Input Efficiency of government and government-aided schools based on primary survey data: A case study of Kolkata

Chapter 7: Summary and Policy Suggestions

Chapter 2:

Review of Literature

2.1 Introduction

The relevance of the education sector in the process of national development has been widely recognized among the prevailing literature. Therefore, the existence of the plethora of literature exploring varied aspects of the education sector becomes apparent in the related domain of work. As the present thesis attempts evaluating the performance of secondary and senior-secondary stages of education in the form of estimating technical efficiency and examining the factors affecting efficiency, the review of literature will be restricted in the area of efficiency evaluation of the education sector. In the present chapter, the discussion on prevailing empirical studies along with the theoretical studies relating to output oriented and input oriented technical efficiency measures have been undertaken across various sections of this chapter.

The current chapter unfolds in the following manner: section 2.2 explores the theoretical literature dealing with the notion in regard to technical efficiency (TEF). Section 2.3 discusses the prevailing empirical studies associated with TEF estimation in national as well as international context. Finally, section 2.4 reveals the gaps in existing research and in connection to that, discusses the contribution of present study in filling the voids of the prevailing literature.

2.2 Theoretical Literature dealing with TEF

The perception about efficiency of the decision making unit is distinguished into TEF and allocative efficiency (AEF) (Farrell, 1957). Conceptually, TEF is reflected by the capability of a productive unit either in generating maximum achievable output with the given extent of input involving a particular production technology or in utilizing the smallest extent of input for generating the given extent of output employing a certain technology. In accordance with Lovell (1993), AEF signifies the capability of a productive unit in combining the outputs and inputs following optimal ratios in consideration of the existing prices and technology. Ghose (2017) mentioned that AEF is attained under the condition of the ratio of marginal production of any two employed inputs in the production, equating with respective input price ratio. Since the present thesis is exclusively focussed on the aspect of TEF, therefore for restricting the

review of literature accordingly, the studies specifically dealing with TEF is relevant for consideration in this chapter.

The existing theoretical as well as empirical studies discussed that for estimating TEF of a productive unit, two distinct approaches are existent and referred to as (a) parametric approach and (b) non-parametric approach. The fundamental proposition for estimating TEF score lies in the comparison of the observed performance of the productive unit with the standard of optimum performance as denoted by the production points on the frontier. The parametric approach considers the specific functional relationship between outputs and inputs for the purpose of constructing the production frontier. The literature suggests that Stochastic Frontier Analysis as a parametric approach relies on an econometric method for measuring the extent of TEF. On the contrary, Data Envelopment Analysis representing the non-parametric approach constructs the frontier involving the method of linear programming under a few simple assumptions relating to the process of production and therefore by measuring the distance it measures the extent of TEF.

2.2.1 Parametric Stochastic Frontier Analysis

Regardless of the fact that Koopmans (1951) proposed a formal definition about TEF, however, Debreu (1951) and Farrell (1957) shed the light on how to measure TEF. Following their perspective, TEF is measured by the provision of maximum equi-proportional augmentation in outputs utilizing the given extent of inputs; and this measure can be converted to deducting the maximum value of equi-proportional contraction in all of the inputs, while keeping the output unchanged, from the value 'unity'. Therefore, TEF score representing the value of unity suggests perfect TEF. Any value lesser than unity is a revelation of technical inefficiency. Therefore, alternative orientations - (i) output augmentation (i.e. output oriented approach) and (ii) input conservation (i.e. input oriented approach) are offered for measuring the extent of TEF.

Suppose a deterministic production frontier is represented by f (X_i, t;), which incorporates X_i as a non-negative input vector, β as the vector of technological parameters during the period of observation and 't' as the specific time. In reality, in a particular time period the observed or actual output of i-th productive unit as denoted by say Y_i, may be positioned under the frontier indicated extent of output which is nothing but the 'maximum achievable output' out of the given extent of input of i-th productive unit. This gap may emerge because of the lack of the production ability of labourers or lack of managerial capacity of managers for regulating

the subordinates (Ray, 2004). Relevantly, such a shortfall is a revelation of technical inefficiency of the productive unit.

Considering this, production relationship between output and inputs of i-th unit can be represented as

$$Y_i = f(X_i, t; \beta) .\exp(-u_i),\ldots\ u_i \geq 0 \qquad (2.a)$$

Therefore, i-th productive unit's output oriented technical efficiency measure (TEF_i) as suggested by Farrell, is presented by the expression revealing the ratio between observed (or actual) output and 'highest achievable' (or optimum) output employing the given extent of inputs (and noted in equation 2.b).

$$TEF_i = Y_i / f(X_i, t; \beta) = \exp(-u_i),\ u_i \geq 0 \qquad (2.b)$$

Given the above expression (2.b), TEF_i is inversely related to u_i, indicating that 'u_i' taking a value of zero will generate $\exp(-u_i) = 1$, representing perfect TEF of the i-th unit. For any positive value of 'u_i', a less than 'unity' value of TEF_i will be generated. TEF_i score will lie between zero and unity. Additionally, from an opposite angle, 'u_i' can be viewed as a representation of technical inefficiency.

However, the deterministic framework is associated with the shortcoming of not considering the impact of any random shock on the frontier outcome corresponding to given input level; for example- bad weather, worker's strike or any such unpredictable occurrence which is beyond the discretion of the productive unit. This drawback is tried to be rectified individually by Aigner et al. (1977), Meeusen and Broeck (1977) while introducing a model that includes an additional term 'v' for capturing the random error with the existing random variable 'u' (a non-negative term). In literature, the framework dealing with this process is referred to as the 'Stochastic Frontier Production Function' (SFPF) model where the benchmark frontier is indeed impacted by stochastic variations that are beyond the discretion of the producer.

Accordingly, Stochastic Frontier is represented as

$$Y_i = f(X_i, t; \beta).\ \exp(v_i) \qquad (2.c)$$

Because of the presence of technical inefficiency, the observed or actual output of the i-th productive unit should be less than the frontier output corresponding to the specific input level, therefore the revised form of 2.c is expressed as

$$Y_i = f(X_i, t; \beta). \exp(v_i) .\exp(-u_i) \qquad (2.d)$$

Equation (2.d) represents the presence of error components i.e. 'u_i' and 'v_i' in the framework where 'v_i' is the model specific error component with standard assumption of zero-mean, constant-variance and thereby of normal-distribution; and 'u_i' is the i-th productive unit specific technical inefficiency capturing error component, following the independent distribution from normal, truncated at the value of zero. Additionally, the assumption of 'no correlation' is prevailing between 'u_i' and 'v_i'.

2.2.2 Non-parametric Data Envelopment Analysis

The strength of the non-parametric approach lies in without considering a certain form of production function, the applicability is relying on linear optimization method based on a few feasible suppositions. While adopting this approach, conceptually two orientations can be followed for TEF measurement: (i) output oriented efficiency i.e. TEF_{out} and (ii) input oriented efficiency i.e. TEF_{inp} . Basically, TEF_{out} deals with the comparison of actual output of a productive unit with the highest possible output producible out of the specific extent of input whereas TEF_{inp} deals with the comparison of actual input used by the productive unit with the lowest input requirement for producing the certain extent of output.

A seminal paper by Farrell (1957) discussed the concept as well as computational aspects of benchmark technology and thereby efficiency while developing the method of estimation of efficient production function based on different productive unit's output and input observations under the consideration of constant returns to scale (CRS) and single output assumptions and also applied it to production data. Later, following the effective suggestion by Hoffman (1957) on application of dual simplex technique for obtaining linear programming solution of estimation, Farrell and Fieldhouse (1962) adopted the technique while discussing the solution for efficient production function estimation under the consideration of increasing returns to scale. However, later, for resolving the issue of the objective function, represented in ratio form, Charnes, Cooper and Rhodes (CCR, 1978) illustrated the conversion technique of fractional problem to ordinary linear programming problem by determining shadow prices as weights in absence of market prices of outputs and input of non-profit decision making units (DMU) in multiple-output, multiple-input context (where outputs and inputs are measurable) and thus introduced data envelopment analysis (DEA) for estimating TEF. CCR (1981) based on empirical observations of organizations like schools, evaluated efficiency of public

programmes using DEA in context of multiple output and multiple-input under consideration of constant returns to scale in production.

Basically, the extent of TEF obtained by any DMU rests on the returns to scale assumption. CRS indicates exact proportionate change in output due to change in input while variable returns to scale (VRS) incorporates the possibility of more than proportionate, less than proportionate and exact proportionate change in output as a result of change in output. Relevantly, capacity output does not remain the same between CRS and VRS assumptions. In actual situations, because of several reasons the productive unit may not always produce at optimal scale and hence the assumption of VRS seems more realistic and is prioritized over the restrictive assumption of CRS. Banker, Charnes and Cooper (BCC, 1984) using actual output and input observations of several DMU and assuming (i) all output input combinations that are observed, are feasible (ii) convex set capturing production possibilities (iii) freely disposable outputs (iv) freely disposable inputs regarding the corresponding technology of production, adopting DEA under consideration of VRS assumption, derived frontier representing (i.e. benchmark) extent of output with which observed output is compared for estimating TEF of a DMU.

The present thesis in line with BCC (1984) estimates TEF_{out} and TEF_{inp} of **secondary** and **higher secondary** (also referred as **senior-secondary**) levels of education in the Indian context employing DEA under the assumption of VRS and the elaborative discussions of these studies is contained in the subsequent chapters.

2.3 Empirical Literature dealing with TEF Estimation

Several literatures are existent in the domain of TEF estimation following parametric approach or non-parametric approach and in some studies employing both of the approaches at varied educational stages in Indian context as well as across the global context.

2.3.1 Around the globe studies dealing with TEF following Parametric Approach: The Studies focusing on Education Sector

Adkins and Moomaw (2007) measured TEF of each school district in Oklahoma state for each individual year between 1990-91 and 1994-95 by simultaneously estimating the parameters of frontier production function and the determinants of inefficiency while adopting a stochastic frontier framework, estimated through maximum likelihood estimation technique following the proposed idea of Battese and Coelli (1995). The study used average district test score as output

variable; and instructional spending as well as non-instructional spending per student as input variables. The result reflects that additional expenditures on instructional and non-instructional aspects promote performance of students by a small extent. Additionally, according to the results, TEF of schools are impacted by the size of the school district and teacher's characteristics like, education, salary and experience.

The paper by Pereira and Moreira (2007) evaluated performance and TEF of secondary schools in Portugal adopting the stochastic production frontier analysis. The objective of the paper was discussing the effect of school variables as well as the non-discretionary environment on output variable, represented by the average score at 12th standard in national examination. The findings of the paper reflected the difference in efficiency levels of the schools and also discussed the favourable impact of seniority of the teacher, private school management and size of the school on output variable. In addition to this, the crucial role of locality of the school is also found.

Kempkes and Pohl (2008) departing from the convention of merely inefficiency identification in universities, contributed in investigating the determinants of efficiency at public universities in Germany between the years 1998 and 2003. Particularly, applying the single-stage stochastic frontier model, the impact of institutional settings as captured by university regulations, is examined on efficiency of the university. The result confirmed the significant effect of state university regulation on university efficiency by revealing that the universities which are operating in a relatively liberal legal framework are more efficient in comparison to the universities that function under relatively restricted state rules.

Agasisti and Johnes (2010) evaluated TEF of universities in Italy over the three years period (i.e. 2001-02 to 2003-04) applying the stochastic frontier model. The result provided useful information related to inter-institutional variation in TEF.

Gyimah-Brempong and Appiah (2010) by estimating the stochastic frontier production function for secondary education in Ghana using the panel dataset at school district level, attempted measuring technical inefficiency of the senior and junior secondary schools with the objective of examining the impact of family input on TEF while considering the passing proportion of the students in the district in "West African Examination Council's certification" examination as educational output.

Kirjavainen (2012) estimated educational production function and efficiency of general upper secondary schools in Finland applying different stochastic frontier models on school-level panel dataset for comparing the results of separate models. Average grade in the Matriculation examination of the school is considered as an output variable which is explained by socio-economic status of the students (measured by education levels of their parents and proportion of single parent), comprehensive school grade point average, school resources, average length of the studies and decentralization of the test. Heterogeneity across the schools are taken into account by estimating different stochastic frontier models i.e. fixed effect model, true fixed effect model, random parameter model, random effect model and true random effect model. However, results show that in the estimated models comprehensive school grade point average positively and significantly affects Matriculation examination score. Again, parental education level has a positive and proportion of single parent has a negative impact on performance. According to the results of the models, schools with higher resources revealed poor performance. Next, the paper proceeds to examine the average inefficiency following five different panel data models and results show that average inefficiency of schools varies across different stochastic models. Fixed effect model shows the highest level of inefficiency but considering the true fixed effect model, the average inefficiency level decreases. The level of average inefficiency is lower in both random effect and true random effect models as compared to fixed effect models. Accordingly, the ranking of the school depending on inefficiency level also changes across different stochastic frontier models. Students' achievement is found to be negatively affected by the decentralization of the tests and the length of studies.

2.3.2 Around the globe studies dealing with TEF following Non-Parametric Approach: The Studies focusing on Education Sector

Ray (1991) adopted DEA for the purpose of evaluating the efficiency of public high schools at different district levels in the state of Connecticut. In the second stage, performing regression analysis the study identified the community's socio-economic characteristics at individual districts as non-discretionary factors for describing the variation in efficiency as obtained from the result of DEA, based upon output and school input alone.

Beasley (1995) presented a DEA based approach for jointly measuring teaching and research efficiency levels for the university departments concerning the same subject under the condition of input resources being shared between teaching and research activities in the department. The paper claimed a wide applicability of this approach though it specifically

applied this approach for determining the results of teaching and research efficiencies for physics and chemistry departments of the universities located in the United Kingdom.

Johnes and Johnes (1995) using DEA examined TEF of research activity of economics departments at universities located in the U.K. considering external funding of research as an input in the process of research. The paper used a similar type of data set as used by university funding council research in the year 1989. The paper finally shed the light on the favourable contribution of DEA in developing reasonable indicators of the performance of universities.

Mancebon and Bandres (1999) estimated the efficiency of Spanish public secondary schools, selected through sampling, applying DEA while specially discussing the theoretical specification of measurement models. The study reflected the characteristics that are setting apart the schools, performing with most efficiency from those performing with least efficiency. Essentially, the study shed the light on the importance of completing the information as provided by the quantitative method like DEA with incorporation of the qualitative information.

Portela and Thanassoulis (2001) proposed DEA for decomposing the overall efficiency estimate as attained by the pupil. Accordingly, the under-attainment of the pupil is decomposed, in the paper, into the elements attributable to the student and to the school and also the nature of the funding system under which the school is functioning.

Avkiran (2001) estimated relative efficiency of the universities in Australia for the year 1995 from the perspectives of three types of performances while developing different DEA models like, overall performance model, performance on education services delivery model and performance on fee-paying enrolment model where each of the three models incorporated distinguished output measures from different perspectives though using the same input variables in these models. The results based on TEF and scale efficiency estimates indicated good performances of the university sector in Australia and also revealed less input-capacity underutilization. The decomposition of TEF reflected the fact that the majority of universities operated under decreasing returns to scale and therefore institutional downsizing was signalled. However, the provision of improvement in fee-paying enrolment related performance was evident from the results. Since the result of the paper based on DEA pointed out the reference set of inefficient universities, the improvement in performance was suggested for such institutions.

Abbott and Doucouliagos (2002) applied non-parametric technique i.e. DEA for evaluating TEF as well as scale efficiency measures of the Victorian Technical and Further Education Institutes for a single year 1995. The results of this paper clearly indicated the provision of improving TEF for these educational institutes; and the variations in scale efficiency and TEF estimates were also evident. As a following step, the paper tried to examine the determinants of efficiency score variations across these institutes while carrying out the regression analysis and the result represented the favourable impact of class size, provision of staff training programs and negative impact of the provision of child-care, access for the disabled on TEF.

Abbott and Doucouliagos (2003) employing DEA and using various output and input measures, estimated scale efficiency and TEF of public universities in Australia for the year 1995. The findings of the paper revealed that in any case of output and input mixture, the universities in Australia are functioning with a high extent of efficiency relative to each other, though the provision of improving the performance was evident for some of the universities.

Flegg et al. (2004) with the objective of evaluating relative efficiency of forty five British universities over the time span 1980-81 to 1992-93, applied non-parametric technique, DEA. Due to the considerable changes in student-staff ratio as well as public funding in universities during 1980-81 to 1992-93, the period was selected as the reference period of this study. Though the findings of this paper reflected the substantial extent of increase in average TEF score (calculated by weighted geometric mean) during the reference period, the rise between 1987-88 and 1990-91 was even more prominently observable.

Ferrari and Laureti (2005) estimated TEF, particularly the output oriented measure of efficiency of human capital creation in university of Florence for the year 1998 while applying DEA and using a set of several output and input measures. Relevantly, the paper modelled human capital creation as a process of production while the students had been considered as the units of production since using inputs like teachers, books and classroom the students could produce themselves graduates. Finally, the result suggested a very high level of overall efficiency among 1998 graduate students at the university of Florence.

Afonso and Aubyn (2006) analyzed the efficiency of secondary education systems of twenty five (mostly OECD) countries employing the two-stage semi-parametric method. The paper initially measured output-oriented efficiency scores considering one output and two input variables and solving DEA problem under the consideration of VRS assumption. As an output variable, the paper incorporated the PISA 2003 performance indicator (capturing average

performances of fifteen year old pupils) for each of the selected countries, and considered 'teacher-student ratio' and 'time spent at school' as input variables. Subsequently, the paper attempted explaining the output efficiency scores by considering non-discretionary/ environmental variables as the regressors in the regression model while adopting the Tobit model and two algorithms (single and double) of bootstrap procedures for investigating the robustness of the regression results. The findings of the paper represented that among all selected nations, Korea, Finland and Sweden turned technically efficient and on average the countries could raise the extent of output by utilizing the same extent of inputs. The result of the second stage, following both Tobit and two algorithms of bootstrap procedure, confirmed the favourable and significant roles of per capita GDP and adult attainment of education in improving efficiency.

Johnes (2006a) for examining the impact of choice of technique on the performance measure of the UK universities, applied DEA and multilevel modelling using the information of 54564 graduate students from UK universities in the year 1993. Adopting the methodology as proposed by Thanassoulis and Portela (2002), individual efficiency score of the student had been decomposed into elements where one is caused by the individual (i.e. student) and the other is caused by the university (of the student's enrolment) which is (i.e. the element mentioned later) again utilized for measuring teaching efficiency of the university. Considering four broad fields of study, namely, pure science, social science, applied science and arts, the result of comparison reflected no strong association between university rankings based upon DEA (efficiency) score and university rankings depending on university effects of multilevel models. The findings of the paper also suggested no correlation between university efficiency level and individual-level efficiency as indicated by DEA score.

Johnes (2006b) exploring the merits and demerits of several alternative methods, for measuring efficiency of higher educational institutions like universities, supported the choice of DEA due to its ease of handling multiple outputs and multiple inputs. The paper illustrated the application of non-parametric DEA approach using the data on approximately hundred universities in England for estimating efficiency for the year 2000-2001. The findings of the paper suggested, on an average, a high level of TEF and scale efficiency of the higher education sector in England. Relevantly, the paper considered the significant outputs like, the quantity and quality of undergraduate degrees, the quantity of postgraduate degrees and research and the significant inputs like, the quantity of postgraduates, administrative expenditure, quantity and quality of

undergraduates, the value of interest payments and depreciation in the process of higher education production in England.

Waldo (2007) measured and analyzed TEF of Swedish public education focusing on the compulsory stage, applying the DEA for the year 1999-2000. The result reflected the variation in mean efficiency levels across different municipalities, indicating the provision of reduction of inputs (by 8-12 percent) while not reducing the output. For explaining the efficiency score differences, in the second-stage Tobit regression is performed taking into account 'local political context whereby the education is provided' and 'competition from private school' as explanatory variables. The findings revealed the impact of political majority in the city council on efficiency though no relation was found between efficiency and the private schools' competition.

Gimenez et al. (2007) conducted a cross-country study on efficiency analysis of education systems of thirty one nations for a specific year, 1999 by applying DEA. The result of TIMSS had been incorporated as internationally comparable data on educational output (considering the mathematics and science knowledge of eighth year school students), for carrying out the analysis of the paper. In multiple output and multiple input framework, the result of estimated overall TEF reflected that some Asian and former communist nations, like, Russian Federation, Chinese Taipei, Hungary, Singapore, the Republic of Korea, Jordan, Thailand, Macedonia, Tunisia and South Africa possessed efficient education systems. Additionally, the findings of the paper revealed that some developed nations, like, Australia, The United States, New Zealand and Canada turned inefficient as these nations failed in achieving the expected standard of academic outcomes, in spite of holding the greater resource allocation to the respective education system.

Kao and Hung (2008) with the objective of investigating whether the inputs are utilized efficiently for producing output in forty one departments of National Cheng Kung University in Taiwan, employed DEA while considering class-teaching load, external grants, publications as the output variables and expenses, personnel, floor space as the input variables that had been utilized by the departments as decision making units. The result of relative efficiency scores helped in identifying the set of inefficient departments at which improvement is needed in terms of input utilization. Specifically, for pointing out the areas where the highest gain is possible by enhancing efficiency, the paper conducted the decomposition analysis of aggregate efficiency measures.

Tajnikar and Debevec (2008) applied DEA to evaluate the relative TEF of the members of University of Ljubljana in Slovenia for 2004-05 and 2005-06 years of the study. As mentioned by the paper, the higher education institutions in Slovenia are classified into several study groups based on the operational expenditure associated with the particular field of the education and accordingly for each study group the certain study group factor (SGF) i.e. the weight by which public funding is received by the institution belonging to the particular study group, is decided. On this ground, the paper tried to examine whether the members of University of Ljubljana, classified into different SGF, show different levels of TEF or not. The findings of the paper revealed that the average TEF of the members of University of Ljubljana belonging to different study groups differ largely, stating about the non-homogeneity of the study groups if reflected in terms of TEF. However, the result revealed inaccurate creation of the group in addition to the inappropriate institutional classifications as the evidence of relatively less efficient institutions receiving more funds (because of belonging to a particular group) is observed and vice-versa.

Agasisti and Bianco (2009) employed DEA to empirically evaluate the teaching efficiency of the universities located in Italy for each particular year between the time span 1998/99 - 2003/04 in order to examine the impact of teaching reform, introduced in Italy in the year 1999, on the efficiency measures of the Italian universities during the reference period. For measuring the output-oriented efficiency, the paper considered the output 'graduates' and incorporated the inputs like, professors, students and facilities. The findings of the paper revealed an improvement in efficiency for the whole system of higher education in Italy between the reference time interval.

Agasisti and Johnes (2009) estimated TEF of English and Italian higher education institutions by applying DEA and the findings of estimated efficiency for higher education institutions in these two countries as obtained on the basis of country-specific benchmark production frontier indicated that these institutions were highly efficient in both of the countries. However, the result of estimated efficiency, obtained on the basis of the benchmark frontier constructed with pooled observations from both the countries for comparing the performances jointly, indicated that the English higher education sector operated more efficiently than the Italian higher education sector. Finally, the pattern of change of efficiency score between the years 2002-03 and 2004-05, reflected the improvement of TEF level in Italian universities while showing the stable level of TEF of English universities over the time span.

Cokgezen (2009) applied the DEA approach for measuring TEF of the faculty of Economics at the private and public universities in Turkey. The result, in an overall sense, represented low efficiency levels of the faculties of Economics though the variation across these units was found as high in Turkey. The comparative analysis of TEF scores between private and public institutions, reflected on an average a relatively higher efficiency level in favour of public institutions under the condition of not considering the quality of data while after considering the output quality, the reduction in gap, between average efficiency scores obtained by private and public institutions, was evident.

Naper (2010) empirically investigated the causal relationship between 'hiring practices of the teachers' and educational efficiency in the school districts of Norway. The impact of hiring practices on the level of efficiency is examined using a Tobit regression model in which educational efficiency, as estimated by DEA, has been treated as a regressand and in the model the heterogeneity of school districts is captured by including observable characteristics of these school districts. The result indicated that the efficiency of those school districts were found to be higher where the teachers had been hired by the principal of the school following the decentralized process than those school districts which followed the centralized hiring process of the teachers. For avoiding the possibility of the correlation between estimated educational efficiency and unobserved characteristics of school districts and thereby the biased Tobit estimates, the paper carried out a second approach at school-level allowing for heterogeneous treatment effect for each individual school and the result indicated that the effect of decentralized hiring is even more stronger in case of those schools having excess teacher supply in comparison to those schools without any excess supply.

Alexander et al. (2010) measured efficiency and examined its determinants for the secondary schools in New Zealand while conducting the two-stage analysis i.e. the first stage DEA is followed by regression analysis in the second-stage. Departing from the convention of 'semi parametric' procedure, double bootstrap procedure as suggested by Simar and Wilson (2007) is used for providing valid statistical inference where unknown serial correlation in efficiency levels is existent. The result of the paper revealed that (formerly private) integrated schools were more efficient than state-owned schools and also girls' and boys' schools were more efficient than co-education schools. The factors explaining the difference in school efficiency have been identified in the regression analysis, revealing the positive impact of teacher's qualification and experience and negative impact of socio-economic deprivation.

Cherchye et al. (2010) applied nonparametric-technique, DEA for evaluating equity as well as efficiency in education at student level. The paper as an aggregation criteria advocated two multidimensional stochastic dominance criteria (where the first considers only efficiency and the second considers the aspect of equity as well) for comparing the public and private school's performances in Flanders. The findings of the paper suggested that after controlling for school environment and considering equity, no evidence of robust dominance of any type of school is found. Additionally, the paper discussed the usefulness of the nonparametric technique that included environmental and equity aspects in order to obtain fair performance comparisons.

Bradley et al. (2010) for measuring and analyzing efficiency of two hundred further education providers in England over the duration 1999–2003, used DEA. The findings of this paper reflected an overall improvement in efficiency level for the further education sector as during the five year interval the mean efficiency level of the providers changed between 83 and 90 percent, though amongst the individual institutions the large extent of variation in efficiency level was observed. Subsequently, a multivariate analysis was conducted with the purpose of identification of the determinants of efficiency and the result indicated more relevance of student-relating variables (like gender, ethnic & age mix) than that of the staff-relating variables in determining the level of efficiency. Additionally, the rate of local unemployment was found to have influence on the efficiency level of the providers. Finally, the paper suggested the policies which include implementation of the strategies for increasing achievement and completion rates of white male and improving administrative support to teachers.

Agasisti (2011) in order to conduct across the countries comparison of performance of higher education systems, estimated and analyzed the efficiency of tertiary education in European countries applying nonparametric technique, DEA and using OECD data-set. The findings of the paper represented perfect efficiency of Switzerland and the United Kingdom in production of tertiary education and also a crucial role of the public sector was found in determination of efficiency scores. Relevantly, a semi-parametric approach was employed in the paper for explaining efficiency variation across the countries in Europe.

Thieme et al. (2012) evaluated TEF of national school-education systems taking into account fifty four nations as DMUs, employing non-parametric frontier model and using the information on internationally standardized test- PISA 2006. The paper included students' 'reading achievement' & 'average achievement in mathematics and sciences' as two desired

output variables and ‘average inequality’ in education as undesired output variable. The inputs are determined through factor analysis on resource variables and resulting two input factors are termed as ‘educational resources factor’ and ‘human resources factor’. The findings of the paper revealed that among all the sample countries, the education system was observed as efficient only in thirteen countries. Further, considering overall results, the paper stated that in the education system inefficient management of resources (i.e. technical inefficiency) had been found as a severe problem. Finally, the continent-wise classification of the result reflected the most technical inefficiency in European countries and in some of the Asian countries.

Cunha and Rocha (2012) employed DEA to estimate relative TEF at public higher education institutional level after segregating these institutions into three categories like, different faculties of University of Porto, public polytechnics and public universities in Portugal for the year 2008. Based on the institution type specific outputs and inputs, the efficiency scores were obtained for each institution exclusively under each of these three categories, after forming each category specific benchmark frontier. The results of the paper pointed out the efficiently performing higher education institutions for each category and hence also reflected that a larger portion of institutions in Portugal was not achieving TEF in higher education production implying the resource wastage in a significant amount in this sector. According to the paper, the importance of such exploration lies in the formation of the basis for further study on the determinants of TEF relating to the higher education sector in Portugal.

Aristovnik (2013) using DEA technique, empirically measured relative TEF of the education sector at different levels across the majority of European Union (EU) (plus Croatia) and OECD (the Organization for Economic Co-operation and Development) countries based on the average data during the period 1999-2007. For examining whether utilization of the public expenditure on education was technically efficient or not, output oriented efficiency estimates were obtained by considering several outputs and inputs at various levels of education across the reference countries. The empirical findings of the paper represented Japan, Finland and Korea as the most technically efficient OECD countries concerning the education sector and Hungary, Estonia and Slovenia as the benchmark efficiency performers amongst Eastern European countries considering primary, secondary and tertiary education levels respectively. In an overall sense, Eastern European countries indicated a comparatively high level of TEF concerning tertiary education.

Cuellar (2014) using the cross-country data on fifteen Latin American countries, assessed efficiency of public spending in secondary and primary schools for each country during the period 2000-2009, applying both Free Disposal Hull (FDH) and DEA as nonparametric approaches. In respect of per student public expenditure on education the output measures in secondary as well as primary schools were evaluated. Additionally, in order to point out the best practices, in the case study the efficiency scores of Colombia at each level of education were compared with the respective most efficient peers.

Blackburn et al. (2014) applying DEA estimated efficiency of secondary and primary schools in Australia. To rule out the possibility of biased efficiency measures arising due to the prevalence of different socio-economic environments (resulting in inappropriate comparison), the paper employed a conditional estimator which does not permit any school to represent the benchmark for the other school if both of the schools do not belong to the same environment. The findings of the paper suggested moderate inefficiency levels in Australia schools and for the quintile of schools operating in the most advantageous environment, efficiency was found to increase. Additionally, improvement in efficiency with the increase in enrolment was also evident in the paper.

Arshad (2014) assessed TEF of secondary education in sixteen sample "Organization of Islamic Conference (OIC)" countries employing DEA method on TIMSS (Third International Mathematics and Science Survey) data for the year 2011. The findings of the paper indicated technical inefficiency of selected OIC countries in educational resource utilization for achieving TIMSS outcomes when comparing such countries' efficiency performances with the performance of non-OIC countries. The result of technical inefficiency at secondary education, obtained for OIC countries did not alter even after adjusting for environmental factors.

Bogetoft et al. (2015) evaluated input efficiency of education relating to the upper secondary level of schools in the Northern countries of Europe and compared such performances with that of the relevant wealthy OECD countries by applying several DEA models and considering several output and input specifications for the year 2010 since in Northern countries of Europe public spending on education has been found to be very high and thus it is leading to the question of efficiency of education sector. In a purely quantitative DEA model where as an output total number of students enrolled and as an input total expenditure were taken into account at various levels, Finland was found as perfectly efficient in most of the model specifications. In the other type of model specification with graduation rate, upper secondary

education completion rate as the quality measures of output and expenditure per student as an input, the finding revealed that Finland had been perfectly efficient (or close to that) whereas Denmark and Norway had been inefficient (reflected by large saving potential) in the view of education production. However, all Nordic countries had been found as perfectly efficient in a model where as an output, upper secondary students' expected income level after completing education (employment corrected) was considered for representing a more comprehensive quality of output along with the input, 'expenditure per student'.

Barra and Zotti (2016) employed DEA for measuring TEF of Science and Technology sector and Humanity and Social Science sector of a big public university particularly focusing on the two major activities i.e. research and teaching, during the time span 2005-2009. Additionally, the paper dealt with different output specifications. The empirical findings revealed that in relation to the research activities, the TEF of Science and Technology sector was comparatively higher than the Humanity and Social Science sector while with respect to the teaching activities, the Humanity and Social Science sector was found to be more technically efficient than Science and Technology sector.

Haug and Blackburn (2017) applied DEA for estimating efficiency across the government secondary schools in New South Wales state of Australia over 2008-2010. Applying Simar and Wilson (2007) double bootstrap procedure (in two stage DEA), the result of the paper revealed that the schools with lesser count of total students, more years of service-experience of teachers, larger proportion of special education students enabling to attract the additional funding from government and also the schools functioning with only girls students are relatively more efficient in comparison to other schools. Additionally, the empirical findings of the paper indicated the favourable impact of greater prior achievement on the academic achievement of the students, though no such influence of student's socio-economic status was observed on student's achievement in this paper.

Gavurova et al. (2017) estimated relative efficiency of the expenditure incurred on secondary education by the government applying DEA technique under the consideration of VRS assumption, following the output-oriented efficiency measuring approach in European countries for a single year, 2015. Before proceeding to the DEA analysis, the paper analyzed International Monetary Fund-published data on government expenditure and OECD-published information on PISA indicators, as a representation of education quality. The result of the paper on an average reflected a high level of efficiency across the evaluated counties.

Wolszczak-Derlacz (2017) evaluated TEF of several public European and American higher education institutions over the years 2000-2010 applying DEA, incorporating several sets of output-inputs and constructing distinguished frontiers i.e. country-specific frontier, regional frontier and global frontier. Relevantly, the paper examined the impact of institutional structure, funding arrangement and location on the extent of inefficiency of higher education institutions. The empirical findings of the paper suggested that matured higher education institutions in Europe (on an average) were comparatively more efficient though no such evidence was found for American institutions. Additionally, an unfavourable impact of government funding on the efficiency level of the universities was observed in Europe; however, such a finding was not confirmed in case of the U.S.

Ciro and Garcia (2018) employed two-step DEA for estimating public education expenditure efficiency focusing on secondary level across thirty seven developing and developed nations over the time span 2012-2015. Based on the two diverse frontier models, out of which one considered the physical input (i.e. the teacher-student ratio) and the other considered the monetary input (i.e. the spending levels), the findings of the paper revealed that Australia, Finland, Japan and Belgium appeared as efficient counties under consideration of both frontier models. Additionally, the paper represented the provision of improving educational output with the existing extent of inputs, considered in physical and monetary forms, in the developing nations. However, the physical frontier model relatively favoured the efficiency performance of developing nations while the other way round was found to be true for developed nations. Finally, the paper represented the roles of parental education and income while explaining efficiency under both the structures of the models.

Sotiriadis et al. (2018) estimated TEF of senior secondary schools in the central Macedonian region in Greece while adopting input-oriented approach of DEA method under consideration of CRS and VRS assumptions for the year 2007-08 (before economic crisis in Greece) and 2010-11 (during economic crisis). The paper, while estimating TEF, involved two output variables: the average marks in the third grade courses of senior secondary school and the count of the students achieving admission to higher educational institutions by national examinations; and three input variables: number of teachers, public expenditure and number of students. Data on these variables were collected from ninety two sample schools out of the total population schools, following proportional stratified sampling technique and since the population schools were categorized in urban schools and rural schools, sub-samples were selected by simple random sampling from each category. The findings of the analysis revealed inefficiency in the

majority of the schools and also reflected an improvement in mean TEF level from the before economic-crisis situation (i.e. 2007-08) to during crisis situation (i.e. 2010-11) under the consideration of both CRS and VRS assumptions.

2.3.3 Around the globe studies dealing with TEF following both Parametric and Non-Parametric Approaches

Chakraborty et al. (2001) estimated TEF of public school districts in Utah using both stochastic and non-stochastic DEA approaches for empirically illustrating the variation in efficiency levels following these two approaches. The paper measured TEF in a single output and multiple input framework based on the data of forty school districts in Utah for the academic year 1992-93. In the paper, stochastic specification estimated efficiency under the assumption of half normal and exponential distributions whereas the non-stochastic specification used the DEA approach. The results revealed that the highly technically efficient districts in stochastic estimation turned less efficient after adopting the non-stochastic DEA approach. The possible reason could be that in the stochastic specification, a deviation of the production function from the maximum can be represented as the sum of a random component and the inefficiency component but in case of DEA the deviation of the production function from the frontier can be regarded as inefficiency (and not allowing for randomness). Hence, the school districts that contained a relatively large random component as compared to the inefficiency component, appeared as highly efficient under stochastic specification but in DEA these school districts turn less efficient.

Mizala et al. (2002) estimated TEF of two thousand schools in Chile following two different methodological approaches: the parametric stochastic frontier and nonparametric DEA, for evaluating the robustness of the result. Efficiency analysis of this paper used the data of fourth standard students of sample Chilean schools for the year 1996. The results of TEF of the schools were presented after classifying the schools by type i.e. private fee-paying, private subsidized and public schools and following both the methods. In this paper, DEA results reflected a wider range of efficiency as compared to the range of efficiency, measured by the stochastic frontier methodology. However, following both the methods a similar ranking of schools based on efficiency levels had been found. Both of the methods also reflected the existence of significant difference in TEF between private fee-paying schools and other types of schools though the stochastic frontier method revealed a lesser difference in TEF between private subsidized schools and public schools than what was displayed by DEA. On the grounds

of mostly the same conclusions of the analysis following two alternative methods, the paper mentioned some severe limitations of using the parametric approach.

Barbetta and Turati (2003) analyzed the efficiency of 497 schools in the piemonte region of Italy applying both Stochastic Frontier and Data Envelopment Analysis after classifying the schools into public, private non-profit and private for-profit schools. In the subsequent stage of the analysis, the paper represented the influence of proprietary structure in explaining the level of efficiency. The result of the paper revealed that public schools were less efficient than non-profit schools but more efficient than for-profit schools. Additionally, the unfavourable effect of disabled and foreign students were observed on efficiency; school size was also identified as another determining factor of the level of efficiency.

Mcmillan and Chan (2006) evaluated efficiency scores of the universities, located in Canada, applying both DEA and stochastic frontier models under certain specifications with the objective of comparing the efficiency measures following the divergent methods. The result reflected the variability of efficiency scores of the universities under two methods, though the rank analysis based on the relative position of each university across the entire set under divergent methods confirmed consistency of ranking.

Rassouli-Currier (2007) empirically measured the efficiency scores of public school education across Oklahoma school districts while employing two methods i.e. DEA and stochastic frontier regression. In this paper, the findings revealed that efficiency scores under the two methods were not identical for the majority of school districts in Oklahoma. Further, the district-specific socio-economic factors were identified as the major determinants of inefficiency following both the methods.

Kempkes and Pohl (2010) employed both DEA and stochastic frontier methods for analyzing relative efficiency of seventy two public universities in Germany during the period 1998-2003. The finding of the paper suggested the better relative efficiency results of West German universities based on the average efficiency score over the referenced period.

Johnes (2013) dealt with the aspect of efficiency of English higher education over the thirteen-year time span applying DEA and stochastic frontier analysis for measuring output distance function while including the measures of research and teaching inputs and outputs. The paper attempted comparing the efficiency results as obtained from the varied estimation technique

and the empirical evidence were utilized for guiding researchers and policy makers, dealing with the study on efficiency.

2.3.4 Studies dealing with TEF Estimation in context of Education Sector in India

The existing studies, dealing with TEF measurement and analysis of the education sector in Indian context referring to different time points are very scant.

Kingdon (1996) empirically represented the relative quality and TEF aspects for two separate institutional setups of school education relating to the urban region in Indian context (i.e. public and private schools) based on the data of Uttar Pradesh. The result of the paper revealed that private school students' raw achievement (on average) advantage in comparison to that of the public school students, actually declined with standardized home-background and for controlling the selectivity of sample though it had not been completely eliminated. The paper further added that due to the lower level of unit cost associated with the standardized achievement advantage in private schools, these schools became relatively more technically efficient.

Sankar (2007) applied DEA for evaluating the efficiency of elementary education production in India using various models and considering the Indian state as the unit of observation and also referring to the time: mid 1990s and 2004-05. The findings of the paper reflected that all the efficient states were not better performing states in respect of educational outcome. The paper cited the examples of the states like Bihar, Uttar Pradesh, Madhya Pradesh and Jharkhand which were the lagged behind states in respect of educational outcome, though operated efficiently due to the aspect of efficiency, showing whether the existing inputs in the production process producing maximum output or not; and hence the efficient unit, showing best utilization of inputs, indicated no possibility of further improvement in the extent of educational output given the existing extent of input. Therefore, for improving educational output in these states, the paper suggested the requirement of increasing investment on inputs. On the contrary, the result also reflected that all better performing states in respect of educational outcome were not necessarily efficient and therefore, the paper suggested better utilization of inputs in use in these types of states rather than increasing more investment. Subsequently, while examining the factors of efficiency levels, the paper revealed that the majority had remained unexplained, though the significant role of density of population was observed in some regressions.

Tyagi et al. (2009) employing DEA on the dataset of three hundred and forty eight elementary schools in the state of Uttar Pradesh, India, estimated TEF as well as efficiency differences for the referenced schools. For TEF estimation, the paper included three outputs like, average marks in mathematics, language, environment studies (each obtained school-wise) and eight inputs, some of which were related to resources of the school like, teaching service, teachers' quality, physical resources and ancillary facilities while some other inputs were related to home-background of the school students like, parental education and profession. These outputs and inputs were constructed using Principal Component Analysis and several models based on output-input mixes and CRS assumption, had been used for evaluating the performance of elementary education at school level. The findings of the paper reflected a lower percentage (19.25%) of total schools operated efficiently and a range of variation in efficiency level was also observed.

Sengupta and Pal (2010) using district level DISE data analyzed the efficiency of primary education in Indian context focusing on a single year 2005–06, following the application of DEA after classifying India into several zones like, Western, Northern, Eastern, Southern, and North-eastern districts. Relevantly, the paper recognized some fundamental aspects relating to education, such as deprivation aspects, policy aspects and social aspects and formed the grand poverty index consisting of varied poverty indicators relating to education in India by applying the formula (dealing with multidimensional perspective) of the Human poverty Index (HPI) proposed by Anand and Sen in 1997 for relating the resulting index with the level of efficiency as obtained from DEA. The findings of the paper revealed high efficiency of eastern districts while the low efficiency values of western districts. Further, the results reflected that the efficiency was adversely influenced by poverty indicators though no significant impact of policy and social indicators were found on efficiency enhancement.

Sengupta and Pal (2012) evaluated efficiency of primary education for the year 2006 in Burdwan District of West Bengal, repeating the same approach as Sengupta and Pal (2010).

Dutta (2012) measured TEF and efficiency differentials of elementary education in India at the state level applying DEA and conducting regression analysis. The paper incorporated output variables like, enrolment rate, completion rate of the respective level of education in 2007-08; and dealt with the input variables like, percentage of full-time teachers, percentage of population having access to upper primary school within three to five km distance and primary school within one km. The result represented that Kerala, Delhi, Nagaland and Tamil Nadu

were efficient states with great achievement levels. However, Uttar Pradesh, Bihar, Odisha and Madhya Pradesh states reflected lower educational outcomes, though with the inputs in use, such states could enhance a limited level of output and hence for these states the paper suggested more investment by the government for offering the adequacy of inputs. Relevantly, the paper performed simple regression analysis for examining the determinants of efficiency.

Purohit (2015) adopted stochastic frontier analysis for evaluating efficiency in enrolment specifically at primary as well as upper-primary stages in private and public schools across different districts of Rajasthan during the time span 2008-2012 and also tried to investigate the reasons behind efficiency differentials. The findings of the paper revealed significant roles of urbanization and income along with the favourable role of direct educational intervention in improving enrolment at the respective level of education. The paper also suggested addressing the district specific gaps for formulation of suitable policies in order to improve outcomes.

Mohapatra (2015) evaluated TEF of secondary education of twenty three Indian states by adopting the non-parametric model under the consideration of CRS assumption and including two educational outputs and five inputs for a single year, 2010–2011. The result revealed perfect efficiency only for ten states while the remaining thirteen states indicated inefficiency in secondary education production.

Ghose (2017) evaluated TEF of primary and upper primary stages of education in the context of India over the time span 2005-06 to 2010-11, applying DEA method on state-level data. The DEA analysis comprised meta frontier as well as group frontier analysis while the later was based on construction of separate frontiers for two distinguished groups i.e. general category states and special category states & union territories. Additionally, Technology closeness ratio representing group frontiers' adjacency to meta frontier, was also computed in the study.

Singh et al. (2018) evaluated relative efficiency of various state boards of Indian higher secondary education for the year 2013, using non-parametric estimation technique. In this study, efficiency levels of each DMU were estimated following an integrated approach of non-parametric DEA and artificial neural network considering five outputs and three inputs, obtained from the statistical report of the ministry of human resource and development, India. Input-oriented CCR model was employed in the paper for efficiency estimation of twenty two state boards of higher secondary education, treated as DMUs; and efficiency scores were reported under consideration of both CRS as well as VRS assumptions. The findings of this

paper pointed out the efficient and inefficient state boards of higher secondary education in India.

2.4 Gaps in Existing Research and the Contribution of Present Study

The exploration of existing literature in the domain of TEF relating to the education sector, shed the light on inadequacy in the literature dealing with TEF aspect (specifically) of secondary and higher-secondary levels of education at the state-level in Indian context. In addition to this, the study of TEF analysis relating to secondary and higher-secondary stages predominantly based on primary survey data, collected at school-level, is even more limited. Therefore, the gap prevails in the existing studies, relating to the estimation and determination of TEF in secondary and higher-secondary stages of education at the Indian-state-level after classifying Indian states & union territories into two categories based on the differences in fiscal condition of the states. Additionally, the gap is also existent in the literature, relating to the detailed determinant analysis of TEF (of secondary and higher-secondary stages) at school-level specifically incorporating the variables capturing students' socio-economic status and students' opinion regarding school attributes in Indian context, using primary survey data. The present thesis intends to fill the voids in the existing studies and contributes to the related domain of the literature mitigating such gaps in the following manner:

First of all, diverging from the prevailing literature, the present thesis based on secondary dataset, contributes by not treating all Indian states & union territories as homogeneous units because of the fact of these units operating under the distinguished fiscal as well as economic environment and hence these states & union territories are segregated into the categories, referred to as general category states (GCS) and special category states & union territories (SCS&UT). Accordingly, focusing on secondary and higher-secondary stages of education, TEF estimation and subsequently examining the determinants of estimated TEF at Indian-state-level is not conducted on the basis of a single frontier; instead, segregated frontiers i.e. one for GCS and other for SCS&UT, are constructed for TEF estimation as well as the affecting factors determination of TEF at state-level in India based on secondary dataset from 2010-11 to 2015-16 and employing DEA.

Secondly, while performing the regression in the subsequent stage of the secondary dataset based TEF analysis of the present thesis, the infrastructural variables relating to schools, policy indicator, social indicators and macro indicator are taken into account for identifying the determinants of TEF of secondary and higher-secondary education levels. The substantial

contribution of the present thesis lies in investigating the individual effect of each explanatory variable included in the determinant analysis instead of constructing the composite index for every broad category of indicators which was earlier executed by Sengupta and Pal (2010, 2012). However, for the purpose of specific policy designing to enhance the level of efficiency, individually identifying the affecting factors of TEF plays a central role.

Thirdly, for mitigating the gap in the literature relating to TEF analysis at school-level in Indian context, a segment of the present thesis estimates TEF of secondary and higher-secondary stages of the schools based on primary survey data, collected following stratified random sampling method from twenty five government-aided and government schools located in Kolkata for 2019-2020 and also determines the affecting factors of resulting TEF scores at both the stages of school education.

Fourthly, during the process of data collection it is noticed that the majority of the students are dependent on the educational assistance received from private tuition which may in turn inflate TEF score attainment of the schools at the respective educational stage. Therefore, the concern of the present thesis is obtaining that extent of TEF variation in these schools which is not explained by private educational assistance. The exploration of such an extent (of variation) has not been attempted in the existing studies dealing with TEF of school education till date, to the best of our knowledge.

Fifthly, the present thesis contributes by filling the existing voids in the prevailing literature in Indian context, relating to the detailed determinant analysis of TEF (of secondary and higher-secondary stages) at school-level using primary survey data, specifically incorporating the aspects like (a) Percentage of students receiving private educational assistance; (b) Government policy; (c) Teacher's Characteristics (Adkins and Moomaw (2007)); (d) School Characteristics (Bradley and Taylor (2002); Andrews, Duncombe and Yinger (2002); Driscoll, Halcoussis, Svorny (2003); Krueger (2003); Newman et al. (2006); Leithwood, Jantzi(2009)); (e) Socio-economic condition of the child (Ray(1991)); (f) School managerial role of Head of the school / HM (Masci, Witte and Agasisti (2018)); (g) Characteristics of the head of the school (Masci, Witte and Agasisti (2018)); (h) Student's perception regarding school attributes. Though individually a single/ a few of these aspects had been taken care of while exploring the determinant analysis of TEF in the prevailing research work across the globe (as supported by the references, cited above), considering all of these crucial aspects together (i.e. from (a) to

(h)) in explaining TEF has not been attempted so far in Indian context, to the best of our knowledge and the present thesis contributes following this direction.

Sixthly, since West-Bengal government is pursuing 'Kanyashree Prakalpa' which is originated by the Department of Women Development and Social Welfare of West Bengal government to conditionally transfer cash to girl students for encouraging schooling of teenage girls and delaying their marriages till the age of 18 aiming to enhance their wellbeing and status, the present thesis contributes to the literature while investigating the influence of this policy intervention on TEF attainment of the school.

Analyzing TEF and its determinants focusing on secondary and higher-secondary stages at Indian-state-level after segregating two state categories during a time span, basically assists in recognizing those states & union territories that are underperforming in relation to the standard (benchmark) TEF and accordingly the relevant policies can also be framed and implemented in order to enhance the level of TEF in these states. In addition to this, the school-level analysis of TEF assists in finding out the percentage of schools performing unsatisfactorily and also designing suitable policies for such poor performing schools. Essentially, because of the relevance of private tuition in school-level analysis of TEF, obtaining that extent of TEF variation in the schools which is not explained by private educational assistance is actually the revelation of the extent of contribution of the private tuition in TEF score attainment by the schools. As these crucial issues had not been addressed in the previous studies, should be dealt with thoroughly.

Chapter 3:

Output Efficiency Analysis of Secondary and Higher Secondary Education: An Inter-state Analysis[1, 2]

3.1 Introduction

Cultivation of human knowledge has been brought up into existence through the advancement of the education sector. In order to reach the target of sustainable development, the majority of the nations pursue an extension strategy regarding the access of education. Embodying the same approach, the Indian government has been pursuing several schemes aiming for growth in the system of education which is materialized through a rise in government expenditure allocation for education. For instance, in India, the upgradation in Secondary education and thereby in school-education was initiated by Rashtriya Madhyamik Shiksha Abhiyan and Samagra Shiksha Mission (government schemes) respectively. The literacy rate in India though reflects a rising pattern, it is however far below in comparison to the global standards. Notably, the Gross Enrolment Ratio at Secondary and H.S. levels have also improved in the country overtime though revealing some across-state dissimilarities. In the light of this scenario, it is vital for policy makers to understand whether the education sector in India has been able to perform efficiently. Therefore, the concern is to perceive whether several schools under each specific state are generating the highest possible extent of educational output with the given extent of input under a certain technology. Conceptually, this concern is related to the question of technical efficiency (TEF), in particular TEF_{out} at state-level; specifically, in the present study, this query arises concerning Secondary and H.S. stages of education. After obtaining the estimates of TEF_{out}, subsequently it is also crucial for the respective stage of education (either Secondary or H.S.) to point out the affecting factors, responsible for TEF_{out} variation across the

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A part of this chapter is published as:

1. Choudhury, S., & Ghose, A. (2022). "Does an Increase in Enrolment of Girls Relative to Boys Stimulate Technical Efficiency of Secondary Education? Empirical Evidence Using Non-parametric Data Envelopment Analysis with Indian State Level Data". In C. Chakraborty & D. Pal (Eds.) Environmental Sustainability, Growth Trajectory and Gender: Contemporary Issues of Developing Economies (Pp. 207–218). Emerald Publishing Limited, UK. ISBN: 9781802621549.

2. Choudhury, S., & Ghose, A. (2023). "Can Gender Inequality in School Enrollment Hinder the Efficiency of the Education Sector?". In C. Chakraborty & D. Pal (Eds.) Gender Inequality and its Implications on Education and Health (pp. 55-67). Emerald Publishing Limited, UK. ISBN: 9781837531813.

states in India. Relevantly, as Indian states & union territories receive diverse proportions of grants and loans in the overall assistance as provided by the centre, all states and union territories cannot be considered as homogeneous units on the ground of functioning under distinct economic as well as fiscal conditions and hence the states (along with union territories) are categorized into two distinguished groups, referred as general category states (GCS) and special category states & union territories (SCS&UT). On account of the evidence of diverse economic environments, the segregated TEF_{out} analysis is justified to carry out for the GCS and SCS&UT concerning Secondary and H.S. education. This type of study is particularly helpful for shedding light on the aspect of TEF_{out} relating to Secondary and H.S. education (individually) at State-level.

Focusing on Secondary and H.S. stages of education, carrying out TEF analysis at state-level is crucial for pointing out several Indian states, performing with lack of efficiency and thus it is helpful for recognizing those states (and union territories) which requires additional attention for developing policies with the objective of promoting efficiency levels in these underperforming states, so that the ultimate aim of across the states full efficiency can be attained. TEF can be perceived following two separate approaches: one approach describes a scenario where further enhancement of any output is not possible with the given extent of input usage, until the extent of other output is decreased (referred to as TEF_{out}); conversely, the other approach describes a scenario where further reduction in usage of any input is not possible for producing a given extent of output, until the usage of other inputs is raised (referred to as TEF_{inp}). Numerous empirical studies are existent in the domain of literature relating to the evaluation of TEF adopting either Parametric-Stochastic Frontier Analysis (SFA) or Non-Parametric-Data Envelopment Analysis (DEA) at school-education or higher education levels; and among them in the Indian scenario, Tyagi et al. (2009); Sengupta and Pal (2010, 2012); Dutta (2012); Mohapatra (2015); Ghose (2017) and Singh et al. (2018) are notable. Relevantly, the review of literature indicates the voids in the prevailing studies relating to the across-time TEF evaluation of Secondary and H.S. education individually at state-level after segregating the Indian states and union territories into two diverse groups i.e. GCS and SCS&UT. Contextually, the objective of the present chapter is while filling the voids, particularly evaluating TEF_{out} of Secondary and H.S. stages of education in GCS as well as in SCS&UT employing DEA for constructing two distinct production frontiers for two state categories where each Indian state (or union territory) is taken into account as the unit of observation.

In tune with the prevailing literature, for estimating TEF of a productive unit, two distinct approaches can be followed: (a) parametric approach (SFA) and (b) non-parametric approach (DEA). However, for conducting the present study, the DEA method is adopted. The strength of the DEA is that without considering a certain form of production function, it is possible to estimate TEF on the basis of actual output-input data. Charnes et al. (1978, 1981) proposed DEA for evaluating TEF of several DMUs in the context of multiple output and multiple input under consideration of the assumption of constant returns to scale (CRS). However, Banker et al. (1984) subsequently extended this notion under the consideration of variable returns to scale (VRS) assumption.

In particular, the attempt of the present chapter is estimating TEF_{out} of Secondary and H.S. education for Separately GCS and SCS&UT over the time span 2010-11 to 2015-16 applying DEA under consideration of VRS assumption and also subsequently, determining the affecting factors, responsible for TEF_{out} (the notion is stated in previous chapter) variation using regression analysis. Accordingly, the contribution of the present chapter can be stated as follows:

(i) Deviating from the prevailing studies, while analyzing TEF_{out} of Secondary and H.S. education it is taken into consideration that in India the GCS and the SCS&UT function in distinguished fiscal and economic atmospheres, thus for the estimation of TEF_{out} scores at state-level, two separate benchmark frontiers are constructed, one for GCS and another for SCS&UT under the assumption of VRS.

(ii) Following the estimation of TEF_{out}, a subsequent step of regression is performed for identification of the determinants of TEF_{out} at Secondary and H.S. levels of education separately for these two state categories (i.e. GCS and SCS&UT). In light of this objective, school-specific infrastructure reflecting variables, social indicators, state-specific macro indicator and policy variable are taken into consideration as determinants. The deviation of the present chapter from the prevailing literature (Sengupta and Pal (2012)) is instead of the formation of composite index, reflecting the wider classification of determinants, the individual effect of each explanatory variable included in the determinant analysis is investigated on TEF_{out} for the specific policy formulation.

The present chapter proceeds as follows: Section 3.2 represents methodology for evaluating TEF_{out}, determinants (as considered) and data sources. Section 3.3 displays empirical findings.

The Sections 3.3.1.1 and 3.3.2.1 discuss the results of TEF_{out} score estimation for GCS and SCS&UT considering Secondary and H.S. levels of education respectively. Next, the Sections 3.3.1.2 and 3.3.2.2 reflect the factors determining TEF_{out} for Secondary and H.S. stages of education respectively. Finally, section 3.3.3 points out the comparison of estimated TEF_{out} score and the determinants of TEF_{out} between Secondary-level and H.S. level of education using State Report Cards, 'Unified District Information System for Education' (UDISE) dataset and this section is followed by the section 3.4 that discusses the conclusion part of the present chapter.

3.2 Methodology, considered Determinants and Data

3.2.1 Methodology for TEF_{out} Estimation

There are two components of efficiency: technical efficiency (TEF) and allocative efficiency (AEF). TEF of a DMU (Decision Making Unit) is measured by either (i) output-oriented (TEF_{out}) approach showing the maximum output quantities that can be proportionately increased without altering input quantities or (ii) input-oriented (TEF_{inp}) approach representing the maximum amount of input quantities, which can be proportionately reduced without changing quantities produced as output. AEF reflects the ability of a DMU to use the inputs in optimal proportions, given their respective price. The measurement and the determinants of TEF, in particular TEF_{out}, are attempted here for Secondary-level as well as for H.S. level, individually for GCS and SCS&UT.

TEF measurement is a two-step problem. First, a benchmark production function, known as frontier, has to be constructed which is supposed to be perfectly efficient. Secondly, comparison of the observed performance of DMU with the benchmark is the basic approach of measuring TEF.

Figure 3.1 represents TEF_{out} and TEF_{inp} in case of single output and input framework.

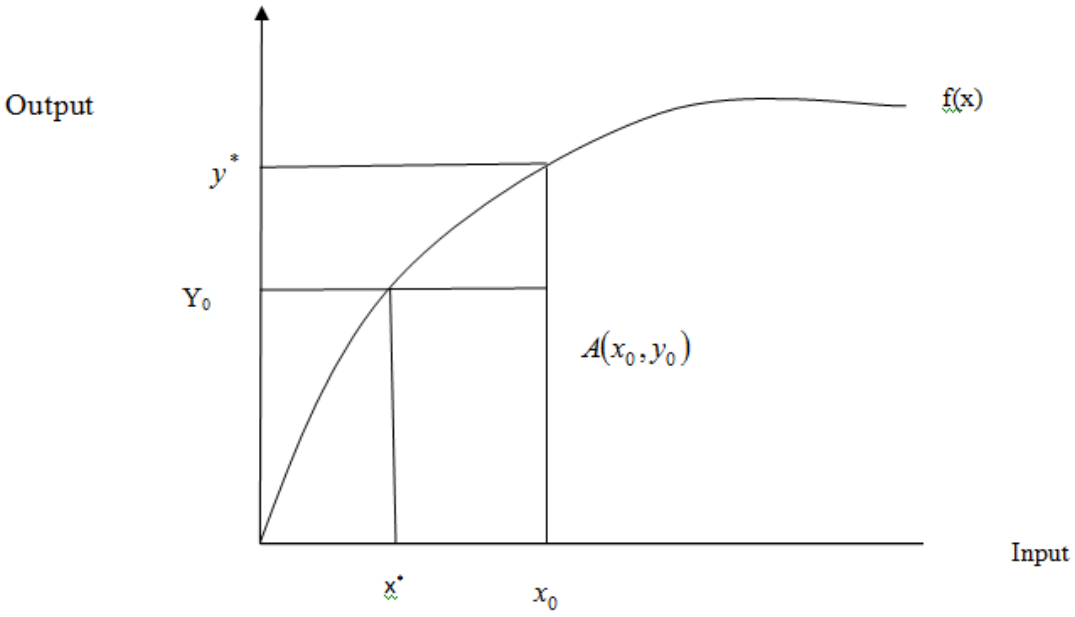

Figure 3.1: TEF_{out} and TEF_{inp}

Source: Bhanja and Ghose (2022)

In Figure 3.1, output y and input x is measured along the horizontal and the vertical axis respectively. Point A (x_0, y_0) represents the actual output-input bundle of a DMU and $y^* = f(x_0)$ holds, where y * is the maximum output producible from input x_0. TEF_{out} of DMU at point A = $\frac{y_0}{y^*}$ which is the comparison of actual output with the maximum producible quantity from the observed input.

For the same output bundle y_0 , the input quantity can be reduced proportionately till the frontier is reached. So, y_0 can be produced from minimum input x *. Thus TEF_{inp} for DMU at a point A= $\frac{x^*}{x_0}$. The TEF score of a DMU takes a value between0 to 1. A value '1' indicates DMU is fully technically efficient.

The TE of the DMU depends also on returns to scale; CRS or VRS.

Figure 3.2 illustrates the basic ideas behind DEA and returns to scale. Four data points (A, C, B', and D) are used here to describe the efficient frontier under VRS. In a simple one output case, only B is inefficient, lies below the frontier, showing capacity underutilization. So unit B

can produce more output at point B' on the frontier (which is equal to theoretical maximum) utilizing same level of input at X_1. Under CRS the frontier is defined by point C for all points along the frontier, with all other points falling below the frontier indicates capacity underutilization. So capacity output corresponding to VRS is smaller than the capacity output corresponding to CRS.

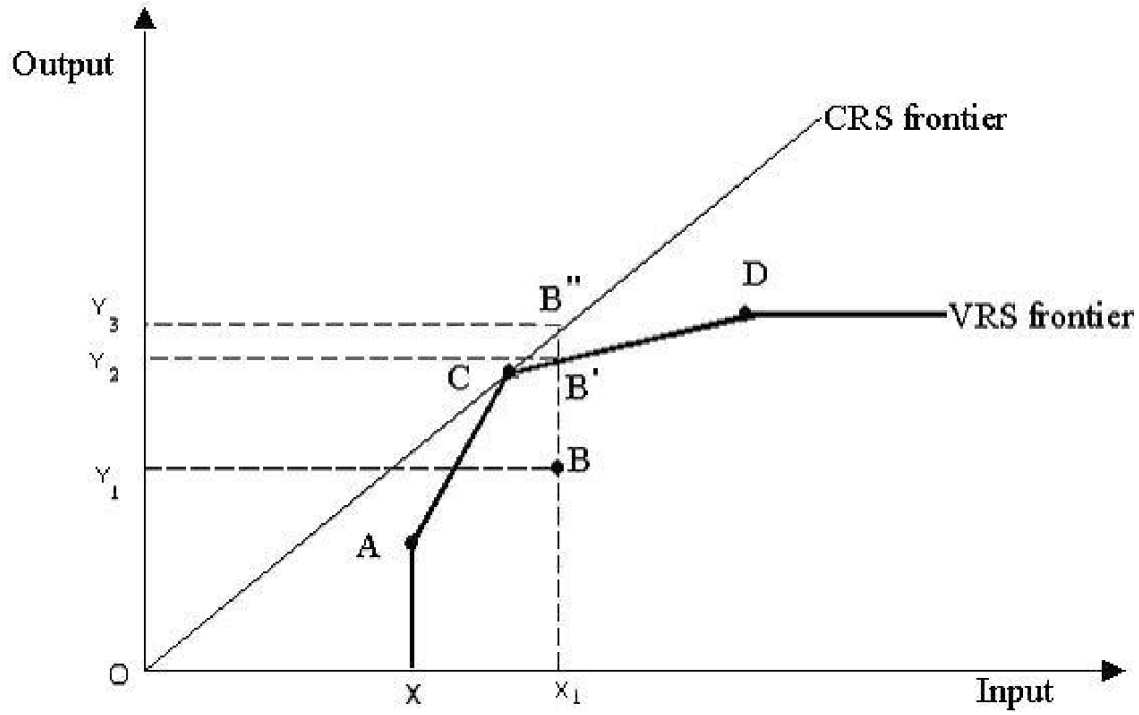

Figure 3.2: The Production Frontier and Returns to scale

Source: Bhanja and Ghose (2022)

Given the actual output-input bundle, TEF_{out} is estimated here by constructing the frontier under VRS using non-parametric DEA following Banker et al. (1984), after making a number of fairly general assumptions about the nature of the underlying production technology, namely, (i) all actually observed output-input combinations are feasible, (ii) the production possibility set is convex, (iii) outputs are freely disposable, (iv) inputs are freely disposable.

3.2.1.1 Methodology for obtaining TEF_{out} Score

Suppose that there are *N* DMUs. Each of them is producing 'g' outputs using 'h' inputs. The DMU t uses input bundle $x^t = \left(x_{1t}, x_{2t}, \ldots\ldots x_{ht}\right)$ for producing the output bundle $y^t = \left(y_{1t}, y_{2t}, \ldots\ldots y_{gt}\right)$. This paper assumes VRS.

The specific production possibility set under VRS is given by

$$T^{VRS} = \left\{ (x, y) : x \geq \sum_{j=1}^{N} \lambda_j x^t ; y \leq \sum_{j=1}^{N} \lambda_j y^t ; \sum_{j=1}^{N} \lambda_j = 1; \lambda_j \geq 0; (j = 1,2....N) \right\} \quad \ldots 3.1$$

the TEF_{out} of any DMU t under VRS technology requires the solution of the following Linear Programming problem

$\max \phi$

Subject to $\sum_{j=1}^{N} \lambda_j y_{rj} \geq \phi y_{rt}$; $(r = 1,2,....g)$;

$$\sum_{j=1}^{N} \lambda_j x_{ij} \leq x_{it}; \ (i = 1,2,.....h)$$

ϕ free, $\lambda_j \geq 0$; $(j = 1,2.....N)$

$$\sum_{j=1}^{N} \lambda_j = 1 \qquad \ldots.3.2$$

TEF_{out} of DMU t can be determined by using equation (3.3).

$$TE_o^t = TE_o^t(x^t, y^t) = \frac{1}{\phi^*} \qquad \ldots.3.3$$

Where ϕ^* is the solution of equation (3.2) showing the maximum value of ϕ. The maximum output bundle producible from input bundle x^t is y* and is defined as $y^* = \phi^* y^t$.

3.2.2 Output-Input Variables for TEF_{out} Measurement using State Level Data

In this context, it is relevant to discuss the differences between the aforementioned educational production function and the benchmark production function, dealt in microeconomics. Firstly, as the educational output is intangible in nature, it therefore necessitates some suitable representation of output in the present chapter by (i) Retention rate and (ii) Passing percentage of students in board examination where the 'passing percentage' is reflecting quality of output. In addition to this, for measuring TEF_{out} levels of the decision making units four inputs, specifically (i) Input 1: Number of the schools per lakh population, (ii) Input 2: Teacher-student ratio, (iii) Input 3: Classroom-pupil ratio and (iv) Input 4: Percentage of teachers qualifying post-graduate or higher degree, are considered. Input 4 is standing for the quality of the teacher-

input. For Secondary-level analysis while stating board examination, the final examination of tenth standard is considered; also while stating 'number of schools per lakh population' the count of the secondary-schools for each one lakh population is regarded. Similarly, for higher-secondary (H.S.) level analysis these variables are noted referring to this specific level. Secondly, shadow prices of outputs and inputs are computed for education production function because of non-existence of the market prices for both. Relevantly, as an accounting unit, the state is considered; hence for each state averaged outputs & averaged inputs are used for conducting TEF_{out} estimation where averaging is executed across various schools (for each output and input) within the domain of the particular state, admitting the school-based variations in output & input values. Specifically, TEF_{out} scores of both Secondary-level and H.S. level are calculated separately for each of the GCS and SCS&UT after constructing segregated frontiers for these two distinct state groups. This chapter uses state-level average representations of outputs & inputs based on secondary data source. In the present chapter, for recognizing the influencing factors of TEF_{out} at Secondary-level and at H.S. level, second-step determinant analysis is performed independently for GCS and SCS&UT referring to the following determinants.

3.2.3 Possible Determinants of TEF_{out} for State-Level Analysis

(A) Poor infrastructural indicators: Since the Government of India is incapable of providing sufficient infrastructures to schools because of the financial stringencies, numerous schools are bound to function with utterly poor infrastructure. Thus, for investigating the presence of negative and significant influence of such poor infrastructure on TEF_{out}, the impacts of the following variables are examined in this chapter: (i) Percentage of 'without building' schools (PWBS); (ii) Percentage of "bad" condition (PBCC) classrooms; (iii) Proportion of schools with single classroom (PSSC); (iv) Proportion of schools with single teacher (PSST); (v) Proportion of Para teachers (PPTEA); (vi) Percentage of schools with absence of drinking water facility (PSADWF); (vii) Percentage of schools with absence of girls toilet (PSAGT); (viii) Percentage of schools with absence of electricity (PSAE); and (ix) Percentage of schools with absence of computer and internet connection (PSACI).

(B) Social indicators: The social inclusion of the Government of India is designed for assuring that a larger number of people from the less advanced groups like scheduled caste (SC), scheduled tribe (ST) and the girl students can acquire the advantage of formal education as the girls also in India function under various social constraints

following which they are withheld the advantages of formal education. Thus, for investigating whether any positive and significant influence of the social inclusion scheme on TEF_{out} is existent or not, in this chapter, the impacts of the following variables are examined: (i) Percentage of SC enrolment (PSCE); (ii) Percentage of ST enrolment (PSTE); (iii) Proportion of female teachers to male teachers (PFTMT); and (iv) Proportion of girl's enrolment to boys (PGETB).

(C) Macro Indicator: For testing the impact of the general economic situation of the state in determining TEF_{out}, the effect of per capita net state domestic product (PCNSDP) (calculated at constant 2011–2012 prices) is examined.

(D) Policy indicator: Considering this broader category, the positive and significant influence of government education expenditure (GEXPOE), represented as a ratio to total expenditure for the state, is examined on TEF_{out}.

The effect of "Percentage of Schools arranging Parent–Teacher Association" (PSAPTA) is also assessed on TEF_{out}.

3.2.4 Data Set and its Sources

The data set comprises seventeen GCS and eighteen SCS&UT for the time frame 2010-11 to 2015-16. In the context of India, the GCS group include: Andhra Pradesh (AP), Bihar (BI), Chhattisgarh (CHHAT), Goa (GO), Gujarat (GUJ), Haryana (HAR), Jharkhand (JHAR), Karnataka (KAR), Kerala (KER), Madhya Pradesh (MP), Maharashtra (MH), Orissa (ORI) , Punjab (PN), Rajasthan (RAJ) , Tamil Nadu (TN), Uttar Pradesh (UP) and West Bengal (WB); while SCS&UT group includes: Andaman &Nicobar Islands (A&N), Arunachal Pradesh (ARU), Assam (AS), Chandigarh (CHAND), Dadra &Nagar Haveli (D&N), Daman &Diu (D&D), Delhi (DEL), Himachal Pradesh (HP), Jammu &Kashmir (J&K), Lakshadweep (LAKH), Manipur (MAN), Meghalaya (MEGH), Mizoram (MIZO), Nagaland (NG), Puducherry (PUD), Sikkim (SIK), Tripura (TP) and Uttarakhand (UK).

The secondary data sources for state level analysis are: 'Unified District Information System for Education' (UDISE) - Secondary State Report Cards; Central Statistics Office, MOSPI, GOI and Budget documents of the state governments.

3.3 Empirical Findings

3.3.1 Analysis of TEF_{out} and Determinants for Secondary Education using UDISE Dataset

3.3.1.1 Result of TEF_{out} Score Estimation for General Category States and Special Category States & Union Territories considering Secondary-Level of Education

In the present chapter, TEF_{out} scores for Secondary education are measured while constructing production frontier under VRS assumption separately for GCS and SCS&UT for each specific year considered under the study i.e. 2010-11 to 2015-16. Estimated result of TEF_{out} score of Secondary education in India for each GCS and SCS&UT individually over the reference period along with the corresponding group mean value of TEF_{out} for each year is displayed in the Tables 3.1 and 3.2 respectively. The specified Tables also show the Grand Average representation of TEF_{out} considering (i) the whole of GCS for all the six years (ii) the whole of SCS&UT for all six years respectively. The results reported in the tables reflect that all out of the whole sets of GCS and SCS&UT are not perfectly technically efficient and variation of TEF_{out} is also observed within and between each state category.

Table 3.1.1: TEF_{out} scores of Secondary-Level of Education for GCS

State	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	Average
AP	1.000	1.000	0.964	1.000	0.984	0.999	0.99
BI	1.000	1.000	1.000	1.000	1.000	1.000	1.00
CHHAT	1.000	1.000	0.940	0.985	0.877	0.877	0.95
GO	1.000	1.000	1.000	1.000	1.000	1.000	1.00
GUJ	0.916	0.906	0.955	1.000	0.898	0.881	0.93
HAR	0.971	0.964	1.000	1.000	0.915	0.915	0.96
JHAR	1.000	1.000	1.000	1.000	1.000	1.000	1.00
KAR	0.863	1.000	1.000	0.993	1.000	0.995	0.97
KER	1.000	1.000	1.000	1.000	1.000	1.000	1.00
MP	0.889	0.889	0.954	0.999	0.841	0.844	0.90
MH	1.000	1.000	1.000	1.000	1.000	1.000	1. 00
ORI	1.000	1.000	0.850	1.000	1.000	1.000	0.97

Contd….

State	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	Average
PN	1.000	1.000	0.994	0.992	0.992	0.993	0.99
RAJ	0.953	0.954	0.954	0.976	0.970	0.963	0.96
TN	1.000	1.000	0.992	1.000	1.000	1.000	0.99
UP	1.000	1.000	0.951	1.000	1.000	1.000	0.99
WB	1.000	1.000	1.000	1.000	1.000	1.000	1.00
Grand Average							0.98

Source: Author's computation

The figures reported in Table 3.1.1 reflect that the average TEF_{out} score considering the Secondary level of education is identified to be higher for ten GCS like, KER, GO, WB, AP, MH, JHAR, BI, TN, UP and PN in comparison to the corresponding grand average value of TEF_{out} for GCS group. Additional information that are also reflected by the Table 3.1.1 concerning the Secondary stage of education are as follows:

(i) Throughout efficiently performing GCS over the sample time interval are KER, MH, GO, WB, BI and JHAR.

(ii) Throughout inefficiently performing GCS are identified as MP and RAJ.

(iii) KAR, HAR and GUJ have remained inefficient at the initial year, subsequently attaining efficiency, but TEF_{out} estimates again decreased in the later years.

(iv) AP, PN and CHHAT initially started as efficiently performing GCS, but across-time changed into inefficient units.

(v) TEF_{out} scores have improved for RAJ and KAR.

(vi) TEF_{out} scores deteriorated for MP, PN, GUJ, HAR and CHHAT from the initial level of efficiency.

Table 3.1.2: TEF_{out} scores of Secondary-Level of Education for SCS&UT

State	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	Average
A&N	1.000	0.995	1.000	1.000	1.000	1.000	0.99
ARU	0.958	0.986	1.000	0.986	1.000	1.000	0.98
AS	1.000	1.000	1.000	1.000	1.000	1.000	1.00
CHAND	0.937	0.962	1.000	1.000	1.000	0.984	0.98
D&N	1.000	1.000	1.000	1.000	1.000	1.000	1.00
D&D	1.000	1.000	1.000	1.000	0.757	0.765	0.92
DEL	1.000	1.000	1.000	1.000	1.000	1.000	1.00
HP	1.000	1.000	0.991	1.000	1.000	1.000	0.99
J&K	0.897	0.937	0.913	0.874	0.899	0.900	0.90
LAKH	1.000	1.000	1.000	1.000	1.000	1.000	1.00
MAN	1.000	0.977	0.972	0.981	0.962	0.982	0.97
MEGH	0.932	0.944	0.934	1.000	0.997	0.991	0.96
MIZO	1.000	1.000	0.954	0.945	0.990	1.000	0.98
NG	0.930	0.910	1.000	0.882	1.000	1.000	0.95
PUD	0.938	0.947	0.961	0.948	0.964	0.980	0.96
SIK	1.000	1.000	0.980	1.000	1.000	1.000	0.99
TP	1.000	1.000	1.000	1.000	1.000	1.000	1.00
UK	0.975	0.984	1.000	0.954	1.000	0.976	0.98
Grand Average							0.97

Source: Author's computation

The results in Table 3.1.2 display that the average TEF_{out} score for the Secondary education is identified to be higher for twelve SCS&UT like, DEL, A&N, TP, AS, LAKH, HP, D&N, SIK, UK, ARU, CHAND and MIZO in comparison to the corresponding grand average value of TEF_{out} for SCS&UT group. Table 3.1.2 also points out some further information regarding the TEF_{out} of Secondary education for SCS&UT, which are as follows:

(i) Throughout efficiently performing SCS&UT over the referenced time interval are DEL, LAKH, D&N, AS and TP.

(ii) Throughout inefficiently performing SCS&UT are identified as J&K and PUD.

(iii) TEF_{out} scores have improved for ARU, MEGH and PUD.

(iv) NG and ARU have remained inefficient at the initial year and subsequently attained efficiency.

(v) TEF_{out} estimates for CHAND confirms perfect efficiency in the intermediate years even though indicating inefficiency at the initial and ending year.

(vi) SIK, A&N and HP have attained perfect efficiency in all the years other than a year.

(vii) MAN and D&D initially started as efficiently performing SCS&UT, but across-time changed into inefficient.

Tables 3.1.1 and 3.1.2 point out that the grand average TEF_{out} score concerning Secondary-level is more for GCS as compared to SCS&UT.

3.3.1.2 Factors Determining TEF_{out} of Secondary-Level of Education

In the determinant analysis of TEF_{out} both for GCS as well as SCS&UT since the concerned states are considered over a time span 2010–2011 to 2015–2016 in this chapter, Breusch–Pagan Lagrange Multiplier (BPLM) test is applied for selecting the appropriate model and the test supports pooled regression model as applicable for GCS while panel regression model as applicable for SCS&UT. Furthermore, the applicability of the random effect model (RE) for SCS&UT is advocated by the Hausman test. On the contrary, for GCS taking into consideration the possibility of contemporaneous correlation as well as adjusting for heteroscedasticity, the estimation of pooled model is performed involving seemingly unrelated regression (SUR) framework. Additionally, applicability of the simple RE is suggested for SCS&UT on the ground of non-existence of heteroscedasticity, autocorrelation and also because of the absence of strong contemporaneous correlation among the generated residuals. After testing various alternative model specifications both for GCS and SCS&UT, the best fitted models are documented in Table 3.1.3 and Table 3.1.4 respectively. Applicability of two distinct techniques therefore strengthens the relevance of classification of Indian states and union territories into GCS and SCS&UT.

Table 3.1.3: Significant Determinants of TEF_{out} of Secondary-level of education for GCS

Variables	Co-efficient	z value	P-value
PWBS	-.0007416	-2.18	0.029
PPTEA	.0007717	2.24	0.025
GEXPOE	.0460776	2.73	0.006
PCNSDP	1.87e-07	2.32	0.020
PGETB	.0089389	2.92	0.004
Constant	.1149112	0.42	0.678
chi2 = 27.04		P value = 0.001	

Source: Author's estimation

Table 3.1.3 illustrates the relevance of each broader indicator category i.e. poor infrastructure, macro indicator, social indicator and policy indicator in determination of TEF_{out} of Secondary level for GCS. To be specific, focusing on Secondary education of GCS, TEF_{out} is influenced significantly by poor infrastructure denoting variables like PWBS and PPTEA; where PWBS is negatively and PPTEA is positively influencing TEF_{out}. Conceptually, on the ground of inadequacy in full-time teachers, para-teachers are employed for meeting the academic requirements of the schools; thus the role of para-teachers in improving TEF_{out} is examined in the determinant analysis of this chapter. Representing the Social indicator, 'PGETB' variable is showing positive significance while determining TEF_{out}, implying that if girls' enrolment increases than that of the boys then it will enhance TEF_{out} of Secondary-level. Again, acting as a macro indicator, per capita net state domestic product for the state [at factor cost (constant prices 2011–2012)] and as a policy indicator, GEXPOE are positively and significantly imparting impact on TEF_{out} of Secondary level of education.

Table 3.1.4: Significant Determinants of TEF_{out} of Secondary-level of education for SCS&UT

Variables	Co-efficient	z value	P-value
PBCC	-.0005489	-1.73	0.085
PSST	-.002752	-1.78	0.075

Contd….

Variables	Co-efficient	z value	P-value
PSADWF	-.0023688	-2.52	0.012
PSAE	-.001316	-1.92	0.055
PSTE	.0004593	2.55	0.011
PGETB	.0009618	1.96	0.050
GEXPOE	.0033346	2.18	0.030
Constant	.824633	14.36	0.000
Wald chi2(15) = 34.03		Prob> chi2 = 0.0034	

Source: Author's estimation

For SCS&UT group, Table 3.1.4 reflects that social indicators, policy indicator and poor infrastructures are portraying crucial roles in explaining TEF_{out} of Secondary level. Explicitly, representing the poor infrastructure of the schools in SCS&UT, 'PBCC', 'PSST', 'PSADWF' and 'PSAE' variables are negatively and significantly influencing TEF_{out}. Again, acting as a policy indicator, 'GEXPOE' variable and as the social indicators, 'PGETB' and 'PSTE' variables are indicating positive significance in determination of TEF_{out} of Secondary-level.

3.3.2 Analysis of TEF_{out} and Determinants for Higher-Secondary Education using UDISE Dataset

3.3.2.1 Result of TEF_{out} Score Estimation for General Category States and Special Category States & Union Territories considering Higher-Secondary Level of Education

For H.S. level of education, TEF_{out} scores are also estimated under VRS assumption while separating Indian states and union territories into two groups i.e. GCS and SCS&UT for each year between 2010-11 and 2015-16. Again, the calculated TEF_{out} score of H.S. education for each GCS and SCS&UT (separately) over the reference period along with the corresponding group average value for every year and the grand average value of TEF_{out} is illustrated in the Tables 3.5 and 3.6 respectively. The TEF_{out} results of H.S. level in both of these tables point out the fact that the proportion of all GCS and all SCS&UT are not becoming perfectly

technically efficient and varying TEF_{out} scores is also noticed within and between each category of states.

Table 3.2.1: TEF_{out} scores of H.S. Level of Education for GCS

States	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	Average
AP	1.000	0.946	0.940	0.938	0.981	1.000	0.97
BI	1.000	1.000	1.000	1.000	1.000	1.000	1.000
CHHAT	0.983	0.982	0.980	0.981	0.981	0.981	0.981
GO	0.943	0.980	1.000	0.960	0.977	0.965	0.97
GUJ	0.995	0.975	0.973	0.971	1.000	1.000	0.99
HAR	0.998	0.979	0.980	0.971	0.971	0.967	0.98
JHAR	1.000	1.000	1.000	1.000	1.000	1.000	1.000
KAR	0.992	0.992	0.994	1.000	1.000	1.000	0.996
KER	1.000	1.000	1.000	1.000	1.000	1.000	1.000
MP	0.953	0.948	0.952	0.955	0.928	0.928	0.94
MH	1.000	1.000	1.000	1.000	1.000	1.000	1.000
ORI	1.000	1.000	1.000	1.000	1.000	1.000	1.000
PN	0.986	0.980	0.985	0.981	0.993	0.980	0.98
RAJ	1.000	1.000	0.961	1.000	1.000	1.000	0.994
TN	1.000	0.986	0.995	0.983	0.985	0.986	0.989
UP	1.000	1.000	1.000	1.000	1.000	1.000	1.000
WB	1.000	1.000	0.963	0.964	0.960	0.964	0.96
Grand Average							0.985

Source: Author's computation

In Table 3.2.1 the displayed results reveal that the average TEF_{out} score considering H.S. level of education is identified to be higher for ten GCS like, KAR, KER, ORI, MH, TN, RAJ, BI, GUJ, JHAR and UP in comparison to the corresponding grand average value of TEF_{out} for GCS. Additional information, reflected by Table 3.2.1 relating to the H.S. stage of education are specified below:

(i) Throughout efficiently performing GCS over the sample time interval are KER, ORI, UP, JHAR, MH and BI.

(ii) Throughout inefficiently performing GCS are identified as MP, CHHAT, PN and HAR.

(iii) KAR and GUJ have remained inefficient at the initial year but attained TEF_{out} in the later years.

(iv) TN and WB initially started as efficiently performing GCS, but subsequently changed into inefficient.

(v) TEF_{out} scores expanded for GUJ, GO and KAR.

(vi) TEF_{out} scores deteriorated for WB, HAR, TN, PN, CHHAT and MP from the initial level of efficiency.

Table 3.2.2: TEF_{out} scores of H.S. Level of Education for SCS&UT

States	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	Average
A&N	1.000	1.000	0.868	0.863	0.869	0.864	0.91
ARU	1.000	1.000	1.000	1.000	1.000	1.000	1.000
AS	1.000	1.000	1.000	1.000	1.000	1.000	1.000
CHAND	1.000	1.000	0.966	1.000	1.000	1.000	0.99
D&N	1.000	1.000	1.000	1.000	1.000	1.000	1.000
D&D	1.000	1.000	0.876	1.000	1.000	0.779	0.94
DEL	1.000	1.000	1.000	1.000	1.000	1.000	1.000
HP	1.000	0.992	0.967	0.993	1.000	1.000	0.99
J&K	0.966	0.964	0.923	1.000	1.000	0.977	0.97
LAKH	1.000	1.000	0.999	1.000	1.000	1.000	1.000
MAN	1.000	1.000	1.000	1.000	1.000	1.000	1.000
MEGH	1.000	1.000	1.000	1.000	0.984	0.991	0.99
MIZO	1.000	0.985	0.982	0.990	1.000	1.000	0.99
NG	1.000	1.000	1.000	1.000	1.000	1.000	1.000
PUD	1.000	1.000	1.000	1.000	1.000	1.000	1.000
SIK	1.000	0.921	0.922	1.000	1.000	0.971	0.96
TP	0.964	0.969	0.968	0.993	0.974	0.986	0.97
UK	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Grand Average							0.983

Source: Author's computation

Table 3.2.2 conveys the average TEF_{out} score for H.S. education turning to be higher for thirteen SCS&UT like, ARU, D&N, MAN, DEL, AS, UK, NG, CHAND, PUD, LAKH, MIZO, HP and MEGH relative to the corresponding grand average value of TEF_{out} for SCS&UT. Further information regarding the TEF_{out} of H.S. education for SCS&UT group, displayed by Table 3.2.2, are noted below:

(i) Throughout efficiently performing SCS&UT over the referenced time interval are ARU, DEL, AS, MAN, D&N, UK, NG and PUD.

(ii) Throughout inefficiently performing SCS&UT is TP.

(iii) TEF_{out} scores have risen for J&K and TP.

(iv) Downturn of TEF_{out} scores are experienced by MEGH, D&D and A&N.

(v) TEF_{out} estimates for J&K confirms perfect efficiency in the intermediate years even though indicating inefficiency at the initial and ending year.

(vi) MEGH, A&N, SIK and D&D initially started as efficiently performing SCS&UT, but later changed into inefficient.

(vii) LAKH and CHAND have attained perfect efficiency in all the years other than 2012-13.

Referring to Tables 3.5 and 3.6, grand average TEF_{out} score of H.S. level is observed to be more for GCS rather than SCS&UT.

3.3.2.2 Factors Determining TEF_{out} of Higher-Secondary Education

While conducting the determinant analysis of TEF_{out} relating to H.S. level, the BPLM test is applied for selecting the appropriate model for GCS as well as SCS&UT and the test supports pooled regression model as applicable for both of the state groups, rather than supporting the panel regression model. Furthermore, the applicability of the simple pooled model both for GCS and SCS&UT is advocated on the ground of absence of strong contemporaneous correlation among the generated residuals. Trialling various alternative model specifications for both of the state groups, provided the best fitted models and results are reflected in Table 3.2.3 and Table 3.2.4 respectively.

Table 3.2.3: Significant Determinants of TEF_{out} of H.S. level for GCS

Variables	Co-efficient	t stat	P-value
PWBS	-.0005499	-1.83	0.070
PPTEA	.0004828	2.00	0.048
PSAGT	-.0004066	-2.41	0.018
PGETB	.0002691	1.79	0.077
GEXPOE	.0033951	3.68	0.000
Constant	.9412368	44.70	0.000
F(14, 87) = 3.73		Prob> F = 0.0001	

Source: Author's estimation

Coming to H.S. education, Table 3.2.3 illustrates the relevance of broader indicator categories like, poor infrastructure, policy indicator and social indicator in determination of TEF_{out} in GCS. In particular, concerning GCS, TEF_{out} of H.S. education is influenced significantly by insufficient infrastructure denoting variables like PWBS, PPTEA, PSAGT. Amongst these insufficient infrastructural determinants, the negative influence of PWBS and PSAGT while the positive influence of PPTEA variable is evident on TEF_{out}. Presenting the Social indicator, 'PGETB' variable is showing positive significance while determining TEF_{out}, implying that if at H.S. level girls' enrolment increases than that of the boys then it will raise TEF_{out} of H.S. level. Again, GEXPOE, as a policy indicator, is positively and significantly impacting on TEF_{out} of H.S. education.

Table 3.2.4: Significant Determinants of TEF_{out} of H.S. level for SCS&UT

Variables	Co-efficient	t stat	P-value
PSSC	-.0026649	-1.99	0.050
PSCE	.0027004	4.50	0.000
PSTE	.0007387	5.14	0.000
PFTMT	.0001184	2.33	0.022
GEXPOE	-.0256147	-2.90	0.005
GEXPOE_Square	.0007642	2.95	0.004
Constant	1.140411	16.25	0.000
F(12, 95) = 4.09		Prob> F = 0.0000	

Source: Author's estimation

Table 3.2.4 focusing on SCS&UT reflects that social indicators, policy indicator and poor infrastructures are illustrating crucial roles in explaining TEF_{out} of H.S. level. Explicitly, representing the insufficient infrastructure of the schools, particularly in SCS&UT, 'PSSC' variable is negatively and significantly influencing TEF_{out}. Again, acting as social indicators, 'PSCE', 'PSTE' and 'PFTMT' variables are indicating positive significance in determination of TEF_{out} of H.S. level. However, TEF_{out} of H.S. level in SCS&UT is related to the policy variable 'GEXPOE' in such a way that 'U' shaped pattern of relation is followed. Such a nonlinear relationship indicates that only after reaching a threshold level of GEXPOE, TEF_{out} of H.S. level can be raised by the rise in GEXPOE in SCS&UT, meaning at least a particular level of GEXPOE will be required for imparting a positive impact of GEXPOE on TEF_{out} of H.S. level in these states. In order to obtain the impact of GEXPOE on TEF_{out}, the marginal effect should be calculated with respect to GEXPOE due to the nonlinear nature of the relationship and the 'negative' value of marginal effect is evident for the present case. This finding of a 'negative' marginal effect is existent as the average GEXPOE for the present sample (16.00) is becoming lesser than the threshold level indicating value of GEXPOE (16.75) after attaining which the favourable effect of GEXPOE is perceived on TEF_{out}. In the case of the present sample, due to the failure of attaining the threshold level of GEXPOE, the favourable marginal effect and thereby the favourable impact of GEXPOE is not experienced and the system is not on the increasing segment of the curve. This result is an indication of the fact that the government should prioritize more on increasing GEXPOE in SCS&UT for obtaining the favourable effect of GEXPOE on TEF_{out} of H.S. level.

3.3.3 Comparison of Estimated TEF_{out} Score and Factors Determining TEF_{out} between Secondary-Level and Higher-Secondary Level using UDISE Dataset

Referring to GCS, the performance, captured in terms of TEF_{out}, of Secondary-level can be compared with H.S. level of education and the findings of such comparisons are note below:

(1) More than the average TEF_{out} score is attained by the GCS - (i) KER, BI, MH, JHAR, UP, TN at both Secondary and H.S. levels (ii) WB, PN, GO, AP specifically at Secondary-level and (iii) KAR, ORI, RAJ, GUJ specifically at H.S. level.

(2) The GCS attaining perfect TEF_{out} throughout the years under observation are (i) KER, JHAR, MH, BI at both Secondary and H.S. levels (ii) WB, GO exclusively at Secondary-level and (iii) ORI, UP exclusively at H.S. level.

(3) The GCS, becoming inefficient throughout is/are (i) MP at both Secondary and H.S. levels (ii) RAJ at Secondary-level and (iii) PN, CHHAT, HAR at H.S. level.

(4) A rising pattern of TEF_{out} across-time is reflected by (i) KAR at both Secondary and H.S. levels and (ii) RAJ at Secondary-level.

(5) Across time deterioration in TEF_{out} score is reflected by (i) HAR, PN, CHHAT at both Secondary and H.S. levels (ii) TN, WB, MP at H.S. level.

(6) The GCS transforming to inefficient, from efficient are (i) CHHAT, AP, PN at Secondary-level and (ii) TN,WB at H.S. level.

(7) Inefficient to efficient transforming GCS are KAR and GUJ at H.S. level though no such GCS is observed at Secondary-level in the referenced time interval.

Referring to SCS&UT, TEF_{out} of Secondary-level can be compared with H.S. level of education and the findings are stated below:

(1) More than the group average TEF_{out} is attained by the SCS&UT - (i) DEL, ARU, D&N, AS, HP, LAKH, UK, CHAND, MAN, MIZO at both Secondary and H.S. levels (ii) TP, A&N, SIK specifically at Secondary-level and (iii) NG, MEGH, PUD specifically at H.S. level.

(2) The SCS&UT attaining perfect TEF_{out} throughout are (i) AS, D&N, DEL at both Secondary and H.S. levels (ii) LAKH, TP exclusively at Secondary-level and (iii) NG, PUD, UK, MAN, ARU exclusively at H.S. level.

(3) The SCS&UT becoming inefficient throughout is/are (i) PUD, J&K at Secondary level and (ii) TP at H.S. level.

(4) A rising pattern of TEF_{out} across-time is reflected by (i) PUD, ARU, MEGH at Secondary level and (ii) J&K, TP at H.S. level.

(5) A deterioration across-time in TEF_{out} score is reflected by (i) MAN at Secondary- level and (ii) MEGH, A&N, D&D at H.S. level.

(6) The SCS&UT transforming to inefficient, from efficient are (i) D&D at both Secondary and H.S. levels, (ii) MAN at Secondary level and (iii) A&N, SIK, MEGH at H.S. level.

(7) The SCS&UT, transformed from inefficient to efficient are NG and ARU at Secondary-level while for H.S. level no such SCS&UT is found in the mentioned time span.

In GCS, it is noticed that PWBS, PGETB, PPTEA and GEXPOE turn up as the common determinants of TEF_{out} at both Secondary and H.S. levels of education, out of which PWBS is negatively while the other three are positively determining TEF_{out} at both the levels. Other than these common determinants, in GCS some specific to the level of education determinants are observed like, PCNSDP with positive sign exclusively at Secondary-level and PSAGT with negative sign solely at H.S. level affects TEF_{out}.

Directing attention to SCS&UT, it is observed that PSTE influences TEF_{out} positively at both Secondary and H.S. levels. In addition to this, GEXPOE can also impart positive impact on TEF_{out} of both the levels. Particularly, PBCC, PSST, PSADWF and PSAE affect TEF_{out} negatively specifically at Secondary-level while PSCE and PFTMT affect TEF_{out} positively at H.S. level. A negative influence of PSSC on TEF_{out} of H.S. level is also evident in this state group.

3.4 Conclusion

The present chapter attempts estimating TEF_{out} of Secondary and H.S. stages of education at state-level for the period 2010–11 to 2015–16 while adopting DEA (non-parametric approach) with the assumption of VRS, after constructing segregated frontiers for two state groups i.e. (i) GCS and (ii) SCS&UT due to the non- homogeneous nature of these two state groups arising because of the operation in distinguished fiscal and economic conditions. Computation of grand average TEF_{out} is performed separately for the two distinguished state groups at both Secondary and H.S. levels. The present chapter also separately attempts determining the factors that can significantly affect TEF_{out} of Secondary level as well as H.S. level in (i) GCS and (ii) SCS&UT. In the summarized form, the principal findings of the present chapter can be noted below:

TEF_{out} results indicate that all GCS and SCS&UT are not identified as perfectly technically efficient units and the extent of TEF_{out} variation across the GCS group and the SCS&UT group are also evident concerning both Secondary and H.S. levels of education.

In particular, considering the Secondary-level, throughout efficiently performing GCS over the sample time interval are identified as KER, MH, GO, WB, BI and JHAR while (throughout) inefficiently performing GCS are MP and RAJ. On the other hand, over the referenced time interval, the SCS&UT appearing as throughout efficient are DEL, LAKH, D&N, AS and TP while the throughout inefficient are identified as J&K and PUD. In the GCS group, during the course of the years TEF_{out} scores have improved for RAJ and KAR while such scores

deteriorated for MP, PN, GUJ, HAR and CHHAT from the initial level of efficiency. Likewise, in the SCS&UT group, TEF_{out} scores have improved for ARU, MEGH and PUD. Again, AP, PN and CHHAT initially started as efficiently performing GCS, but across time transformed into inefficient units. On the other hand, in the SCS&UT group, MAN and D&D initially started as efficiently performing units, but across time changed into inefficient entities; NG and ARU remained inefficient at the initial year and subsequently attained efficiency. The grand average TEF_{out} score concerning the secondary-level is observed to be more for GCS in relation to SCS&UT.

Next, focusing on H.S. level, throughout efficiently performing GCS over the specified time duration are KER, ORI, UP, JHAR, MH and BI while all over inefficient remaining GCS are MP, CHHAT, PN and HAR. Likewise, over 2010-11 to 2015-16, the SCS&UT appearing as throughout efficient are ARU, DEL, AS, MAN, D&N, UK, NG and PUD while the throughout inefficient is identified as TP. Considering the referenced years, in the GCS group TEF_{out} scores have expanded for GUJ, GO and KAR while such scores deteriorated for WB, HAR, TN, PN, CHHAT and MP. On the other hand, in the SCS&UT group, TEF_{out} scores have improved for J&K and TP and worsens for MEGH, D&D and A&N. In addition to this, TN and WB initially started as efficiently performing GCS, but subsequently performed inefficiently while KAR and GUJ attained TEF_{out} in the later years though being inefficient initially. Similarly, considering SCS&UT group it becomes evident that MEGH, A&N, SIK and D&D initially started as efficiently performing units, but across time deteriorated to inefficiently performing units. Referring to the findings, in this chapter the grand average TEF_{out} score of H.S. level is identified as more for GCS in comparison to SCS&UT group.

Subsequently, performing the determinant analysis in this chapter, TEF_{out} of Secondary-level is observed to be positively impacted by GEXPOE, PGETB, PCNSDP, PPTEA, and negatively impacted by the lack of school infrastructure revealing variable 'PWBS' in GCS. On the contrary, in SCS&UT, TEF_{out} of Secondary education is observed to be positively influenced by PGETB, PSTE, GEXPOE while it is negatively influenced by insufficient infrastructure denoting variables like, PBCC, PSST, PSADWF and PSAE. Analyzing the determinants of TEF_{out} of Secondary education, it can be stated that in GCS determinants from all broader indicator categories like, poor infrastructure, macro, policy and social indicators and in SCS&UT, the determining variables from each of the broader categories other than the macro indicator play pivotal roles in explaining TEF_{out}.

Coming to the determinant analysis of TEF_{out} of H.S. level, in GCS the evidence of GEXPOE, PPTEA, PGETB impacting positively while PWBS and PSAGT impacting negatively are found on TEF_{out} score. These negatively impacting variables are actually revealing the fact that the lack of infrastructural conditions prevailing in the school are being detrimental to the efficiency performance. Dealing with the TEF_{out} determinants for SCS&UT group at H.S. stage, it is observed that the factors which are positively determining TEF_{out} scores are PSCE, PSTE and PFTMT while the negatively determining factor has been PSSC. A crucial finding of the present chapter reveals that for SCS&UT group, the government should prioritize more on increasing GEXPOE for experiencing the favourable influence of GEXPOE on TEF_{out} score of H.S. level as for such states the positive influence of GEXPOE on TEF_{out} score is existent only after reaching a certain threshold level of government education expenditure.

Comparing TEF_{out} of Secondary-level with that of the H.S. level sheds the light on the following facts:

The GCS, attaining perfect TEF_{out} across all years under observation at both Secondary and H.S. levels are KER, JHAR, MH, BI; while WB, GO being throughout efficient exclusively at Secondary-level and ORI, UP exclusively at H.S. level. On the other hand, the SCS&UT, attaining perfect TEF_{out} throughout at both the levels are AS, D&N, DEL while LAKH, TP attain TEF_{out} throughout exclusively at Secondary-level and NG, PUD, UK, MAN, ARU exclusively at H.S. level. Next, the GCS becoming inefficient across all years at both Secondary and H.S. levels is MP while RAJ remains inefficient throughout only at Secondary-level and PN, CHHAT, HAR only at H.S. level. The SCS&UT becoming inefficient throughout at Secondary level are PUD, J&K while at H.S. level is TP. Additionally, the GCS, deteriorated to inefficient, from the perfect efficiency at Secondary-level are CHHAT, AP, PN while at H.S. level are TN,WB. Likewise, the SCS&UT changing to inefficient, from efficient at both Secondary and H.S. levels is D&D while MAN shows this pattern of TEF_{out} deterioration exclusively at Secondary level and A&N, SIK, MEGH exclusively at H.S. level. Following the referenced time interval, the GCS transformed from inefficient to efficient are KAR and GUJ at H.S. level while this pattern of TEF_{out} change is revealed by the SCS&UT like NG and ARU at Secondary-level.

The comparison of determinant analysis of TEF_{out} between Secondary-level and H.S. level reflects the following findings:

Focusing on GCS, it is observed that PWBS, PGETB, PPTEA and GEXPOE appear as the common determinants of TEF_{out} at both Secondary and H.S. levels of education, out of which PWBS is negatively while the other three are positively determining TEF_{out} at both the levels. However, in SCS&UT, the evidence of 'PSTE' variable influencing TEF_{out} positively at both Secondary and H.S. levels is found and also the situation of GEXPOE imparting positive impact on TEF_{out} of both the levels is observed.

Apart from such common determinants, in GCS, 'PCNSDP' with positive sign influences TEF_{out} exclusively at Secondary-level and 'PSAGT' with negative sign influences TEF_{out} solely at H.S. level. On the other hand, in SCS&UT, PBCC, PSST, PSADWF and PSAE affect TEF_{out} negatively specifically at Secondary-level while PSCE and PFTMT affect TEF_{out} positively at H.S. level. In such states, evidence of the negative influence of PSSC on TEF_{out} of H.S. level is also observed.

In consideration of the analysis of present chapter it can be conferred that policy variable, social indicators and school-specific unfavourable infrastructural indicating variables can be changed in the proper direction in order to elevate TEF_{out} of Secondary and H.S. levels of education in Indian GCS and SCS&UT individually.

A related concern pertains to the degree of inefficiency corresponding to each input utilized in the process of educational production, particularly at Secondary and H.S, stages; and this topic is explored in the next chapter.

Chapter 4:

An Inter-state Analysis of Input Efficiency of Secondary and Higher Secondary Education

4.1 Introduction

An alternative notion of estimating technical efficiency (TEF) of a decision-making unit (DMU) involves input-oriented measure of TEF score. The performance in the form of TEF attainment of the Indian state (or union territory) as DMU at Secondary and Higher Secondary (H.S.) stages is also crucial to be viewed from the perspective of efficient input utilization for producing the actual (particular) level of output. Therefore, the question is whether the schools corresponding to each state are producing the particular level of output using the minimum extent of input or not (under certain technology)? This query relates to the aspect of TEF_{inp}. As stated in the previous chapter, Indian states and union territories function under non-homogeneous and diverse economic and fiscal conditions and in light of this fact it is essential and justified to perform the TEF_{inp} evaluation separately for the two state groups i.e. general category states (GCS) and special category states & union territories (SCS&UT). The relevance of this analysis lies in identification of those states, operating with inefficient input usage and subsequently pointing out the factors which can be altered in the desired direction for enhancing TEF_{inp} performances of deficient states.

Particularly, the present chapter measures TEF_{inp} of Secondary and H.S. stages of education in GCS and SCS&UT individually, employing data envelopment analysis (DEA) through the process of construction of the individual benchmark frontier for each of the two state-categories under the generalized consideration of variable returns to scale (VRS). In addition to this, the present chapter identifies the affecting factors of TEF_{inp} distinctly for GCS and SCS&UT groups. Contextually, revealing the contribution of the present chapter seems relevant and are noted below:

(i) Using the secondary source data set for state-level, the present chapter evaluates TEF_{inp} of Secondary and H.S. levels individually over the time span 2010-11 to 2015-16 while separating the analysis for GCS and SCS&UT in India and employing DEA with VRS assumption. Since the prevailing study regarded all Indian states (and union territories) as homogeneous units of observation, the fundamental contribution of the present

chapter is recognizing the fact of a diverse economic atmosphere for the referred two groups of states and thereby conducting the distinct TEF_{inp} analysis for GCS and SCS&UT. Additionally, the across-time analysis is expected to shed light on the pattern of transformation in TEF_{inp}. While estimating TEF_{inp}, the input slack value estimation for each relevant input in the respective education production process is essential for identifying the inputs according to the extent of inefficient utilization.

(ii) Filling the voids of the prevailing studies, the present chapter instead of trying to relate composite index with TEF_{inp} estimates, attempts investigating individual influence of each explanatory variable under the categories like, infrastructure denoting variables, social indicator, policy indicator and macro indicator representing the state.

The present chapter is organized in the following manner: Section 4.2 represents the methodology for TEF_{inp} evaluation and data; and section 4.3 displays empirical findings. Section 4.3.1.1 and 4.3.2.1 reflect the result of TEF_{inp} estimation for GCS and SCS&UT considering Secondary and H.S. levels respectively. Next, the sections 4.3.1.2 and 4.3.2.2 respectively reveal the computed results on Radial movement & Slack movement for different Inputs focusing on Secondary and H.S. education. Again, 4.3.1.3 and 4.3.2.3 sections represent the factors determining TEF_{inp} of Secondary and H.S. levels of education respectively. Finally, section 4.4 discusses concluding remarks of the present chapter.

4.2 Methodology and Data

In this chapter, the discussion on methodology is separated into two segments. The former segment reflects the methodology on evaluating TEF_{inp} of different states as DMUs focusing on the referenced stages of school-education. Basically, TEF_{inp} of a DMU can be measured by comparing its observed input with the minimum required extent of input that can produce the observed extent of output i.e. the extent of input quantity that can be proportionally reduced without altering the observed bundle of output. However, the later segment sheds light on computation of the extra usage of each input used in education production.

4.2.1 Methodology for Estimating TEF_{inp} Score

It is supposed that there are N DMUs. Each of them is producing 'g' outputs using 'h' inputs. The DMU t uses input bundle $x^t = \left(x_{1t,} x_{2t,\ldots\ldots\ldots} x_{ht}\right)$ for producing the output bundle $y^t = \left(y_{1t,} y_{2t,\ldots\ldots\ldots} y_{gt}\right)$. This paper assumes VRS technology.

The specific production possibility set under VRS is given by

$$T^{VRS} = \left\{ (x, y) : x \geq \sum_{j=1}^{N} \lambda_j x^t ; y \leq \sum_{j=1}^{N} \lambda_j y^t ; \sum_{j=1}^{N} \lambda_j = 1; \lambda_j \geq 0; (j = 1,2....N) \right\} \quad \ldots(4.1)$$

The TEF_{inp} of any DMU t under VRS technology requires the solution of the following linear programming (LP) problem

$$\min \theta$$

$$\text{s.t.} \quad \sum_{j=1}^{N} \lambda_j x_{ij} \leq \theta x_{it} ; \qquad (i = 1, 2, \ldots\ldots.., h)$$

$$\sum_{j=1}^{N} \lambda_j y_{rj} \geq y_{rt} ; \qquad (r = 1, 2, \ldots\ldots.., g)$$

$$\sum_{j=1}^{N} \lambda_j = 1 ;$$

$$\theta \text{ free}, \lambda_j \geq 0 \ (j = 1, 2, ..., N) . \qquad \ldots.(4.2)$$

TEF_{inp} of DMU t can be determined by using equation (4.2).

$$TE_I^t (x^t, y^t) = \theta^* . \qquad \ldots.(4.3)$$

Where θ* is the solution of equation (4.2). The minimum input required to produce the given level of output y is $x_*^t = \theta^* x^t$.

4.2.2 Description of Radial and Slack Movement

Using the LP models radial measures of TEF are obtained. Here, TEF is measured along a ray from the origin to the observed production point. In such a radial projection of an observed output-input bundle onto the frontier, sometimes all the inputs used are not potentially reduced. The horizontal or vertical portion of an isoquant accounts for inefficiency in usage of inputs. As a result there may be the possibility of the existence of input slack for the case of multiple output-input in the production process. Among the output produced by firm t, the largest output bundle with the same output mix as (y^t_1, y^t_2) that can be produced from the input bundle (x_1*, x_2*) is (ϖ* y_1*, ϖ* y_2*).

It is sometimes possible to expand individual outputs by a factor larger than ϖ*. It is also possible that firm t may not entirely use up all the individual components of the input bundle to produce the expanded output bundle. Hence all the inputs used are not potentially reduced.

The input slack variable can be defined as

$Si^- = x_{it} - x^*_{it}$, (i=1,2,…,h)

The existence of inefficiency in input utilization basically implies the existence of radial and or slack movement and by considering the sum of these two movements the extent of input inefficiency can be measured.

The input slack can be explained graphically as depicted in Figure 4.1.

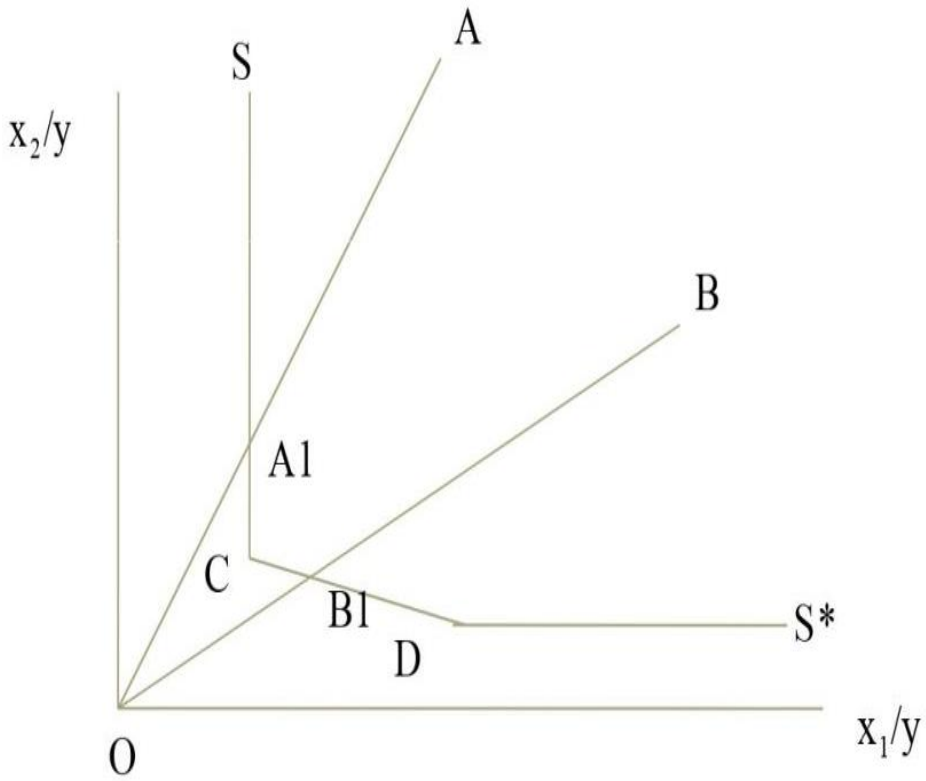

Figure 4.1: Measurement of Input Slack and Radial Movement

Source: Bhanja and Ghose (2022)

In Figure 4.1, C and D are two efficient DMUs which are on the frontier. DMU A and B are inefficient. Point A1 is on the frontier but here also the DMU is inefficient as one can reduce the amount of x_2 input by CA1 and still produce the same output. So CA1 is the input slack movement of input x_2 while AA1 is the input radial movement. Thus the extent of inefficiency of input is the sum of this radial and slack movement.

4.2.3 The variables used for TEF_{inp} Estimation and Determinant Analysis

For analysing TEF_{inp} of Secondary as well as H.S. education level, the same output-input variables along with the same set of possible determinants are considered as done in chapter 3, using the same 'Unified District Information System for Education' (UDISE) dataset. The time span of the analysis also remains the same as chapter 3 i.e. 2010-11 to 2015-16.

4.3 Empirical Findings

4.3.1 Analysis of TEF_{inp} of Secondary Education using UDISE Dataset

4.3.1.1 Result of TEF_{inp} Score Estimation for GCS and SCS&UT considering Secondary Level of Education

Considering secondary education level, Table 4.1.1 and Table 4.1.2 demonstrates estimated TEF_{inp} scores by assuming VRS for each year under the sample time frame i.e. 2010-11 to 2015-16 along with the computed average TEF_{inp} score over the specified time duration for GCS and SCS&UT respectively. In addition to this, tables 4.1.1 and 4.1.2 display the grand average TEF_{inp} scores allowing for all GCS for all years, as well as all SCS&UT for all years separately. It is also evident from the tabulated result that TEF_{inp} scores are not the same within & between GCS and SCS&UT. Further, not all GCS and all SCS&UT achieve full efficiency (TEF_{inp}) for each of the years of the present study.

Table 4.1.1: TEF_{inp} of Secondary level of education over different years for GCS

States	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	Average
AP	1.000	1.000	0.948	1.000	0.945	0.995	0.981
BI	1.000	1.000	1.000	1.000	1.000	1.000	1.000
CHHAT	1.000	1.000	0.833	0.862	0.667	0.684	0.841
GO	1.000	1.000	1.000	1.000	1.000	1.000	1.000
GUJ	0.873	0.851	0.846	1.000	0.964	0.944	0.913
HAR	0.631	0.611	1.000	1.000	0.562	0.557	0.727
JHAR	1.000	1.000	1.000	1.000	1.000	1.000	1.000
KAR	0.871	1.000	1.000	0.979	1.000	0.983	0.972
KER	1.000	1.000	1.000	1.000	1.000	1.000	1.000
MP	0.661	0.633	0.875	0.992	0.744	0.801	0.784
MH	1.000	1.000	1.000	1.000	1.000	1.000	1.000

Contd….

States	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	Average
ORI	1.000	1.000	1.000	1.000	1.000	1.000	1.000
PN	1.000	1.000	0.652	0.945	0.937	0.939	0.912
RAJ	0.741	0.825	0.767	0.828	0.835	0.719	0.786
TN	1.000	1.000	0.952	1.000	1.000	1.000	0.992
UP	1.000	1.000	0.872	1.000	1.000	1.000	0.979
WB	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Grand Average							0.935

Source: Author's computation

Table 4.1.1 reflects the following evidences on TEF_{inp} for the secondary education level exploring GCS:

(i) Over the specified time duration, the mean TEF_{inp} scores for AP, KER, GO, WB, BI, KAR, MH, ORI, JHAR, TN and UP reflect higher figures than the computed grand mean TEF_{inp} score '0.935'.

(ii) TEF_{inp} score equal to unity is continuously achieved by GO, MH, KER, JHAR, BI, WB and ORI during the time span; while a continuous input inefficiency is experienced by MP and RAJ.

(iii) HAR and KAR appeared as inefficient states at the start, but gained perfect efficiency (TEF_{inp}) over the time, even though at the concluding year of this study, these two states experienced input inefficiency again. Conversely, CHHAT, AP and PN proved input efficiency at the beginning year, but afterwards became inefficient.

(iv) KAR, MP and GUJ reflect a growing pattern of TEF_{inp} score referring to the initial TEF_{inp}; even if TEF_{inp} worsens for GUJ during the in-between phase of the study. On the contrary, CHHAT, HAR, PN, AP and RAJ reflect a deteriorating pattern of TEF_{inp}, though HAR and RAJ show improvements in-between.

(v) TN and UP appeared as perfectly efficient (TEF_{inp}) GCS for each year in this study excluding the year 2012-13. Conversely, GUJ is identified to attain TEF_{inp} score equal to unity only for a single year, amongst all years under this study.

Table 4.1.2: TEF_{inp} of Secondary level of education over different years for SCS&UT

States	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	Average
A&N	1.000	0.638	1.000	1.000	1.000	1.000	0.939
ARU	0.855	0.645	1.000	0.780	1.000	1.000	0 .880
AS	1.000	1.000	1.000	1.000	1.000	1.000	1.000
CHAND	0.845	0.610	1.000	1.000	1.000	0.710	0.860
D&N	1.000	1.000	1.000	1.000	1.000	1.000	1.000
D&D	1.000	1.000	1.000	1.000	0 .629	0.645	0 .879
DEL	1.000	1.000	1.000	1.000	1.000	1.000	1.000
HP	1.000	1.000	0.699	1.000	1.000	1.000	0.949
J&K	0.674	0.657	0.790	0.644	0.653	0.585	0 .667
LAKH	1.000	1.000	1.000	1.000	1.000	1.000	1.000
MAN	1.000	0.640	0.928	0.847	0.813	0.841	0 .844
MEGH	0.764	0.688	0.604	1.000	0.990	0.881	0.821
MIZO	1.000	1.000	0.734	0.791	0.850	1.000	0.895
NG	0.807	0.700	1.000	0.717	1.000	1.000	0. 870
PUD	0.700	0.787	0.719	0.764	0.780	0.811	0.760
SIK	1.000	1.000	0.746	1.000	1.000	1.000	0.957
TP	1.000	1.000	1.000	1.000	1.000	1.000	1.000
UK	0.767	0 .680	1.000	0.892	1.000	0.751	0.848
Grand Average							0.898

Source: Author's computation

Table 4.1.2 reflects the following findings on TEF_{inp} for the secondary education level of SCS&UT:

(i) The mean TEF_{inp} scores for AS, DEL, SIK, A&N, HP, TP, LAKH, D&N over the mentioned time frame, reflect relatively higher values than that of the calculated grand average TEF_{inp} which is obtained as '0.898'.

(ii) TEF_{inp} is consistently achieved by AS, TP, LAKH, DEL and D&N in all years under observation; while input inefficiency is consistently experienced by J&K and PUD.

(iii) CHAND, NG, ARU and UK appeared as inefficient states at the start but across time these SCS&UT gained perfect TEF_{inp} although, at the final year of this study, two states, CHAND and UK yet again experienced input inefficiency. On the contrary, D&D, MAN and MIZO, reflected TEF_{inp} at the beginning and these states became inefficient later.

(iv) PUD, ARU, MEGH and NG reflect a rising pattern of TEF_{inp} in comparison to the initial TEF_{inp} score; however, TEF_{inp} worsens for MEGH, ARU and NG during intermediate years of the study. Conversely, CHAND, MAN, D&D, J&K and UK reflect a diminishing pattern of TEF_{inp}, though CHAND, UK and J&K confirm improvements midway.

(v) A&N, HP and SIK appeared as perfectly efficient (TEF_{inp}) SCS&UT for each year in this study with the exception of 2011-12 and 2012-13 respectively; while MAN and MEGH are identified to attain '1.000' value of TEF_{inp} only for a single year, in the view of all years under this observation.

(vi) In spite of starting and ending efficiently, MIZO turned inefficient (TEF_{inp}) in three intermediate years, 2012-13, 2013-14 and 2014-15.

4.3.1.2 Computation of Radial movement & Slack movement for different Inputs for Secondary Education

Radial and slack movements capture the degree of inefficiency of the inputs, used in the production process. The states showing input efficiency for a specific level of education, scoring '1' for all the years under the study, reflect the radial measure as zero. However, slack movement may exist for these states, indicating extent of input inefficiency. Again, for the states with higher averages of TEF_{inp} for a specific education level, there may still exist radial and slack movements, meaning that input can be further reduced while output remains the same. For all the different inputs used by GCS as well as SCS&UT in education production during the period 2010-11 to 2015-16, the percentages of radial and slack movements are computed as the ratios of radial and slack movements to the actual value of the corresponding input usage and expressed as a fraction of 100, (utilizing input-oriented DEA results for the specific level of education); and the average representation over the years for each input's radial and slack movement, expressed in percentage terms are represented for all GCS and SCS&UT in table respective tables of this chapter. Table 4.1.3 and table 4.1.4 represent radial movement and slack movement (in percentage) for each of the various inputs of secondary education

production in GCS and SCS&UT respectively; and also reflects the average figures taking all GCS together as well as all SCS&UT together respectively; considering the percentage of radial and slack movements of each of the inputs used in secondary education production.

Table 4.1.3: Radial movement and slack movement (in percentage) of different inputs considering TEF_{inp} measurement of Secondary education for GCS

State	Number of Secondary Schools Per Lakh Population		Teacher-Student Ratio		Classroom-Pupil Ratio		Percentage of Teachers Qualifying Post Graduation or Higher Degree	
	Radial	Slack	Radial	Slack	Radial	Slack	Radial	Slack
AP	-1.86	-6.68	-1.65	0.00	-2.33	-2.98	-1.88	-3.16
BI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CHHAT	-15.91	-13.19	-15.10	0.00	-17.18	-0.88	-15.90	-8.87
GO	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
GUJ	-8.91	-1.06	-8.75	-5.13	-9.23	-10.92	-8.72	0.00
HAR	-27.33	-1.28	-27.30	-3.95	-28.60	-0.62	-27.31	0.00
JHAR	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
KAR	-2.80	-7.19	-2.52	-7.48	-3.37	-13.50	-2.79	0.00
KER	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MP	-21.74	-7.30	-23.58	-1.26	-21.36	-3.40	-21.56	-6.42
MH	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ORI	0.00	-0.02	0.00	-1.13	0.00	0.00	0.00	-0.02
PN	-8.84	-23.15	-8.77	-9.28	-9.07	0.00	-8.79	-2.96
RAJ	-21.33	-26.86	-21.20	-4.28	-20.82	-8.00	-21.42	0.00
TN	-0.79	-3.46	-0.50	-4.50	-0.68	0.00	-0.80	-6.00
UP	-2.11	0.00	-2.40	-9.60	-2.70	-0.90	-2.13	0.00
WB	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Average	-6.57	-5.31	-6.57	-2.74	-6.79	-2.42	-6.55	-1.61

Source: Author's Computation

Table 4.1.3 result displays for secondary level, the radial movement of **input 1**, 'number of secondary schools per-lakh population', appears lowest i.e. zero percent for seven GCS, namely, MH, GO, WB, KER, BI, JHAR, ORI; while this measure appears as highest for HAR. Averaging the radial movement of input 1 for GCS reflects a value of 6.57% (absolute term) and the GCS identified as falling below the average level are MH, AP, GO, KER, WB, TN, ORI, KAR, UP, BI and JHAR. After examining the slack movement of this input for secondary level, it has been observed that the GCS, GO, KER, WB, BI, MH, JHAR and UP exhibit the lowest slack movement, which is recorded as a value of zero. As found in table 4.1.3 for GCS, the mean slack movement value of input 1 is established at 5.31 percent and among these GCS, KER, GO, WB, GUJ, BI, HAR, TN, UP, MH, JHAR and ORI are identified for attaining lower slack movement value in comparison to this average.

Taking into account **input 2**, 'teacher-student ratio' for secondary level, and analyzing its radial movement focusing on GCS, it is noted that seven states, namely, KER, ORI, WB, BI, MH, GO and JHAR reflect the lowest radial movement, with a value of zero. Considering input 2, the average value of the radial movement for GCS is found as 6.57 percent which is same as average radial movement value for input1; and the states lying below this average radial movement are: AP, KAR, WB, KER, ORI, JHAR, BI, MH, TN, GO and UP. Taking into account the slack movement of input 2 for secondary level, it has been observed that GCS like AP, GO, KER, CHHAT, MH, BI, JHAR and WB have attained the lowest score, representing a value of zero. In the context of slack movement, it is clear from table 4.1.3 that the mean slack movement value for this input is computed as 2.74 percent and the states, AP, WB, KER, GO, MP, JHAR, ORI, BI and CHHAT have a lower slack movement, compared to this calculated average.

Upon analyzing **input 3**, 'classroom-pupil ratio' for secondary stage concerning radial movement, it becomes evident that the average radial movement value is 6.79 percent for GCS; and the states KAR, WB, KER, GO, AP, ORI, MH, BI, TN, JHAR and UP reflect radial movement below this average. Seven GCS such as WB, MH, KER, BI, GO, JHAR and ORI confirm the lowest radial movement of this input, measured at zero percent. On the contrary, the slack movement for input 3, reveals that states like, GO, TN, KER, JHAR, MH, BI, PN, ORI and WB experience lowest slack movement (zero percent). Further, as found in table 4.1.3, the average value of slack movement of this input is noted at 2.42% for GCS. Among this category of states, MH, WB, TN, CHHAT, KER, PN, GO, BI, HAR, JHAR, UP and ORI are identified for revealing lower slack movement value in comparison to this figure of mean.

While assessing the radial movement for **input 4**, 'Percentage of teachers with qualification post-graduation and above' considering secondary stage of education for GCS, it becomes evident that KER, GO, WB, BI, MH, JHAR and ORI are associated with the lowest levels (i.e. zero percent) of radial movement. For input 4, TN, GO, KER, WB, UP, BI, AP, MH, JHAR, ORI and KAR display a radial movement below the average level (6.55%). Conversely, the slack movement for input 4, reveals that GCS like RAJ, KER, HAR, KAR, GO, WB, GUJ, JHAR, BI, MH and UP experience lowest slack movement (zero percent). As found in table 4.1.3, the average value of slack movement of input 4 is noted at 1.61% for GCS. Among this category of states, KAR, RAJ, ORI, KER, GUJ, WB, MH, HAR, GO, JHAR, UP and BI are recognized for depicting relatively lesser slack movement value in comparison to this mean, found in the context of secondary-level education.

Table 4.1.4: Radial movement and slack movement (in percentage) of different inputs considering TEF_{inp} measurement of Secondary education for SCS&UT

State	Number of Secondary Schools Per Lakh Population		Teacher-Student Ratio		Classroom-Pupil Ratio		Percentage of Teachers Qualifying Post Graduation or Higher Degree	
	Radial	Slack	Radial	Slack	Radial	Slack	Radial	Slack
A&N	-2.66	0.00	-2.73	-3.49	-3.09	-3.09	-2.70	0.00
ARU	-2.80	-9.08	-2.82	-0.74	-2.95	-0.98	-2.76	-0.58
AS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CHAND	-2.50	-8.06	-2.50	-23.21	-2.20	-2.93	-2.58	-8.19
D&N	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
D&D	-6.82	0.00	-6.92	-4.78	-7.40	-3.70	-7.02	-0.17
DEL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
HP	-1.69	-27.17	-1.80	0.00	-1.80	-11.50	-1.68	-12.72
J&K	-29.78	-11.71	-30.64	0.00	-31.01	-4.66	-30.11	0.00
LAKH	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MAN	-4.54	-23.61	-4.52	-9.00	-4.55	0.00	-4.54	-0.90
MEGH	-11.18	-20.61	-11.01	-5.21	-12.09	-4.24	-11.20	0.00

Contd….

State	Number of Secondary Schools Per Lakh Population		Teacher-Student Ratio		Classroom-Pupil Ratio		Percentage of Teachers Qualifying Post Graduation or Higher Degree	
	Radial	Slack	Radial	Slack	Radial	Slack	Radial	Slack
MIZO	-6.56	-19.60	-6.45	-16.05	-6.63	-10.28	-6.58	0.00
NG	-6.20	-5.53	-6.18	-9.92	-6.90	-5.50	-6.28	-4.55
PUD	-20.88	-16.32	-20.37	-3.62	-21.05	-4.64	-20.83	0.00
SIK	-0.90	-4.93	-0.95	-2.22	-1.30	0.00	-0.90	0.00
TP	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UK	-9.75	-20.06	-9.82	-6.24	-10.70	-0.97	-9.83	-4.87
Average	-5.90	-9.26	-5.93	-4.69	-6.20	-2.92	-5.94	-1.78

Source: Author's Computation

Result of table 4.1.4 confirms, the radial movement of **input 1,** 'number of secondary schools per-lakh population', turns lowest (zero percent) for five SCS&UT, like, AS, D&N, DEL, LAKH and TP; whereas the same measure turns highest for J&K. Considering input 1, the average radial movement for SCS&UT is established at 5.90%. The SCS&UT lying below this mean radial movement value are: AS, SIK, DEL, A&N, CHAND, ARU, D&N, LAKH, MAN, TP and HP. Seven SCS&UT like, A&N, DEL, AS, TP, D&D, LAKH and D&N are showing the lowest or zero slack movement value of this input. For input 1, in table 4.1.4, the mean slack movement is clearly evident at 9.26%. Again, SCS&UT, NG, A&N, DEL, TP, CHAND, SIK, AS, D&D, LAKH, D&N and ARU have lower slack movement value, compared to this average.

After considering **input 2** (teacher-student ratio) for the secondary stage with a focus on SCS&UT and accounting for radial movement, it has been noticed from table 4.1.4 that states like, DEL, AS, TP, D&N and LAKH have the lowest radial movement, with a zero value. The calculated average for the radial movement of input 2 is 5.93% for SCS&UT. The states that fall below the average level are specifically identified as DEL, SIK, AS, HP, A&N, TP, MAN, D&N, ARU, LAKH and CHAND. Upon considering the slack movement of input 2 for secondary stage, it has been found in table 4.1.4 that the SCS&UT, DEL, HP, AS, J&K, D&N, TP and LAKH experience the lowest slack movement, which is recorded as zero. It has been

noted for SCS&UT that the mean slack movement for input 2 is 4.69 % and the states, DEL, PUD, HP, SIK, AS, J&K, A&N, LAKH, D&N, TP and ARU exhibit comparatively lesser values of slack movements when compared to this mean value.

Taking into consideration **input 3** (classroom-pupil ratio) for secondary level and its corresponding radial movement, it has been found that the average value of the radial movement turns as 6.20% in the view of SCS&UT and among these states CHAND, TP, SIK, DEL, ARU, D&N, A&N, HP, LAKH, AS and MAN fall below this mean value in terms of radial movement. Five SCS&UT such as TP, DEL, D&N, LAKH and AS demonstrate the lowest radial movement of input 3, measured at zero percent. However, in consideration of slack movement of input 3, states like, DEL, TP, MAN, AS, D&N, SIK and LAKH have recorded the lowest measure, corresponding to a value of zero and SIK, DEL, MAN, TP, AS, ARU, D&N, LAKH and UK show, for this input, the slack movement below the average level of 2.92%.

Upon considering **input 4** (Percentage of teachers with qualification post-graduation and above) for secondary education with regard to radial movement, it has been observed that the SCS&UT such as DEL, LAKH, AS, D&N and TP reflect the least level (i.e. zero percent) of radial movement. Additionally, for input 4, CHAND, SIK, DEL, HP, TP, AS, LAKH, ARU, D&N, MAN and A&N reveal a radial movement below the average value (5.94%). On the contrary, upon examining the slack movement of input 4 for secondary level, it has been observed that the slack movement is non-existent or zero in SCS&UT, like, TP, PUD, A&N, DEL, SIK, D&N, AS, LAKH, MEGH, J&K and MIZO. It has also been noted for this input that considering SCS&UT the mean slack movement is 1.78% and PUD, SIK, MAN, A&N, J&K, LAKH, DEL, TP, D&N, ARU, MEGH, AS, MIZO and D&D show lesser values of slack movements relative to this mean value.

Measuring both the radial and slack movements of the inputs play a crucial role in providing an understanding of the inefficiency levels associated with each of the various inputs, utilized in the process of production. The ultimate importance lies in estimating the degree of inefficiency exhibited by each input, which can be quantified by considering the combined sum of both radial and slack movements for that particular input and such results of the extent estimation of input inefficiency for each of the inputs are employed for ranking the inputs accordingly. In Tables 4.1.5 and 4.1.6 below, the combined value of radial & slack movement

added together for each of the inputs are presented for GCS and SCS&UT respectively, along with the corresponding grand mean combined movement value for each input.

Table 4.1.5: Combined movement (in percentage) of different inputs considering TEF_{inp} measurement of Secondary education for GCS

State	Number of Secondary Schools Per Lakh Population	Teacher-Student Ratio	Classroom-Pupil Ratio	Percentage of Teachers Qualifying Post Graduation or Higher Degree
AP	-8.54	-1.65	-5.32	-5.03
BI	0.00	0.00	0.00	0.00
CHHAT	-29.11	-15.10	-18.07	-24.77
GO	0.00	0.00	0.00	0.00
GUJ	-9.98	-13.88	-20.15	-8.72
HAR	-28.61	-31.25	-29.22	-27.31
JHAR	0.00	0.00	0.00	0.00
KAR	-9.99	-10.00	-16.87	-2.79
KER	0.00	0.00	0.00	0.00
MP	-29.04	-24.84	-24.76	-27.99
MH	0.00	0.00	0.00	0.00
ORI	-0.02	-1.13	0.00	-0.02
PN	-31.99	-18.05	-9.07	-11.74
RAJ	-48.19	-25.48	-28.82	-21.42
TN	-4.25	-5.00	-0.68	-6.80
UP	-2.11	-12.00	-3.60	-2.13
WB	0.00	0.00	0.00	0.00
Average	-11.87	-9.32	-9.21	-8.16

Source: Author's Computation

In Table 4.1.5, the average value of the combined movement (i.e. radial & slack movements considered collectively) of input 1 considering secondary education is shown as 11.87% for GCS; and among these states, WB, KAR, GO, AP, MH, KER, ORI, GUJ, JHAR, TN, UP and BI are showing lower combined movement values than the computed average. On the contrary, RAJ is identified as a state, showing the highest combined movement of input 1.

According to input 2, for the secondary level, the mean combined movement is turned as 9.32% and there are nine GCS, namely AP, WB, KER, TN, MH, BI, ORI, GO and JHAR show combined movement figures below this average. However, a state like HAR shows the greatest degree of combined movement.

As far as input 3 is concerned for the secondary stage, the average combined movement is observed as 9.21% and the GCS where the combined movement is reflecting the lower values compared to the average are: KER, WB, AP, TN, GO, PN, JHAR, BI, MH, UP and ORI. HAR is the GCS with the highest combined movement of input 3.

A mean value of 8.16 % of the combined movement is found when input 4 is taken into account for secondary level of education. There are states with lower combined movement than the GCS average considering input 4, including KAR, MH, KER, TN, WB, AP, GO, BI, JHAR, ORI and UP. Referring to secondary education, the maximum level of combined movement for input 4 is observed for MP.

As illustrated by the empirical analysis of GCS concerning secondary education, WB, KER, GO, MH, JHAR and BI reflect the minimum value of combined movement for all the four inputs of secondary level education production.

Therefore, considering GCS, this analysis provides insight into the input inefficiency levels for various inputs of the secondary educational production, while revealing whether any input is used in excess to produce a particular output level or not. The figures of combined movements of the four inputs concerning secondary stage of education reveal the following information, keeping GCS into consideration:

(1) The input utilization performance of GCS such as AP, TN and ORI are considered as good since they show lesser combined movement (i.e. radial and slack movement considered collectively) values for all the four inputs compared to the corresponding mean combined movement value (taking all the GCS into account) of each input considered in this study.

(2) Poor performance, in the view of input utilization, is observed for GCS like MP, CHHAT, HAR and RAJ as these states demonstrate greater combined movement values for all the inputs than the corresponding mean combined movement value (considering all the GCS) of each input considered for this analysis. Specifically, RAJ and MP have been identified as the worst-performing GCS in consideration of the inputs, 'number of secondary schools per lakh population' and 'percentage of teachers with qualification post-graduation and above' at secondary level' respectively. In addition to this, HAR shows the most inefficient utilization of the inputs, 'classroom-pupil ratio' and 'teacher-student ratio' at the secondary level.

Using a combined estimate of Radial and Slack movements, the performances of various inputs of secondary level are analyzed for GCS and the result reveals that the average inefficiency is found to be **greatest for input1** (11.87%), followed by input 2 (9.32 %) and input 3 (9.21 %), and **lowest for input 4** (8.16 %) respectively. Thus, this finding of input inefficient-utilization suggests that the same output level is possible to be produced using less of the inputs at the secondary stage with better input utilization at GCS.

Table 4.1.6: Combined movement (in percentage) of different inputs considering TEF_{inp} measurement of Secondary education for SCS&UT

State	Number of Secondary Schools Per Lakh Population	Teacher-Student Ratio	Classroom-Pupil Ratio	Percentage of Teachers Qualifying Post Graduation or Higher Degree
A&N	-2.66	-6.22	-6.18	-2.70
ARU	-11.88	-3.56	-3.93	-3.34
AS	0.00	0.00	0.00	0.00
CHAND	-10.57	-25.71	-5.13	-10.77
D&N	0.00	0.00	0.00	0.00
D&D	-6.82	-11.70	-11.10	-7.19
DEL	0.00	0.00	0.00	0.00
HP	-28.86	-1.80	-13. 30	-14.40
J&K	-41.49	-30.64	-35.68	-30.11

Contd….

State	Number of Secondary Schools Per Lakh Population	Teacher-Student Ratio	Classroom-Pupil Ratio	Percentage of Teachers Qualifying Post Graduation or Higher Degree
LAKH	0.00	0.00	0.00	0.00
MAN	-28.15	-13.51	-4.55	-5.44
MEGH	-31.80	-16.21	-16.33	-11.20
MIZO	-26.15	-22.50	-16.92	-6.58
NG	-11.73	-16.11	-12.40	-10.83
PUD	-37.19	-23.99	-25.68	-20.83
SIK	-5.83	-3.17	-1.30	-0.90
TP	0.00	0.00	0.00	0.00
UK	-29.81	-16.05	-11.67	-14.70
Average	-15.16	-10.62	-9.12	-7.72

Source: Author's Computation

In Table 4.1.6 for SCS&UT, the average value of the combined movement (i.e. radial & slack movements considered collectively) of input 1 considering secondary stage education is reflected as 15.16 % ; and among these states, NG, TP, DEL, AS, LAKH, D&N, ARU, SIK, A&N, D&D and CHAND are reflecting lower combined movement values than the computed average. On the contrary, J&K is identified as a union territory, reflecting the highest combined movement of input 1.

As far as input 2 is concerned for the secondary level, the mean combined movement turns as 10.62% and there are nine SCS&UT, namely TP, AS, DEL, SIK, A&N, D&N, HP, ARU and LAKH, reflecting combined movement figures below this mean level. However, J&K reflects the greatest degree of combined movement for input 2 as well.

According to input 3, for the secondary stage, the average combined movement is observed as 9.12%, and the SCS&UT where the combined movement is reflecting the lower values compared to the average are A&N, AS, MAN, DEL, ARU, CHAND, TP, SIK, LAKH and D&N. J&K experiences the highest combined movement for input 3, in the 'SCS&UT' group.

A mean value of 7.72% is found when the combined movement of input 4 is considered for secondary education taking into account SCS&UT. There are states & union territories with lesser combined movement figures than the average combined movement of this input for this particular category, including AS, MAN, DEL, SIK, D&D, A&N, TP, D&N, MIZO, ARU and LAKH. The maximum level of combined movement for input 4, considering SCS&UT, is observed for J&K.

Based on the empirical analysis of SCS&UT, it has been noticed that DEL, TP, AS, LAKH and D&N reflect the minimum value of combined movement for each of the four inputs used in secondary education level.

This analysis for SCS&UT identifies the inputs that are used in excess for producing a particular level of educational output at secondary stage. The figures of combined movements of the inputs relating to secondary education of SCS&UT reveal the following facts:

(1) The performance relating to input utilization of A&N, SIK and ARU are considered as good since these states represent lesser combined movement (i.e. radial and slack movement considered collectively) values for all the inputs compared to the corresponding mean combined movement value (considering all the SCS&UT) of each input considered for this analysis.

(2) Poor performance concerning input utilization is evident for SCS&UT such as, J&K, MEGH, UK and PUD since the states demonstrate larger combined movement figures for all the four inputs than the corresponding inputs' mean combined movement values. Specially, J&K has been recognized as the worst-performing unit in the 'SCS&UT' group considering all the four inputs, like 'number of secondary schools per lakh population', 'classroom-pupil ratio', 'teacher-student ratio' and 'percentage of teachers with qualification post-graduation and above' at secondary level.

Based on the combined estimate of Radial and Slack movements, the performances of the inputs are analyzed considering secondary level and it is found that the average inefficiency is **greatest for input 1** (15.16%), followed by input 2 (10.62%) and input 3 (9.12%), and **lowest for input 4** (7.72%) respectively. Therefore, such findings for SCS&UT imply that producing the same extent of the output at the secondary stage is possible, using the less input level, with better utilization.

4.3.1.3 Factors Determining TEF_{inp} of Secondary-Level of Education

The purpose of this section is describing the significant factors, determining TEF_{inp} of secondary-stage of education, focusing on GCS and SCS&UT separately. Since the dataset consists of 17 GCS over the six consecutive years i.e. 2010-11 to 2015-16, testing the appropriateness of using either pooled model or panel model for analyzing the determinants of TEF_{inp} considering Secondary education of GCS is necessary. In order to do that, this study employs the BPLM test. The result of the BPLM test confirms the appropriateness of using panel model for this dataset and therefore further selection between the random effect and fixed effect model is confirmed through the Hausman test in favour of the random effect model. Several alternative models are tested under trial and the best fitted model is reported in the Table 4.1.7 below.

Table 4.1.7: Factors determining TEF_{inp} of Secondary Education level in GCS

Variables	Coefficient	z-value	p-value	
PWBS	-.0211843	-3.21	0.001	Wald chi2 = 24.26 Prob> chi2 = 0.0069
PPTEA	.0121591	1.76	0.078	
PGETB	.0035879	2.37	0.018	
GEXPOE	.1290399	2.15	0.031	
PCNSDP	7.84e-07	1.87	0.062	
Constant	-.5420582	-1.04	0.298	

Source: Author's Estimation

At the Secondary-stage of education, Table 4.1.7 demonstrates that TEF_{inp} for GCS is significantly affected by social indicator, policy variable, the general environment of the state revealing macro indicator, in addition to, infrastructure indicating factors like, 'PWBS' and 'PPTEA'. Following the result of this determinant analysis, it is particularly observed that PWBS turn into a significant variable with a negative sign (at a one percent level of significance) in determining TEF_{inp} which actually reveals, TEF_{inp} depressing effect of PWBS as a poor infrastructure variable. Basically, lacking a building in the school premises hinders specified input variables of the schools to be fully utilized and hence, TEF_{inp} score declines at secondary-level in GCS with a higher degree of absence of the school buildings. Additionally, 'PPTEA' being a significantly affecting infrastructural variable with positive sign in the determination of TEF_{inp}, indicates that a rise in para teachers' proportion in the school promotes

TEF_{inp} of secondary education. Basically, this result depicts the fact that para teachers play an important role in the absence of the required number of full-time teachers, in the form of reducing capacity underutilization of other resources used as inputs in educational production and hence TEF_{inp} rises with the rise in PPTEA. 'PGETB', as a social indicator, affects TEF_{inp} of secondary education significantly and positively which is an indication of the fact that improving girls enrolment to boys, i.e., bringing more girls to the formal education system will actually improve TEF_{inp} in secondary education process. Table 4.1.7 reveals that the policy variable, 'GEXPOE' influences TEF_{inp} of secondary-level in GCS positively. This result implies, TEF_{inp} enhancing role of 'GEXPOE' in the GCS, as a higher level of educational expenditure for the state by the government may reduce input's inefficient utilization in educational production at the secondary-level, resulting in more TEF_{inp} score attainment by the schools at secondary-level. 'PCNSDP' being a macro indicator, positively impacts on TEF_{inp} of secondary education for GCS as suggested by statistical significance of this variable, in Table 4.1.7, with positive sign. This finding basically reveals that the GCS where 'PCNSDP' is higher, parents are more aware of sending their children into schools and following the presence of more students, inputs of educational production process at secondary-level will be utilized in a better manner, leading to higher TEF_{inp} score. A reasonable extent of goodness of fit is also suggested by the regression model, reported in table 4.1.7.

Taking into account the dataset of 18 SCS&UT over the six consecutive years (2010-11 to 2015-16), the appropriateness of using either pooled model or panel model for analyzing the determinants of TEF_{inp} considering Secondary education of SCS&UT is tested through BPLM test. However, the result of BPLM test confirms the appropriateness of using pooled model over panel model for this dataset and further due to non-existence of contemporaneous correlation, simple pooled regression model is adopted. As Breusch-Pagan test confirms the existence of heteroskedasticity problem in the model, therefore two-step GLS technique is applied for deriving the results of the determinant analysis of TEF_{inp} of Secondary stage of education for SCS&UT. Several alternative models are tested under trial and the best fitted model is reported in the Table 4.1.8 below.

Table 4.1.8: Factors determining TEF_{inp} of Secondary Education level in SCS&UT

Variables	Coefficient	z-value	p-value	
PBCC	-.0013146	-1.40	0.162	
PSST	-.0061104	-2.87	0.004	Wald chi2 =
PSADWF	-.0051481	-3.17	0.002	153.66
PSAE	-.0097141	-3.12	0.002	Prob> chi2
PPTEA	.0143355	2.98	0.003	= 0.0000
PSTE	.001222	2.76	0.006	
GEXPOE	.0211317	3.97	0.000	
Constant	.5157232	4.12	0.000	

Source: Author's Estimation

Table 4.1.8 depicts that TEF_{inp} at the secondary-level of education, for SCS&UT, is significantly determined by infrastructure specifying indicators, social indicator, in addition to, the policy indicator. As poor school infrastructure specifying indicators, 'PSST', 'PSADWF' and 'PSAE' are significantly and negatively impacting TEF_{inp} of the secondary-level. 'PBCC' is also affecting TEF_{inp} of secondary-level adversely for these states. These findings are the revelation of the individual dampening effect of each of the mentioned infrastructural factors i.e. PSST, PSADWF, PSAE and PBCC on TEF_{inp} of the secondary-stage for SCS&UT. Precisely, as bad classroom conditions may hinder better utilization of existing inputs of secondary education production in the school, it leads to lower levels of TEF_{inp} in SCS&UT. However, PBCC is showing a lower level of significance. Likewise, the schools, in SCS&UT, running just with one teacher, will generally leave the inputs' capacity underutilized in the process, leading to less attainment of TEF_{inp} at secondary level. Further, in absence of the facility of either electricity or drinking water in the schools, located at SCS&UT, a reduced level of TEF_{inp} at secondary-stage will be attained. On the other hand, following the pattern of GCS, in SCS&UT as well a higher value of 'PPTEA', as a school infrastructure variable, improves TEF_{inp} at secondary-stage. Table 4.1.8 reveals that 'PSTE' being a social indicator, positively impacts on TEF_{inp} of secondary-level; specifically at SCS&UT. Taking all SCS&UT together, since the average representation of ST population percentage out of the total population is 41.77, it reflects that SCS&UT are much more dominated by tribal population and due to this fact, an increase in enrolment for these states in turn must be associated with increase in scheduled tribe enrolment. Higher enrolment may result in better utilization of

existing input resources at the schools, leading to higher scores of estimated TEF_{inp} at secondary-level for these states. As a policy variable, GEXPOE, imparting a positive impact on TEF_{inp} of secondary-education, is also confirmed for SCS&UT. A very high extent of goodness of fit is observed for the regression model, analyzing the determinants of TEF_{inp} of secondary-stage in SCS&UT and reported in table 4.1.8.

4.3.2 Analysis of TEF_{inp} of Higher-Secondary Education using UDISE Dataset

4.3.2.1 Result of TEF_{inp} Score Estimation for GCS and SCS&UT considering Higher-Secondary Level

In Table 4.2.1 and Table 4.2.2, estimated TEF_{inp} scores by assuming VRS for each year taking into account the sample time frame i.e. 2010-11 to 2015-16 along with the calculated average TEF_{inp} over the mentioned time duration for GCS and SCS&UT considering H.S. education level are presented, respectively. Additionally, tables 4.2.1 and 4.2.2 specify the grand average TEF_{inp} scores considering all GCS and all years together, as well as all SCS&UT and all years together. It appears from the tabulated result that TEF_{inp} scores are not the same within & between GCS and SCS&UT; also, not all GCS and all SCS&UT attain full input efficiency for each of the years under consideration.

Table 4.2.1: TEF_{inp} of H.S. level of education over different years for GCS

States	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	Average
AP	1.000	0.975	0.671	0.732	0.833	1.000	0.869
BI	1.000	1.000	1.000	1.000	1.000	1.000	1.000
CHHAT	0.779	0.790	0.698	0.743	0.748	0.790	0.758
GO	0.779	0.748	1.000	0.713	0.846	0.883	0.828
GUJ	0.982	0.904	0.809	0.964	1.000	1.000	0.943
HAR	0.838	0.700	0.680	0.687	0.724	0.782	0.735
JHAR	1.000	1.000	1.000	1.000	1.000	1.000	1.000
KAR	0.829	0.853	0.912	1.000	1.000	1.000	0.932
KER	1.000	1.000	1.000	1.000	1.000	1.000	1.000
MP	0.896	0.821	0.771	1.000	0.784	0.884	0.859
MH	1.000	1.000	1.000	1.000	1.000	1.000	1.000
ORI	1.000	1.000	1.000	1.000	1.000	1.000	1.000

Contd….

States	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	Average
PN	0.918	0.864	0.683	0.823	0.855	0.859	0.834
RAJ	1.000	1.000	0.862	1.000	1.000	1.000	0.977
TN	1.000	0.858	0.761	0.765	0.818	0.857	0.843
UP	1.000	1.000	1.000	1.000	1.000	1.000	1.000
WB	1.000	1.000	1.000	1.000	0.929	0.993	0.987
Grand Average							0.916

Source: Author's computation

According to Table 4.2.1, the following facts on TEF_{inp} can be noted for the H.S. education level of GCS:

(i) Average TEF_{inp} scores, over the specified time frame, for KER, KAR, GUJ, JHAR, MH, RAJ, ORI, UP, WB and BI turn higher than the computed grand average TEF_{inp} score '0.916'.

(ii) Perfect TEF_{inp} is continuously achieved by KER, BI, MH, JHAR, UP and ORI during the course of the time; while throughout inefficiency is observed for PN, HAR and CHHAT.

(iii) KAR and GUJ appeared as inefficient states at the start, but gained perfect efficiency (TEF_{inp}) across time, while TN and WB proved input efficiency at the beginning, but became inefficient afterwards.

(iv) KAR, GO, GUJ and CHHAT reflect a rising pattern of TEF_{inp} score; even though TEF_{inp} level deteriorated for GUJ, GO and CHHAT during the intermediate phase of the study. Conversely, TN, PN, WB, HAR and MP reflect a falling pattern of TEF_{inp} in the view of initial TEF_{inp} score.

(v) RAJ appeared as a perfectly efficient (TEF_{inp}) GCS for each of the years, considered in this study; other than the year 2012-13. On the contrary, GO, TN, MP are observed to attain perfect input efficiency score just for a single year, amongst all the six years under this study.

(vi) Despite starting and ending efficiently, AP, however, shows input inefficiency in the four intermediate years, i.e. 2011-12, 2012-13, 2013-14 and 2014-15.

Table 4.2.2: TEF_{inp} of H.S. level of education over different years for SCS&UT

States	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	Average
A&N	1.000	1.000	0.615	0.683	0.736	0.714	0.791
ARU	1.000	1.000	1.000	1.000	1.000	1.000	1.000
AS	1.000	1.000	1.000	1.000	1.000	1.000	1.000
CHAND	1.000	1.000	0.612	1.000	1.000	1.000	0.935
D&N	1.000	1.000	1.000	1.000	1.000	1.000	1.000
D&D	1.000	1.000	0.644	1.000	1.000	0.769	0.902
DEL	1.000	1.000	1.000	1.000	1.000	1.000	1.000
HP	1.000	0.605	0.750	0.625	1.000	1.000	0.830
J&K	0.634	0.843	0.716	1.000	1.000	0.745	0.823
LAKH	1.000	1.000	0.638	1.000	1.000	1.000	0.940
MAN	1.000	1.000	1.000	1.000	1.000	1.000	1.000
MEGH	1.000	1.000	1.000	1.000	1.000	1.000	1.000
MIZO	1.000	0.754	0.654	0.614	1.000	1.000	0.837
NG	1.000	1.000	1.000	1.000	1.000	1.000	1.000
PUD	1.000	1.000	1.000	1.000	1.000	1.000	1.000
SIK	1.000	0.693	0.630	1.000	1.000	0.813	0.856
TP	0.732	0.724	0.662	0.650	0.714	0.814	0.716
UK	1.000	0.652	0.671	0.629	1.000	1.000	0.825
Grand Average							0.914

Source: Author's computation

Table 4.2.2 reflects the following TEF_{inp} results for the H.S. education taking SCS&UT into consideration:

(i) Over the specified period of time, the mean TEF_{inp} scores for ARU, DEL, CHAND, NG, AS, LAKH, MAN, D&N, PUD and MEGH reflect relatively larger figures than that of the computed grand average TEF_{inp}, obtained as '0.914'.

(ii) TEF_{inp} is consistently achieved by DEL, ARU, MAN, AS, MEGH, PUD, D&N and NG during all the years of the study; while input inefficiency is consistently shown by only one special category state, TP.

(iii) J&K appeared as an inefficient state at the beginning but across time this state gained perfect efficiency in input utilization, even though the state yet again reflected inefficiency at the ending year of this study. Conversely, A&N, SIK and D&D, reflected input efficiency at the start but have undergone inefficiency later.

(iv) J&K indicate an improving pattern of TEF_{inp} in comparison to the TEF_{inp} score at the initial time point. Similarly, at the terminal year TEF_{inp} of TP improved than its initial value, though TEF_{inp} value reduced for this state during intermediate years. On the contrary, SIK, D&D and A&N indicate a reducing pattern of TEF_{inp}, though D&D and SIK exhibit recovery in the midway.

(v) CHAND and LAKH appeared as perfectly efficient (TEF_{inp}) union territories for each year in this study, excluding 2012-13.

(vi) Even though starting and ending efficiently, MIZO, HP and UK appear as inefficient (TEF_{inp}) special category states in the three middle years, 2011-12, 2012-13 and 2013-14.

4.3.2.2 Computation of Radial movement & Slack movement for different Inputs for Higher-Secondary Education

Table 4.2.3: Radial movement and slack movement (in percentage) of the inputs considering TEF_{inp} measurement of H.S. education for GCS

State	Number of H.S. Schools Per Lakh Population		Teacher-Student Ratio		Classroom-Pupil Ratio		Percentage of Teachers Qualifying Post Graduation or Higher Degree	
	Radial	Slack	Radial	Slack	Radial	Slack	Radial	Slack
AP	-13.36	-21.00	-13.89	-10.46	-13.10	-13.10	-13.14	-2.02
BI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CHHAT	-24.32	-25.60	-24.16	-4.47	-28.00	-13.45	-24.18	0.00
GO	-17.61	0.00	-17.70	-16.83	-20.05	-21.29	-17.17	-0.72
GUJ	-5.82	-12.42	-5.89	0.00	-6.16	-3.36	-5.68	0.00
HAR	-26.58	-17.99	-26.88	-12.85	-28.81	-10.73	-26.50	-0.10

Contd….

State	Number of H.S. Schools Per Lakh Population		Teacher-Student Ratio		Classroom-Pupil Ratio		Percentage of Teachers Qualifying Post Graduation or Higher Degree	
	Radial	Slack	Radial	Slack	Radial	Slack	Radial	Slack
JHAR	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
KAR	-6.96	-0.05	-6.81	-25.57	-7.09	-37.71	-6.76	-2.27
KER	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MP	-14.05	-19.19	-14.78	0.00	-14.10	-16.66	-14.07	-0.63
MH	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ORI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PN	-16.70	-25.50	-16.36	-14.67	-15.94	-7.70	-16.64	0.00
RAJ	-2.30	-10.97	-2.50	0.00	-2.30	0.00	-2.29	0.00
TN	-15.75	-20.87	-15.85	-14.05	-16.72	-27.27	-15.68	0.00
UP	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WB	-1.26	-11.64	-0.93	-1.85	-1.00	-3.00	-1.30	-1.63
Average	-8.51	-9.72	-8.57	-5.93	-9.02	-9.07	-8.44	-0.43

Source: Author's Computation

The result of table 4.2.3 shows for H.S. level, the radial movement of input 1 i.e. 'number of H.S. schools per-lakh population', turns lowest (zero percent) for six GCS, namely, KER, MH, ORI, UP, BI, JHAR; and the same measure turns highest for HAR. Considering input 1, the average value of the radial movement for GCS is found as 8.51% (in absolute terms) and the GCS lying below this average radial movement are: KER, MH, WB, ORI, RAJ, KAR, GUJ, UP, BI, JHAR. Taking into account the slack movement of this input, it has been observed that GCS like KER, MH, GO, ORI, BI, UP and JHAR have attained the lowest score, indicating a value of zero. In the context of slack movement, it is clear from table 4.2.3 that the mean slack movement value for input 1 is 9.72 percent and the GCS, KER, KAR, MH, GO, ORI, BI, JHAR and UP have a lower slack movement value compared to this average.

Upon analyzing input 2 i.e. 'teacher-student ratio' for H.S. level and focusing on GCS considering radial movement, it becomes evident that six states, namely, KER, MH, BI, ORI, JHAR and UP have the lowest radial movement, with a value of zero. Averaging the radial

movement of this input for GCS reveals a value of 8.57 percent and the states identified as falling below the average level are KER, GUJ, KAR, MH, RAJ, WB, ORI, BI, UP and JHAR. After examining the slack movement of input 2 for H.S. level, it has been observed that the GCS, GUJ, KER, MH, MP, RAJ, ORI, JHAR, BI and UP exhibit the lowest slack movement, which is recorded as zero. As found in table 4.2.3 for GCS, the mean slack movement value of this input is established at 5.93%. Among all these states, KER, CHHAT, MH, GUJ, WB, RAJ, JHAR, UP, ORI, MP and BI are identified for attaining lower value of slack movement in comparison to this mean value.

Taking into account input 3 i.e. 'classroom-pupil ratio' for H.S. stage and analyzing its radial movement, it has been observed that the average radial movement value is 9.02 percent for GCS; and the states KAR, KER, MH, GUJ, ORI, WB, UP, JHAR, RAJ and BI reflect radial movement below this average. Six GCS such as KER, MH, ORI, UP, JHAR and BI demonstrate the lowest radial movement of input3, measured at zero percent. However, in the view of slack movement of the same input, states like, KER, RAJ, MH, JHAR, ORI, BI and UP have reflected a zero value. Furthermore, for input 3, KER, PN, RAJ, GUJ, ORI, MH, WB, JHAR, BI and UP indicate slack movement below the average of 9.07%.

While examining the radial movement for input 4 i.e. 'Percentage of teachers with qualification post-graduation and above' considering H.S. stage of education for GCS, it becomes evident that KER, ORI, BI, MH, UP and JHAR reflect the lowest levels (i.e. zero percent) of radial movement. For this particular input, KAR, GUJ, KER, UP, RAJ, BI, MH, ORI, JHAR and WB reflect a radial movement below the average (8.44%). On the contrary, the slack movement for the same input, reveals that GCS like, KER, CHHAT, ORI, PN, TN, MH, JHAR, GUJ, UP, BI and RAJ experience lowest slack movement (zero percent). As found in table 4.2.3, the average value of slack movement of input 4 is noted at 0.43% for GCS. Among these states, HAR, RAJ, KER, TN, CHHAT, PN, ORI, MH, GUJ, BI, UP and JHAR are identified for revealing lower slack movement value in comparison to this mean value.

Table 4.2.4: Radial movement and slack movement (in percentage) of the inputs considering TEF_{inp} measurement of H.S. education for SCS&UT

State	Number of H.S. Schools Per Lakh Population		Teacher-Student Ratio		Classroom-Pupil Ratio		Percentage of Teachers Qualifying Post Graduation or Higher Degree	
	Radial	Slack	Radial	Slack	Radial	Slack	Radial	Slack
A&N	-23.77	-13.58	-24.18	-23.67	-26.13	-12.93	-23.60	0.00
ARU	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
AS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CHAND	-6.78	0.00	-6.93	0.00	-7.02	0.00	-6.72	0.00
D&N	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
D&D	-7.61	0.00	-7.59	-38.19	-8.95	-38.23	-8.69	0.00
DEL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
HP	-16.69	-25.83	-18.21	-18.49	-16.43	-9.70	-16.69	0.00
J&K	-19.33	-21.32	-19.10	-0.54	-26.51	-22.79	-19.17	-3.87
LAKH	-6.84	0.00	-6.30	-22.87	-6.95	-19.40	-6.76	-2.24
MAN	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MEGH	0.00	-2.68	0.00	-2.45	0.00	0.00	0.00	-2.09
MIZO	-16.03	-15.69	-16.91	-21.02	-15.77	0.00	-15.93	-14.63
NG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SIK	-14.40	0.00	-13.28	-27.85	-13.26	-16.75	-14.40	0.00
TP	-31.11	-30.58	-31.15	-32.02	-33.27	0.00	-31.18	-12.74
UK	-20.37	0.00	-19.25	-1.83	-20.37	-22.09	-19.16	-17.83
Average	-9.05	-6.09	-9.05	-10.50	-9.70	-7.88	-9.02	-2.97

Source: Author's Computation

Result of table 4.2.4 confirms, the radial movement of input 1 i.e. 'number of H.S. schools per-lakh population', turns lowest (zero percent) for eight SCS&UT, like, ARU, AS, D&N, DEL, MAN, MEGH, NG, PUD; whereas the same measure turns highest for TP. Considering this input, the average radial movement for SCS&UT is established at 9.05%. The SCS&UT lying

below this mean radial movement value are: ARU, AS, CHAND, D&N, D&D, DEL, LAKH, MAN, MEGH, NG and PUD. Twelve SCS&UT like, DEL, AS, SIK, NG, CHAND, MAN, D&N, D&D, LAKH, PUD, UK, ARU are showing the lowest or zero slack movement value of input 1. For input 1, in table 4.2.4, the mean slack movement is clearly evident at 6.09%. Furthermore, the SCS&UT like, DEL, CHAND, SIK, NG, AS, MEGH, MAN, D&N, ARU, PUD, D&D, UK and LAKH have lower slack movement value compared to this average.

After considering input 2 (teacher-student ratio) for H.S. stage with a focus on SCS&UT and accounting for radial movement, it has been noticed from table 4.2.4 that states like, DEL, AS, NG, PUD, D&N, ARU, MAN and MEGH have the lowest radial movement, with a zero value. The calculated average for the radial movement of input 2 is 9.05% for SCS&UT. The states that fall below the average level are specifically identified as DEL, PUD, CHAND, AS, D&D, D&N, ARU, MEGH, NG, MAN and LAKH. Upon considering the slack movement of input 2 for H.S. stage, it has been found in table 4.2.4 that the SCS&UT, DEL, AS, CHAND, PUD, D&N, NG, MAN and ARU experience the lowest slack movement, which is recorded as zero. It has been noted for SCS&UT that the mean slack movement for input 2 is 10.50 % and the states, DEL, J&K, AS, PUD, D&N, CHAND, MEGH, NG, ARU, UK and MAN exhibit comparatively lesser values of slack movements when compared to this mean value.

Taking into consideration input 3 (classroom-pupil ratio) for H.S. level and its corresponding radial movement, it has been found that the average value of the radial movement turns as 9.70 % in the view of SCS&UT and among these states DEL, AS, MAN, ARU, NG, MEGH, CHAND, D&D, LAKH, PUD and D&N fall below this mean value in terms of radial movement. Eight SCS&UT such as DEL, AS, MAN, ARU, NG, MEGH, PUD and D&N demonstrate the lowest radial movement of input 3, measured at zero percent. However, in consideration of slack movement of the same input, states like, AS, DEL, CHAND, D&N, ARU, MAN, MIZO, MEGH, TP, NG and PUD have recorded the lowest measure, corresponding to a value of zero and these states also show, for this input, the slack movement below the average level of 7.88%.

Upon considering input 4 (Percentage of teachers with qualification post-graduation and above) for H.S. education with regard to radial movement, it has been observed that the SCS&UT such as DEL, ARU, NG, MAN, PUD, D&N, AS and MEGH reflect the least level (i.e. zero percent) of radial movement. Additionally, for this input, DEL, ARU, CHAND, NG, LAKH, D&D, MAN, PUD, D&N, AS and MEGH reveal a radial movement below the average value (9.02%).

On the other hand, upon examining the slack movement of input 4 for H.S. level, it has been observed that the slack movement is non-existent or zero in twelve SCS&UT, like, A&N, DEL, AS, CHAND, D&N, ARU, HP, D&D, NG, MAN, PUD and SIK. It has also been noted for input 4 that considering SCS&UT the mean slack movement is 2.97 % and A&N, AS, MEGH, DEL, LAKH, CHAND, HP, D&N, SIK, ARU, D&D, MAN, PUD and NG show lesser values of slack movements relative to this mean value.

As a measure of degree of inefficiency, exhibited by each input utilized in the education (production) process, the combined sum of both radial and slack movements for the specific input is quantified and such results of the extent estimation of input inefficiency for each of the inputs play central role for ranking the used inputs. Tables 4.2.5 and 4.2.6 below displays the combined value of radial & slack movement added together for each of the inputs, presented for GCS and SCS&UT respectively, along with each input's corresponding grand mean combined movement value.

Table 4.2.5: Combined movement (in percentage) of the inputs considering TEF_{inp} measurement of H.S. education for GCS

State	Number of H.S. Schools Per Lakh Population	Teacher-Student Ratio at	Classroom-Pupil Ratio	Percentage of Teachers Qualifying Post Graduation or Higher Degree
AP	-34.36	-24.35	-26.20	-15.16
BI	0.00	0.00	0.00	0.00
CHHAT	-49.92	-28.62	-41.44	-24.18
GO	-17.61	-34.54	-41.35	-17.89
GUJ	-18.25	-5.89	-9.52	-5.68
HAR	-44.57	-39.73	-39.54	-26.59
JHAR	0.00	0.00	0.00	0.00
KAR	-7.00	-32.38	-44.80	-9.03
KER	0.00	0.00	0.00	0.00
MP	-33.23	-14.78	-30.76	-14.71
MH	0.00	0.00	0.00	0.00

Contd….

State	Number of H.S. Schools Per Lakh Population	Teacher-Student Ratio at	Classroom-Pupil Ratio	Percentage of Teachers Qualifying Post Graduation or Higher Degree
ORI	0.00	0.00	0.00	0.00
PN	-42.20	-31.03	-23.64	-16.64
RAJ	-13.27	-2.50	-2.30	-2.29
TN	-36.62	-29.90	-43.98	-15.68
UP	0.00	0.00	0.00	0.00
WB	-12.90	-2.78	-4.00	-2.94
Average	-18.23	-14.50	-18.09	-8.87

Source: Author's Computation

In Table 4.2.5, the average value of the combined movement (i.e. radial & slack movements considered collectively) of input 1 considering H.S. education is shown as 18.23% for GCS; and among these states, GO, KER, KAR, WB, MH, UP, RAJ, BI, ORI and JHAR are showing lower combined movement values than the computed average. On the contrary, CHHAT is identified as a state, showing the highest combined movement of this input.

According to input 2, for the H.S. level, the mean combined movement is turned as 14.50% and there are nine GCS, namely GUJ, MH, KER, BI, JHAR, ORI, RAJ, UP and WB show combined movement figures below this average. However, a state like HAR shows the greatest degree of combined movement.

As far as input 3 is concerned for the H.S. stage, the average combined movement is observed as 18.09% and the GCS where the combined movement is reflecting the lower values compared to the average are: MH, GUJ, KER, RAJ, ORI, BI, JHAR, WB and UP. KAR is the GCS with the highest combined movement of this input.

A mean value of 8.87% of the combined movement is found when input 4 is taken into account for H.S. level. There are states with lower combined movement than the GCS average considering this input, including KER, MH, WB, GUJ, ORI, RAJ, JHAR, UP and BI. The maximum level of combined movement for input 4 is observed for HAR.

As illustrated by the empirical analysis of GCS, KER, MH, BI, ORI, UP and JHAR reflect the minimum value of combined movement for all the four inputs of H.S. education.

As a measure of input inefficiency level for various inputs, utilized in H.S. education production (reflecting excess input usage to produce a particular output level) , the combined movements of the four inputs referring to H.S. level reveal the following information, keeping GCS into consideration:

(1) The input utilization performance of GCS such as RAJ and WB are considered as good since they show lesser combined movement (i.e. radial and slack movement considered collectively) values for all the four inputs compared to the corresponding mean combined movement value (taking all the GCS into account) of each input considered in this study.

(2) Poor performance, in the view of input utilization, is observed for GCS like HAR, MP, PN, CHHAT, AP and TN, as these states demonstrate greater combined movement values for all the inputs than the corresponding mean combined movement value (considering all the GCS) of each input considered for this analysis. Specifically, CHHAT and KAR have been identified as the worst-performing GCS in consideration of the inputs, 'number of H.S. schools per lakh population' and 'classroom-pupil ratio at H.S. level' respectively. In addition to this, HAR shows the most inefficient utilization of the inputs, 'percentage of teachers with qualification post-graduation and above' and 'teacher-student ratio' at the H.S. level.

Using a combined estimate of Radial and Slack movements, the performances of various inputs of H.S. level are analyzed for GCS and the result reveals that the average inefficiency is found to be **greatest for input1** (18.23%), followed by input 3 (18.09%) and input 2 (14.50%), and **lowest for input 4** (8.87%) respectively. Thus, this finding of input's inefficient-utilization suggests that the lesser input level is capable of producing the given extent of the output at the H.S. stage with only better input utilization at GCS.

Table 4.2.6: Combined movement (in percentage) of the inputs considering TEF_{inp} measurement of H.S. education for SCS&UT

State	Number of H.S. Schools Per Lakh Population	Teacher-Student Ratio	Classroom-Pupil Ratio	Percentage of Teachers Qualifying Post Graduation or Higher Degree
A&N	-37.35	-47.85	-39.06	-23.60
ARU	0.00	0.00	0.00	0.00
AS	0.00	0.00	0.00	0.00
CHAND	-6.78	-6.93	-7.02	-6.72
D&N	0.00	0.00	0.00	0.00
D&D	-7.61	-45.78	-47.18	-8.69
DEL	0.00	0.00	0.00	0.00
HP	-42.52	-36.70	-26.13	-16.69
J&K	-40.65	-19.64	-49.30	-23.04
LAKH	-6.84	-29.17	-26.35	-9.00
MAN	0.00	0.00	0.00	0.00
MEGH	-2.68	-2.45	0.00	-2.09
MIZO	-31.72	-37.93	-15.77	-30.56
NG	0.00	0.00	0.00	0.00
PUD	0.00	0.00	0.00	0.00
SIK	-14.40	-41.13	-30.01	-14.40
TP	-61.69	-63.17	-33.27	-43.92
UK	-20.37	-21.08	-42.46	-36.99
Average	-15.15	-19.55	-17.59	-11.99

Source: Author's Computation

In Table 4.2.6 for SCS&UT, the average value of the combined movement (i.e. radial & slack movements considered collectively) of input 1 considering H.S. stage is reflected as 15.15% and among these states, DEL, ARU, SIK, CHAND, AS, NG, MEGH, D&N, LAKH, PUD, MAN and D&D are reflecting lower combined movement values than the computed average. On the contrary, TP is identified as a state, reflecting the highest combined movement of this input.

As far as input 2 is concerned for the H.S. level, the mean combined movement turns as 19.55% and there are nine SCS&UT, namely DEL, ARU, NG, D&N, MAN, AS, CHAND, PUD and MEGH, reflecting combined movement figures below this mean level. However, a state like TP reflects the greatest degree of combined movement for input 2 as well.

According to input 3, for the H.S. stage, the average combined movement is observed as 17.59%, and the SCS&UT where the combined movement is reflecting the lower values compared to the average are DEL, AS, CHAND, ARU, D&N, MEGH, NG, MIZO, MAN and PUD. J&K is observed in the SCS&UT group, with the highest combined movement of this input.

A mean value of 11.99% is found when the combined movement of input 4 is considered for H.S. education taking into account SCS&UT. There are states with lesser combined movement figures than the average combined movement of this input for this particular category of states, including ARU, DEL, NG, CHAND, MAN, PUD, MEGH, LAKH, D&N, AS and D&D. The maximum level of combined movement for input 4, considering SCS&UT, is observed for TP.

Based on the empirical analysis of SCS&UT, it has been noticed that ARU, AS, DEL, NG, D&N, PUD and MAN reflect the minimum value of combined movement for each of the four inputs of H.S. education level.

This analysis for SCS&UT identifies the inputs that are used in excess for producing a particular level of educational output at the H.S. stage. The figures of combined movements of the inputs relating to the H.S. education of SCS&UT reveal the following facts:

(1) The performance relating to input utilization of SCS&UT like, MEGH and CHAND are considered as good since these states represent lesser combined movement values for all the inputs compared to the corresponding mean combined movement value (considering all the SCS&UT) of each input considered for this analysis.

(2) Poor performance concerning input utilization is evident for SCS&UT such as, A&N, HP, TP, J&K and UK, since the states demonstrate larger combined movement figures for all the four inputs than the corresponding inputs' mean combined movement values. Particularly, TP has been recognized as the worst-performing special category state in consideration of the majority of the inputs, like 'number of H.S. schools per lakh population', 'teacher-student ratio' and 'percentage of teachers with qualification post-graduation and above' at the H.S. level. Additionally, J&K shows maximum level of inefficient-utilization for the input 'classroom-pupil ratio at H.S. level'.

Based on the combined estimate of Radial and Slack movements, the performances of the inputs are analyzed considering H.S. level and it is found that the average inefficiency is **greatest for input 2** (19.55%), followed by input 3 (17.59%) and input 1 (15.15%), and **lowest for input 4** (11.99%) respectively. Therefore, such findings for SCS&UT imply that producing the given extent of the output at the H.S. stage is possible using the lesser extent of input, with better utilization.

4.3.2.3 Factors Determining TEF_{inp} of Higher-Secondary Education

The representation of the significant factors that determine TEF_{inp} at H.S. level of education, prioritizing GCS and SCS&UT separately, is pointed out in this section.

Since the dataset comprises both the state dimension (17 GCS) as well as the year dimension (2010-11 to 2015-16), to analyze TEF_{inp} determining factors with respect to H.S. education for GCS, BPLM test is executed to examine whether the panel model or pooled model is appropriate to apply. The result of the BPLM test reveals the appropriateness of using pooled model for this dataset and more specifically, simple pooled model is supported because of the absence of contemporaneous correlation. Further, the existence of heteroskedasticity has been tested and confirmed through Breusch-Pagan test, rendering the application of OLS improper for estimating simple pooled model using such a dataset. Thus, heteroskedasticity rectified two-step GLS estimation technique is adopted while executing the regression for explaining TEF_{inp} variation at H.S. level in GCS. After trialling various alternative models, the best-fitting model is reported in Table 4.2.7.

Table 4.2.7: Significant Determinants of TEF_{inp} considering H.S. Education at the state level for GCS

Variables	Coefficient	Z- value	P>|z|
PWBS	-.0010561	-2.99	0.003
PPTEA	.0023417	3.03	0.002
PSAGT	-.0012574	-2.01	0.044
PSACI	-.0003202	-1.32	0.188
PGETB	.0015332	2.92	0.004
GEXPOE	.0072373	2.35	0.019
Constant	.8334304	11.99	0.000
Wald chi2 = 100.98		Prob > chi2 = 0.0000	

Source: Author's Estimation

With respect to H.S. education, the results for GCS exhibit in Table 4.2.7 that while determining TEF_{inp}, the policy, infrastructural and social indicators play a key role. In the infrastructure indicating aspect, 'PWBS', 'PSAGT', 'PSACI' individually imparts a negative effect and 'PPTEA' imparts a positive effect on TEF_{inp} , regarding H.S. level of education. However, among these four infrastructural factors, 'PSACI' shows a lower level of significance. Grounds of the observed adverse effect and favourable effect of 'PWBS' and 'PPTEA' respectively on TEF_{inp} at H.S. level are similar to that of the discussion of the 'secondary-level' case. The schools that lack girls' toilets in GCS, possibly dampen the appropriate utilization of inputs at H.S. level education production indirectly by discouraging girls students to attend the school and hence, resulting in association with less TEF_{inp} score. Additionally, the H.S. schools that lack the internet in addition to the computer facility, may lead to capacity underutilization of the other resources used as inputs in the (H.S. level) process of education production. Therefore, focusing on the H.S. education, these observations indicate that TEF_{inp} has the adverse impact of 'PSAGT' and 'PSACI' in GCS. 'PGETB', in the social aspect, induces TEF_{inp} of H.S. positively and significantly, declaring the evidence of improving the girls' to boys' proportion in the H.S. education, i.e., bringing more girls to the formal education system will actually bring a favourable outcome in TEF_{inp}. Referring to the H.S. education for GCS, 'GEXPOE', being a policy variable, induces TEF_{inp} significantly and positively, confirming the TEF_{inp} enhancing role of 'GEXPOE' in the GCS. Furthermore, Table 4.2.7 provides the evidence of a considerably high goodness of fit.

Next, taking into account the dataset, comprising of both the SCS&UT and year (six consecutive years i.e. 2010-11 to 2015-16) dimensions, the decision regarding the appropriateness of using either pooled model or panel model for analyzing the determining factors of TEF_{inp} with respect to H.S. education for SCS&UT, has been reached through BPLM test and the result validates the applicability of panel model over pooled model for this dataset. Further, the decision regarding the selection between random effect or fixed effect model is reached through the Hausman test in favour of random effect model. In table 4.2.8 below, the best fitted model from various alternative models is reported.

Table 4.2.8: Significant Determinants of TEF_{inp} considering H.S. Education at the state level for SCS&UT

Variables	Coefficient	Z- value	P>|z|
PPTEA	.0023285	3.21	0.001
PWBS	-.0036941	-1.36	0.175
PFTMT	.0004686	2.05	0.041
PGETB	.0016125	1.57	0.117
GEXPOE	-.1084325	-3.01	0.003
GEXPOE Square	.0030622	2.94	0.003
Constant	1.589725	5.20	0.000
Wald chi2 = 27.50		Prob > chi2 = 0.0006	

Source: Author's Estimation

Table 4.2.8, for SCS&UT, demonstrates the prominent roles of policy, infrastructural and social factors in determination of TEF_{inp} of H.S. level. Explicitly, as an inadequate infrastructure indicating factor, 'PWBS' appears in a negatively significant role while 'PPTEA' appears in a positively significant role in explaining TEF_{inp} of H.S. level for these states. Therefore, for H.S. level, TEF_{inp} depressing and TEF_{inp} rising roles of 'PWBS' and 'PPTEA' respectively are confirmed by Table 4.2.8. However, in this case, 'PWBS' is associated with the low level of significance. Again, 'PFTMT' and 'PGETB', revealing the social factor aspect, are individually depicting a positive effect in the determination of TEF_{inp} of H.S. stage in this category of states. The finding of the significant, positive role of 'PFTMT' is actually the revelation of the fact that increasing proportion of female to male teacher, i,e., increasing employability of female teachers may promote TEF_{inp}. In addition to this, for SCS&UT, Table 4.2.8 confirms the existence of non-linear U-shaped relationship between TEF_{inp} of H.S. level

and ‘GEXPOE’ as the coefficient of the variable turns negatively significant and the coefficient of the square term turns positively significant, revealing that after the specific minimum level referred as the ‘threshold level’ of ‘education expenditure incurred by government’ (for the state), TEF_{inp} increases with increase in GEXPOE. However, the grand average value of GEXPOE for the SCS&UT (16.00) between 2010-11 to 2015-16, turns relatively lesser than the threshold level value of GEXPOE (17.70); after which the positive effect of ‘GEXPOE’ on TEF_{inp} of H.S. level will be evident. Thus, the minimum value of ‘GEXPOE’ required for indicating increasing TEF_{inp} of H.S. level has not been reached for the present sample of SCS&UT and consequently, the estimated marginal effect of ‘GEXPOE, in the present case, is found to be negative. Hence, for SCS&UT, to obtain the positive effect of ‘GEXPOE’ on TEF_{inp} of H.S. level and thereby, the positive marginal effect of GEXPOE, the government should increase the expenses on education more in such states so that GEXPOE in these states overshoots the ‘threshold level of GEXPOE’. In an overall sense, a reasonable extent of goodness of fit is reflected by the model represented in Table 4.2.8.

4.3.3 Comparison of Estimated TEF_{inp} Score and Factors Determining TEF_{inp} between Secondary-Level and Higher-Secondary Level using UDISE Dataset

Focusing on GCS, the TEF_{inp} performance of Secondary-level is compared with that of the H.S. level. and the major findings are stated below:

(1) Greater than the group average TEF_{inp} score is attained by the GCS - (i) KER, JHAR, WB, MH, KAR, BI, ORI, UP at both Secondary and H.S. levels; (ii) GO, AP, TN specifically at Secondary-level and (iii) GUJ, RAJ specifically at H.S. level.

(2) The GCS, achieving perfect TEF_{inp} throughout the years under observation is/are (i) KER, MH,ORI, BI, JHAR at both Secondary and H.S. levels; (ii) WB, GO exclusively at Secondary-level and (iii) UP exclusively at H.S. level.

(3) The GCS becoming input inefficient throughout are (i) MP and RAJ at Secondary-level and (ii) PN, CHHAT, HAR at H.S. level.

(4) An increasing tendency of TEF_{inp} across time is reflected by (i) GUJ, KAR at both Secondary and H.S. levels; (ii) MP only at Secondary-level and (iii) CHHAT, GO at H.S. level.

(5) Across the time, a decreasing tendency in TEF_{inp} score is reflected by (i) HAR, PN at both Secondary and H.S. levels; (ii) AP, RAJ, CHHAT specifically at Secondary-level and (iii) TN, WB, MP only at H.S. level.

(6) The GCS which transformed over the years to inefficient, from efficient are (i) CHHAT, AP, PN at Secondary-level and (ii) TN,WB at H.S. level.

(7) Considering the referenced time interval, inefficient to efficient transforming GCS are identified as KAR and GUJ at H.S. level. However, no such GCS is found at Secondary-level.

The results of the comparison of TEF_{inp} of Secondary-level with the H.S. level in SCS&UT are noted below:

(1) Higher than the group average TEF_{inp} score is attained by the SCS&UT - (i) DEL, LAKH, AS, D&N at both Secondary and H.S. levels; (ii) TP, HP, A&N, SIK exclusively at Secondary-level and (iii) CHAND, MAN, ARU, PUD, NG and MEGH exclusively at H.S. level.

(2) The SCS&UT, achieving perfect TEF_{inp} throughout the whole period are (i) DEL, D&N, AS at both Secondary and H.S. levels; (ii) LAKH, TP specifically at Secondary-level and (iii) ARU, MAN, MEGH, PUD, NG specifically at H.S. level.

(3) The SCS&UT becoming input inefficient throughout is/are (i) J&K, PUD at Secondary level and (ii) TP at H.S. level.

(4) An upward movement of TEF_{inp} score across the time is reflected by (i) PUD, NG, ARU, MEGH at Secondary-level and (ii) J&K at H.S. level.

(5) A downward movement of TEF_{inp} score during the specified years is evidenced by (i) CHAND, J&K, D&D, MAN, UK at Secondary-level and (ii) A&N, SIK at H.S. level.

(6) The SCS&UT, transformed to inefficient, from perfect TEF_{inp} during the years under observation are (i) D&D at both Secondary and H.S. levels; (ii) MAN, MIZO only at Secondary level and (iii) A&N, SIK only at H.S. level.

(7) The SCS&UT that are upgrading from inefficient to efficient are NG and ARU at Secondary-level but for H.S. level no such SCS&UT is identified.

While performing the determinant analysis for GCS group at both the levels of education, it is observed that PWBS, GEXPOE, PGETB and PPTEA are the common determinants of TEF_{inp} concerning both Secondary and H.S. levels of education. Among these common determinants, other than the poor-infrastructure variable 'PWBS', all are positively determining TEF_{inp} at both the levels. However, in GCS some specific to the level of education determinants have

been identified like, PCNSDP with positive sign specifically at Secondary-level and PSAGT, PSACI with negative sign exclusively at H.S. level influences TEF_{inp}.

Focusing on SCS&UT, it is noticed that PPTEA favourably influences TEF_{inp} at both Secondary and H.S. levels. Additionally, GEXPOE can also impart a positive effect on TEF_{inp} of both the levels. Specifically, PBCC, PSST, PSADWF and PSAE affect TEF_{inp} negatively and PSTE influences TEF_{inp} positively at Secondary-level while PGETB and PFTMT affect TEF_{inp} positively and PWBS influences TEF_{inp} negatively at H.S. level.

4.4 Conclusion

It is the primary purpose of this chapter, to evaluate whether Secondary and H.S. education is performing efficiently in various Indian states and union territories; in the view of input utilization. More specifically, the chapter deals with the input oriented approach of technical efficiency (TEF_{inp}) estimation which refers to the ability of the individual state/union territory, as a decision making unit, to contract the input usage at a lowest possible level while retaining the output at the same level and following that the degree of inefficiency of each of the diverse inputs used in the respective education production process is captured and analysed in this chapter. Further, identification of TEF_{inp} influencing factors for Secondary and H.S. stages of education and related analysis also belong to the scope of this chapter.

In view of the fact that estimating TEF_{inp} for every year over the given time span provide added information, this chapter focusing on 'Secondary' and H.S. levels of education, estimates TEF_{inp} scores by assuming variable returns to scale for each year under the sample time frame i.e. 2010-11 to 2015-16, independently for 'GCS' and 'SCS&UT', applying DEA in the framework of two outputs & four inputs for which the data is obtained from secondary data source: UDISE. Basically, differing 'loans to grants' ratios (as received from central government) across various Indian states & union territories, form the basis of grouping as 'GCS' and 'SCS&UT'. Following the obtained TEF_{inp} scores, in the second step, an analysis of determinants of TEF_{inp} for both 'Secondary' and H.S. stages have been conducted in this chapter using regression models and taking into account the perspectives of 'Policy', 'Infrastructure', 'Social' and 'Macro' indicators (broadly).

Because of the differing 'loans to grants' ratios, calculated from overall assistance as accepted by various Indian states & union territories, the states including union territories are arranged into two classes: GCS and SCS&UT. Accordingly, this study organizes TEF_{inp} analysis of both

'Secondary' and 'H.S.' levels for the two groups of 'state-categories' i.e. for 'GCS' and 'SCS&UT' individually. Following this, the Secondary as well as H.S. education related study of this chapter deals with two separate samples, comprising- (1) 17 GCS for six successive years i.e. 2010-11 to 2015-16; and (2) 18 SCS&UT referred to the same six successive years.

From the results of both 'Secondary' and 'H.S.' education related analysis of this chapter, it is evident that TEF_{inp} scores are not the same within & between 'GCS' and 'SCS&UT' corresponding to a particular education level; further, dealing with the Secondary and H.S. education not all GCS as well as not all SCS&UT are observed to achieve full TEF_{inp} for each of the years taken under consideration for this study.

Specifically, exploring the Secondary-level, for 'GCS' it is found that over the specified time duration, the mean TEF_{inp} scores for AP, KER, GO, WB, BI, KAR, MH, ORI, JHAR, TN and UP, reflect higher figures than the computed grand mean TEF_{inp} score '0.935'; while for 'SCS&UT' it is found that the mean TEF_{inp} scores for AS, DEL, SIK, A&N, HP, TP, LAKH, D&N over the mentioned time-frame, reflect relatively higher values than that of the calculated grand average TEF_{inp} which is obtained as '0.898'. Exploring GCS for Secondary-level it is found that over the specified time duration, TEF_{inp} score equal to unity is continuously achieved by GO, MH, KER, JHAR, BI, WB and ORI while a continuous input inefficiency is experienced by MP and RAJ. Similarly, considering SCS&UT for Secondary-level, TEF_{inp} is observed to be consistently achieved by AS, TP, LAKH, DEL and D&N during the time span while input inefficiency is consistently experienced by J&K and PUD. In the GCS group, CHHAT, AP and PN proved input efficiency for Secondary-level education production at the beginning year, but afterwards became inefficient. Similarly, in SCS&UT group, D&D, MAN and MIZO, reflected TEF_{inp} at the beginning and these states became inefficient later; on the contrary, ARU and NG appeared as inefficient states at the start but across-time these SCS&UT achieved perfect TEF_{inp} at Secondary-level.

Focusing on H.S. level of education, for 'GCS', it is noted that the average TEF_{inp} scores, over the specified time frame, for KER, KAR, GUJ, JHAR, MH, RAJ, ORI, UP, WB and BI turn higher than the computed grand average TEF_{inp} score '0.916'; while for 'SCS&UT' the mean TEF_{inp} measure over the specified period of time, for ARU, DEL, CHAND, NG, AS, LAKH, MAN, D&N, PUD and MEGH reflect relatively larger figures than that of the computed grand average TEF_{inp} , obtained as '0.914'. In GCS, for H.S. level, it is observed that the perfect TEF_{inp} is continuously achieved by KER, BI, MH, JHAR, UP and ORI during all the years of

the study while throughout inefficiency is observed for PN, HAR and CHHAT. On the other hand, as SCS&UT, TEF_{inp} at H.S. level is consistently achieved by DEL, ARU, MAN, AS, MEGH, PUD, D&N and NG during the course of the time while input inefficiency is consistently shown by TP. In the GCS group corresponding to H.S. level of education, KAR and GUJ appeared as inefficient states at the start, but gained perfect efficiency (TEF_{inp}) across-time, while TN and WB proved input efficiency at the beginning, but became inefficient afterwards. Considering SCS&UT, the evidence of A&N, SIK and D&D reflecting input efficiency at the beginning but becoming inefficient later is observed, for the H.S. level.

Furthermore, the chapter discusses how inefficient the use of various inputs is, in the 'Secondary' and 'H.S.' education production context. Using the combined figures of radial and slack movements, inefficient use of various inputs of Secondary and H.S. level are analyzed for 'GCS' and 'SCS&UT' individually. The result, referring to the 'GCS' group for Secondary level, reveals that the average inefficiency is found to be greatest for input 1 i.e. 'number of secondary schools per-lakh-population' (11.87%), followed by input 2 or 'teacher-student ratio' (9.32 %) and input 3 or 'classroom-pupil ratio'(9.21 %) respectively; and it is lowest for the input 4 i.e. **'**percentage of teachers with academic qualification post-graduation or higher' (8.16 %). On the other hand, referring to 'SCS&UT', inefficient-utilization for various inputs considering Secondary-level reflects that the average inefficiency is greatest for the input 1 (15.16%), followed by input 2 (10.62%) and input 3 (9.12%) respectively; and it is observed as the lowest for input 4 (7.72%). In addition to this, for 'H.S.' stage of education, using again the respective combined estimates, the performances of various inputs are analyzed for 'GCS' as well as 'SCS&UT'; and the result for 'GCS' reveals that the average inefficiency is pointed out as the maximum for input 1 i.e. 'number of H.S. schools per-lakh-population' (18.23%), followed by the input 3 (18.09%) and input 2 (14.50%) respectively, and the lowest is noted for input 4 (8.87%) while the result for 'SCS&UT' group confirms that the average inefficiency is greatest for input 2 (19.55%), followed by input 3 (17.59%) and input 1 (15.15%), and is lowest for input 4 (11.99%) respectively. Therefore, such findings of input's inefficient-utilization in this chapter imply that producing the same extent of output at both the 'Secondary' and 'H.S.' stages is possible using the less of input levels, just with better utilization, in both of the state categories i.e. GCS and SCS&UT.

For the purpose of describing the significant factors, determining TEF_{inp} for Secondary-stage and H.S. stage of education, focusing on GCS and SCS&UT separately, initially the appropriateness of applying the specific type of regression model is evaluated by BPLM test.

The ‘BPLM’ test outcome confirms the appropriateness of selecting ‘panel model’ for the analysis of determinants of TEF_{inp} for : (i) ‘Secondary-stage’ education focusing on ‘GCS’, (ii) ‘H.S. stage’ education focusing on ‘SCS&UT’; and furthermore the applicability of the random effect model is supported by Hausman test (over fixed effect) for both the mentioned data structures. Conversely, the appropriateness of choosing the pooled model for the other two datasets i.e. for (i) ‘Secondary-stage’ education focusing on ‘SCS&UT’ , (ii) ‘H.S. stage’ education focusing on ‘GCS’ are supported by BPLM test outcomes; and more specifically, simple pooled model is supported because of the absence of contemporaneous correlation, but due to the existence of the problem of heteroskedasticity as identified through Breusch-Pagan test, the heteroskedasticity rectified two-step GLS estimation technique is adopted while estimating simple pooled models using such datasets.

Secondary-stage of education results demonstrate that TEF_{inp} (1) for GCS is significantly affected by social indicator, policy variable, the general environment of the state revealing macro indicator, in addition to, infrastructure indicating factors, and (2) for SCS&UT, is significantly determined by infrastructure specifying indicators, social indicator, in addition to, the policy indicator. Likewise, with respect to H.S. education, the results (3) for GCS demonstrates the prominent roles of policy, infrastructural and social factors in determination of TEF_{inp}, and (4) for SCS&UT, claim that while determining TEF_{inp}, the policy, infrastructural and social indicators play an essential role.

Referring to the GCS, it is particularly observed for Secondary-level of education that in the infrastructural aspect, PWBS turns into a significant variable reflecting a negative sign while ‘PPTEA’ turns into a significant variable reflecting a positive sign in determining TEF_{inp}. Additionally, ‘PGETB’, as a social indicator, affects TEF_{inp} significantly and positively which is an indication of the fact that improving the girls’ to boys’ proportion i.e. bringing more girls in formal secondary education system in GCS, will actually improve TEF_{inp}. Also, ‘GEXPOE’ being a policy indicator and ‘PCNSDP’ being a macro indicator, positively impacts on TEF_{inp} of secondary education stage in GCS as suggested by statistical significance of these variables with positive signs.

Next, in relation to H.S. education, the results for states in the ‘general category’ indicate that in the infrastructural ground, ‘PPTEA’ imparts a positive effect while ‘PSACI’, ‘PWBS’,‘PSAGT’, individually imparts a negative effect on TEF_{inp}. However, less significance is noted for ‘PSACI’ in the infrastructural determinant category. ‘PGETB’ and

'GEXPOE' referring to the social and policy aspect, respectively, influence TEF_{inp} of H.S. education significantly and positively, revealing the TEF_{inp} raising roles of 'PGETB' and 'GEXPOE' in the GCS.

Referring to 'SCS&UT', TEF_{inp} at the secondary education level is explicated by the prominent roles of poor school infrastructure specifying indicators like, 'PSADWF', 'PSST', 'PBCC' and 'PSAE' which are significantly and negatively impacting TEF_{inp} of the secondary-level, revealing the individual dampening effect of each of the mentioned infrastructural factors on TEF_{inp} of the Secondary-stage for this category of states; though among these variables 'PBCC' is less significant. Also, in 'SCS&UT' a higher value of 'PPTEA' and 'GEXPOE' as school infrastructure variable and policy variable, respectively, improves TEF_{inp} at Secondary-stage significantly. 'PSTE' being a social indicator, positively and significantly impacts on TEF_{inp} of secondary-level, specifically at SCS&UT; because of these areas being much more dominated by tribal population, an increase in enrolment for these states in turn seems to be associated with increase in scheduled tribe enrolment.

In addition to this, 'SCS&UT' demonstrates at the H.S. level of education that as an infrastructure indicating factor, 'PWBS' appears in a negative role while 'PPTEA' appears in a positively significant role in explaining TEF_{inp} of H.S. level. However, 'PWBS' is found as a less significant determinant. Also, in this category of states, 'PFTMT' and 'PGETB', in the social factor aspect, are individually depicting a positive effect with statistical significance in the determination of TEF_{inp} of H.S. stage. The positive role of 'PFTMT' basically suggests that increasing proportion of female to male teacher, i,e., increasing employability of female teachers may enhance TEF_{inp}. On the ground of policy, the coefficient of 'GEXPOE' being negatively significant and the coefficient of its square term being positively significant, specifies the existing non- linear U-shaped relationship between TEF_{inp} of H.S. level and 'GEXPOE', revealing that after a certain minimum level referred to as the 'threshold level' of 'education expenditure incurred by government' (for the state), TEF_{inp} increases with increase in GEXPOE. However, the minimum value of 'GEXPOE' required for indicating increasing TEF_{inp} of H.S. level has not been reached for the present sample of SCS&UT, consequently, for obtaining the positive effect of 'GEXPOE' on TEF_{inp} of H.S. level, the government should increase the expenses on education relatively more in this particular group of states.

Comparing TEF_{inp} of Secondary-level with that of the H.S. level sheds the light on the following facts:

In the GCS group, throughout the referenced years, the states achieved perfect TEF_{inp} at both Secondary and H.S. levels are KER, MH,ORI, BI, JHAR; whereas WB, GO achieved throughout full TEF_{inp} exclusively at Secondary-level and UP exclusively at H.S. level. On the other hand, in the SCS&UT group, perfect TEF_{inp} throughout the whole period is achieved by DEL, D&N, AS at both Secondary and H.S. levels; while throughout full TEF_{inp} specifically at Secondary-level is achieved by LAKH, TP; and solely at H.S. level the same is achieved by ARU, MAN, MEGH, PUD, NG. Again, the GCS appeared to be inefficient throughout at Secondary-level are MP and RAJ and at H.S. level are PN, CHHAT, and HAR. Similarly, the SCS&UT becoming input inefficient throughout at Secondary-level are J&K, PUD and at H.S. level is TP. In addition to this, though starting with perfect TEF_{inp} ,the GCS which transformed over the time interval as inefficient at Secondary-level are CHHAT, AP, PN and at H.S. level are TN,WB. The SCS&UT that transformed to inefficient, from perfect TEF_{inp} during the years under observation only at Secondary level are MAN, MIZO and only at H.S. level are A&N, SIK; while considering both the Secondary and H.S. levels, this deterioration is reflected by D&D. Considering the referenced time interval, inefficient to efficient transforming GCS at H.S. level are KAR and GUJ; though such a transformation at Secondary-level is not found for any state in GCS category. On the other hand, the SCS&UT that are transforming from inefficient to efficient over the span of years considering Secondary-level are NG and ARU, though no such SCS&UT is observed for H.S. level.

The comparison of determinant analysis of TEF_{inp} between secondary-level and H.S. level reflects the following findings:

Dealing with the GCS group, it is noticed that PWBS, GEXPOE, PGETB and PPTEA are the common determinants of TEF_{inp} of both Secondary and H.S. levels of education. Among these common determinants, other than the poor-infrastructure variable 'PWBS', all are positively determining TEF_{inp}. Considering the SCS&UT group, it is observed that PPTEA favourably determines TEF_{inp} at both Secondary and H.S. levels. Besides, GEXPOE can also impart a favourable effect on TEF_{inp} at both the levels.

Other than the above-mentioned common determinants of TEF_{inp}, in GCS some specific to the level of education determinants have been identified; like, PCNSDP with positive sign specifically at Secondary-level and PSAGT, PSACI with negative sign exclusively at H.S. level influences TEF_{inp}. In SCS&UT, PBCC, PSST, PSADWF and PSAE affect TEF_{inp} negatively and PSTE influences TEF_{inp} positively specifically at Secondary-level whereas the negative

influence of PWBS and the positive influences of PFTMT and PGETB are specifically found on TEF_{inp} of H.S. level.

The analysis of the present chapter recognizes the determinants, affecting TEF_{inp} of Secondary and H.S. education at state-level, particularly in GCS and SCS&UT. Such an analysis is crucial for ruling out the disparities in the obtained level of TEF_{inp} across the states in the specific state-group. In this context, further in-depth analysis of TEF across the schools concerning the Secondary and H.S. stages of education is essential to perceive the scenario of TEF at school-level and thus it is attempted to discuss in the next chapter.

Chapter 5:

Analysis of Output Efficiency of Government and Government-Aided Schools based on Primary Survey Data: A Case Study of Kolkata[3]

5.1 Introduction

The well-established literature on the linkage between human capital and national economic growth necessitates the expansion of human capital through the development of educational institutions in the nation. Therefore, the function of the school in the role of the educational institution is of great importance and hence the performance of the school-education-system should be evaluated at school-level. In Indian context, the voids are observed in the prevailing literature on technical efficiency (TEF) analysis of Secondary and Higher Secondary (H.S.) stages at school-level, particularly using primary survey data. With the objective of filling the voids in the existing studies, the present chapter contributes in the following direction:

(i) This chapter estimated output oriented technical efficiency (TEF_{out}) of the schools at Secondary and H.S. stages separately employing data envelopment analysis (DEA), under variable returns to scale (VRS) assumption, on primary survey data, collected following stratified random sampling method from twenty five government-aided and government schools located in Kolkata for the duration 2019-2020.

(ii) Considering the obtained TEF_{out} scores as the explained variable, the present chapter determines the affecting factors of TEF_{out} at Secondary and H.S. stages of school education. Specifically, the present chapter while determining TEF_{out} of the respective education level, tries to examine each specific variable's (under certain wider indicator category) influence on resulting TEF_{out} score, instead of forming and relating any composite index to TEF_{out}.

(iii) During the student survey, it was observed that the major proportion of the students depend on private tuition at both Secondary and H.S. levels and due to the fact that

[3] A part of this chapter is published as: Ghose, A., & Choudhury, S. (2023). "Measurement and Determinants of Efficiency of Government and Government-Aided Secondary Schools in Kolkata: An Application of Data Envelopment Approach". In Raychaudhuri, A., & Ghose, A. (Eds.) Managing Pandemic and Correcting Development Fundamentals: India's Great Challenge (Pp. 273–301). Springer, Singapore. ISBN: 9789811986796.

TEF_{out} of the school possibly be inflated at both the levels by the role of private tuition, thus the concern of the present chapter is measuring the extent of (across-school) TEF_{out} variation that is not explained by private educational assistance.

(iv) Since West Bengal government initiated 'Kanyashree Prakalpa' for incentivizing the schooling of teenage girls, the present chapter deals with examining the influence of this policy measure on TEF_{out} of schools corresponding to the concerned education level.

The present chapter unfolds with the following arrangement: Section 5.2 discusses the data & the process of data collection and also informs about the methodology used; and section 5.3 displays the empirical findings. The sections 5.3.1.2 and 5.3.2.2 reveal the results of TEF_{out} scores of Secondary and H.S. stages of schools respectively. Next, in 5.3.1.3 and 5.3.2.3 sections, the determinants of TEF_{out} of schools corresponding to the Secondary and H.S. levels are discussed respectively. Additionally, the result of the extent of TEF_{out} variation that is not explained by the role of private tuition at Secondary-level and H.S. level of schools are also reflected respectively in the sections 5.3.1.3 and 5.3.2.3. Lastly, section 5.4 presents the conclusion of this chapter.

5.2 Methodology and Data

5.2.1 Methodology for TEF_{out} Estimation

In this chapter the methodology of DEA, as discussed in chapter 3, is employed for obtaining Output Oriented Technical Efficiency (TEF_{out}) Score at school-level referring to Secondary and H.S. levels, using the data collected through primary source at school-level.

5.2.2 Output-Input Variables for TEF_{out} Measurement using School Level Data

Educational output, not being a physical product, needs to be represented by some well-suited variables in a multiple output-input structure of education production.

Specifically, referring to secondary-level of school, five output variables are accounted for TEF_{out} measurement; namely (1) maximum score obtained in secondary-level board examination,(2) percentage of first division marks scoring students, (3) average scores achieved in language group, (4) average scores achieved in science group and (5) average scores achieved in mathematics.

Generally, the course of study of H.S. level is classified into three streams, namely, Science, Arts and Commerce. Most of the H.S. schools that are surveyed for the purpose of this chapter, did not offer commerce as a branch of study to the students. Hence, Science and Arts streams are taken together for considering and analyzing the efficiency aspect in the overall sense for the H.S. stage of education at the school level. Thus, referring to H.S. level of school, six output variables are regarded as: (1) maximum score obtained in H.S. level board examination, (2) percentage of first division marks scoring students, (3) average scores achieved in mathematics, (4) average scores achieved in language group, (5) average scores achieved in science group and (6) average scores achieved in arts group.

In the present chapter, four inputs are accounted for TEF_{out} estimation referring to both secondary-level as well as senior-secondary-level. The referred inputs are: (1) classroom-pupil ratio, (2) teacher-student ratio, (3) percentage of masters or higher degree qualifying teachers and (4) per student expenditure incurred by the school on a monthly basis.

This study includes 'percentage of masters or higher degree qualifying teachers' as an input variable for indicating the quality of teacher input. Relevantly, it should be mentioned that the fund received from Samagra Shiksha Mission by the school is expended for students' benefit. Again, it is crucial to point out that the shadow prices of outputs and inputs are to be computed due to the nonexistence of output and input market prices.

After estimating TEF_{out} levels, a regression analysis is performed in the second-stage to identify its determinants.

5.2.3 Possible Determinants of TEF_{out}

The determinants of TEF_{out} , in this chapter, are included either from the school's perspective or from students' perspective for both secondary-level as well as senior-secondary-level and all such probable determinants of the analysis are classified and stated under the following heading of broad categories:

(a) Characteristics of teachers: TEF_{out} for both the school-education levels can possibly be affected by teacher's characteristics; and for examining this effect for the mentioned levels of school-education, following variables are considered: (i) full-time teachers' average service experience (in years) (Z1), (ii)proportion of part-time teaching faculty (Z2), (iii) part-time teachers' average service experience (Z3).Usually, schools mitigate the shortage of full-time

teachers by recruiting part-time teachers and hence it is important to examine the role of part-time teachers in enhancing efficiency.

(b) School infrastructure and administration related variables: This chapter tries to investigate whether school infrastructure and administration can significantly influence TEF_{out} scores obtained by the schools, considering both the levels, and this aspect is regarded while dealing with the following variables' effects: (i) proportion of teaching-posts remaining vacant (Z4), (ii) proportion of non-teaching post remaining vacant (Z5), (iii) whether the Headmaster/ Headmistress (HM) is present on duty (Z6), (iv) whether the school is featuring smart classroom (Z7), (v) Count of smart classrooms (Z8), (vi) whether librarian of the school is present on duty (Z9) and (vii) whether all laboratory staffs are present on duty (Z10).

(c) School characteristics and student composition related variables: In the light of the fact that both state and central government of India is consistently taking policies for incentivizing backward section of students for bringing them into the formal education system, it is relevant to test whether the larger proportion of backward students attending education system as well as some school characteristics improve the TEF_{out} of both the school-education levels or not? Therefore, the impact is tested for following variables: (i) reserve category students' proportion (Z11), (ii) physically disable/PD students' proportion (Z12), (iii) proportion of students enrolled in vocational programmes (Z13), (iv) percentage of english-competent students (Z14),(v) class size (Z15) (defined by the count of sections in the class), (vi) reserve category teachers' proportion (Z16) and (vii) male to female teachers' ratio (Z17).

The 'proportion' mentioning variables relating to students are considered taking into account entire set of the students in the class.

(d) Policy variables: An important concern is to find out whether government policy intervention for the school education plays any significant role in promoting TEF_{out}, obtained by the school at the mentioned school-education level or not. Accordingly, the effects of the following variables are considered: (i) needy students' proportion (the ones who are availing free studentship) (Z18), (ii) level of government funding received by the school, excluding the salary payment of non-teaching and teaching staffs(Z19) and (iii) proportion of girl students receiving Kanyashree (Z20).'Kanyashree Prakalpa' is originated by the Department of Women Development and Social Welfare of West Bengal government to conditionally transfer cash to girl students for encouraging schooling of teenage girls and delaying their marriages till the age of 18,aiming to enhance their wellbeing and status. Here, the study tries to examine the

presence of significant contributions of 'Z19' as well as 'Z20' in enhancing TEF_{out}. Although 'Z11' is included under the broader determinant category relating to student composition, the variable can also be treated as a policy variable due to reflecting the social inclusion policy of the government. Accordingly, the role of the social inclusion policy by the government in determining TEF_{out} levels can also be tested.

(e) School managerial role of Headmaster/ Headmistress (HM): This chapter also attempts to assess whether the HM's role in school management can help in raising TEF_{out} of the schools or not. Accordingly, the following variables are taken into account for both secondary and senior-secondary levels: (i) while taking a decision HM's interaction with students and teachers (Z21), (ii) while taking a decision HM's interaction with parents (Z22), (iii) interaction with other school's HM by the HM of the concerned school (Z23) and (iv) interaction frequency of HM with State Education Department (Z24).

(f) Characteristics of the head of the school (HM): This chapter also tries to examine the role of HM's characteristics in affecting TEF_{out} scores for both the levels of school-education. Hence, effects of the following variables are tested: (i) gender of HM (Z25), (ii) HM's age (Z26), (iii) HM's experience (in years) (Z27), (iv) HM's educational qualification (Z28) and (v) HM' salary (gross) (Z29).

(g) Socio-economic background of the students and student's characteristics: Here, the question is whether the student's characteristics as well as socio-economic background of the student, can affect TEF_{out} score of the school? Accordingly, the influence of the following variables in determining TEF_{out} is examined for both secondary and senior-secondary levels: (i) mother's academic qualification (Z30), (ii) father's academic qualification (Z31), (iii) monthly parental income (Z32), (iv) percentage of students opting for private educational assistance (i.e. private tuition) (Z33), (v) number of subjects learning from private tutors (Z34), (vi)study hours at home (Z35), (vii) percentage of students possessing text books at home (Z36), (viii) percentage of students consulting reference book (Z37), (ix) commute time to school each way (in minutes) (Z38), (x) percentage of students earning income (Z39), (xi) percentage of younger siblings per student (Z40), (xii) percentage of elder siblings per student (Z41) and (xiii) percentage of students involved with household chores (Z42).

(h) Quality of school attributes based on student's perception: This chapter also tries to investigate the role of the quality of school attributes in determining TEF_{out} of secondary and H.S. levels of the school-education. In view of that, the following variables relating to student's

perceptions about different school attributes are taken into account:(i) student's opinion regarding the regularity of running classes (Z43), (ii) student's opinion regarding teaching quality (Z44), (iii) student's opinion regarding quality of Laboratory (Z45), (iv) student's opinion regarding drinking water quality (Z46) and (v) student's opinion regarding sanitation facility in the school (Z47). In this case, for ensuring the authenticity of information, student's opinions regarding various school attribute's quality are noted.

The information relating to the broader category of the determinants (a) to (f) are noted from school administration and the information relating to categories (g) and (h) are noted from students.

In this regard, the entire analysis is performed in two stages. In the initial stage, the TEF_{out} scores of different schools concerning the specific education-level is estimated. In the second stage, regression analysis is conducted to identify the factors affecting such TEF_{out} level of the school, considering the estimated TEF_{out} score (obtained in stage one) as explained variable and all the above-mentioned possible determinants as explanatory variables. Following the objective of assessing the individual effect of the explanatory variable on TEF_{out} achieved by the schools at both the levels of school-education, any composite index (representing each of the broader categories) is not formed.

5.2.4 The Process of Data Collection

This chapter is based on primary survey data, collected through directly filling up the questionnaires on the basis of the information gathered from 25 government and government aided schools in Kolkata for the year 2019-2020. The dataset is comprised of the information collected through two different surveys:

(i) School survey- The information has been collected through questioning the appropriate school authority about the school-level of interest.

(ii) Student survey- The information is collected through directly questioning the students regarding their characteristics, socio-economic background and also on the topic of their opinion about teaching, academic and infrastructural environment in the school. For this study, the student survey has been immensely crucial for perceiving the reflection of the quality of some school attributes including teaching, and family background of the students.

Sample Selection Procedure:

For the selection of sample schools, the following procedure has been adopted:

The complete list of the schools, classified into 23 different circles in Kolkata, is published by the Department of Education under the Government of West Bengal. For data collection purposes, the complete list is collected and treated as 'population'. Considering each of 23 circles as relevant stratum, the stratified random sampling procedure is followed for selecting the school. The proportion of schools in each stratum is computed and considered as population proportion which is assumed to be equal with sample proportion. Using a random number table and assumption of equality between population proportion and sample proportion, the sample schools are selected for the study. Suppose, for the i-th stratum, the population proportion of the school turns Pi. Then assuming the equality between the population proportion and the sample proportion, from 'i-th' stratum, **25x Pi** number of schools should be selected.

For the present chapter, the student survey is conducted by selecting randomly eight students from each school referring to secondary-level whereas focusing on H.S. level, this survey is conducted by selecting randomly eight students from arts stream and eight students from science stream (due to absence of commerce stream in several surveyed schools) to capture the overall picture of the students of H.S. level in each surveyed school following the below-mentioned procedure:

Randomly selected eight students, from secondary-level of each sample school, comprise four general category and four reserve category students. More precisely, from class IX, two general and two reserve category (i.e. four) students are selected; and from class X as well two general and two reserve category (i.e. four) students' selection pattern is followed. In the view of senior-secondary-level, the same composition of student selection holds for class XI and class XII of arts stream as well as for science stream. It is to be noted that the student sample includes male, female and also backward class students.

Information on output and input variables have been collected through interviewing the school administration relating to the specific education-level at school. However, both the school authority and the students of the schools are interviewed to collect the data on all the probable determinants.

5.2.5 Definition and Description of the Variables

Considering **School infrastructure & administration related variables,** it is stated that information on some variables are dichotomous in nature. For example, 'Z6','Z7', 'Z9' and 'Z10'are representing '1' value for presence and '0' value for absence of the respective variable.

Considering **school characteristics & student-composition related variables,** it can be noted that the variable, 'Z11' incorporates all the backward social categories, i.e. Scheduled Tribe (ST), Scheduled Caste (SC) and Other Backward Class (OBC) while defining reserve category of students. Since the medium of instruction, in all the surveyed schools, is Bengali, competency of English among the students is crucial for consideration as it may positively affect TEF_{out} of the school-level education. Information on the variable 'Z14', is collected as it is stated by the English teacher about English competency of the class. Again, while referring to class size, the number of sections in a particular class of the school is indicated.

In the **teacher's characteristics related variable** category**,** it is mentioned that both the 'Z1' and 'Z3' variables are counted in years.

Coming to **the policy variables**, it can be pointed out that 'Z18' is represented by the proportion of free studentship receiving students. Again, two types of funds are received by the school authorities; namely, Government fund and Samagra Shiksha Mission fund. It is standard practice to use a portion of Samagra Shiksha Mission fund for the purpose of the students and therefore this is used for computation of the input variable, reflecting 'per student expenditure incurred' for the estimation of TEF_{out}. As the interest of this study is investigating the effect of government fund on TEF_{out}, the amount of fund received from West Bengal government excluding the salary payment of non-teaching & teaching staffs (i.e. Z19), is considered as the possible determinant of TEF_{out}.

Coming to the **variables, indicating school managerial role of Headmaster/ Headmistress (HM),** it can be noted that information on some variables are 'yes'/'no' type. For example, 'Z21', 'Z22' and 'Z23' are dummy variables representing '1' value for 'yes' and '0' value for 'no'. Since government schools are liable for interacting with the state education department, frequency of interaction seems crucial for this chapter. The information on the variable 'Z24' is categorical in nature; representing '1' value for 'one time interaction in six months', '2' value

for ‘one time interaction in a month’ and ‘3’ value for ‘weekly interaction’ with the state education department.

Considering **characteristics of HM related variables**, it can be mentioned that the information on ‘Z25’is dichotomous, representing ‘0’ value for female HM and ‘1’ value for male HM.‘Z26’ and ‘Z27’ are two variables, noted in years. In this study, data on the variable ‘Z28’ represents the number of years spent for studying (only UG=15, UG+B.ED=15+2=17,only PG=17,UG+BP.ED=15+3=18, PG+B.ED=17+2=19, DOUBLE PG= 17+2= 19, PG+BP.ED= 17+3 =20, PG+B.ED+M.ED= 17+2+ 2=21, Ph.D. = 17+5= 22,Ph.D. +B.ED= 22+2 =24, PGBT+ DOUBLE PG+ Ph.D. 1+19+5= 25).Again, while noting the variable ‘Z29’, the gross salary is considered and the variable is expressed in rupees.

Considering **students’ characteristics & socio-economic background related variables**, it can be stated that the information on both ‘Z30’ and ‘Z31’ variables are represented by the number of years spent for studying, i.e. ‘0’ value refers to illiteracy, ‘4’ represents literacy upto class IV, ‘8’ value denotes literacy up to class VIII, ‘10’ indicates literacy up to class X, ‘12’ value stands for literacy up to class XII, ‘15’ refers to literacy up to graduation, ‘17’ denotes literacy up to post graduation. Mean value of the corresponding income range of the parents is represented as ‘Z32’. For example, parents, falling in the monthly income brackets ‘Rs.0 - Rs.10,000’, ‘Rs.10,000-Rs.25,000’and ‘Rs.25,000 -Rs.50,000’are noted to have monthly income, equal to corresponding mean value of the income group i.e. ‘Rs. 5000’, ‘Rs. 17,500’ and ‘Rs. 37,500’ respectively. The variables, ‘Z34’,‘Z35’ and ‘Z38’,are represented by the average value of responses by the respondent students in the class corresponding to each variable.

The variables, representing the **student’s opinion regarding school attributes’ quality** are categorical in nature. Based on the student’s opinion about ‘teaching Quality’, ‘ Class Regularity’, ‘Quality of laboratory’, ‘Sanitation facility’ and ‘Quality of drinking water’ in the school, categorization is made for each of the mentioned variables as: ‘1’ value stands for excellent quality, ‘2’ indicates good quality, ‘3’ represents ‘not a bad quality’ and ‘4’ denotes poor quality of the school attribute.

5.3 Empirical Findings

5.3.1 Analysis of TEF_{out} of Secondary-Level Education of Schools using Primary Survey Data: A Case of Inter-School Study in Kolkata

5.3.1.1 Descriptive Statistics of the possible Determinants for Secondary-Level of Sample Schools

Before moving on to the TEF_{out} analysis relating to secondary-stage, the primary concern is to state the summary measures of the variables (except dummy and categorical variables) for developing an idea about such variables. Table 5.1.1 represents summary statistics of the determinants of TEF_{out} considering secondary-level of school-education.

Table 5.1.1: Summary statistics of the explanatory variables used in determinant analysis of TEF_{out} at secondary-stage of school education (Kolkata)

Variables	Mean	Standard Deviation	Coefficient of Variation
Z1	15.9	2.95	18.55
Z2	0.11	0.11	100.00
Z3	8.6	5.52	64.19
Z4	0.18	0.15	83.33
Z5	0.35	0.24	68.57
Z8	1	0.69	69.00
Z11	0.20	0.14	70.00
Z12	0.00088	0.003	340.91
Z13	0.09	0.24	266.67
Z14	37	22.23	60.08
Z15	2	0.52	26.00
Z16	0.26	0.12	46.15
Z17	1.5	1.99	132.67
Z18	0.03	0.08	266.67

Contd….

Variables	Mean	Standard Deviation	Coefficient of Variation
Z19	859694	537696	62.55
Z20	0.47	0.45	95.74
Z26	51.9	4.99	9.61
Z27	7.4	6.155832	83.19
Z28	20	1.98	9.90
Z29	76186	9425.58	12.37
Z30	9	2.26	25.11
Z31	11	2.27	20.64
Z32	12935	7861.17	60.77
Z33	97.65	7.17	7.34
Z34	6	1.51	25.17
Z35	4	1.35	33.75
Z36	96.39	8.55	8.87
Z37	76.17	24.40	32.03
Z38	19	11.14	58.63
Z39	8.30	17.41	209.76
Z40	50.94	32.20	63.21
Z41	49.06	32.20	65.63
Z42	54.78	26.78	48.89

Source: Author's computation with primary survey data for the year 2019-2020

5.3.1.2 Measure of TEF_{out} of Secondary-Stage of Schools

Table 5.1.2 represents TEF_{out} scores of each of the sample schools considering secondary-level of education, under the assumption of variable returns to scale (VRS) and also reflects the average value of the estimated TEF_{out} scores. Data envelopment Analysis program, by Coelli (1996), has been applied in the study for estimating TEF_{out}.

Table 5.1.2 : TEF_{out} estimates for Secondary-level of sample schools

Serial Number	Schools	TEF_{out} Scores
1.	School 1	1.000
2.	School 2	1.000
3.	School 3	0.984
4.	School 4	0.737
5.	School 5	1.000
6.	School 6	0.859
7.	School7	1.000
8.	Schools 8	1.000
9.	School 9	1.000
10.	School 10	1.000
11.	School 11	0.784
12.	School 12	1.000
13.	School 13	1.000
14.	School 14	0.996
15.	School 15	0.871
16.	Schools 16	1.000
17.	School 17	0.972
18.	School 18	1.000
19.	School 19	0.820
20.	School 20	0.776
21.	School 21	0.683
22.	School 22	1.000
23.	School 23	0.956
24.	School 24	0.936
25.	Schools 25	0.945
Mean TEF_{out}		0.933

Source: Author's computation with primary survey data for the year 2019-2020

Efficiency results, following an output oriented approach, reflect that 52% sample schools are inefficient considering the secondary-stage of education; indicating that such schools using the

existing resources can produce more of output. Additionally, variation of TEF_{out} scores among the different schools is also noticed. Estimated TEF_{out} scores at secondary-level of schools lie between 0.683 and 1.000. Considering the sample of 25 schools for secondary-stage, the result indicates that the number of schools showing above the average level of TEF_{out} (0.933) is 18.

5.3.1.3 Determinants of TEF_{out} for Secondary-Stage of Schools

For the determinant analysis of TEF_{out} of secondary-level of the schools, the above-mentioned possible factors are considered. Largely, while collecting students' data it is noticed that the majority of the students at secondary-level (and also for H.S. level) education take private tuition and thus the possibility arises that the TEF_{out} scores of the schools might be inflated by the role of private tuition. Hence, it would be appropriate to measure the extent of the variation of TEF_{out} of the schools in absence of private tuition, taken by the students. This contribution is attempted by the present chapter, performing the under-mentioned steps:

Step I: A regression is carried out considering TEF_{out} scores of secondary-level as dependent variable and Z33 as independent variable along with other explanatory variables. The result identifies the determinants of TEF_{out} and also confirms significance of Z33 variable, after controlling for other explanatory variables as determinants of TEF_{out} and thus indicates that the TEF_{out} scores obtained by the schools at secondary-level is basically dependent on 'Z33' variable.

Step II**:** Further, Z33 is not an exogenously determined explanatory variable. Rather it is in turn determined by several other explanatory variables in the system considering secondary-stage. Therefore, the determinants of Z33 for secondary-level are identified initially in step II and thereafter the estimated value of Z33 (referred as Z33hat for secondary-stage) is also obtained on the basis of the regression model that explains Z33 in relation to other variables.

Step III: As a next step, a regression is conducted using TEF_{out} as explained variable and estimated Z33 with other determinants of TEF_{out} as explanatory variables. This step provides the final result regarding the determinants affecting TEF_{out} of secondary-level and supports the significant role of 'Z33hat' in determining such TEF_{out}.

Step IV: For obtaining such measure of the variation of TEF_{out} that can be achieved by schools for secondary-level in absence of private tuition received by the students, a regression is carried out taking into account TEF_{out} of secondary-level of schools as explained variable and only estimated Z33 (i.e. Z33hat) as an explanatory variable in step IV. The residual series for this regression is obtained where the residual actually reflects that extent of TEF_{out} variation,

concerning the secondary-level of schools, which is not influenced by‘Z33’.This measure of TEF_{out} was tried to be obtained for secondary-level in the present chapter.

Step V: In the last step, the explanatory variables of the obtained residual in step IV(showing that measure of TEF_{out} which remains unexplained by ‘percentage of private educational assistance receiving students’), are tried to be identified by performing a regression; and the result is confirming other important determinants of TEF_{out} other than Z33 for secondary-level.

The result of the mentioned regression in step I is represented in Table 5.1.3.

Table 5.1.3: Determinants of TEF_{out} for secondary-stage considering original value of ‘private tuition’ variable

Variables	Coefficient	t-value	p-value	
Z1	-0.011222	-3.205113	0.0107	
Z15	0.144856	5.067341	0.0007	
Z21	0.099318	2.342531	0.0438	
Z27	-0.006837	-3.097046	0.0128	
Z19	7.87E-08	3.061691	0.0135	
Z11	0.369413	4.219407	0.0022	
Z20	0.002049	2.434865	0.0377	Adjusted R-square =0.832543
M1	-1.84E-05	-2.903391	0.0175	
M9	0.054111	3.435406	0.0074	
Z36	0.001554	1.114552	0.2939	
Z9	0.070530	2.831028	0.0197	
Z33	0.005191	1.920728	0.0870	
Z8	0.033693	1.627196	0.1381	
Constant	-0.202493	-0.728327	0.4849	

Source: Author’s computation with primary survey data for the year 2019-2020

As cross-section regression may contain heteroskedasticity problem, the above regression model (reported in table 5.1.3) is tested for the problem applying the Breusch–Pagan test. Result confirms the absence of heteroskedasticity as chi^2 turns '0.83' with Prob (probability) > chi^2 = 0.3621, for the model, which basically indicates a greater p-value than the threshold value '0.05'; reflecting the acceptance of homoskedasticity as a null hypothesis. Therefore, the parameters of this regression model are estimated, applying OLS.

Table 5.1.3 shows significant relationship between TEF_{out} of secondary-level and the undermentioned variables:

(1) HM's school managerial role reflecting variable, Z21 is favourably and significantly impacting on TEF_{out} score for secondary-stage of the schools. Additionally, an interaction variable M9 between two such managerial role indicating variables, Z21 and Z24 (M9 being equal to Z24*Z21), is appearing as positive and significant in determining TEF_{out} of secondary-stage of the schools**.** Therefore, the result represents the favourable school managerial role of HM in promoting TEF_{out} at secondary-level of schools. Also, the significance of interaction variable 'Z24*Z21' states that given the value of Z24, TEF_{out} level of the school is dependent on Z21 and vice versa.

(2) Again, Z27 as HM's (on-the-job) experience defining variable, negatively determines TEF_{out} at secondary-level of school, indicating the fact that the schools featuring junior HM will have comparatively greater TEF_{out} score than the schools featuring senior HM.

(3) Since the variable, Z1 negatively determines TEF_{out}, hence it is the revelation of the fact that the schools featuring comparatively junior full-time-teachers, achieve greater TEF_{out} at secondary-level.

(4) Considering the broader category relating to school infrastructure as determinant, Z8 and Z9 variables are found to be positively and significantly affecting TEF_{out} scores of secondary education at school level. Therefore, the results indicate the facts: (a) the schools with better infrastructural facility in the form of higher count of smart classrooms will be capable of obtaining greater TEF_{out} and (b) the schools with librarian, present on duty will remain more technically efficient (output-oriented) at secondary-level in comparison to the schools where librarian is not present on duty.

(5) Z19 as a policy variable, positively impacts on TEF_{out} score of the school relating to the secondary-level, suggesting that greater amount of funding from government to the school can lead TEF_{out} score to higher level. In addition to this, another policy variable,

Z20 depicts an inverted U-shaped nonlinear relationship with TEF_{out} of secondary-level as coefficient of Z20 and of its square term 'Z1' represents positive and negative signs respectively. Such result confirms the initial increase in TEF_{out} score with an increase in Z20, but this pattern of relation holds until a threshold limit is reached; and that point onwards TEF_{out} decreases with the rise in Z20. Specifically, the marginal effect of Z20 turns positive at the average level of this variable for the present sample, hence reflecting that by raising the proportion of students receiving Kanyashree, TEF_{out} of secondary-level can be raised. This result is ensured by the average value of Kanyashree becoming lesser than the threshold-level value after which the negative relation prevails.

(6) Characteristics of school, composition of students and characteristics of students reflecting variables: (i) Z15 is favourably and significantly influencing TEF_{out} of secondary-level of schools, supporting TEF_{out} enhancing role of larger class size at secondary-level education, (ii) Z11, as a student composition representing variable, positively impacts on TEF_{out} and thus it is pointing out the favourable role of government's social inclusion policy, practiced in favour of socially backward students, in enhancing TEF_{out}, (iii) Again, Z36 is positively influencing TEF_{out} of secondary-stage of school, implying that the school featuring larger percentage of students possessing all text books at home, will gain relatively greater TEF_{out} score (but showing low statistical significance) and (iv) 'student characteristics' defining variable, Z33 is positively determining TEF_{out} of secondary-stage of school, confirming that the school featuring larger percentage of students receiving private educational assistance will attain comparatively higher TEF_{out}. Table 5.1.3 also displays a high level of goodness of fit.

The reported results in Table 5.1.3, validate our hunch that TEF_{out} of secondary-stage of the school is significantly explained by Z33 and hence, the extent of TEF_{out} may be inflated by the role of percentage of secondary-level students receiving private educational assistance. Relevantly, the concern is obtaining the part of the variation of TEF_{out} score, attained at secondary-level by the schools, remaining unexplained by Z33.

Such variation of TEF_{out} scores of the schools for secondary-stage have been obtained while performing the above-mentioned steps i.e. starting from step II and proceeding up to step IV. The regression, reported in Table 5.1.3, considers the 'percentage of students receiving private

educational assistance' i.e. Z33 as an exogenously determined variable. However, such consideration may be improper due to the fact of Z33 being determined by some of the other variables within the system (i.e. the possibility of Z33 being an endogenous variable).

The regression model, explaining 'Z33' for secondary-stage, is tested for the heteroskedasticity problem applying Breusch–Pagan test and as a result chi^2 value, turning as 8.19 with Prob>chi^2 = 0.0042, reflects a lesser p-value than the threshold value, '0.05'; revealing the acceptance of 'heteroskedasticity' as an alternative hypothesis. Therefore, for estimating the regression model, Generalized Least Square technique is applied. The best fitted regression model explaining 'Z33' is reported in Table 5.1.4 below, after trying out different alternative models.

Table 5.1.4: Determinants of 'private tuition' considering secondary-stage of schools

Variables	Coefficient	t-value	p-value	
Z38	0.3832	4.06	0.0049	
Z39	-0.2979	-4.92	0.000	
Z30	-1.3813	-2.66	0.008	Wald Chi 2 = 43.07
Z31	1.1320	2.12	0.034	Prob> Chi 2= 0.000
M15	6.0302	1.85	0.064	
Z41	-0.0605	-2.13	0.033	
Constant	95.8076	20.42	0.0000	

Source: Author's computation with primary survey data for the year 2019-2020

The reported results in Table 5.1.4 indicate the significant explanatory factors of 'Z33' concerning secondary-stage of school and thus the significant roles of these explanatory factors in determining 'Z33'are discussed below:

1. Z38 as a positive and significant explanatory factor of Z33, highlights the fact that longer commute duration to school may discourage students' school attendance and hence as an alternative source of gaining knowledge, students may opt for private tuition.

2. A negatively significant relation is evident between Z30 and Z33, suggesting that lower academic qualification of mothers may hinder the academic help, the students could get at home and thus the students have to rely on private tuition.
3. On the contrary, Z31 positively impacts on Z33, expressing the fact that the father with higher academic qualification sets higher academic ambition for the child as well and therefore the father will find sending his child to private tuition classes beneficial.
4. The interaction variable between Z4 and Z43 as represented by the variable 'M15', displays positive relation with Z33, implying that if more teaching-position remains vacant and or the irregularity of the classes (as reflected by higher order sample value of student's opinion variable relating to class regularity) are experienced, then students would like opting for private educational assistance outside of school.
5. The variable, Z39 represents a negative influence on Z33, revealing that as the students involved in work for earning income generally find less time, hence taking private tuition will not be convenient for such students.
6. The variable, Z41 as a negatively impacting variable on Z33 depicts the fact that with higher count of elder siblings, parents feel less inclined for sending children to private tuition classes as such students are expected to get academic benefits from their elder siblings at home.

A good result of goodness of fit is also evident for this regression model.

Next, on the basis of the estimated parameters of the regression model, determining 'Z33'for secondary-stage (as mentioned in step II and presented by Table 5.1.4), the 'estimated Z33' i.e. 'Z33hat' is generated; which is utilized in the next step (i.e. step III) as an explanatory variable along with the set of other explanatory factors for obtaining the determinants of TEF_{out} concerning secondary-level. The result is reported in Table 5.1.5, showing explained behaviour of TEF_{out} of the secondary-stage of schools in terms of the explanatory factors that are included in the model as mentioned in step III.

Table 5.1.5: Determinants of TEF_{out} using 'estimated private tuition' as explanatory variable for Secondary-level of the schools

Variables	Coefficient	t-value	p-value	
X1	-0.117604	-3.47	0.006	
X15	0.12554197	3.82	0.003	
X21	0.1264107	3.11	0.011	
X27	-0.06687	-3.24	0.009	
X19	6.04 E-08	2.97	0.014	
X11	0.3672129	4.26	0.002	Adjusted R-square = 0.8330
X20	0.008876	2.34	0.0438	
M1	-5.4E-05	-2.83	0.0197	
M9	0.250264	1.64	0.133	
X36	0.0034903	2.31	0.044	
X9	0.0715772	2.92	0.015	
X8	0.034692	1.65	0.131	
Z33hat	0.0081762	2.25	0.048	
Constant	-0.5581762	1.38	0.196	

Source: Author's computation with primary survey data for the year 2019-2020

The regression, reported in Table 5.1.5, is tested for heteroskedasticity problem applying Breusch–Pagan test and the result indicates acceptance of 'homoskedasticity' as null hypothesis since chi^2 appears as 0.47 with $Prob>chi^2 = 0.4941$; showing a higher p-value compared to the threshold value '0.05'. Therefore, for estimating parameters of the regression, OLS is applied and the result is represented in table 5.1.5.

Since the reported result of Table 5.1.5 displays similar type of outcomes as in table 5.1.3 i.e. specifically in the form of the same set of determinants of TEF_{out} of secondary-level with the same sign conditions and statistical significance other than the role of Z33hat, the interpretation of Table 5.1.5 remains the same as Table 5.1.3. Regardless of this fact, the estimated coefficients associated with these explanatory variables differ between these two tables. Additionally, the evidence of Z33hat appearing as a significant explanatory factor of TEF_{out}, indicates that all the significantly determining factors of Z33 itself are in turn indirectly affecting TEF_{out} relating to secondary-stage of schools. A high goodness of fit is reflected by the result, reported in Table 5.1.5. Moving forward to step IV, a regression is conducted considering TEF_{out} for secondary-stage of the schools as a response variable and Z33hat as the only explanatory variable; accordingly the residual series, referred as R1TEO, is generated from this regression model. R1TEO depicts *the extent of TEF_{out} variation, among the schools for secondary-level, which* '*percentage of private educational assistance receiving students*' *could not explain*. The present chapter attempted obtaining such a result which is reflected in Table 5.1.6.

Table 5.1.6: Measure of TEF_{out} variation which is not explained by 'private tuition' considering Secondary-stage of the schools

Serial Number	Schools	Measure of TEF_{out} variation which is not explained by the 'percentage of private educational assistance receiving students' at Secondary-level
1.	School 1	0.07807
2.	School 2	0.07294
3.	School 3	0.01541
4.	School 4	0.19561
5.	School 5	0.05158
6.	School 6	0.03086
7.	School7	0.0729
8.	Schools 8	0.04601

Contd….

Serial Number	Schools	Measure of TEF_{out} variation which is not explained by the 'percentage of private educational assistance receiving students' at Secondary-level
9.	School 9	0.08113
10.	School 10	0.06277
11.	School 11	0.13566
12.	School 12	0.06165
13.	School 13	0.04417
14.	School 14	0.0559
15.	School 15	0.05569
16.	Schools 16	0.06737
17.	School 17	0.07418
18.	School 18	0.06017
19.	School 19	0.11422
20.	School 20	0.18266
21.	School 21	0.23837
22.	School 22	0.06768
23.	School 23	0.04002
24.	School 24	0.08215
25.	Schools 25	0.08274
Mean		0.08280

Source: Author's computation with primary survey data for the year 2019-2020

Because of the major role of Z33 in explaining TEF_{out} variation among the schools for secondary-stage, the reported result in Table 5.1.6 displays that the extent of TEF_{out} variation which is remaining unexplained by the 'percentage of private educational assistance receiving students' at secondary-level is very low; it ranges between 1.5% to 23.8% with the average representation of 8.28%. Such a result points out the fact that TEF_{out} scores of the schools

concerning secondary-stage will be a minor value if the students do not opt for receiving any private educational assistance outside of school.

Relevantly, the factors determining R1TEO or 'the extent of TEF_{out} which is not explained by the percentage of private tuition receiving students' at secondary-stage are important to identify and such results are represented by Table 5.1.7.

Table 5.1.7: Determinants of that measure of TEF_{out} variation, not explained by 'private tuition' considering Secondary-level of the schools

Variables	Coefficient	t-value	p-value	
Z1	-0.011954	-3.838688	0.0033	
Z15	0.150758	5.854412	0.0002	
Z21	0.111050	2.857086	0.0170	
Z27	-0.007744	-3.926376	0.0028	
Z19	4.84E-08	2.954758	0.0144	
Z11	0.334073	4.142709	0.0020	Adjusted R-square =0.852814
Z20	0.001825	2.364252	0.0397	
M1	-1.54E-05	-2.723513	0.0214	
M9	0.039062	2.803166	0.0187	
Z36	0.002908	2.288500	0.0451	
Z9	0.075806	3.606313	0.0048	
Z8	0.020187	1.058517	0.3147	
Constant	-0.692787	-4.938104	0.0006	

Source: Author's computation with primary survey data for the year 2019-2020

Table 5.1.7 reflects that the determining factors of TEF_{out} after excluding the role of 'percentage of private educational assistance receiving students' at secondary-level of schools remain the same as shown by the results in Table 5.1.3 and Table 5.1.5. A high goodness of fit is also evident from Table 5.1.7.

5.3.2 Analysis of TEF_{out} of Higher-Secondary Level of Schools using Primary Survey Data: A Case of Inter-School Study in Kolkata

5.3.2.1 Descriptive Statistics of the possible Determinants for Higher-Secondary Level of Sample Schools

For H.S. stage, the idea about the possible determinants of TEF_{out} is provided by the summary measures of these variables (except dummy and categorical variables). Representation of the summary statistics of the determinants of TEF_{out} considering H.S. level of school-education is offered by Table 5.2.1.

Table 5.2.1: Summary statistics of the explanatory variables used in determinant analysis of TEF_{out} at H.S. stage of school education (Kolkata)

Variables	Mean	Standard Deviation	Coefficient of Variation
Z1	15.9	2.95	18.55
Z2	0.11	0.11	100.00
Z3	8.6	5.52	64.19
Z4	0.18	0.15	83.33
Z5	0.35	0.24	68.57
Z8	1	0.69	69.00
Z11	0.25	0.17	68.00
Z12	0.0014	0.006	428.57
Z13	0.03	0.07	233.33
Z14	60	20.45	34.08
Z15	1	0.33	33.00
Z16	0.26	0.12	46.15
Z17	1.5	1.99	132.67
Z18	0.12	0.22	183.33
Z19	859694	537696	62.55
Z20	0.51	0.41	80.39
Z26	51.9	4.99	9.61
Z27	7.4	6.16	83.24
Z28	20	1.98	9.90
Z29	76186	9425.58	12.37

Contd….

Variables	Mean	Standard Deviation	Coefficient of Variation
Z30	11	1.38	12.55
Z31	13	1.83	14.08
Z32	16800	5973.91	35.56
Z33	93.96	3.26	3.47
Z34	6	0.60	10.00
Z35	5	0.80	16.00
Z36	92.74	12.01	12.95
Z37	54.30	24.19	44.55
Z38	23	10.53	45.78
Z39	4.30	8.02	186.51
Z40	53.91	28.58	53.01
Z41	46.09	28.58	62.01
Z42	51.35	21.01	40.92

Source: Author's computation with primary survey data for the year 2019-2020.

5.3.2.2 Measure of TEF_{out} of Higher-Secondary Stage of Schools

Focusing on H.S. level, TEF_{out} score of each of the sample schools under the assumption of variable returns to scale (VRS) is represented by Table 5.2.2 which additionally reveals the average value of the estimated TEF_{out} scores. In this context as well, TEF_{out} scores are measured by adopting the data envelopment analysis as done in the case of secondary-level.

Table 5.2.2: TEF_{out} estimates for H.S. stage of sample schools

Serial Number	Schools	TEF_{out} Scores
1	School 1	1.000
2	School 2	1.000
3	School 3	1.000
4	School 4	0.973
5	School 5	0.873
6	School 6	1.000
7	School 7	1.000

Contd….

Serial Number	Schools	TEF_{out} Scores
8	School 8	1.000
9	School 9	1.000
10	School 10	0.907
11	School 11	0.933
12	School 12	1.000
13	School 13	0.954
14	School 14	0.982
15	School 15	0.892
16	School 16	0.991
17	School 17	0.866
18	School 18	1.000
19	School 19	0.818
20	School 20	1.000
21	School 21	0.652
22	School 22	1.000
23	School 23	0.945
24	School 24	0.889
25	School 25	0.893
Mean TEF_{out}		0.943

Source: Author's estimation with primary survey data for the year 2019-2020.

TEF_{out} scores as reported in Table 5.2.2 reflect that 56% sample schools are inefficient considering H.S. stage of education, pointing out that these schools using the existing resources can produce more of the output. In addition to this, variation of TEF_{out} scores among the different schools relating to H.S. level is also evident and estimated TEF_{out} scores lie between 0.652 and 1.000. The reported results of 25 sample schools for H.S. stage indicates that the number of schools showing above the average level of TEF_{out} (0.943) is sixteen.

5.3.2.3 Determinants of TEF_{out} for Higher-Secondary Stage of Schools

Referring to H.S. level of the schools, the determinant analysis of TEF_{out} takes the above-mentioned possible factors into account. For senior-secondary-level, the majority of the students receiving private tuition is noticed while collecting students' data; thus due to the

possibility of TEF_{out} scores of the schools being inflated by the role of private tuition leads the present chapter to measure the extent of TEF_{out} variation for H.S. level of the schools in absence of the contribution of private tuition, following the five necessary steps as mentioned and attempted at the secondary-level counterpart of the present chapter.

The findings of the mentioned regression in step I are displayed in Table 5.2.3.

Table 5.2.3: Determinants of TEF_{out} for H.S. stage considering original value of 'private tuition' variable

Variables	Coefficient	t-value	p-value	
Z33	.0186287	7.54	0.000	Adjusted R-squared = 0.9082
Z9	.0356719	2.24	0.040	
Z25	.0179219	1.59	0.132	
Z19	-1.54e-07	-2.14	0.049	
M16	5.90e-13	1.98	0.067	
Z20	.0017365	2.02	0.062	
M9	.0091574	1.87	0.081	
Z8	.0360739	3.39	0.004	
Constant	-.8511282	-3.63	0.002	

Source: Author's estimation with primary survey data for the year 2019-2020.

Since cross-section regression may experience the issue of heteroskedasticity, the above regression model (reported in table 3) is tested for the problem applying the Breusch–Pagan test. Result confirms absence of heteroskedasticity problem as chi^2 turns '1.15' with $Prob>chi^2$ = 0.2828,for the model, which basically indicates a greater p-value than the threshold value '0.05'; reflecting the acceptance of homoskedasticity as null hypothesis. Therefore, parameters of the model are estimated, applying OLS.

Table 5.2.3 shows significant relationship between TEF_{out} of H.S. level and the below-specified variables:

(1) HM's school managerial role: **'**M9' as an interaction variable between the HM's managerial role indicating two variables i.e. Z21 and Z24 (M9 being equal to Z24*Z21), is appearing as a positive and significant determining factor of TEF_{out} concerning H.S. stage of the schools**.** Therefore, such a result depicts the positive school

managerial role of HM in raising TEF_{out} for senior-secondary-stage of the schools. Also, the significance of interaction variable 'Z24*Z21' expresses that given the value of Z24, TEF_{out} score of the school is dependent on Z21 and vice versa.

(2) Gender of HM: Under the broader category relating to HM's characteristics, Z25 shows positive and significant relationship with TEF_{out} of the H.S. stage of the schools. The result implies that the school under male headship is more technically efficient as compared to the schools under female headship. However, Z25 is showing a low level of significance.

(3) School Infrastructure: 'Z8' and 'Z9' as the variables representing the school infrastructure category, are found to be positively and significantly affecting TEF_{out} scores of H.S. education at school level. Therefore, reported results depict the facts: (a) The school featuring more smart classrooms will be capable of obtaining higher TEF_{out} at H.S. level and (b) The H.S. school with the on-duty presence of a librarian will remain more technically efficient (following an output oriented approach) in comparison to the schools where librarians are absent from duty.

(4) Policy Variables: Under this broader category, (i) Z20 shows positive significance in determining TEF_{out} of H.S. stage of the schools, implying the positive role of Kanyashree in promoting TEF_{out} and (ii) Z19 confirms the existence of non-linear U-shaped relationship between TEF_{out} of H.S. level of the schools and 'Z19' as the coefficient of the variable turns negatively significant and the coefficient of the square term i.e. 'M16' turns positively significant, implying that after a minimum level pointed as the threshold level of government fund (Z19), TEF_{out} increases with increase in Z19. However, the average value of Z19 for the sample schools turns 947456 (approx.), indicating greater value than the threshold level value of Z19 i.e. 130508 approx.; after which the positive effect of Z19 on TEF_{out} of H.S. level will be realized. Thus, the minimum value of Z19 required for indicating increasing TEF_{out} has been reached for the present sample of H.S. level schools and hence the system is at the rising segment of the curve. Consequently, in this chapter**,** the estimated marginal effect is found to be positive, reflecting the positive role of Z19 in determination of TEF_{out} of H.S. stage**.**

(5) Student's Characteristics: As a student's characteristic defining variable, Z33 turns highly significant with positive sign for senior-secondary-stage of the schools;

reflecting the fact that the schools with higher percentage of private tuition receiving students will achieve greater levels of TEF_{out}.

The result of the regression model represented in Table 5.2.3 shows very high goodness of fit. Additionally, Table 5.2.3 proves our hunch: TEF_{out} of the H.S. stage of the school gets determined by Z33 at this specific education level. Therefore, as these private tuition receiving students may inflate TEF_{out} scores, achieved by the schools, the concern would be to quantify the appropriate extent of TEF_{out} variation that can be explained by the set of determinants excluding Z33.To compute this extent, concerning H.S. level, the above-mentioned steps are followed:

In the above regression, reported in Table 5.2.3, 'Z33' appears as an exogenous variable. In contrast, due to the possibility of Z33 at senior-secondary-level being in turn determined by other variables within the system, it however may be an endogenous variable.

For the senior-secondary-level study, the regression model explaining 'Z33', is tested for the heteroskedasticity problem applying Breusch–Pagan test and as a result chi^2 value, turning as 7.63 with Prob>chi^2 = 0.0057, reflects a lesser p-value than the threshold value, '0.05'; revealing the acceptance of 'heteroskedasticity' as an alternative hypothesis. Therefore, for estimating the regression model, Generalized Least Square technique is applied. The best fitted regression model explaining 'Z33' at H.S. level is reported in Table 5.2.4 below, after trying out various alternative models.

Table 5.2.4: Determinants of 'private tuition' considering H.S. stage of schools

Variables	Coefficient	z -value	p-value	
Z39	-.3437361	-6.20	0.000	Wald chi2 = 105.23
Z4	23.32613	7.41	0.000	
Z3	-.4895709	-5.37	0.000	Prob> chi2 = 0.0000
Z36	-.0560985	-1.73	0.084	
Z38	.0479339	5.49	0.000	
Constant	91.13512	23.35	0.000	

Source: Author's computation with primary survey data for the year 2019-2020

The results of Table 5.2.4 suggest the explanatory variables, playing a significant role in determining 'Z33' at H.S. level. Respective roles of mentioned explanatory variables are noted below:

1. The variable 'Z4' is positively and significantly related to Z33; revealing the fact that if the proportion of vacant to total teaching posts increases in the school then more students of senior-secondary-level may prefer receiving private tuition.
2. A negative and significant relation is found between the variables Z39 and Z33**;** suggesting that the students who work to bring in money, may find lack of time for attending private tuition and hence if the percentage of such students will go up at senior-secondary-level, the value of Z33 will go down.
3. The variable 'Z3' turns negatively significant in determining Z33; implying the fact that with more years of experience, part-time teachers are likely to offer better academic benefits to the senior-secondary-level students and hence it is less likely that the students join private tuition classes as an alternative to the classes run by schools.
4. As a student characteristic reflecting variable, Z36 negatively affects Z33, indicating that the students having all the textbooks at home, may read and acquire knowledge on their own and therefore their chance of taking private tuition seems less.
5. The variable 'Z38' is playing a positive role in explaining Z33, indicating that if the time of traveling to school is high, the students of senior-secondary-level are less likely to attend school every day and hence they may have to depend more on private tuition for acquiring knowledge.

The regression, explaining 'Z33' shows very high goodness of fit.

Next, as discussed for secondary-level study, the estimated parameters of the regression model, determining 'Z33' for H.S. level as well are utilized (as mentioned in step II and presented by Table 5.2.4), for generating the series of 'estimated Z33' concerning H.S. stage and referred as 'Z33hat2' which is utilized in the next step (i.e. step III) as an explanatory variable along with the set of other explanatory factors for obtaining the determinants of TEF_{out} for H.S. level. The reported results in Table 5.2.5, displaying explained behaviour of TEF_{out} concerning the H.S. stage of schools in terms of these above referenced explanatory factors.

Table 5.2.5: Determinants of TEF_{out} using 'estimated private tuition' as explanatory variable for H.S. level of the schools

Variables	Coefficient	t-value	p-value	
Z33hat2	.0187878	5.24	0.000	
Z9	.0463905	2.29	0.037	
Z25	.0302317	1.58	0.134	
Z19	-1.65e-07	-2.01	0.063	Adjusted R-squared = 0.8447
M16	6.03e-13	1.85	0.083	
Z20	.004583	1.96	0.069	
M9	.0171668	2.08	0.055	
Z8	.0482924	3.67	0.002	
Constant	-.9266207	-2.65	0.018	

Source: Author's computation with primary survey data for the year 2019-2020

The regression, reported in Table 5.2.5, is tested for heteroskedasticity problem applying Breusch–Pagan test and the result indicates acceptance of 'homoskedasticity' as null hypothesis since chi^2 appears as '3.57' with Prob>chi^2 = 0.0588, showing a higher p-value compared to the threshold value '0.05'. Therefore, for estimating parameters of the regression, OLS is applied and the result is displayed in table 5.2.5.

While representing the determinants of TEF_{out} for H.S. level, Table 5.2.5 reflects the results akin to Table 5.2.3 in the form of the same set of significant determinants with the same sign conditions; except 'estimated Z33' or 'Z33hat2'. Although the estimated values of the coefficient of these determinants vary between the two mentioned tables, the interpretations of the results remain the same as Table 5.2.3 results. It is, however, important to note that for the regression reported in table 5.2.5, the average 'Z19' for the sample schools (947456 approx.) is again showing a greater value than the computed critical value of 'Z19' i.e. 136816 approx., after which the positive effect of Z19 on TEF_{out} of H.S. level will be realized. Thus, for the present sample of H.S. schools, the relation between these two variables is found on the upward rising portion of the curve and consequently, the estimated marginal effect of Z19 is found to be positive, reflecting the positive role of Z19 in determination of TEF_{out} of H.S. stage. Although the results, explaining the determinants of TEF_{out} are reported both in Table 5.2.3 and Table 5.2.5, however, the result of Table 5.2.5 will be relevant for explaining the determinants since Z33 relating to the H.S. stage of the schools is actually found to be an endogenous

variable. As 'Z33hat2' is determining TEF_{out} significantly, the factors significantly explaining 'Z33hat2' are also in turn indirectly affecting TEF_{out} of the senior-secondary-level of schools. The result of regression in Table 5.2.5 also reflects high goodness of fit. Next, as stated in step IV, a regression is carried out considering TEF_{out} of H.S. level of the schools as explained variable and only estimated Z33 i.e. Z33hat2 as an explanatory variable for obtaining the residual series, referred as 'R2TEO' which *specifically shows the extent of* TEF_{out} *variation* between the schools (concerning H.S. stage) *that is not explained by* the private educational assistance receiving students' percentage at H.S. level. The result, excluding the role of private tuition on TEF_{out} variation at H.S. level of the schools, is reported in Table 5.2.6 and reflects what was attempted to find out in the present chapter.

Table 5.2.6: Measure of TEF_{out} variation which is not explained by 'private tuition' considering H.S. stage of the schools

Serial Number	Schools	Measure of TEF_{out} variation at H.S. level which is not explained by Z33
1	School 1	0.0351119
2	School 2	0.0113506
3	School 3	0.0546421
4	School 4	0.0394412
5	School 5	0.0429601
6	School 6	0.0503452
7	School 7	0.0392209
8	School 8	0.0114496
9	School 9	0.0282235
10	School 10	0.0612875
11	School 11	0.044573
12	School 12	0.0287091
13	School 13	0.0045111
14	School 14	0.0291011
15	School 15	0.0744493

Contd….

Serial Number	Schools	Measure of TEF_{out} variation at H.S. level which is not explained by Z33
16	School 16	0.0864397
17	School 17	0.0101241
18	School 18	0.0258512
19	School 19	0.0249646
20	School 20	0.0587875
21	School 21	0.0415968
22	School 22	0.0182931
23	School 23	0.0040876
24	School 24	0.0537179
25	School 25	0.0497179
Mean		0.0371583

Source: Author's estimation with primary survey data for the year 2019-2020.

The result of Table 5.2.6 reflects that the major part of variation in TEF_{out} of H.S. stage is explained by Z33 (capturing the role of private tuition) and therefore the remaining part of variation, which is not explained by Z33, is very less; it ranges between 0.40% and 8.64% with the average value 3.72%.

This result implies that TEF_{out} of the schools will actually be low without the students opting for private tuition at H.S. level.

Thus, in the present chapter, finding out the factors affecting that measure of TEF_{out} which remains unexplained by the role of private tuition (R2TEO**)** at H.S. stage is also relevant and such result is reported in Table 5.2.7.

Table 5.2.7: Determinants of that measure of the variation of TEF_{out}, not explained by 'private tuition' considering H.S. level of the schools

Variables	Coefficient	t-value	p-value	
Z9	.0314895	1.80	0.091	
Z25	.0420415	2.41	0.029	
Z19	-7.90e-08	-1.98	0.066	Adjusted R-squared = 0.4199
M16	2.36e-13	1.79	0.092	
Z20	.0046853	1.95	0.069	
M9	.0126386	1.96	0.067	
Z8	.0416375	3.32	0.004	
Constant	-.1185065	-2.49	0.024	

Source: Author's computation with primary survey data for the year 2019-2020

The regression result in Table 5.2.7 shows that for H.S. stage of the schools the determinants of the measure of TEF_{out}, obtained excluding the role of Z33, are the same as Table 5.2.3 and Table 5.2.5. Therefore, Table 5.2.7 indicates reliability of the result. However, for the regression reported in table 5.2.7, the average 'Z19' of the sample schools (947456 approx.) is yet again showing a greater value than the computed critical value of Z19 i.e. 167373 approx. Thus, for the present sample of H.S. schools, the relation between two variables, 'Z19' and 'R2TEO', is found on the upward rising portion of the curve and consequently, the estimated marginal effect of Z19 is found to be positive, reflecting positive role of Z19 in determination of 'R2TEO' for H.S. stage**.** A not so high goodness of fit of this regression model in turn supports the fact that since the major variation in TEF_{out} relating to H.S. level of the schools is explained by Z33, the remaining extent of TEF_{out} variation is low and hence goodness of fit for this regression is also not very high.

5.3.3 Comparison of TEF_{out} Performance and Factors Determining TEF_{out} between Secondary-Level and Higher-Secondary Level of Schools using Primary Survey Data

The TEF_{out} results for Secondary-stage indicate that 52% sample schools are inefficient while referring to H.S. stage 56% sample schools become inefficient, indicating relatively greater extent of (output-oriented) inefficiency at H.S. level in comparison to the Secondary-level of schools.

Since the result of the determinant analysis reveals that 'Z33' explains the larger segment of variation in TEF_{out} for secondary-stage as well as for H.S. stage, therefore investigating the residual segment of variation in TEF_{out} for both stages, excluding the contribution of Z33 is crucial and it ranges from 1.5% to 23.8% with the average value 8.28% for Secondary-level while for H.S. level of schools it ranges between 0.40% and 8.64% with the average value 3.72%. This result is an indication of very low TEF_{out} score attainment by the schools in absence of the contribution of private tuition; however, it is further lower for H.S. level than Secondary-level.

The comparison between the determinants of TEF_{out} of Secondary-level and H.S. level, reveals that some factors can commonly determine TEF_{out} of both Secondary and H.S. levels like, private tuition receiving students' percentage, frequency of HM's interaction with state-education department, HM's interaction with teachers and students while taking policy decision, proportion of students receiving Kanyashree, amount of funding received by school from government, librarians presence on duty and the count of smart classroom in the school.

However, other than these common determinants, the specific to Secondary-level determinants of TEF_{out} are also evident like, full-time teachers' experience, class size, reserve category students' proportion, HM's experience, proportion of students possessing textbooks at home; though any such specific to level determinants of TEF_{out} are not found for H.S. level.

5.4 Conclusion

In the existing literature, the present chapter contributes by measuring TEF_{out} of twenty five Kolkata based government aided & government schools for secondary and H.S. stages of education, using stratified random sample surveyed data, applying DEA and also determining the factors influencing TEF_{out} scores for secondary-level as well as for H.S. level of school education. The TEF_{out} results reveal that 52% sample schools are inefficient considering secondary-stage of education while 56% sample schools are inefficient referring to H.S. stage of education, indicating that these schools are capable of producing more output utilizing the same amount of existing inputs. Variation of TEF_{out} scores among different schools is evident for both the levels of school education.

Since the observations for secondary-level and H.S. level of the sample schools separately suggest that the majority of students avail of private tuition, it, therefore, raises the possibility of inflating TEF_{out} scores of these schools for the concerned levels of education. Thus, in the

case of secondary-stage and also for H.S. stage of schools, the question deals with what happens to TEF_{out} measure in the absence of private tuition or, what extent of TEF_{out} variation is not explained by 'Z33'?

The question arising for secondary-level as well as H.S. level can be addressed by following several steps, individually for these two levels of school education, where as a primary step TEF_{out} is explained in terms of 'Z33' and the set of other determining variables. As 'Z33' itself can in turn be determined by several other factors of the system, the determinants of Z33 and consequently 'estimated Z33' is also obtained for both the school education levels. Concerning the secondary-level of school, 'estimated Z33' series is referred as 'Z33hat' while relating to H.S. level it is referred as 'Z33hat2'. Next, in case of both secondary-level and H.S. level determinant analysis, TEF_{out} is regressed on 'estimated Z33' for obtaining the residual series (referred as 'R1TEO' for secondary-level and 'R2TEO' for H.S. level) which reflects that measure of TEF_{out} variation, remaining unexplained by Z33 for the specific level of school-education.

The result reveals that 'Z33' explains the major part of variation in TEF_{out} for secondary-stage as well as for H.S. stage and therefore the remaining part of variation, which is not explained by Z33, is very less; for secondary-level of schools it ranges from 1.5% to 23.8% with the average value 8.28% while for senior-secondary-level of schools it ranges between 0.40% and 8.64% with the average value 3.72%. This result is in fact an indication of very low TEF_{out} score attainment by the schools at both the school education levels, in absence of the role of private tuition. In this regard, a serious concern is raised and it urges us to improve the situation in the future.

Present chapter identifies the following determinants of TEF_{out} (other than Z33) considering secondary-stage of the school education:

1) HM's school managerial role reflecting variable, Z21 as well as an interaction variable between Z21 and Z24 are favourably and significantly impacting TEF_{out} score for secondary-stage of the schools, representing the favourable school managerial role of HM in promoting TEF_{out} at secondary-level. The significance of the interaction variable indicates that given the value of Z24, TEF_{out} level of the school is dependent on Z21 and vice versa, revealing the crucial roles of both of these factors in determination of TEF_{out} relating to secondary-level of the schools.

2) HM's experience defining variable, Z27 adversely influences TEF_{out} score of secondary-level of school, expressing that the schools operated by junior HM will achieve greater TEF_{out} than the schools operated by senior HM.

3) Full-time teacher's service experience negatively influences TEF_{out}, revealing that the schools functioning with comparatively junior full-time-teachers, attain greater TEF_{out} at secondary-level.

4) School infrastructure and administration defining variables, Z8 and Z9 are favourably and significantly affecting TEF_{out} scores of secondary-level of schools, depicting that (a) the schools with higher count of smart classrooms will obtain greater TEF_{out} and (b) the schools with librarian's presence on duty will obtain more TEF_{out} at secondary-level in comparison to the schools operating without on duty presence of librarian.

5) Policy variable, Z19 positively determines TEF_{out} score of the school relating to the secondary-level, indicating that higher level of government funding improves TEF_{out} score attainment of the school. Another policy variable, Z20 depicts an inverted U-shaped nonlinear relationship with TEF_{out} of secondary-level, confirming the initial increase in TEF_{out} score with an increase in Z20 until reaching a threshold limit which onwards TEF_{out} decreases with the rise in Z20. Specifically, the marginal effect of Z20 turning positive at the average level of this variable for the present sample, reflecting that by raising the proportion of students receiving Kanyashree, TEF_{out} of secondary-level can be raised for the present case. The average value of Kanyashree becoming lesser than the threshold-level value (after which the negative relation prevails) basically ensures such a result of positive marginal effect.

6) Characteristics of school, composition of students and characteristics of students defining variables: (i) Z15 is favourably and significantly influencing TEF_{out} of secondary-level of schools, supporting TEF_{out} enhancing role of larger class size at secondary-level education, (ii) 'reserved category student's proportion' positively impacts on TEF_{out} , pointing out the favourable role of government's social inclusion policy practice in enhancing TEF_{out}, (iii) Z36 as a 'student characteristics' defining variable, positively determines TEF_{out} of secondary-stage of school, implying that the school functioning with larger percentage of students possessing textbooks at home, will attain relatively more TEF_{out} level.

Relevantly, the below stated variables are identified for determining 'Z33' at secondary-level of schools:

(i) Z38 as a positive and significant explanatory factor of Z33, conveys that longer commute duration to school may discourage school attendance of the students; hence they may depend on private tuition. (ii) The finding of adverse relation between Z30 and Z33, depicts that lower academic qualification of mother may be unfavourable for getting academic help at home leading the students to be more dependent on private tuition (iii) In contrast, Z31 depicts positive relation with Z33, revealing that higher academic qualification of father sets higher academic ambition for the child which is inducing the father for sending his child to private tuition classes. (iv) The interaction variable between Z4 and Z43, positively affects Z33, pointing out that if irregularities of the classes are experienced and or more teaching-positions remain vacant, then students would like opting for private tuition outside of school. (v) A negative influence of Z39 is evident on Z33, indicating that as the students involved in work for earning income, find less time; hence such students are unlikely to join private tuition classes. (vi) Z41 adversely affects Z33, revealing that with more count of elder siblings, students may get better academic benefits at home which makes parents unwilling for sending children to private tuition classes.

Focusing on the H.S. stage of the schools, this chapter also identifies the below stated determinants of TEF_{out}:

1) TEF_{out} of H.S. stage of the schools is determined positively and significantly by the interaction term 'M9' between two variables, Z21 and Z24, suggesting the positive school managerial role of HM in promoting TEF_{out} of the concerned stage of the schools.

2) The variable 'Z25' is positively and significantly affecting TEF_{out}, suggesting that the schools under male headship perform more efficiently at H.S. level in comparison to the female-headed schools. The significance level of Z25 is, however, low.

3) The variable 'Z8' is positively and significantly affecting TEF_{out} of the H.S. level of the schools, implying that the efficiency level is higher for those schools operating with presence of more smart classrooms. In addition to this, the variable 'Z9' is also turning positively significant, meaning presence of librarian on duty can lead the TEF_{out} of

those schools to the higher level in comparison to the schools where librarian is absent from duty.

4) For the H.S. level analysis of this chapter, 'Z19' shows negative significance whereas its square term shows positive significance in determining TEF_{out} of senior-secondary-stage of the school, denoting a non-linear U-shaped relation of this variable with TEF_{out} which basically indicates that only after a certain level of Z19, TEF_{out} will be positively impacted by this variable. The calculated marginal effect at mean value of 'Z19' being positive is suggesting that for the sample schools relation between these two variables is lying at the rising part of the curve and hence the result is actually reflecting a positive role of government funding in determination of TEF_{out} of H.S. stage of the schools**.** Further, a positive significance of 'Z20' in determination of TEF_{out} of H.S. stage is also evident for these schools, implying the positive role of Kanyashree in promoting TEF_{out}.

In relation to this, it is relevant to note that the undermentioned variables are responsible for determining 'Z33' at H.S. level:

(i) The variable 'Z4' depicts a positive and significant relation with Z33 which reveals that with increase in vacant teaching positions in the school, students of H.S. level prefer joining private tuition more. (ii) A negative and significant relation is found between 'Z39' and 'Z33', suggesting the fact that since the working students face the problem of time scarcity, they are less likely to attend private tuition. (iii) The variable **'**Z3' is negatively and significantly affecting 'Z33', implying that more experienced part-time teachers are likely to offer better teaching skills and for this reason, the senior-secondary-level students are less likely to join private tuition classes as an alternative of scheduled classes in the schools.(iv) The variable 'Z36' is also negatively and significantly related to 'Z33' representing the fact that possessing all the textbooks, may be beneficial for the students for acquiring knowledge on their own and it will be less likely that these students will opt for private tuition. (v) A positive and significant relationship is identified between 'Z38' and 'Z33', reflecting that due to the high travel time, the H.S. level students may face inconvenience of visiting school every day and hence for deriving academic benefits, the students may depend more on joining private tuition.

The determinant analysis of TEF_{out} for the school-level study corresponding to the Secondary-level and H.S. level is essential for recognizing each factor that may affect TEF_{out} at school-level and depending on such findings, changing the factors in proper direction for each of the referenced level of school education, TEF_{out} can be enhanced at school-level.

Chapter 6:

Analysis of Input Efficiency of Government and Government-Aided Schools based on Primary Survey Data: A Case Study of Kolkata

6.1 Introduction

Since technical efficiency (TEF) can be viewed from the alternative perspective of input conservation, at the school-level it is worth examining the efficient utilization of the inputs of education production. In this connection, the concern is for the production of the observed extent of educational output at Secondary and Higher Secondary (H.S.) levels, are different schools capable of using the minimum required extent of input or not? This concern basically points out the aspect of input oriented technical efficiency (TEF_{inp}) where the inefficiency deals with the provision of reduction in the extent of input while not altering the extent of output (under a certain technology). Following the review of the prevailing literature, it is noticed that in the Indian scenario TEF_{inp} evaluation concerning Secondary and H.S. stages at the school-level are limited. Hence, the present chapter contributes in the domain of literature in following manner:

(i) The present chapter based on primary survey data, estimates TEF_{inp} of the schools at Secondary and H.S. stages separately employing non-parametric data envelopment analysis (DEA), under the consideration of variable returns to scale (VRS) assumption. For performing the analysis, the primary source data is collected for the time interval 2019-2020, following stratified random sampling method from twenty five government-aided and government schools located in Kolkata.

(ii) Subsequently, for Secondary and H.S. stages at school-level, the resulting TEF_{inp} scores are tried to explain through assessing the individual effect of each specific variable, considered in the determinant analysis of the present chapter and not through any constructed composite index. The present chapter also examined the influence of 'Kanyashree Prakalpa' on TEF_{inp} scores of the schools for the respective level of education.

(iii) Since the major proportion of the students at Secondary and H.S. levels were noticed to depend on private tuition which possibly lead to the increment in TEF_{inp} attainment

of the school, therefore the concern of the present chapter is capturing the extent of TEF_{inp} variation across schools which remains unexplained by private tuition referring to the concerned education levels.

(iv) In the present chapter, the input slack values are computed for each relevant input used in production of education at the respective stages of the schools, following which inputs are recognized according to the extent of inefficient utilization of inputs and are ranked accordingly.

The present chapter unfolds with the following structure: section 6.2 informs about the data and methodology used in this chapter; while section 6.3 discloses the empirical findings. The sections 6.3.1.1 and 6.3.2.1 represent the results of TEF_{inp} measurement in reference to Secondary-stage and H.S. stage of schools respectively. Next, the sections 6.3.1.2 and 6.3.2.2 reflect the computed Radial movement & Slack movement values for various inputs referring to the Secondary-stage and H.S. stage respectively of schools. Again, 6.3.1.3 and 6.3.2.3 sections reveal the determinants of TEF_{inp} for Secondary-stage and H.S. stage of the schools respectively. The measure of TEF_{inp} variation which is not explained by private educational assistance at Secondary and H.S. stages of the schools are also documented in sections 6.3.1.3 and 6.3.2.3 respectively. Finally, section 6.4 discusses the concluding part of the present chapter.

6.2 Methodology and Data

Methodology for obtaining TEF_{inp} score at school-level concerning secondary and H.S. stages and also the description of radial & slack movement of input are the same as discussed in chapter 4.

For conducting the analysis of TEF_{inp} corresponding to Secondary as well as H.S. education stages based on school level data, the same output-input variables together with the same set of possible determinants have been taken into consideration in this chapter as done in chapter 5. The same dataset relating to output-input variables as well as the set of possible determinants are used for analyzing TEF_{out} and TEF_{inp} in chapter 5 and chapter 6, respectively, focusing on secondary and H.S. stages of education at school level; and the relevant dataset (representing the year 2019-2020) is prepared through surveying and collecting data from ‘twenty five’ government & government aided sample schools, located in Kolkata region. Therefore, the

procedure of data collection, sample selection and description including definition of the variables remain the same with those discussed in chapter 5.

6.3 Empirical Findings

6.3.1 Analysis of TEF_{inp} of Secondary-Level Education of Schools using Primary Survey Data: A Case of Inter-School Study in Kolkata

6.3.1.1 Measure of TEF_{inp} in reference to Secondary-Stage Education of Schools

Table 6.1.1 represents TEF_{inp} scores of each of the sample schools considering secondary-level of education for the year 2019-2020, under the assumption of variable returns to scale (VRS) and also reflects the average value of the estimated TEF_{inp} scores. Data envelopment Analysis program, by Coelli (1996), has been applied in the study for estimating TEF_{inp}.

Table 6.1.1 : TEF_{inp} estimates for Secondary-level of sample schools

Serial Number	Schools	TEF_{inp} Scores
1	School 1	1.000
2	School 2	1.000
3	School 3	0.881
4	School 4	0.942
5	School 5	1.000
6	School 6	0.797
7	School 7	1.000
8	School 8	1.000
9	School 9	1.000
10	School 10	1.000
11	School 11	0.925
12	School 12	1.000
13	School 13	1.000
14	School 14	0.934
15	School 15	0.938
16	School 16	1.000
17	School 17	0.981
18	School 18	1.000

Contd….

Serial Number	Schools	TEF_{inp} Scores
19	School 19	0.864
20	School 20	0.887
21	School 21	0.655
22	School 22	1.000
23	School 23	0.890
24	School 24	0.940
25	School 25	0.945
Mean TEF_{inp}		0.943

Source: Author's computation using primary survey data for the year 2019-2020

Efficiency results, following input oriented approach, reflect that fifty six percent of sample schools are operating inefficiently considering the secondary-stage of education; indicating that these schools are capable of producing the existing output level utilizing less of the inputs. Additionally, variation of TEF_{inp} scores amongst the different schools is also evident. Estimated TEF_{inp} scores, in the view of secondary-stage of the schools, lie between 0.655 and 1.000. Considering the sample of twenty five schools for secondary-stage, the result indicates that the number of schools showing TEF_{inp} scores above the 'mean TEF_{inp}' (0.943) is fourteen.

6.3.1.2 Computation of Radial movement & Slack movement for different Inputs referring to Secondary-Stage Education of Schools

Table 6.1.2: Radial movement and slack movement (in percentage) of different inputs considering TEF_{inp} measurement in reference to Secondary stage education of sample schools, located in Kolkata

Sl. No.	Schools	Classroom-Pupil ratio		Teacher-Student ratio		Percentage of teachers with qualification master degree and above		Per student monthly expenditure of school	
		Radial	Slack	Radial	Slack	Radial	Slack	Radial	Slack
1.	School 1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.	School 2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.	School 3	-12.06	0.00	-11.84	-15.13	-11.93	-1.13	-11.93	0.00
4.	School 4	-5.84	-28.80	-5.63	-30.12	-5.75	0.00	-5.75	0.00

Contd….

Sl. No.	Schools	Classroom-Pupil ratio		Teacher-Student ratio		Percentage of teachers with qualification master degree and above		Per student monthly expenditure of school	
		Radial	Slack	Radial	Slack	Radial	Slack	Radial	Slack
5.	School 5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.	School 6	-20.35	-45.88	-20.35	-50.99	-20.31	0.00	-20.31	-2.77
7.	School 7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8.	School 8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9.	School 9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10.	School 10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11.	School 11	-7.62	-45.71	-7.55	-46.94	-7.51	0.00	-7.51	0.00
12.	School 12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
13.	School 13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
14.	School 14	-6.61	-22.48	-6.71	-25.33	-6.57	0.00	-6.57	-10.82
15.	School 15	-6.17	0.00	-6.06	0.00	-6.17	-19.34	-6.17	-65.35
16.	School 16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
17.	School 17	-2.12	0.00	-1.81	-26.76	-1.89	0.00	-1.89	-31.92
18.	School 18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
19.	School 19	-13.61	-31.11	-13.55	-49.68	-13.58	0.00	-13.58	0.00
20.	School 20	-11.21	-28.22	-11.41	0.00	-11.31	0.00	-11.30	-30.48
21.	School 21	-34.41	-16.84	-34.42	-0.23	-34.47	0.00	-34.47	0.00
22.	School 22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
23.	School 23	-10.96	0.00	-11.15	-13.83	-10.97	0.00	-10.97	-4.93
24.	School 24	-9.01	-15.55	-8.61	-17.64	-6.09	-1.18	-5.57	-8.72
25.	School 25	-8.00	-15.00	-7.32	-17.52	-5.92	-1.16	-5.53	-8.65
Average		-5.92	-9.98	-5.86	-11.77	-5.70	-0.91	-5.66	-6.55

Source: Author's computation using primary survey data for the year 2019-2020

Table 6.1.2 outcome displays for secondary-level, the radial as well as slack movements of inputs: 'classroom-pupil ratio', 'teacher-student ratio', 'percentage of teachers with master degree and above qualification' and 'per student monthly expenditure of school'. Averaging the radial movement of the input representing 'classroom-pupil ratio' over the sample schools, a value of 5.92% (absolute term) is found and the number of sample schools identified as falling below the average level is 'fourteen' out of which 'twelve' schools reflect the lowest i.e. zero

percent as this input's radial movement. As found in table 6.1.2 for secondary-level, the mean slack movement value of input 'classroom-pupil ratio' over sample schools is established at 9.98 percent and in comparison to this average, 64% of the sample schools are identified for attaining lower slack movement value and also the percentage of the sample schools remain the same for exhibiting a zero value of slack movement concerning this input.

Upon analyzing the radial movement concerning the input, 'teacher-student ratio', it becomes evident that the average figure is 5.86 percent for the secondary-stage of the sample schools; and among these sample schools 56% reflects radial movement below this average while 12% confirms the lowest radial movement of this input, measured at zero percent. On the contrary, the finding of this input's slack movement based on the table 6.1.2, reveals that 56% of sample schools secure the lowest slack movement (zero percent). Further, as reflected by the table 6.1.2, the average value of slack movement of this input across twenty five sample schools is noted at 11.77% for the secondary-stage and among these, 60% sample schools are identified for revealing lower slack movement value in comparison to this figure of mean.

Taking into account 'percentage of teachers with master's degree or higher academic qualification' as an input and analyzing its radial movement focusing on secondary-level of the schools, it is noted that 48% of the sample schools reflect a value of zero (lowest) as radial movement. Considering this input, the average value of the radial movement across the sample schools is found as 5.70 percent for secondary-level; and the percentage of sample schools lying below this average is 'fifty two'. After examining the slack movement of this input for secondary-level of schools, it has been observed from table 6.1.2 that 84% sample schools reflect a lower slack movement, compared to the calculated mean of slack movement for this input, computed as 0.91 percent and the same percentage of sample schools are identified for attaining the lowest score, representing a value of zero.

Assessing the radial movement for input, 'per student monthly expenses of school' considering secondary-level of the schools, it is noticed that twelve schools out of the total sample schools have secured the lowest levels (i.e. zero percent) of radial movement and 60% of sample schools display a radial movement below the computed average level (5.66%). On the contrary, as found in table 6.1.2, the average value of slack movement of this input is observed at 6.55% for the secondary-stage of the sample schools and in comparison to this average, relatively lesser slack movement is exhibited by 76% sample schools. For this input, the figures of slack

movement reveals that seventeen schools amongst total sample schools could attain lowest slack movement (zero percent).

Though the figures of radial and slack movements offer the notion of inefficiency with regard to individual input, however, for estimating the degree of inefficiency exhibited by each input, the computation of combined movement as an additive representation of radial and slack movements, for every individual input, is required. Further, such findings can form the basis for ranking of the inputs accordingly. In Table 6.1.3 below, the combined value of radial & slack movement added together for each of the inputs focusing on secondary-stage of the schools including corresponding mean combined movement value, computed across sample schools, are represented for every individual input.

Table 6.1.3: Combined movement (in percentage) of different inputs considering TEF_{inp} measurement in reference to Secondary stage education of sample schools, located in Kolkata

Sl. No.	Schools	Classroom-Pupil ratio	Teacher-Student ratio	Percentage of teachers with qualification master degree and above	Per student monthly expenditure of school
1.	School 1	0.00	0.00	0.00	0.00
2.	School 2	0.00	0.00	0.00	0.00
3.	School 3	-12.06	-26.97	-13.05	-11.93
4.	School 4	-34.64	-35.75	-5.75	-5.75
5.	School 5	0.00	0.00	0.00	0.00
6.	School 6	-66.23	-71.34	-20.31	-23.08
7.	School 7	0.00	0.00	0.00	0.00
8.	School 8	0.00	0.00	0.00	0.00
9.	School 9	0.00	0.00	0.00	0.00
10.	School 10	0.00	0.00	0.00	0.00
11.	School 11	-53.33	-54.49	-7.51	-7.51
12.	School 12	0.00	0.00	0.00	0.00
13.	School 13	0.00	0.00	0.00	0.00
14.	School 14	-29.09	-32.04	-6.57	-17.39

Contd….

Sl. No.	Schools	Classroom-Pupil ratio	Teacher-Student ratio	Percentage of teachers with qualification master degree and above	Per student monthly expenditure of school
15.	School 15	-6.17	-6.06	-25.51	-71.52
16.	School 16	0.00	0.00	0.00	0.00
17.	School 17	-2.12	-28.58	-1.89	-33.81
18.	School 18	0.00	0.00	0.00	0.00
19.	School 19	-44.72	-63.23	-13.58	-13.58
20.	School 20	-39.43	-11.41	-11.31	-41.79
21.	School 21	-51.25	-34.65	-34.47	-34.47
22.	School 22	0.00	0.00	0.00	0.00
23.	School 23	-10.96	-24.98	-10.97	-15.90
24.	School 24	-23.56	-24.96	-7.27	-14.28
25.	School 25	-23.99	-26.13	-7.08	-14.18
Average		-15.90	-17.62	-6.61	-12.21

Source: Author's computation using primary survey data for the year 2019-2020

In Table 6.1.3, the average value of the combined movement (i.e. radial & slack movements considered collectively) for the input, 'classroom-pupil ratio' over twenty five schools considering secondary-stage is shown as 15.90%; and 64% amongst these sample schools are evidencing somewhat smaller combined movement values in comparison to the calculated average. Further, from the combined movement perspective of this input, 48% of the sample schools are found to be associated with the value of 'zero'.

According to the 'teacher-student ratio', an input of the secondary-level of education production of the schools, the mean combined movement figure across the sample schools is evident at 17.62% and there are 56% schools, among these sample schools, expressing combined movement figures below this average. However, the lowest degree of combined movement is ensured by 48% sample schools.

Referring to the secondary-stage of the schools, the minimum level (i.e. zero) of combined movement for the input, representing the percentage of teachers qualified master degree and above, is observed for 48% sample schools. A mean value of 6.61% of the combined movement is found when the mentioned input is taken into account for secondary-level and considering

this input, 60% sample schools have been noted with below the combined movement average measure.

As far as 'per student monthly expenses' by the schools is concerned as an input for the secondary-level of this study, the average combined movement is noted as 12.21% and 60% sample schools are sighted as reflecting the lower values when compared to this combined movement average figure. Additionally, 48% sample schools attain the lowest or zero-valued combined movement for this input.

Hence, the aforementioned findings imply that 48% sample schools reflect the minimum value of combined movement for all the four inputs of secondary-stage at school level. The figures of combined movements of the four inputs, as a signal of excess input utilization for producing a particular output level, therefore reveal the following information on various inputs employed in the secondary-level education production of schools:

(1) The competency of input utilization performance (in overall sense) is recognised for 48% sample schools as these schools exhibit lesser combined movement values for all the four inputs in comparison to the corresponding input's mean combined movement value.

(2) Twenty percent of sample schools have to deal with poor performance, in the view of input utilization as such sample schools for every individual input of secondary-level education production reveal relatively greater values of combined estimate of Radial and Slack movements, when compared to the corresponding input's calculated average combined movement figure.

(3) Employing the combined estimates, the performances of various inputs of secondary-level are analyzed for sample schools and the result expresses that the average inefficiency is observed to be **greatest for the input '**teacher-student ratio' (17.62%), followed by the inputs, classroom-pupil ratio (15.90%) and per student expenses of school on a monthly basis (12.21%), and **lowest for the input,** percentage of teachers with master degree and above academic qualification (6.61%).

6.3.1.3 Determinants of TEF_{inp} for Secondary-Stage of Schools

As done in chapter 5 (while analyzing determinants of TEF_{out} concerning secondary-stage of education), the same set of possible factors are considered for the determinant analysis of TEF_{inp} of secondary levels of the schools in the present chapter. Referring to the secondary-

stage, since the possibility of TEF_{inp} scores of the schools becoming inflated arises because of the fact of majority of the students getting private educational assistance, it would be appropriate to measure the extent of the variation of TEF_{inp} of the schools in absence of the influence of private tuition. The present study tries to make a contribution in this specific direction, carrying out the following procedures:

Step I: For the secondary level, a regression analysis is carried out considering TEF_{inp} scores as response variable while Z33 as a determining variable alongside other explanatory variables. While recognizing the determinants of TEF_{inp} , the result confirms significance of the Z33 variable, after controlling for other predictors of TEF_{inp} and thereby the dependence of TEF_{inp} scores obtained by the schools at secondary level on 'Z33' seems evident.

Step II: In addition to the previous step, due to the fact of Z33 being determined by several other explanatory variables in the system (i.e. not exogenously determined) considering the secondary stage, the determinants of Z33 should be identified in the step II with the objective of obtaining the estimated value of Z33 (i.e. Z33hat) as guided by the regression model that explains Z33 in terms of other variables. Since the regression explaining 'Z33' has already been conducted for the secondary-stage in chapter 5, the step II results is followed from there.

Step III: Next in line, a regression is executed using TEF_{inp} as response variable while 'estimated Z33' with other determinants of TEF_{inp} as explanatory variables. As a final result, the outcome of this step evidences the determinants affecting TEF_{inp} of the secondary stage, affirming the significant effect of 'Z33hat'.

Step IV: With the aim of obtaining such measure of the variation of TEF_{inp} that can be secured by secondary schools in absence of the guidance provided by private tutors to students, a regression is performed taking TEF_{inp} of secondary schools as response variable and only estimated Z33(i.e. Z33hat) as explanatory variable, in step IV. Corresponding to this regression, the residual series indicates that extent of TEF_{inp} variation of the secondary schools, which is not impacted by 'Z33' and for the present study, such measure is obtained.

Step V: As an ultimate execution, a regression is performed with the purpose of recognizing the explanatory variables of the obtained residual in step IV (showing that measure of TEF_{inp} which is unexplained by '% of private tuition taking students'), following which other important determinants of TEF_{inp} other than Z33 are discerned.

The result of the specified regression in step I is illustrated in Table 6.1.4.

Table 6.1.4 : Determinants of TEF_{inp} of Secondary stage considering original value of 'private tuition' variable

Variables	Coefficient	z-value	p-value	
Z15	.0498254	2.27	0.023	
Z19	3.36e-08	2.43	0.015	
Z20	.2180345	2.22	0.026	Wald chi2 = 62.98
M30	-.1783514	-1.85	0.064	
Z21	.126821	4.21	0.000	Prob > chi2 = 0.0000
Z33	.0075451	3.47	0.001	
Z45	-.0582828	-2.71	0.007	
Z6	.0821633	2.64	0.008	
Z8	.0241317	1.34	0.181	
Constant	-.0858083	-0.38	0.704	

Source: Author's estimation with primary survey data for the year 2019-2020

Given the possibility of heteroskedasticity problem in case of cross-sectional data, the regression model which is specified for determining TEF_{inp} of secondary level considering original value of Z33 along with other possible factors, is tested concerning the problem, applying the Breusch–Pagan test. The result, in the context of this model, confirms presence of heteroskedasticity problem as 'wald $chi^{2'}$ turns '10.64' with Prob>chi^2 = 0.0011, which points out a lesser p-value than the threshold value '0.05'; reflecting the acceptance of 'heteroscedasticity' as an alternative hypothesis. Therefore, the parameters of the model are estimated by applying heteroskedasticity corrected GLS (generalized least squares) method.

Table 6.1.4 illustrates the significant relationship between TEF_{inp} of secondary level and the variables that are noted below:

(1) As a HM's school managerial role representing variable, 'Z21' is appearing as positive and significant in determining TEF_{inp} of secondary stage of the schools. Therefore, the result supports the positive role of HM's interaction with students and teachers of the school while taking any school-related decision, in promoting TEF_{inp} of secondary-level.

(2) As a policy variable, 'Z20' validates the existence of non-linear inverted U-shaped relationship with TEF_{inp} of secondary-level as the coefficient of 'Z20' indicates positive

significance and the coefficient of its square term, 'M30' (Z20*Z20=M30) indicates negative significance, implying the fact that even though 'Z20' leads to an increase in TEF_{inp} of secondary-level initially, however, after reaching a threshold level of Z20 i.e. the proportion of students receiving Kanyashree, TEF_{inp} reduces with the rise in 'Z20'. Considering the secondary level of sample schools, the average value of Z20 turns to 0.47 while the threshold level of Z20 after which a negative effect is felt, is 0.61. Since the mean is less than the threshold level of Z20, the present sample exists on the upward rising portion of the curve and hence the marginal effect of Z20 is positive, implying TEF_{inp} rises with Z20 but this increase in TEF_{inp} arising out of the rise in Z20 cannot be sustained without restriction. There is a threshold limit of Z20 , such that any further rise in Z20 will in fact reduce the level of TEF_{inp}. Intuitively, a rise in 'Z20 leading to a rise in TEF_{inp} of secondary-level can be justified as: due to the persistence of the higher Z20 value in the secondary-level of the schools, producing increased educational output is possible utilizing the same quantity of inputs (as suggested by TEF_{out} results of chapter 5, relating to secondary-level), following which it may also be possible for the school to produce the same output quantity utilizing the reduced input quantity and this signifies the indication of an improved TEF_{inp} due to a rise in Z20.

Under the policy variable category, 'Z19' shows positive significance in determining TEF_{inp} of secondary-stage of the schools, implying the positive role of receipt of government funding amount by the school (other than the salary payments to non-teaching & teaching staffs) in promoting TEF_{inp} of secondary-stage.

(3) As a component of school infrastructure and administration related determinants, 'Z6' and 'Z8 'variables are noted for positively and significantly affecting TEF_{inp} scores of secondary-education-level at schools. Therefore, such results demonstrate the facts: (a) the school with HM's on-duty presence will remain more input efficient in comparison to the school where HM's absence is observed during the duty hours; (b) the school featuring more smart classrooms will possess the ability to secure a higher TEF_{inp} score for secondary level. However, the variable 'Z8' is associated with a low level of significance.

(4) As a school characteristics defining variable, 'Z15' positively affects TEF_{inp} of secondary-level with a satisfactory level of significance which is basically a revelation of the fact that the schools where size of the class is greater will achieve a greater level of TEF_{inp}.

(5) From the perspective of students, the quality of school attribute describing variable, 'Z45' evidences its negative significance in determining TEF_{inp} of secondary-level of schools. Since the variable 'Z45', reflecting students' opinion regarding the quality of laboratory, is defined as noting a higher order value for poor quality of laboratory and relatively lower order value for comparatively a better quality of laboratory from the perspective of the students (i.e. '1' stands for excellent quality, '2' indicates good quality, '3' represents 'not a bad quality' and '4' denotes poor quality), the negative sign of 'Z45' with statistical significance denotes consistency of the result. Such a result basically reflects the finding that the schools featuring a relatively better quality of laboratory from the students' viewpoint (implying lower order assigned value), will achieve a higher level of TEF_{inp} (implying a higher order value of efficiency score) at the secondary-level.

(6) As a student's characteristic representing variable, 'Z33' turns highly significant with positive sign while determining TEF_{inp} for secondary-stage of the schools, which expresses the fact that the schools with higher percentage of students getting private educational assistance at secondary-level, are capable of achieving a greater level of TEF_{inp}. Intuitively, as given the level of inputs, the schools with larger percentage of students getting private educational assistance can produce increased levels of outputs at secondary-stage, therefore in turn such schools can also produce the specific output quantities utilizing lesser input quantities at secondary-level, indicating the notion of TEF_{inp}. Following this, the finding of a significant positive influence of 'Z33' in determination of TEF_{inp} at secondary-level can be explained.

A good measure of goodness of fit is confirmed by the regression model represented in Table 6.1.4. Additionally, Table 6.1.4 proves our hunch: TEF_{inp} of the secondary-stage of school gets determined by 'Z33'.Therefore, the group of private educational assistance getting students may inflate TEF_{inp} scores, achieved by the schools. Accordingly, here the concern would be to quantify the appropriate extent of TEF_{inp} variation that can be explained by the set of determinants excluding 'Z33'.To compute this extent, concerning secondary level, the aforementioned steps are pursued:

As previously indicated, 'Z33' may not be an exogenous variable because of the possibility that it may in turn be determined by other variables within the system and thus explaining 'Z33' in terms of other determinants, seems essential in step II. The explanatory variables, playing a

significant role in determining 'Z33' for secondary-level, has already been recognized in Chapter 5 and hence due to the validity of the same result (as reported in chapter 5), in context of TEF_{inp} analysis for secondary-level of this chapter, the result of the regression model explaining 'Z33' is to be stated briefly. Applying the GLS method, the parameters of the model, explaining the behaviour of Z33 are estimated due to the existence of heteroscedasticity problem. Result evidences positive significance of (i) 'M15' as an interaction variable between the 'teaching-post remaining vacant' (Z4) and 'student's opinion regarding regularity of class' (Z43), School commute duration (Z38), Father's educational qualification (Z31), ; and negative significance of (ii) Mother's educational qualification (Z30), Percentage of students involved in income earning (Z39), Per student percentage of elder sibling (Z41) while explaining Z33. After obtaining the estimated parameters for this regression model, determining 'Z33' (as mentioned in step II and reported in chapter 5 while analysing TEF_{out} of secondary-level), a series of estimated values of Z33, referred as 'Z33hat' is derived and subsequently it is utilised in the next step (i.e. step III) as an explanatory variable along with the set of other explanatory factors for obtaining the determinants TEF_{inp} of secondary-level. The result is reported in Table 6.1.5, reflecting explained behaviour of TEF_{inp} of secondary-level of the schools in relation to the explanatory factors, included in the model as discussed in step III.

Table 6.1.5 : Determinants of TEF_{inp} using 'estimated private tuition' as explanatory variable for Secondary level of the schools

Variables	Coefficient	z-value	p-value	
Z15	.0573994	2.12	0.034	
Z19	2.23e-08	2.11	0.035	
Z20	.1308787	1.85	0.065	
M30	-.0815825	-1.93	0.054	
Z21	.0847629	2.13	0.033	Wald chi2 = 31.96
Z33hat	.0049551	3.08	0.002	Prob > chi2 = 0.0001
Z45	-.0375926	-2.55	0.011	
Z6	.089709	2.42	0.015	
Z8	.0306529	1.32	0.186	
Constant	.4001909	1.13	0.260	

Source: Author's estimation with primary survey data for the year 2019-2020

The regression, specified for explaining TEF_{inp} of secondary-level of the schools considering 'Z33hat' series as explanatory variable along with other probable determinants (as mentioned in chapter 5 while discussing the analysis of TEF_{out} at secondary-level), is tested for heteroskedasticity problem applying Breusch–Pagan test and the result indicates acceptance of ' heteroscedasticity' as an alternative hypothesis since chi^2 appears as 7.99 with $Prob>chi^2$ = 0.0047. Therefore, for estimating parameters of this regression, GLS is applied and the heteroscedasticity corrected result is represented in table 6.1.5.

While demonstrating the determinants of TEF_{inp} relating to secondary level, Table 6.1.5 evidences the similar result as Table 6.1.4 in the form of the same set of significant determinants with the same sign conditions; other than 'Z33hat'. Even though the estimated values of the coefficient of determinants differ, the interpretations of the results remain consistent as Table 6.1.4 results. It is, however, important to note that for the regression reported in table 6.1.5, the average 'Z20' for the sample schools (0.47 approx.) is again showing a lesser value than the computed critical value of 'Z20' i.e. 0.80 approx., prior to attaining which the positive effect of 'Z20' on TEF_{inp} will be realized. Thus, for the present sample of secondary-level of the schools, the relation between these two variables is found on the upward rising portion of the curve and consequently, the estimated marginal effect of 'Z20' is found to be positive, reflecting positive role of 'Z20' in determination of TEF_{inp} of secondary-stage upto a specific limit as indicated by the (mentioned) critical level. Therefore, the result of increase in TEF_{inp} arising out of the increase in Z20 not sustaining without restriction and beyond the threshold (or critical) limit of Z20 any further increase in Z20, reducing the level of TEF_{inp} remains consistent as the result of Table 6.1.4. Even though the results, explaining the determinants of TEF_{inp} relating to secondary-level are reported both in Table 6.1.4 and Table 6.1.5, however, the result of Table 6.1.5 will be relevant for explaining the determinants since 'Z33' is actually recognized as an endogenous variable. In the light of the fact that several factors significantly explain 'Z33hat' which again determines TEF_{inp} significantly, the factors involved in explaining 'Z33hat' are also in turn indirectly affecting TEF_{inp} of secondary-level of schools. The result of regression, in Table 6.1.5, also reflects a reasonable level of goodness of fit. In the sequel, as stated in step IV, a regression is carried out considering TEF_{inp} of secondary-level as explained variable and only estimated Z33 i.e. 'Z33hat' as an explanatory variable for deriving the residual series (of the regression), referred as 'R3TEI' which specifically shows the extent of TEF_{inp} variation between the schools that is not explained by Z33, concerning secondary-level of education. The result, excluding the role of guidance from private tutoring on TEF_{inp} variation, is noted in Table 6.1.6 which reflects the crucial attempt of this chapter.

Table 6.1.6 : Measure of total TEF_{inp} variation which is not explained by 'private tuition' considering Secondary stage of the schools

Serial Number	Schools	Measure of total TEF_{inp} variation which is not explained by Z33
1	School 1	0.05608
2	School 2	0.05611
3	School 3	0.06036
4	School 4	0.00228
5	School 5	0.04509
6	School 6	0.13777
7	School 7	0.05743
8	School 8	0.05347
9	School 9	0.09803
10	School 10	0.05264
11	School 11	0.01762
12	School 12	0.05397
13	School 13	0.05002
14	School 14	0.01807
15	School 15	0.00284
16	School 16	0.05456
17	School 17	0.04226
18	School 18	0.04554
19	School 19	0.08328
20	School 20	0.05309
21	School 21	0.28609
22	School 22	0.04714
23	School 23	0.05078
24	School 24	0.00111
25	School 25	0.00089
Average		0.05706

Source: Author's computation with primary survey data for the year 2019-2020.

As displayed by the result of the Table 6.1.6, the major part of variation in TEF_{inp} of secondary-level is explained by Z33 (i.e. the guidance received by the students from private tuition) and consequently the remaining part (i.e. residual) of variation, which is not explained by Z33, is actually nominal and it ranges between 0.09 % and 28.61% with the average representation 5.71 %.

The interpretation of this result indicates that TEF_{inp} of secondary schools will actually be low without the students receiving guidance from private tuition. Accordingly, in this study, finding out the factors affecting that measure of TEF_{inp} of secondary-level which remains unexplained by the role of guidance received from private tuition (i.e. R3TEI) is also relevant and the result is documented in Table 6.1.7.

Table 6.1.7 : Determinants of that measure of the variation of TEF_{inp} , not explained by 'private tuition' considering Secondary level of the schools

Variables	Coefficient	z-value	p-value	
Z15	.0540769	2.01	0.044	
Z19	3.37e-09	2.58	0.019	
Z20	.2418794	2.02	0.044	Wald chi2 = 32.61
M30	-.1758123	-1.76	0.097	
Z21	.1096995	2.99	0.003	Prob > chi2 = 0.0001
Z45	-.0472713	-1.80	0.072	
Z6	.0744106	1.96	0.050	
Z8	.0256551	1.74	0.099	
Constant	-.2799639	-3.58	0.000	

Source: Author's estimation with primary survey data for the year 2019-2020.

It is evident from the regression result, documented in Table 6.1.7 that the determinants of the measure of TEF_{inp} which is obtained excluding the role of 'Z33' are the same as conveyed by the Table 6.1.4 and Table 6.1.5. Therefore, Table 6.1.7 indicates reliability of the result. However, for the regression reported in table 6.1.7, the average 'Z20' for the sample schools (0.47 approx.) is yet again showing a relatively lower value than the computed critical value of 'Z20' i.e. 0.69 approx. Thus, for the present sample of secondary-level of the schools, the relation between two variables, 'Z20' and 'R3TEI', is found on the upward rising portion of the curve and consequently, the estimated marginal effect of 'Z20 is found to be positive,

reflecting positive role of 'Z20' in determination of that segment of the variation of TEF_{inp} which is not explained by the students receiving guidance from private tuition at secondary-stage of the school but it holds up to a threshold limit, indicated by the mentioned critical value of 'Z20'; after which the relation between these two variables will be turned as negative with any further rise in the level of 'Z20'. Goodness of fit has been reasonable for this regression model.

6.3.2 Analysis of TEF_{inp} of Higher-Secondary Level of Schools using Primary Survey Data: A Case of Inter-School Study in Kolkata

6.3.2.1 Measure of TEF_{inp} in reference to Higher-Secondary Stage Education of Schools

Table 6.2.1 conveys TEF_{inp} scores of each of the sample schools for the year 2019-2020 considering H.S. level of education, under the assumption of variable returns to scale (VRS) and also denotes the computed average TEF_{inp} score for the same level of education. Data envelopment Analysis program, by Coelli (1996), has been employed for estimating TEF_{inp} concerning H.S. level of schools in the chapter.

Table 6.2.1 : TEF_{inp} estimates for H.S. level of sample schools

Serial Number	Schools	TEF_{inp} Scores
1	School 1	1.000
2	School 2	1.000
3	School 3	1.000
4	School 4	0.980
5	School 5	0.820
6	School 6	1.000
7	School 7	1.000
8	School 8	1.000
9	School 9	1.000
10	School 10	0.913
11	School 11	0.954
12	School 12	1.000

Contd….

Serial Number	Schools	TEF_{inp} Scores
13	School 13	0.741
14	School 14	0.833
15	School 15	0.761
16	School 16	0.902
17	School 17	0.954
18	School 18	1.000
19	School 19	0.850
20	School 20	1.000
21	School 21	0.582
22	School 22	1.000
23	School 23	0.801
24	School 24	0.916
25	School 25	0.919
Mean TEF_{inp}		0.917

Source: Author's computation using primary survey data for the year 2019-2020

Input oriented approach based results of efficiency depict that 56% of sample schools at the H.S. stage perform without efficiency which is a manifestation of these schools' inefficient utilization of the inputs for producing the existing output level. Additionally, Table 6.2.1 is evidencing the variation of TEF_{inp} scores amongst the different sample schools concerning senior-secondary-stage and these scores, in the view of the referred stage of education of the schools, lie between 0.582 and 1.000. Taking the sample of twenty five schools into account for H.S. stage, the finding of fifteen schools scoring above the 'mean TEF_{inp}' (0.917) is shown in the aforementioned table.

6.3.2.2 Computation of Radial movement & Slack movement for different Inputs referring to Higher-Secondary Stage Education of Schools

Table 6.2.2: Radial movement and slack movement (in percentage) of different inputs considering TEF_{inp} measurement in reference to H.S. stage education of sample schools, located in Kolkata

Sl. No.	Schools	Classroom-Pupil ratio		Teacher-Student ratio		Percentage of teachers with qualification master degree and above		Per student monthly expenditure of school	
		Radial	Slack	Radial	Slack	Radial	Slack	Radial	Slack
1.	School 1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.	School 2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.	School 3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.	School 4	-2.04	-65.43	-2.03	-66.26	-2.03	0.00	-2.03	0.00
5.	School 5	-18.03	-62.63	-18.04	-64.64	-18.04	0.00	-18.04	0.00
6.	School 6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7.	School 7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8.	School 8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9.	School 9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10.	School 10	-8.64	-42.73	-8.62	0.00	-8.70	0.00	-8.70	-8.41
11.	School 11	-4.58	-82.87	-4.57	-83.11	-4.57	0.00	-4.57	-77.51
12.	School 12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
13.	School 13	-25.87	-2.11	-25.90	-13.01	-25.89	0.00	-25.89	0.00
14.	School 14	-16.66	-13.67	-16.67	-25.73	-16.68	0.00	-16.68	-23.62
15.	School 15	-23.85	0.00	-23.86	0.00	-23.91	0.00	-23.90	-50.22
16.	School 16	-9.86	-42.13	-9.85	-43.67	-9.82	0.00	-9.82	-34.66
17.	School 17	-4.59	-49.35	-4.58	-54.18	-4.57	0.00	-4.57	-13.84
18.	School 18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
19.	School 19	-14.99	-78.73	-14.99	-80.20	-14.99	0.00	-15.00	-61.88
20.	School 20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
21.	School 21	-41.84	-54.57	-41.84	-53.61	-41.84	0.00	-41.84	-7.75
22.	School 22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
23.	School 23	-19.89	-23.61	-19.88	-34.96	-19.89	0.00	-19.89	-16.95
24.	School 24	-22.81	-54.63	-20.54	-57.27	-9.35	0.00	-11.75	-33.07
25.	School 25	-22.70	-54.58	-20.53	-57.19	-9.32	0.00	-11.69	-33.02
Average		-9.45	-25.08	-9.28	-25.35	-8.38	0.00	-8.57	-14.44

Source: Author's computation using primary survey data for the year 2019-2020

The radial as well as slack movements for inputs of H.S. education production of schools is displayed by Table 6.2.2. Analyzing the input - classroom pupil ratio, the computed average of the radial movement over the sample schools, is identified as 9.45% (absolute term) and the percentage of sample schools, witnessed as falling below this average level is 60% while the 'zero percent' radial movement value is reflected by only 44% of sample schools. As found in table 6.2.2 for H.S. level, the mean slack movement value of this input across the sample schools is noted at 25.08 percent and while comparing to this average, 60% of the sample schools are observed attaining the lower slack movement value. Also, the percentage of the sample schools exhibiting the lowest i.e. zero value of slack movement, concerning this input, is 48%.

Table 6.2.2 is evidencing the average radial movement figure concerning the input, 'teacher-student ratio' as 9.28 percent for the H.S. stage of the sample schools; and thus confirming 60% of sample schools, securing radial movement below this average. Additionally, for this input, 44% sample schools achieve the radial movement, measured at zero percent (i.e. lowest). Conversely, in accordance with table 6.2.2, fifty two percent sample schools are recognized as achieving the lowest slack movement (zero percent) for this input. Further, as reflected by the table 6.2.2, the average value of slack movement of the same input across twenty five sample schools is noted at 25.35 percent for senior-secondary-stage; and in comparison to this figure of mean, fifty six percent sample schools represent lower slack movement value.

Analyzing the radial movement of 'percentage of teachers, qualified master's or higher degree' as an input and focusing on H.S. level of the schools, it is noticed that 44% sample schools exhibit, as radial movement, a value of zero. Noting the radial movements across the sample schools for this input, the average is computed as 8.38 percent for H.S. level; and fifty six percent sample schools are recognized for showing the radial movement figure below this average. In contrast, following the table 6.2.2 for senior-secondary stage of schools, the evidence of all sample schools procuring the 'zero' slack movement score is found for the same input; and such results therefore indicate the corresponding mean value as 0.00 percent.

After examining the radial movement of 'per student expenses by school on a monthly basis' focusing on the senior-secondary level of the schools, it is observed that eleven schools among the entire sample of schools have secured the lowest or zero percent radial movement and 56% sample schools reflect the radial movement below the computed average level (8.57%). On the contrary, as found in the table 6.2.2, the average slack movement value of this input is observed

at 14.44% for the senior-secondary stage of the sample schools and in comparison to this average, relatively lesser slack movement is exhibited by 68% sample schools. In the context of this input, fourteen schools amongst total sample schools have been recognized to attain zero percent slack movement.

Due to the relevance of estimating the degree of inefficiency exhibited by each input, an additive measure of radial and slack movements (i.e. combined movement), for each individual input in relation to the H.S. stage of the schools is shown in Table 6.2.3 below. The table also outlines across the sample schools mean combined movement value, corresponding to each of the individual inputs. The necessity of such computations lie in the ability of ranking of the inputs based on these outcomes.

Table 6.2.3: Combined movement (in percentage) of different inputs considering TEF_{inp} measurement in reference to H.S. stage education of sample schools, located in Kolkata

Sl. No.	Schools	Classroom-Pupil ratio	Teacher-Student ratio	Percentage of teachers with qualification master degree and above	Per student monthly expenditure of school
1.	School 1	0.00	0.00	0.00	0.00
2.	School 2	0.00	0.00	0.00	0.00
3.	School 3	0.00	0.00	0.00	0.00
4.	School 4	-67.47	-68.29	-2.03	-2.03
5.	School 5	-80.67	-82.69	-18.04	-18.04
6.	School 6	0.00	0.00	0.00	0.00
7.	School 7	0.00	0.00	0.00	0.00
8.	School 8	0.00	0.00	0.00	0.00
9.	School 9	0.00	0.00	0.00	0.00
10.	School 10	-51.37	-8.62	-8.70	-17.11
11.	School 11	-87.45	-87.68	-4.57	-82.08
12.	School 12	0.00	0.00	0.00	0.00
13.	School 13	-27.98	-38.91	-25.89	-25.89
14.	School 14	-30.33	-42.40	-16.68	-40.30

Contd….

Sl. No.	Schools	Classroom-Pupil ratio	Teacher-Student ratio	Percentage of teachers with qualification master degree and above	Per student monthly expenditure of school
15.	School 15	-23.85	-23.86	-23.91	-74.13
16.	School 16	-52.00	-53.52	-9.82	-44.47
17.	School 17	-53.94	-58.75	-4.57	-18.41
18.	School 18	0.00	0.00	0.00	0.00
19.	School 19	-93.73	-95.19	-14.99	-76.87
20.	School 20	0.00	0.00	0.00	0.00
21.	School 21	-96.41	-95.45	-41.84	-49.60
22.	School 22	0.00	0.00	0.00	0.00
23.	School 23	-43.50	-54.85	-19.89	-36.85
24.	School 24	-77.29	-77.81	-9.32	-44.71
25.	School 25	-77.44	-77.73	-9.35	-44.82
Average		-34.54	-34.63	-8.38	-23.01

Source: Author's computation using primary survey data for the year 2019-2020

In Table 6.2.3, the average value of the combined movement (i.e. radial & slack movements considered collectively) for the input, 'classroom-pupil ratio' over twenty five schools considering H.S. stage is shown as 34.54%; and 56% amongst these sample schools are evidencing somewhat smaller combined movement values in comparison to the calculated average. Further, from the combined movement perspective of this input, 44% of the sample schools are found to be associated with the value of 'zero'.

According to the 'teacher-student ratio', an input of the H.S. level of education production of the schools, the mean combined movement figure across the sample schools is evident at 34.63% and there are 52% schools, among these sample schools, expressing combined movement figures below this average. However, for this input as well the lowest degree of combined movement (i.e. zero) is ensured by 44% sample schools.

Referring to the H.S. stage of the schools, the minimum level (i.e. zero) of combined movement for the input, representing the percentage of teachers qualified master degree and above, is

again observed for 44% sample schools. A mean value of 8.38% of the combined movement is found when the mentioned input is taken into account for H.S. level and considering this input, 56% sample schools have been noted with below the combined movement average measure.

As far as 'per student monthly expenses' by the schools is concerned as an input for the H.S. level of this study, the average combined movement is noted as 23.01% and 60% sample schools are sighted as reflecting the lower values when compared to this combined movement average figure. Additionally, 44% sample schools attain the lowest or zero-valued combined movement for this input as well.

Hence, the aforementioned findings imply that 44% sample schools reflect the minimum value of combined movement for all the four inputs of H.S. stage at school level. The figures of combined movements of the four inputs, as a signal of excess input utilization for producing a particular output level, therefore reveal the following information on various inputs employed in the H.S. level education production of schools:

(1) The competency of input utilization performance (in overall sense) is recognized for 44% sample schools as these schools exhibit lesser combined movement values for all the four inputs in comparison to the corresponding input's mean combined movement value.

(2) Twenty eight percent of sample schools have to deal with poor performance, in the view of input utilization as such sample schools for every individual input of H.S. level education production reveal relatively greater values of combined estimate of Radial and Slack movements, when compared to the corresponding input's calculated average combined movement figure.

(3) Employing the combined estimates, the performances of various inputs of H.S. level are analyzed for sample schools and the result expresses that the average inefficiency is observed to be **greatest for the input '**teacher-student ratio' (34.63%), followed by the inputs, classroom-pupil ratio (34.54%) and per student expenses of school on a monthly basis (23.01%), and **lowest for the input,** percentage of teachers with master degree and above academic qualification (8.38%).

6.3.2.3 Determinants of TEF_{inp} for Higher-Secondary Stage of Schools

Following the considerations of all the determinants (of efficiency) of H.S. stage in chapter 5, the same set of possible factors are taken into consideration while analyzing the determinants of TEF_{inp} concerning H.S. level in this chapter as well. Bearing in mind the possibility of TEF_{inp} scores of the schools being inflated by the role of private educator's assistance to students, the extent of the variation of TEF_{inp} in absence of the influence of private tuition is attempted to be measured for H.S. stages of the schools. Carrying out the five consecutive steps (i.e. step I to step V as mentioned in section 6.3.1.4) for H.S. level, the present study tries to make a contribution in the specified direction.

Table 6.2.4. demonstrates the result of the regression model which considers TEF_{inp} scores of H.S. level as response variable and the variable 'Z33' for senior-secondary stage as a determinant alongside other explanatory variables of H.S. education.

Table 6.2.4 : Determinants of TEF_{inp} of H.S. stage considering original value of 'private tuition' variable

Variables	Coefficient	t-value	p-value	
Z21	.0059978	1.99	0.067	Adjusted R-squared =0.6766
Z8	.0094069	1.84	0.089	
Z33	.0270939	5.34	0.000	
Z25	.0726126	1.81	0.093	
Z19	1.01e-09	1.94	0.075	
Z44	-.0473203	-2.07	0.059	
Z35	.0311248	2.17	0.049	
Z15	.0757121	1.66	0.122	
Constant	-1.960029	-4.07	0.001	

Source: Author's estimation with primary survey data for the year 2019-2020

The possibility of heteroskedasticity problem for the regression model, reported in table 6.2.4, is tested while applying the Breusch–Pagan test and the result, in this context, confirms absence of heteroskedasticity problem as 'wald $chi^{2'}$ turns '1.56' with Prob>chi^2 = 0.2117 which

declares a greater p-value than the threshold value '0.05', reflecting the rejection of 'heteroscedasticity' as an alternative hypothesis. Therefore, the coefficients of the regression model are estimated by applying the OLS (ordinary least square) technique.

Table 6.2.4 reflects the significant relationship between TEF_{inp} of H.S. level and the variables, specified below:

(1) While representing the HM's school managerial role, 'Z21' variable is impacting positively and significantly on TEF_{inp} of H.S. stage at the school levels and hence the positive role of HM's interaction with students and teachers of the school while taking any school-related decision is noticed in fostering TEF_{inp} at H.S. stage.

(2) As a policy indicating variable, 'Z19' imparts a positive and significant impact in determining TEF_{inp} of H.S. stage of the schools, revealing the favourable role of government funds allocated to the school (other than the salary payments to non-teaching & teaching staffs) in enhancing TEF_{inp} score at H.S. level.

(3) As a school infrastructure and administration related variable, 'Z8' positively affects TEF_{inp} of H.S. stage at 10% level of significance which is basically a revelation of the fact that the schools with greater count of smart classrooms will achieve a greater level of TEF_{inp}.

(4) Representing the School characteristics and student composition related category, the variable 'Z15' reflects positive effect in determining TEF_{inp} of H.S. level of the schools, implying that the size of the class matters positively for promoting TEF_{inp} of H.S. level, though the significance level is found to be low.

(5) The variable, Z44 appears with negative sign and statistical significance for determination of TEF_{inp} of H.S. stage; signifying that teaching quality in the school noted on the basis of students' opinion has favourable impact in TEF_{inp} determination at H.S. stage. Representing 'Quality of school attributes based on student's perception' category, the variable 'Z44', is defined in such a manner that a higher order value is noted for poor quality of teaching and relatively lower order value for comparatively a better quality of teaching from the perspective of the students (i.e. '1' stands for excellent quality, '2' indicates good quality, '3' represents 'not a bad quality' and '4' denotes poor quality). Hence,the negative sign of 'Z44' with statistical significance actually denotes the consistency of the positive impact creating result of 'Z44' on

TEF_{inp}, implying the schools with better teaching quality will attain higher TEF_{inp} at senior-secondary-level and vice-versa.

(6) Amongst the 'characteristics of the head of the school' defining variables, 'Z25' reveals the evidence of the male-headed H.S. schools attaining a greater level of TEF_{inp} in comparison to the female-headed H.S. schools. The mentioned regressor reflects a ten percent level of statistical significance.

(7) Within the 'student's characteristics' reflecting category, 'Z33' and 'Z35' variables are representing statistical significance, imparting a positive effect on TEF_{inp} at H.S. level. The finding indicates that the H.S. schools, educating the students with more study duration at home are capable of achieving higher TEF_{inp} score; and also the schools with higher percentage of H.S. level students getting private educational assistance, achieve a greater level of TEF_{inp} at senior-secondary-level.

The regression model, represented in Table 6.2.4., shows a moderately good measure of goodness of fit. In addition to this, for H.S. stage of school as well our intuition of TEF_{inp} getting positively determined by 'Z33' is proved by Table 6.2.4 which is suggesting that the group of private educational assistance receiving students basically inflate TEF_{inp} scores, achieved by the schools relating to H.S. level and therefore, quantifying the appropriate extent of TEF_{inp} variation that can be explained by the set of determinants excluding 'Z33' concerning senior-secondary-level should be another major concern of this study which is addressed following the computation of the referred extent through execution of the aforementioned (in section 6.3.1.4 for secondary-level) steps:

'Z33' not being an exogenous variable relating to senior-secondary-stage too, because of its in turn dependency on other variables within the system, in step II 'Z33' must be explained in terms of other determinants. The explanatory variables, playing a significant role in determining 'Z33' for H.S. level, has already been explored in Chapter 5 and thereby because of the validity of the same result (as reported in chapter 5), in context of TEF_{inp} analysis for H.S. level as well, the result of the regression model explaining 'Z33' for senior-secondary-level should be noted precisely. Employing GLS, the parameters of the model, explaining Z33 variation are estimated in context of H.S. stage of schools because of the prevalence of heteroscedasticity problem and accordingly the finding displays positive significance of (i) Teaching-post remaining vacant (Z4), School commute duration (Z38); and negative significance of (ii) Years of part-time teachers' experience (Z3), Percentage of students

involved in income earning (Z39), Percentage of students having availability of all the textbooks at home (Z36) while explaining Z33 for senior-secondary-level. Next, considering the estimates for this regression model, a series of estimated values of Z33 for H.S. level, referred as 'Z33hat2' is derived and is utilised in the next step as an explanatory variable along with the set of other explanatory factors for obtaining the determinants TEF_{inp} of senior-secondary-level and the result is noted in Table 6.2.5 which basically reflects explained behaviour of TEF_{inp} of H.S. level of the schools in relation to the explanatory factors including 'Z33hat2'.

Table 6.2.5 : Determinants of TEF_{inp} using 'estimated private tuition' as explanatory variable for H.S. level of the schools

Variables	Coefficient	t-value	p-value	
Z21	.0057157	1.96	0.071	
Z8	.0106103	1.81	0.094	
Z33hat2	.0297141	3.60	0.003	
Z25	.0908031	1.77	0.101	Adjusted R-squared = 0.4832
Z19	1.26e-09	1.90	0.080	
Z44	-.0007697	-2.07	0.059	
Z35	.035552	1.99	0.068	
Z15	.1244077	1.85	0.088	
Constant	-2.120778	-2.86	0.013	

Source: Author's estimation with primary survey data for the year 2019-2020

The regression model, presented in table 6.2.5 confirms absence of heteroskedasticity problem as 'wald $chi^{2'}$ of Breusch–Pagan test turns '2.67' with Prob>chi^2 = 0.1026 which declares a greater p-value than the threshold value '0.05', indicating the rejection of alternative hypothesis stating existence of 'heteroscedasticity'. Hence, the coefficients are estimated by employing the OLS (ordinary least square) technique for this regression model and is noted in table 6.2.5.

During the Illustration of the factors of TEF_{inp} for senior-secondary-level in Table 6.2.5, the prevalence of the similar result is noticed, due to the representation of same set of significant determinants with the same sign conditions (except 'Z33hat2'), in Table 6.2.5 as in Table 6.2.4.

However, the difference in the estimated values of the regression coefficients is observed between these two regression results. Hence, interpretations of the results remain the same for table 6.2.5 as Table 6.2.4 results. Since 'Z33hat2' turns out to be one of the significant determinants of TEF_{inp}, the factors which are significantly impacting 'Z33hat2', indirectly impacts on TEF_{inp} of H.S. level of schools as well. Reasonably good 'goodness of fit' is also reflected by Table 6.2.5. Next, following the step in order, a regression is carried out considering TEF_{inp} of H.S. schools as regressand while only 'Z33hat2' as a regressor to obtain the residual series, labelled as '**R4TEI**' which *specifically shows the extent of* TEF_{inp} *variation* between the H.S. schools *that is not explained by Z33 for senior-secondary-level* and the result is noted in Table 6.2.6. Such findings point out the result, tried to obtain in the present chapter for H.S. level, excluding the role of private educational assistance on TEF_{inp} variation.

Table 6.2.6 : Measure of TEF_{inp} variation which is not explained by 'private tuition' considering H.S. stage of the schools

Serial Number	Schools	Measure of total TEF_{inp} variation which is not explained by Z33
1	School 1	0.00696
2	School 2	0.03527
3	School 3	0.08022
4	School 4	0.07247
5	School 5	0.06926
6	School 6	0.07576
7	School 7	0.06421
8	School 8	0.01160
9	School 9	0.05279
10	School 10	0.03059
11	School 11	0.09333
12	School 12	0.00632
13	School 13	0.19244

Contd….

Serial Number	Schools	Measure of total TEF_{inp} variation which is not explained by Z33
14	School 14	0.09461
15	School 15	0.18070
16	School 16	0.02458
17	School 17	0.10610
18	School 18	0.00335
19	School 19	0.03653
20	School 20	0.08452
21	School 21	0.07640
22	School 22	0.04248
23	School 23	0.11417
24	School 24	0.00604
25	School 25	0.01297
Average		0.06295

Source: Author's computation with primary survey data for the year 2019-2020

Table 6.2.6 displays, as the considerable part of variation in TEF_{inp} of senior-secondary stage is explained by the private educational assistance receiving students (in percentage term), hence the remaining part of variation, which is not explained by Z33 at this level, is basically found in a very small extent and it ranges between 0.34% and 19.24% with the mean representation of 6.30%. Such a finding is the confirmation of the fact that TEF_{inp} scores of senior-secondary schools will be accounted as low without such students receiving private tuition assistance.

Accordingly, the factors, affecting that measure of TEF_{inp} of H.S. stage which remains unexplained by the role of Z33 at this level (i.e. R4TEI**),** are seeming relevant to determine and are noted in Table 6.2.7.

Table 6.2.7 : Determinants of that measure of the variation of TEF_{inp} , not explained by 'private tuition' considering H.S. level of the schools

Variables	Coefficient	t-value	p-value	
Z21	.0284575	1.85	0.085	
Z8	.0184946	1.65	0.122	
Z25	.0846716	1.72	0.108	Adjusted R-squared = 0.1213
Z19	2.86e-11	1.81	0.092	
Z44	-.0077298	-2.04	0.061	
Z35	.0376204	1.95	0.071	
Z15	.1274744	2.00	0.065	
Constant	-.2892161	-1.29	0.219	

Source: Author's estimation with primary survey data for the year 2019-2020

The regression, result of which is noted in Table 6.2.7, confirms 'homoskedasticity' as 'wald $chi^{2'}$ of Breusch–Pagan test turns '2.94' with Prob>chi^2 = 0.0863 (declaring a greater p-value than the threshold value); and hence OLS technique is employed for estimation and the regression result confirms the influencing factors of that measure of TEF_{inp}, obtained excluding the role of 'Z33', are appearing as the same as Table 6.2.4 and Table 6.2.5 for H.S. level of schools. Therefore, Table 6.2.7 basically reveals the reliability of such results. Since for H.S. level as well, the considerable extent of variation in TEF_{inp} is explained by Z33 and the remaining extent of TEF_{inp} variation turns low, a not so high goodness of fit is observed for this regression model.

6.3.3 Comparison of TEF_{inp} Performance and Factors Determining TEF_{inp} between Secondary-Level and Higher-Secondary Level of Schools using Primary Survey Data

Comparing the results of TEF_{inp} between Secondary-level and H.S. level reflects that 56% sample schools are operating inefficiently corresponding to both Secondary and H.S. levels. However, intending to capture the real scenario of TEF_{inp} of the schools excluding the contribution of Z33 since considerable proportion of students avail private tuition at both levels of education, the residual part of variations in TEF_{inp} for both secondary and H.S. levels are measured which remain unexplained by Z33. For secondary-level it ranges between 0.09 %

and 28.61% with the average value 5.71% while for senior-secondary level it ranges between 0.34% and 19.24% with the average figure 6.30%. Such outcomes are the revelation of very nominal TEF_{inp} score attainment by the schools at these two concerned levels of education in exclusion of the contribution of private tuition, though it is observed to be even slightly lesser for Secondary-level.

In the course of comparison of the determinants of TEF_{inp} between Secondary-level and H.S. level, it is noticed that several factors commonly determine TEF_{inp} of both Secondary and H.S. levels, like HM's interaction with student and teacher in developing school-related policies, percentage of private tuition receiving students, the quantity of government funding received by the schools, class size and count of the smart classroom.

However, aside from such commonly affecting determinants, there are several factors that exclusively determine TEF_{inp} of Secondary-level, such as kanyashree receiving students' proportion, HM's presence on duty and students' opinion regarding quality of laboratory. Likewise, TEF_{inp} of H.S. level of school is exclusively affected by students' opinion regarding teaching quality, gender of HM and study duration of the students at home.

6.4 Conclusion

This chapter contributes in the area of pre-existing research by measuring TEF_{inp} of twenty five Kolkata based government aided & purely government schools for secondary and senior-secondary stages of education (separately), using stratified random sample surveyed data, applying DEA and also determining the factors influencing TEF_{inp} scores at both the stages of education. Considering secondary and H.S. stages of education separately, the TEF_{inp} results reveal that 56% sample schools are operating inefficiently, indicating the capability of these schools of producing the existing output levels utilizing lesser inputs. The variations of TEF_{inp} scores amongst the different sample schools concerning both the stages of school education are also found in this chapter.

In this chapter, the radial as well as slack movements of inputs: 'classroom-pupil ratio', 'teacher-student ratio', 'percentage of teachers with master degree and above qualification' and 'per student monthly expenditure of school' have been computed for secondary as well as H.S. levels as these two measures offer the notion of inefficiency with regard to individual input.

For secondary-level, considering 'classroom-pupil ratio' as input, it is found that 48 percent sample schools reflect the lowest (i.e. zero percent) radial movement and 64% of the sample

schools are identified for exhibiting a zero value of slack movement. Next, concerning the input, 'teacher-student ratio', it becomes evident that 12% sample schools for secondary-level confirms the lowest radial movement, measured at zero percent while the lowest slack movement attaining figure (in percentage term) of sample schools for the same input turns as 56%. After examining the radial and slack movements of input, 'percentage of teachers with master's degree or higher academic qualification' for secondary-level of schools, it has been observed that 48% of the sample schools reflect a value of zero (lowest) as radial movement while 84% of sample schools are identified for attaining the lowest slack movement score, representing a value of zero. Upon analyzing the input, 'per student monthly expenses of school', it is noticed that 48 percent sample schools have secured the lowest levels (i.e. zero percent) of radial movement and for the same input, the figures of slack movement confirms that seventeen schools amongst total sample schools have been able to attain a 'zero' slack movement value (lowest).

For H.S. level, considering 'classroom-pupil ratio' as an input, 44% of sample schools are witnessed as attaining 'zero percent' radial movement value whereas concerning the same input, the percentage of the sample schools exhibiting the 'zero' slack movement is found as 48%. Again, focusing on 'teacher-student ratio' as an input, it is evident that 44% sample schools achieve the radial movement, measured at zero percent (lowest) and 52% percent sample schools, for the input, achieve the lowest slack movement (i.e. zero) relating to H.S. level. Next, examining the input, 'percentage of teachers, qualified master's or higher degree', it is noted that 44% sample schools exhibit 'zero' radial movement value whereas the evidence of all sample schools procuring the 'zero' slack movement score is found for this input. Analyzing 'per student expenses by school on a monthly basis' as an input for H.S. education production at school-level, it is again observed that 44% among the sample schools secured the lowest or zero percent radial movement while 56% amongst the total sample schools have been recognized for securing the slack movement, noted at zero percent.

For estimating the degree of inefficiency, indicated by each input, the computation of combined movement as an additive representation of radial and slack movements, for every individual input, is executed in this chapter as such outcomes can form the basis for ranking of the inputs. Hence, the combined values of radial & slack movements added together for each of the inputs focusing on secondary-stage and H.S. stages of the schools separately, are computed in this chapter.

Referring to the secondary-stage of the schools, the minimum level (i.e. zero) of combined movement for all four inputs is observed for 48% sample schools which also indicates the competency of input utilization performance (in overall sense) as such schools exhibit lesser combined movement values for all the four inputs in comparison to the corresponding input's mean combined movement value. On the contrary, in the view of input utilization, 20% of sample schools have to deal with poor performance, as such sample schools for every individual input reveal relatively greater values of combined estimate, when compared to the corresponding input's mean combined movement figure. The result of combined movement for the four inputs expresses that the average inefficiency is noted to be greatest for the input **'**teacher-student ratio' (17.62%), followed by the inputs, classroom-pupil ratio (15.90%) and per student expenses of school on a monthly basis (12.21%), and lowest for the input, percentage of teachers with master degree and above academic qualification (6.61%) at secondary-level.

Considering the combined movement perspective for all four inputs utilized at H.S. stage of the schools, 44% of the sample schools are found to be associated with the value of 'zero', referring to the proficient overall input utilization at this stage of education by such schools due to the revelation of lesser combined (for every input) movement figure than the corresponding input's mean combined movement figure. Conversely, 28% of sample schools reveal poor performance, in consideration of input utilization, showing a somewhat greater combined estimate of radial and slack movements in comparison to corresponding input's average combined movement value, holding for each individual input. Also, referring to the senior-secondary-stage of schools and analyzing the combined estimates, the average inefficiency level is found to be greatest for **'**teacher-student ratio' (34.63%), followed by 'classroom-pupil ratio' (34.54%) and 'per student expenses of school on a monthly basis' (23.01%); and found as lowest for **'**percentage of teachers with master degree and above academic qualification' (8.38%).

As a determinant, majority of students availing of private tuition, as suggested by the observations for both secondary and H.S. levels of sample schools, raises the possibility of inflating TEF_{inp} scores and therefore the concern arises about what happens to TEF_{inp} measure when the effect of private tuition is not present or, what extent of TEF_{inp} variation is remaining beyond the explanation given by 'Z33' at both secondary and H.S. levels. To address the concern, TEF_{inp} is primarily explained in terms of 'Z33' and the set of other determining variables and next as 'Z33' can in turn be determined by several other factors of the system,

the determinants of Z33 and consequently 'estimated Z33' series, referred as 'Z33hat' and 'Z33hat2' for secondary and H.S. levels respectively are also derived. Following this, TEF_{inp} is regressed on 'estimated Z33' for both the levels of school education with the objective of deriving the residual series as 'R3TEI' and 'R4TEI' for secondary and H.S. levels respectively. These residual series actually quantifies that measure of TEF_{inp} variation, remaining beyond the explanation given by Z33, concerning both the levels of education.

The results convey that as 'Z33' (i.e. the guidance received by the students from private tuition) explains the considerable part of variation in TEF_{inp} for both secondary and H.S. levels, therefore the residual part of variations, which are remaining unexplained by Z33 at both levels of education, are nominal; and for secondary-level it ranges between 0.09 % and 28.61% with the average value 5.71% while for senior-secondary level it ranges between 0.34% and 19.24% with the mean representation of 6.30%. Such results are the revelation of very less TEF_{inp} scores attainment by the schools at these two concerned levels of education, in absence of private tuition's contribution.

The above findings indicate that Z33 significantly and favourably affects TEF_{inp} attainment of Secondary as well as H.S. stages of the schools, describing that the schools with higher percentage of secondary-level and also H.S. level students getting private educational assistance, attain an improved level of TEF_{inp} relating to the corresponding stage of the schools.

Considering secondary-level of school education, the present chapter identifies the following determinants of TEF_{inp} (other than Z33) as:

1) 'Z21' appears as a positive and significant determinant of TEF_{inp} at the secondary stage of the schools, supporting the positive role of HM's interaction with students and teachers of the school while taking any school-related decision, in promoting TEF_{inp}.

2) Policy variable, 'Z20' validates the existence of non-linear inverted U-shaped relationship with TEF_{inp} of secondary-level as the coefficient of 'Z20' indicates positive significance and the coefficient of its square term, 'M30' (Z20*Z20=M30) indicates negative significance, implying that even though 'Z20' i.e. 'proportion of students receiving Kanyashree' leads to an increase in TEF_{inp} of secondary-level initially, however, after reaching a threshold level of this variable, TEF_{inp} reduces with the rise in 'Z20'. For the present sample of schools, the average value of Z20 turns less than the threshold level of Z20, therefore the present sample exists on the upward rising portion of the curve, resulting in a positive marginal effect of Z20. This finding implies that for

the present sample, TEF_{inp} arises following the rise in Z20. However, this positive relation can be sustained only to the extent of the threshold limit of Z20. Another policy variable, 'Z19' positively impacts on TEF_{inp} of secondary-stage of the schools, implying the positive role of receipt of government funding amount by the school in fostering TEF_{inp} score relating to secondary-level.

3) In the present chapter, for secondary-education-level at schools, 'Z6' and 'Z8' are noted as positively affecting administration and infrastructure variables on TEF_{inp} level. Such results point out: (a) the favourable effect of HM's on-duty presence in the school on TEF_{inp} in comparison to the schools where HM's absence is observed during the duty hours; (b) the schools featuring more smart classrooms are associated with higher TEF_{inp} score at secondary level (though showing low significance).

4) School characteristic variable 'Z15' positively impacts on TEF_{inp} of secondary-level, revealing the fact that the greater level of TEF_{inp} is gained by those schools where size of the class is greater.

5) Quality of school attribute describing variable, 'Z45' evidences its influence in determining TEF_{inp} of secondary-level of schools with a negative sign. Since the variable 'Z45', reflecting students' opinion regarding the quality of laboratory, is defined as noting a higher order value for poor quality of laboratory and relatively lower order value for comparatively a better quality of laboratory from the perspective of the students, the negative sign of 'Z45' basically denotes that the schools featuring a relatively better quality of laboratory (implying lower order assigned value), achieve an improved level of TEF_{inp} (implying higher order value of efficiency score) at secondary-stage of education.

Next, considering H.S. level of schools, the undermentioned determinants of TEF_{inp} (other than Z33) are recognized:

1) HM's school managerial role describing variable, 'Z21' is determining TEF_{inp} of H.S. stage at the school level positively, expressing the favourable role of HM's interaction with students and teachers while reaching any school-related decision in fostering TEF_{inp} relating to senior-secondary-stage.

2) Again, 'Z19' exerts a positive impact in determination of TEF_{inp} of H.S. stage of the schools, indicating the favouring role of government funds allocated to the school in enhancing its H.S. level's TEF_{inp} score.

3) Infrastructure variable, ‘Z8’ positively impacts on TEF_{inp} of H.S. stage which basically expresses that the schools with greater count of smart classrooms, attain a greater level of TEF_{inp}.

4) ‘Z15’ as a school-characteristic variable, reflects positive effect in determining TEF_{inp} of H.S. level of the schools, implying the importance of the ‘size of the class’ in fostering TEF_{inp} of H.S. level (though showing low significance).

5) For H.S. stage, ‘Z44’ appears as a significantly influencing factor of TEF_{inp} with a negative sign; declaring that teaching quality in the school has favourable impact in TEF_{inp} determination at H.S. stage. ‘Quality of school attributes’ describing variable ‘Z44’, is defined in such a manner that a higher order value is noted for poor quality of teaching and relatively lower order value for comparatively a better quality of teaching, noted from the perspective of the students. Hence, the negative sign of ‘Z44’ actually implies that the schools with better teaching quality, attain higher TEF_{inp} at senior-secondary-level.

6) ‘Student's characteristics’ capturing variable, ‘Z35’ impart a positive effect on TEF_{inp} at H.S. level, pointing out that the H.S. schools, educating the students with more study duration at home are capable of achieving higher TEF_{inp} score.

7) ‘Z25’ as a HM’s characteristic defining variable, reveals the evidence of the male-headed schools attaining a greater level of TEF_{inp} in comparison to those schools, not under male headship.

The determinant analysis of TEF_{inp} of schools for Secondary and H.S. levels are the central parts of the analysis of this chapter as such results not only help in identifying the determining factors of TEF_{inp} at the concerned levels of school education but also help in improving TEF_{inp} through changing these factors in proper direction.

Chapter 7:

Summary and Policy Suggestions

7.1 Introduction

The system of Secondary and higher-secondary (H.S.) education have been recognized as the crucial stages of education due to its inevitable roles in forming the bridge towards higher education. In the view of the essentiality of this phase of education, the government of India initiated 'Rastriya Madhyamik Shiksha Abhiyan' scheme in 2009 with the objective of access and quality enhancement in this targeted stage of education. Additionally, the Secondary stage, taken as a whole, receives the second highest portion of the aggregated education expenditure, following the elementary education expenditure. Keeping these in mind, evaluating the performance of Secondary-stage and H.S. stage individually in the form of technical efficiency (TEF) analysis, seems to be fundamentally essential. Therefore, the question arises, whether Indian Secondary and H.S. stages of education are capable of generating the maximum extent of output with the given extent of input; or conversely, can these stages of education (individually) produce the given extent of output while utilizing the inputs at the 'minimum required' extent under a certain technology?

Accordingly, the present study wants to address this issue. In the present study, the efficiency analysis of Indian Secondary and H.S. stages of education is classified into two broader segments: one dealing with the state-level analysis of efficiency while segregating Indian states and union territories into two categories for the time span 2010-11 to 2015-16 based on secondary data; and the other dealing with the school-level analysis of efficiency based on primary survey data for the government and government-aided schools located in Kolkata for the year 2019-2020.

Considering the voids in the existing research relating to TEF analysis of school education, the present study attempts estimating TEF of Secondary and H.S. stages at Indian-state-level as well as at school-level using the data obtained from Secondary source (Unified District Information System for Education (UDISE)) and collected from primary source respectively. Further, the state-level analysis of TEF of Secondary and H.S. stages are conducted following separated perspective based approaches i.e. output oriented technical efficiency (TEF_{out}) and input oriented technical efficiency (TEF_{inp}) approaches. In contrast to the prevailing studies in

Indian context, the state-level TEF analysis of Secondary and H.S. stages (following both TEF_{out} and TEF_{inp} approaches), are segregated for the two categories of states i.e. general category states (GCS) and special category states & union territories (SCS&UT). This classification of all Indian states and union territories (UT) into two groups is supported by the fact that these units are not operating under the homogenous fiscal as well as economic environments. In the succeeding segment, the school-level analysis of TEF relating to Secondary and H.S. stages are performed individually following TEF_{out} and TEF_{inp} approaches. The state-level analysis segment of this study, is essential for identifying those GCS and SCS&UT, performing inefficiently. Further, the school-level analysis of TEF is also crucial for developing the idea of what percentage of schools are performing inefficiently in Secondary as well as H.S. education. Relevantly, for raising TEF of the bad performing units (school or Indian state here) at Secondary as well as H.S. stages of education, the policies are prescribed depending on the determinant analysis and following such policies the underachievers can also perform like the fully efficient units. Therefore, the present study sheds light on the elaborative analysis relating to TEF at Secondary and H.S. education and also discusses about policy formulation targeting the improvement in performances of the underachievers.

The exploration of literature indicates some voids in the existing studies dealing with estimation of TEF accompanied by determination of the affecting factors on TEF of Secondary and H.S. education in the Indian context.

Therefore, while mitigating the gaps, **the present study contributes to the literature** in the following direction. **First of all,** the present study contributes by estimating TEF, applying non-parametric data envelopment analysis (DEA) under variable returns to scale assumption, for each year and determining the affecting factors of the estimated TEF at Secondary and H.S. stages individually during the period 2010-11 to 2015-16 using Secondary-source data at Indian state-level, while constructing separated benchmark production frontiers for two distinguished state categories namely, GCS and SCS&UT, and accordingly conducting the separated TEF analysis for the two referenced state groups, as these two groups are not homogeneous. To be specific, the Indian states, considered as GCS are: Andhra Pradesh (AP), Bihar (BI), Chhattisgarh (CHHAT), Goa (GO), Gujarat (GUJ), Haryana (HAR), Jharkhand (JHAR), Karnataka (KAR), Kerala (KER), Madhya Pradesh (MP), Maharashtra (MH), Orissa (ORI) , Punjab (PN), Rajasthan (RAJ), Tamil Nadu (TN), Uttar Pradesh (UP) and West Bengal (WB), while the SCS&UT are: Andaman & Nicobar Islands (A&N), Arunachal Pradesh (ARU), Assam (AS), Chandigarh (CHAND), Dadra & Nagar Haveli (D&N), Daman & Diu

(D&D), Delhi (DEL), Himachal Pradesh (HP), Jammu & Kashmir (J&K), Lakshadweep (LAKH), Manipur (MAN), Meghalaya (MEGH), Mizoram (MIZO), Nagaland (NG), Puducherry (PUD), Sikkim (SIK), Tripura (TP) and Uttarakhand (UK). This segment of the study (i.e. the state-level analysis), is conducted on the basis of the data obtained from State Report Cards, UDISE. Prevailing study on TEF evaluation of Secondary and H.S. education has not attempted the separate (TEF) analysis for the two distinguished categories of Indian states (& union territories). Additionally, comparison of TEF across time in this sector is also found to be very scanty. Notably, TEF is estimated, in the present study, from different perspectives, referred to as TEF_{out} and TEF_{inp}. The measure of TEF_{out} helps to point out whether any state as a decision making unit (DMU) becomes capable of attaining the maximum producible extent of output with the given extent of input usage or not (under a certain technology) in production of Secondary and H.S. education and also represents the extent of output that is possible to expand without expanding the extent of input usage. From another perspective, the measure of TEF_{inp} recognizes whether any state becomes capable of producing the given extent of output using the minimum required extent of input or not in production of Secondary and H.S. education and also represents the extent of input usage that is possible to reduce without reducing the extent of output. As guided by the literature, the estimation of TEF rests on the production relation between output and input variables. Relevantly, it is essential to point out the following deviations of education production function from the conventional micro-economic idea: (1) the output of education sector is intangible. Therefore, representation of output by appropriate measures is essentially required; and in the state-level analysis segment of the present study, as output variables (i) Retention rate and (ii) Passing Percentage of students are included. The output, revealing 'passing percentage of students' stands for the quality aspect. However, other than these outputs, several alternative compatible outputs can also be taken into account. Likewise, the inputs, included for state-level analysis are: (i) Number of schools for each lakh of population (referred as input 1), (ii) Teacher-student ratio (referred as input 2), (iii) Classroom-pupil ratio (referred as input 3) and (iv) Percentage of teachers qualifying post-graduation or higher degree (referred as input 4). The quality aspect of input is incorporated while including 'qualification of the teacher'. Contextually, the included output and input variables in the school-level analysis segment of the present study should be pointed out. The output variables, included for analyzing TEF of Secondary-stage of the schools are: (i) Highest score obtained in board examination, (ii) Percentage of students scoring first division marks, (iii) Average scores obtained in language group, (iv) Average scores obtained in mathematics, (v) Average scores obtained in science group. Since most of

the surveyed schools for the school-level analysis have not introduced commerce as a stream, the Science and Arts streams are taken together for considering and analyzing the TEF aspect in the overall sense for the H.S. stage at the school level. The output variables, included for analyzing TEF of H.S. stage of the schools are: (i) Highest score obtained in (H.S. level) board examination, (ii) Percentage of students scoring first division marks, (iii) Average scores obtained in Language group, (iv) Average scores obtained in Mathematics, (v) Average scores obtained in Science group and (vi) Average scores obtained in Arts group. For the school-level analysis of the present study, the included input variables are: (i) Classroom-pupil ratio, (ii) Teacher-student ratio, (iii) Percentage of teachers qualifying master's or higher degree and (iv) Per student monthly expenditure incurred by the school. Revisiting the aspect of deviation of education production function (from the standard), it is relevant to state that in the education production process, prices of output and inputs are absent and hence shadow prices have to be derived. Following the estimation of TEF, in the subsequent stage, while performing the regression for the Secondary dataset based determinant analysis of TEF in the present study, the infrastructural variables relating to schools, policy indicator, social indicators and macro indicator are taken into account for identifying the affecting factors of TEF of Secondary and H.S. education at the state-level.

Thus, the **second** contribution of the present study towards the literature is examining the individual influence of each explanatory variable included in the determinant analysis on TEF instead of forming the composite index for every broad category of indicators which was executed in earlier studies. Notably, in order to design the specific policy for enhancing the level of TEF, individually identifying the affecting factors is crucial.

Thirdly, addressing the literature gap relating to TEF analysis at school-level in the Indian context, a segment of the present thesis estimates TEF of Secondary and H.S. stages of the schools based on primary survey data, collected following stratified random sampling method from twenty five government-aided and government schools located in Kolkata for 2019-2020 and also determines the affecting factors of resulting TEF scores at both the stages of school education.

Fourthly, while collecting the data it is noted that the majority of the students depend on the private educational assistance (outside the school), leading the TEF score attainment of the schools at the respective educational stage, upwardly inflated; therefore, the present study obtained that extent of TEF variation in these schools which is not explained by private

educational assistance. Since the exploration of such an extent has not been attempted in the earlier studies (to the best of our knowledge), the estimation of the extent of TEF variation that is not explained by private educational assistance is a substantial contribution towards the literature.

Fifthly, another contribution of the present study is derived from mitigating the gaps in the prevailing literature, relating to the extensive determinant analysis of TEF (of Secondary and H.S. stages) at school-level in Indian context, using primary survey data, specifically incorporating the individual factors under all the following aspects: (a) Percentage of students receiving private educational assistance; (b) Government policy; (c) Teacher's Characteristics; (d) School characteristics; (e) Socio-economic condition of the child; (f) School managerial role of Head of the school (HM); (g) Characteristics of the head of the school; (h) Student's opinion regarding school attributes.

Sixthly, as the West-Bengal government has introduced 'Kanyashree Prakalpa' for encouraging schooling of teenage girls under the age of eighteen years, the present study examined the influence of this kind of a policy on TEF attainment of the school and contributes to literature following this direction.

Based on the state-level analysis segment of the present thesis, some specific policies are prescribed for raising (i) TEF_{out} and (ii) TEF_{inp} at (a) Secondary and (b) H.S. stages of education for GCS and SCS&UT separately. Likewise, depending on the school-level analysis segment of the present thesis, the specific policies are formulated for boosting (i) TEF_{out} and (ii) TEF_{inp} of (a) Secondary and (b) H.S. stages at school-level. Finally, in view of the whole analysis, some common policies are tried to suggest for improving TEF (1) at state-level and also (2) at school-level for the sample schools under the study.

Paying attention to the preceding research questions, the analysis of the present thesis is performed; relatedly, the particulars of the chapters are noted below:

Chapter 1 shed light on the background as well as the motivation of the present thesis. **Chapter 2** elaborates upon literature review, classified into - the review of the prevailing studies relating to the methodological dimensions of TEF estimation; and the review of the earlier contributions on empirical studies relating to the TEF analysis of the education sector. The existing empirical studies on TEF_{out} and TEF_{inp} estimation of the education sector considering the Indian context as well as around the globe are discussed in chapter 2.

Subsequently, chapter 2 discusses the contribution of the present thesis towards the literature while explaining the linkage between this thesis and the prevailing literature.

Chapter 3 measures TEF_{out} of Secondary and H.S. stages of education separately at state-level, after classifying Indian states into the two distinguished categories, referred to as GCS and SCS&UT, employing data envelopment analysis (DEA) for each year during the period 2010-11 to 2015-16 and also determines the affecting factors of TEF_{out} scores. The determination of the factors affecting TEF_{out} scores is executed under the framework of the panel regression analysis.

Chapter 4 deals with the estimation of TEF_{inp} scores in production of Secondary and H.S. education for each of the GCS as well as SCS&UT over 2010-11 to 2015-16 and also determines the factors that can explain the variations in the resulting TEF_{inp} scores. In addition to this, chapter 4 also computes the slack movement and radial movement for each of the inputs utilized in the process of education production. Such an analysis sheds light on the extent of inefficient utilization corresponding to each input and also points out that input which is most inefficiently used in the process of production.

Chapter 5 measures TEF_{out} scores of schools for Secondary and H.S. stages of education separately employing DEA on primary survey data, collected following stratified random sampling method from twenty five government-aided and government schools located in Kolkata for 2019-2020 and also determines the affecting factors of TEF_{out} scores corresponding to the Secondary as well as H.S. stages of school education while considering the cross-sectional regression framework. Relevantly, while surveying it was observed that a major proportion of the students receive private educational assistance and as this fact can inflate TEF_{out} score attainment of the school, therefore, in chapter 5, the extent of TEF_{out} variation which is not explained by private educational assistance is measured for depicting the real scenario of TEF_{out} of the schools corresponding to the referenced stages of school education individually.

Chapter 6 estimates TEF_{inp} scores of Secondary stage as well as H.S. stage at school-level based on the primary survey data on twenty five government-aided and government schools located in Kolkata for 2019-2020 and also determines the factors explaining the variation in TEF_{inp} scores of the respective stage of school education. Again, with the objective of depicting the reality of TEF_{inp} of the schools relating to the Secondary and H.S. stages of education, Chapter 6 measures the extent of TEF_{inp} variation which is not explained by private educational

assistance. Additionally, for measuring the extent of inefficient utilization corresponding to each used input in Secondary and H.S. education production (individually) at school-level, in chapter 6, the slack movement as well as radial movement are computed for each incorporated input in the corresponding education production process.

7.2 Major Findings

The important findings of the thesis are noted below:

7.2.1 Findings on State-Level Analysis

In the state-level analysis segment of the present thesis, TEF_{out} and TEF_{inp} are measured for a specific level of education (either Secondary or H.S.) separately for GCS and SCS&UT for each specific year considered under the study i.e. 2010-11 to 2015-16; and the mean TEF_{out} score and mean TEF_{inp} score for each GCS and each SCS&UT is calculated over the reference period individually for Secondary and H.S. stages of education. The grand average of TEF_{out} measure as well as TEF_{inp} measure are obtained, for Secondary and H.S. levels separately, by calculating the average over (i) the whole of GCS taking into account all the six years and (ii) the whole of SCS&UT accounting all six years. The calculated grand average figures are used for observing the TEF_{out} and TEF_{inp} performances in an overall sense for GCS and SCS&UT relating to the Secondary and H.S. stages of education.

7.2.1.1 Findings on TEF_{out}: State-Level Analysis

Relating to both Secondary and H.S. levels of education, the findings of TEF_{out} estimates indicate that all GCS and SCS&UT are not perfectly efficient and the extent of TEF_{out} variation across the GCS group and the SCS&UT group are also evident.

Concerning the Secondary-level, the grand average TEF_{out} score is observed as better for the GCS group in comparison to the SCS&UT group.

Particularly, focusing on the **Secondary-level** following observations can be made:

A. **Throughout efficient or inefficient States/UT**

(i) **Throughout efficiently performing GCS over the sample time** duration are KER, MH, GO, WB, BI and JHAR.

(ii) **Throughout inefficiently performing GCS** are MP and RAJ.

(iii) Considering SCS&UT, over the referenced time period, **the SCS&UT, appearing as throughout efficient** are DEL, LAKH, D&N, AS and TP.

(iv) **Throughout inefficient SCS&UT** are J&K and PUD.

B. The states /UT for which efficiency has increased

(i) In the GCS group, during the course of the years **TEF_{out} scores have improved for** RAJ and KAR.

(ii) In the SCS&UT group, TEF_{out} scores have **improved** for ARU, MEGH and PUD.

C. The states /UT for which efficiency has decreased

For GCS group, TEF_{out} scores **deteriorated f**or MP, PN, GUJ, HAR and CHHAT from the initial level of efficiency.

D. The states /UT which turned efficient to inefficient

(i) AP, PN and CHHAT **initially started as efficiently performing** GCS, but across-time **transformed into inefficient** units.

(ii) On the other hand, in the SCS&UT group, MAN and D&D **initially started as efficiently** performing units, but **across-time changed into inefficient** units.

E. The states /UT which turned inefficient to efficient

Considering SCS&UT group, NG and ARU remained **inefficient at the initial year** and **subsequently attained efficiency**.

In accordance with the findings of H.S. level, it is noted that the grand average TEF_{out} score for GCS has been higher in relation to SCS&UT.

Particularly, focusing on the **H.S. level** following observations can be made:

A. Throughout efficient or inefficient States/UT

(i) **Throughout efficiently performing GCS** over the specified time frame are KER, ORI, UP, JHAR, MH and BI.

(ii) **All over inefficient remaining GCS** are MP, CHHAT, PN and HAR.

(iii) Over the referenced time interval, the **SCS&UT, appearing as throughout efficient** are: ARU, DEL, AS, MAN, D&N, UK, NG, PUD.

(iv) **Throughout inefficient SCS** is observed as TP.

B. The states /UT for which efficiency has increased

(i) In the GCS group, during the referenced years, **TEF_{out} scores have expanded** for GUJ, GO and KAR.

(ii) In the SCS&UT group, TEF_{out} scores have **improved** for J&K and TP.

C. The states /UT for which efficiency has decreased

(i) For GCS group, TEF_{out} scores **deteriorated** for WB, HAR, TN, PN, CHHAT and MP.

(ii) For SCS&UT group, TEF_{out} scores **worsen** for MEGH, D&D and A&N.

D. The states /UT which turned efficient to inefficient

(i) TN and WB initially **started as efficiently performing GCS**, but in **the subsequent years performed inefficiently.**

(ii) Considering SCS&UT group, it becomes evident that MEGH, A&N, SIK and D&D **initially started as efficiently performing units**, but **across-time deteriorated to inefficiently performing units.**

E. The states /UT which turned inefficient to efficient

In the GCS group, KAR and GUJ **attained TEF_{out} in the later years though being inefficient initially.**

Comparing TEF_{out} of Secondary-level with that of the H.S. level reflects the following facts: The GCS, achieving perfect TEF_{out} across all years under observation at both Secondary and H.S. levels are KER, JHAR, MH, BI; while WB, GO appeared as efficient throughout the time span exclusively at Secondary-level and ORI, UP exclusively at H.S. level. Likewise, the SCS&UT, achieving perfect TEF_{out} throughout at both the levels are AS, D&N, DEL while LAKH, TP reflect TEF_{out} throughout exclusively at Secondary-level and NG, PUD, UK, MAN, ARU exclusively at H.S. level. Additionally, the GCS, appearing as inefficient across all years at both Secondary and H.S. levels is MP while RAJ remains inefficient throughout only at Secondary-level and PN, CHHAT, HAR only at H.S. level. The SCS&UT, becoming inefficient throughout at Secondary level are PUD, J&K while at H.S. level is TP. Further, the GCS, deteriorated to inefficient, from the perfect efficiency at Secondary-level are CHHAT, AP, PN while at H.S. level are TN,WB. Similarly, the SCS&UT changing to inefficient, from

efficient at both Secondary and H.S. levels is D&D, while MAN reflects this same pattern of TEF_{out} deterioration exclusively at Secondary-level and A&N, SIK, MEGH exclusively at H.S. level. The GCS, transformed from inefficient to efficient, within the referenced time duration, are KAR and GUJ at H.S. level while at Secondary-level, this same pattern of TEF_{out} change is reflected by the SCS&UT like, NG and ARU.

While conducting the determinant analysis of TEF_{out} of Secondary-level, it is noticed that TEF_{out} ,for GCS is significantly determined by social indicator, policy variable, the general environment of the state revealing macro indicator, in addition to, infrastructure indicating factors, and for SCS&UT, is significantly affected by infrastructure specifying indicators, social indicator, in addition to, the policy indicator.

In particular in GCS, TEF_{out} of Secondary-level is observed to be positively impacted by government education expenditure (GEXPOE), proportion of girl's enrolment to boys (PGETB), per capita net state domestic product (PCNSDP), proportion of para teachers (PPTEA), implying that an increase in government expenditure in education, girls enrolment to boys, per capita net state domestic product, proportion of para teachers can increase the level of TEF_{out}.

Similarly TEF_{out} is negatively impacted by the lack of school infrastructure reflecting variable 'percentage of without building schools' (PWBS) in GCS. This necessitates improvement in school infrastructure as revealed by formation of school building for the required school.

On the other hand, in SCS&UT, TEF_{out} of Secondary education is observed to be positively influenced by PGETB, percentage of Scheduled Tribe enrolment (PSTE), GEXPOE, implying increase in enrolment of girls to boys, increase in Scheduled Tribe (ST) enrolment and improving government expenditure in education may enhance TEF_{out}.

Conversely, for SCS&UT, TEF_{out} is negatively influenced by insufficient infrastructure denoting variables like, percentage of "bad" condition classrooms (PBCC), proportion of schools with single teacher (PSST), percentage of schools with absence of drinking water facility (PSADWF) and percentage of schools with absence of electricity (PSAE), suggesting that improvement in condition of the classroom, increase in number of teachers, provision of safe drinking water, provision of electricity may foster the level of TEF_{out}.

Moving towards the determinant analysis of TEF_{out} of H.S. level, in GCS the evidence of GEXPOE, PPTEA, PGETB impacting positively, showing that increase in government

expenditures in education, proportion of para teachers, girls enrolment to boys may have a favourable effect on TEF_{out}.

Similarly, for H.S. level and in GCS, PWBS and percentage of schools with absence of girls toilet (PSAGT) impacting negatively are found on TEF_{out} score. These negatively impacting variables are actually revealing the fact that the lack of infrastructural conditions prevailing in the school are being detrimental to the efficiency performance.

Dealing with the SCS&UT group for H.S. level, it is observed that the factors which are positively determining TEF_{out} scores are percentage of scheduled caste enrolment (PSCE), PSTE and proportion of female teachers to male teachers (PFTMT), supporting that increase in percentage of Scheduled Caste (SC) and ST enrolment, proportion of female to male teachers can boost up TEF_{out}.

Similarly, for SCS&UT the negatively determining factor is 'proportion of schools with single classroom' (PSSC), suggesting that increase in number of classroom can increase TEF_{out}.

Additionally, a crucial finding reveals that for SCS&UT group and for H.S. level, there exists a threshold level after which the positive effect of government education expenditure on $TEF_{out.}$ is felt and the sample value of the government expenditure on education is below that of the threshold level. Thus, the government should prioritize more on increasing GEXPOE for experiencing the favourable influence of GEXPOE on TEF_{out} score corresponding to H.S. level.

Our analysis also supports some common determinants for $TEF_{out.}$ for Secondary and H.S. level. Dealing with the GCS, it is observed that PWBS, PGETB, PPTEA and GEXPOE appear as the common determinants of TEF_{out} at both Secondary and H.S. levels of education, out of which 'PWBS' is adversely while the other three are favourably determining TEF_{out} at both the levels. Likewise, in SCS&UT, the evidence of 'PSTE' influencing TEF_{out} positively at both Secondary and H.S. levels is observed and also empirically found that GEXPOE imparting positive impact on TEF_{out} relating to both the education levels.

Other than such common determinants, in GCS, 'PCNSDP' with positive sign influences TEF_{out} exclusively at Secondary-level and 'PSAGT' with negative sign influences TEF_{out} solely at H.S. level. Further, in SCS&UT, PBCC, PSST, PSADWF and PSAE affect TEF_{out} adversely specifically at Secondary-level while PSCE and PFTMT affect TEF_{out} favourably at H.S. level. For this category of states, empirically the negative influence of 'PSSC' on TEF_{out} of H.S. level is also found.

7.2.1.2 Findings on TEF_{inp} : State-Level Analysis

In line with the results of both Secondary and H.S. education related analysis, it is noticed that TEF_{inp} scores are not the same within & between 'GCS' and 'SCS&UT' corresponding to a specific level of education. Further, not all GCS as well as not all SCS&UT achieve full TEF_{inp} for each of the years taken under consideration (i.e. 2010-11 to 2015-16).

Exploring the Secondary-level, the grand average TEF_{inp} score is observed as better for the GCS group in comparison to the SCS&UT group.

Specifically, focusing on the **Secondary-level** following observations can be made:

A. Throughout efficient or inefficient States/UT

(i) For GCS, it is found that **over the specified time duration, TEF_{inp} score equal to unity is continuously achieved** by GO, MH, KER, JHAR, BI, WB and ORI.

(ii) In GCS, a **continuous input oriented technical inefficiency** is experienced by MP and RAJ.

(iii) Considering SCS&UT, **TEF_{inp} is observed to be consistently achieved** by AS, TP, LAKH, DEL and D&N during the time span.

(iv) In SCS&UT group, **input oriented technical inefficiency is consistently experienced** by J&K and PUD.

B. The states /UT for which efficiency has increased

(i) Considering GCS, **a growing pattern of TEF_{inp} score** is reflected by KAR, MP and GUJ referring to the initial TEF_{inp}.

(ii) Considering SCS&UT, PUD, ARU, MEGH and NG **reflect a rising pattern of TEF_{inp}** in comparison to the initial TEF_{inp} score.

C. The states /UT for which efficiency has decreased

(i) In GCS group, CHHAT, PN and AP reflect a **deteriorating pattern of TEF_{inp}**.

(ii) In SCS&UT group, MAN, D&D and J&K reflect a **diminishing pattern of TEF_{inp},** though J&K shows recovery in the midway.

D. The states /UT which turned efficient to inefficient

(i) In the GCS group, CHHAT, AP and PN proved **input efficiency at the beginning, but afterwards became inefficient**.

(ii) Likewise, in SCS&UT group, D&D, MAN and MIZO, reflected **TEF_{inp} at the beginning and these states became inefficient later.**

E. The states /UT which turned inefficient to efficient

ARU and NG appeared as **inefficient states at the start but across-time these SCS&UT gained perfect TEF_{inp}.**

According to the findings of H.S. level, the grand average TEF_{inp} score is observed as better for the GCS group in comparison to the SCS&UT group.

Referring to the **H.S. level,** following observations can be made:

A. Throughout efficient or inefficient States/UT

(i) For GCS group, it is observed that the **perfect TEF_{inp} is continuously achieved** by KER, BI, MH, JHAR, UP and ORI during all the years of the study.

(ii) **Throughout inefficiency is observed** for the GCS like, PN, HAR and CHHAT.

(iii) As SCS&UT, **TEF_{inp} is consistently achieved** by DEL, ARU, MAN, AS, MEGH, PUD, D&N and NG during the course of the time.

(iv) In SCS&UT group, **input inefficiency is consistently shown** by TP.

B. The states /UT for which efficiency has increased

(i) In GCS group, KAR, GO, GUJ and CHHAT reflect a **rising pattern of TEF_{inp} score.**

(ii) In SCS&UT group, J&K **indicates an improving pattern** of TEF_{inp} in comparison to the TEF_{inp} score at the initial time point. Similarly, at the terminal year TEF_{inp} of TP improved than its initial value.

C. The states /UT for which efficiency has decreased

(i) Considering GCS, TN, PN, WB, HAR and MP reflect a **falling pattern of TEF_{inp}** in the view of initial TEF_{inp} score.

(ii) Considering SCS&UT, SIK, D&D and A&N indicate a **reducing pattern of TEF_{inp},** though D&D and SIK exhibit recovery in the midway.

D. The states /UT which turned efficient to inefficient

(i) Considering GCS, TN and WB proved **input efficiency at the beginning, but became inefficient afterwards.**

(ii) In the SCS&UT group, A&N, SIK and D&D reflected **input efficiency at the start but have undergone inefficiency later.**

E. The states /UT which turned inefficient to efficient

In the GCS group, KAR and GUJ **appeared as inefficient states at the start, but gained perfect efficiency (TEF_{inp}) across-time.**

Comparing TEF_{inp} results of Secondary-level with that of the H.S. level indicates some observations: In the GCS group, throughout the whole period, the states achieved perfect TEF_{inp} at both Secondary and H.S. levels are KER, MH,ORI, BI, JHAR; whereas WB, GO achieved throughout full TEF_{inp} exclusively at Secondary-level, and UP achieved throughout TEF_{inp} exclusively at H.S. level. On the other hand, in the SCS&UT group, perfect TEF_{inp} throughout the span of the years is achieved by DEL, D&N, AS at both Secondary and H.S. levels; while throughout full TEF_{inp} specifically at Secondary-level is achieved by LAKH, TP; and solely at H.S. level the same is achieved by ARU, MAN, MEGH, PUD, NG. Again, the GCS appeared to be inefficient throughout at Secondary-level are MP and RAJ and at H.S. level are PN, CHHAT, HAR. Similarly, the SCS&UT becoming input inefficient throughout at Secondary-level are J&K, PUD and at H.S. level is TP. In addition to this, though starting with perfect TEF_{inp} ,the GCS which transformed over the time interval as inefficient at Secondary-level are CHHAT, AP, PN and at H.S. level are TN,WB. The SCS&UT that transformed to inefficient, from perfect TEF_{inp} during the years under observation only at Secondary level are MAN, MIZO and only at H.S. level are A&N, SIK; while considering both the Secondary and H.S. levels, this deterioration is reflected by D&D. Considering the referenced time interval, inefficient to efficient transforming GCS at H.S. level are KAR and GUJ; though at the Secondary-level such type of transformation is not observed for any GCS. Again, the SCS&UT that are transforming from inefficient to efficient over the referenced years at Secondary-level are NG and ARU, though such a transformation has not been noticed for any SCS&UT concerning the H.S. level.

Considering the determinant analysis of the Secondary education, it is found that the level of TEF_{inp} ,for GCS is significantly determined by social indicator, policy variable, the general environment of the state revealing macro indicator, in addition to, infrastructure indicating factors, and for SCS&UT, is significantly affected by infrastructure specifying indicators, social indicator, in addition to, the policy indicator.

Referring to the GCS, it is particularly observed for Secondary-level that in the infrastructural aspect, PWBS turns into a significant variable reflecting a negative sign while 'PPTEA' turns into a significant variable reflecting a positive sign in determining TEF_{inp}, implying that increase in proportion of para teachers in the school and formation of school building can boost up TEF_{inp}.

Additionally, 'PGETB', as a social indicator, affects TEF_{inp} significantly and positively which is an indication of the fact that improving the girls' to boys' proportion at Secondary education system in GCS, will actually improve TEF_{inp}, i.e., more social inclusions of the girls to the formal education system will in turn promote TEF_{inp}. Also, 'GEXPOE' being a policy indicator and 'PCNSDP' being a macro indicator, positively impacts on TEF_{inp} of Secondary-stage in GCS.

Referring to 'SCS&UT', TEF_{inp} at the Secondary-level is explicated by the prominent roles of poor school infrastructure specifying indicators like, 'PSADWF', 'PSST', 'PBCC' and 'PSAE' which are significantly and negatively impacting TEF_{inp} of the Secondary-level, though among these variables 'PBCC' is less significant, implying the improvement in drinking water conditions, increase in number of teachers, betterment in the condition of classrooms, provision of electricity in the school building can improve the situation of TEF_{inp}.

Also, in 'SCS&UT', a higher value of 'PPTEA' and 'GEXPOE' as school infrastructure variable and policy variable, respectively, improves TEF_{inp} at Secondary-stage significantly. 'PSTE' being a social indicator, has positive and significant impact on TEF_{inp} of Secondary-level in SCS&UT, because of the tribal population dominance in these areas.

In connection with H.S. education, the findings for GCS demonstrates the prominent roles of policy, infrastructural and social factors in determination of TEF_{inp}, and for SCS&UT, claim is the essential roles of the policy, infrastructural and social indicators while determining TEF_{inp}.

For example, in relation to H.S. education, the results for states in the 'general category' indicate that on the infrastructural ground, 'PPTEA' imparts a positive effect, supporting that

the increase in the proportion of para teacher can boost up TEF_{inp}. Additionally, in the GCS, 'PGETB' and 'GEXPOE' referring to the social and policy aspect, respectively, influence TEF_{inp} of H.S. education significantly and positively, implying that improving government education expenditure and girls' enrolment, i.e., more social inclusions of the girls to the formal education system may in turn promote TEF_{inp}.

At the same time, for GCS, 'percentage of schools with absence of computer & internet connection' (PSACI), 'PWBS','PSAGT', individually imparts a negative effect on TEF_{inp} of H.S. level, supporting the provision of computer and internet facility, constructing building and girls' toilet in school premises can enhance TEF_{inp}. However, less significance is found for 'PSACI' in the infrastructural determinant category.

On the other hand, the results of the determinants of TEF_{inp} for H.S. level considering SCS&UT demonstrates that as an infrastructure indicating factor, 'PWBS' appears in a negative role implying that constructing school building may improve the scenario of TEF_{inp}; while 'PPTEA' appearing in a positively significant role indicating that increasing para-teachers proportion can boost up TEF_{inp}. However, 'PWBS' is noted as a less significant determinant.

In SCS&UT group, 'PFTMT' and 'PGETB', in the social factor aspect, are individually depicting a positive effect in the determination of TEF_{inp} of H.S. level, suggesting that increasing proportion of female to male teacher, i,e., increasing employability of female teachers and improving girls enrolment to boys, i.e., bringing more girls to the formal education system may promote TEF_{inp}. On the ground of policy, the coefficient of 'GEXPOE' being negatively significant and the coefficient of its square term being positively significant, specifies the existing non-linear U-shaped relationship between TEF_{inp} of H.S. level and 'GEXPOE' in SCS&UT, revealing that after a specific minimum level referred to as the 'threshold level' of 'education expenditure incurred by government' (for the state), TEF_{inp} increases with increase in GEXPOE. However, the sample mean of GEXPOE is less than the minimum value of 'GEXPOE' required for indicating increasing TEF_{inp} of H.S. i.e., the minimum required level has not been achieved yet for the present sample of SCS&UT, consequently, for obtaining the positive effect of 'GEXPOE' on TEF_{inp} of H.S. level, the government should prioritize raising educational expenses in SCS&UT.

The comparison of the findings of determinant analysis of TEF_{inp} between Secondary-level and H.S. level suggests: For the GCS group, it is observed that PWBS, GEXPOE, PGETB and PPTEA are the common determinants of TEF_{inp} of both Secondary and H.S. levels of education.

Among these common determinants, other than the poor-infrastructure variable 'PWBS', all are positively determining TEF_{inp}. With reference to the SCS&UT group, it is noticed that PPTEA positively determines TEF_{inp} at both Secondary and H.S. levels. Besides, GEXPOE can also impart a positive impact on TEF_{inp} at both the levels.

Apart from the stated common determinants of TEF_{inp}, in GCS some specific to the level of education determinants have been pointed out; like, PCNSDP with positive sign specifically at Secondary-level and PSAGT, PSACI with negative sign exclusively at H.S. level influences TEF_{inp}. In SCS&UT, PBCC, PSST, PSADWF and PSAE influence TEF_{inp} negatively and PSTE influences TEF_{inp} positively specifically at Secondary-level while the negative influence of PWBS and the positive influences of PFTMT and PGETB are evident on TEF_{inp} of particularly H.S. level of education.

Relevantly, the extent of inefficient use of various inputs, in the 'Secondary' and 'H.S.' education production should also be brought to attention. Using the combined figures of radial and slack movements, inefficient use of various inputs of Secondary and H.S. level are analyzed for 'GCS' and 'SCS&UT' individually. The result, referring to the 'GCS' group for Secondary-level, reveals that the average inefficiency is found to be greatest for input 1 i.e. 'number of Secondary schools per-lakh-population' (11.87%), followed by input 2 or 'teacher-student ratio' (9.32 %) and input 3 or 'classroom-pupil ratio'(9.21 %) respectively; and it is lowest for the input 4 i.e. **'**percentage of teachers qualifying master's or higher degree' (8.16 %).

On the other hand, referring to 'SCS&UT', assessment of inefficient utilization of various inputs considering Secondary-level reflects that the average inefficiency is greatest for the input 1 (15.16%), followed by input 2 (10.62%) and input 3 (9.12%) respectively; and it is observed as the lowest for input 4 (7.72%). In addition to this, for 'H.S.' stage of education, using again the respective combined estimates, the performances of various inputs are analyzed for 'GCS' as well as 'SCS&UT'; and the result for 'GCS' reveals that the average inefficiency is reflected as the maximum for input 1 i.e. 'number of H.S. schools per-lakh-population' (18.23%), followed by the input 3 (18.09%) and input 2 (14.50%) respectively, and the lowest is noted for input 4 (8.87%); while the result for 'SCS&UT' group confirms that the average inefficiency is greatest for input 2 (19.55%), followed by input 3 (17.59%) and input 1 (15.15%), and is lowest for input 4 (11.99%) respectively. In both the state categories (i.e. GCS and SCS&UT), these observations on input inefficient-utilization reflect that producing the

given extent of output, both at the Secondary-level as well as at the H.S. level, is possible utilizing the lesser extent of inputs (corresponding to the specific level of education) with better utilization.

7.2.2 Findings on School-Level Analysis

In order to mitigate the gap in the prevailing literature relating to the school-level analysis of TEF at Secondary and H.S. levels in Indian context, one segment of the present study attempts filling such a void based on the data, collected through primary survey following stratified random sampling method from twenty five Kolkata based government-aided and government schools. Relevantly, the data was collected by conducting (i) school survey and (ii) student survey from each surveyed school. Based on the school survey data, TEF_{out} and TEF_{inp} scores are measured employing DEA whereas utilizing both the school survey data as well as the student survey data, the determinant analysis of TEF_{out} and TEF_{inp} are performed (individually). For Secondary and H.S. levels, as the observations of the sample schools separately suggest that the major proportion of the students availing private tuition may possibly inflate TEF_{out} and TEF_{inp} scores of these schools for the concerned levels of education, thus, in the case of Secondary-stage and also for H.S. stage, the concern is what happens to TEF_{out} and TEF_{inp} measures in the absence of the contribution of private tuition. In order to address this issue, the present thesis follows several steps, individually for the two stages of school education, where, as a primary step TEF_{out} score (or TEF_{inp} score, in case of the input conservation perspective based analysis) is explained in terms of the 'percentage of students opting for private tuition' (Z33) and the set of other determining variables. As 'Z33' itself can in turn be determined by several other factors of the system, the determinants of Z33 and consequently 'estimated Z33' is also obtained for both the school education levels.

Since one of the objectives of the thesis is to find out the variation of TEF_{out} (or TEF_{inp}) not accounted by the students taking private tuition, in case of both Secondary-level and H.S. level analysis, TEF_{out} (or TEF_{inp}) is regressed on 'estimated Z33' for obtaining the residual series which reflects that measure of TEF_{out} (or TEF_{inp}) variation which remains unexplained by Z33 for the specific level of school-education. Such empirical results are expected to reflect the real scenario of the performances of Secondary and H.S. stages of education at school-level.

7.2.2.1 Findings on TEF_{out} : School-Level Analysis

The findings on TEF_{out} reveal that 52% sample schools are inefficient considering Secondary-stage while 56% sample schools are inefficient referring to H.S. stage of education, indicating that these schools are capable of producing more output utilizing the same extent of existing inputs. Variation of TEF_{out} scores among different schools is observed for both of the school education levels.

However, for capturing the real scenario of TEF_{out} attainment by the schools at both Secondary-level and H.S. level excluding the upwardly inflating impact of 'Z33', this segment of the present study obtains the extent of TEF_{out} variation that is not explained by Z33. The result reveals that, as 'Z33' explains major part of variation in TEF_{out} for Secondary-stage as well as for H.S. stage, therefore, the remaining part of variation, which is not explained by Z33, is very less; for Secondary-level of schools it ranges from 1.5% to 23.8% with the average value 8.28% while for H.S. level of schools it ranges between 0.40% and 8.64% with the average value 3.72%. This result, in absence of the role of private tuition, is in fact an indication of very low TEF_{out} score attainment by the schools at both of the education levels.

Such important findings are implied by the fact that Z33 (at the respective level of school education) plays a pivotal role in determining TEF_{out} level of schools for the respective stage (i.e. Secondary-stage or H.S. stage), representing high statistical significance with a positive sign. Other than this key determinant, TEF_{out} can be explained in terms of several other affecting factors in case of both Secondary-stage and H.S. stage of school.

The determinants of TEF_{out} considering Secondary-stage of the schools are the following:

(i) HM's school managerial role reflecting variable, 'while taking a decision whether HM interacts with students and teachers' (Z21) as well as an interaction variable between Z21 and 'interaction frequency of HM with State Education Department' (Z24) are favourably and significantly impacting TEF_{out} score for Secondary-stage of the schools, representing the favourable school managerial role of HM in promoting TEF_{out} at Secondary-level. The significance of the interaction variable indicates that given the value of Z24, TEF_{out} level of the school is dependent on Z21 and vice versa (implying the crucial roles of both of these factors). (ii) HM's experience **(**Z27) adversely influences the TEF_{out} score of the school for Secondary-level, expressing that the schools operated by junior HM will achieve greater TEF_{out} than the schools operated by senior HM. (iii) Full-time teacher's service experience (Z1) adversely

influences TEF_{out}, revealing that the schools functioning with comparatively junior full-time-teachers, attain greater TEF_{out} at Secondary-level. (iv) School infrastructure and administration defining variables, 'number of smart classroom' (Z8) and 'whether librarian of the school is present on duty' (Z9) are favourably and significantly affecting TEF_{out} scores of Secondary-level of schools, depicting that (a) the schools with higher count of smart classrooms will obtain greater TEF_{out} and (b) the schools with librarian's presence on duty will obtain more TEF_{out} at Secondary-level in comparison to the schools operating without on duty presence of librarian. (v) Policy variable, 'amount of government fund received by the school, excluding the salary payment of non-teaching and teaching staffs' (Z19) positively determines TEF_{out} score of the school relating to the Secondary-level, indicating that higher level of government funding improves TEF_{out} score attainment of the school. Another policy variable, 'proportion of girl students receiving Kanyashree' (Z20) depicts an inverted U-shaped nonlinear relationship with TEF_{out} of Secondary-level, confirming the initial increase in TEF_{out} score with an increase in Z20 until reaching a threshold limit which onwards TEF_{out} decreases with the rise in Z20. Specifically, the marginal effect of Z20 turning positive at the average level of this variable for the present sample, reflecting that by raising the proportion of students receiving Kanyashree, TEF_{out} of Secondary-level can be raised for the present case. The average value of Kanyashree becoming lesser than the threshold-level value basically ensures such a result of positive marginal effect. (vi) Characteristics of school, composition of students and characteristics of students defining variables: (a) Class size (Z15) is favourably and significantly influencing TEF_{out} of Secondary-level of schools, supporting TEF_{out} enhancing role of larger class size at Secondary-level education, (b) Reserved category student's proportion (Z11) positively impacts on TEF_{out} , pointing out the favourable role of government's social inclusion policy practice in enhancing TEF_{out}, (c) Percentage of students possessing text books at home (Z36) as a 'student characteristics' defining variable, positively determines TEF_{out} of Secondary-stage of school, implying that the school functioning with larger percentage of students possessing textbooks at home, will attain relatively more TEF_{out} level.

Further, the determinants of TEF_{out} of the schools for H.S. level are:

(i) TEF_{out} of H.S. stage of the schools is determined positively and significantly by the interaction term between two variables, Z21 and Z24, suggesting the positive school managerial role of HM in promoting TEF_{out} of the referred stage of the schools. (ii) Gender of HM (Z25) is positively and significantly affecting TEF_{out}, suggesting that the schools under male headship perform more efficiently at H.S. level in comparison to the female-headed

schools; although the significance level of Z25 appears as low. (iii) The variable 'Z8' is positively and significantly affecting TEF_{out} of the H.S. level of the schools, implying that the efficiency level is higher for those schools operating with presence of more smart classrooms. Additionally, the variable 'Z9' is also turning positively significant, meaning the presence of librarian on duty can lead the TEF_{out} of those schools to the higher level in comparison to the schools where librarian is absent from duty. (iv) 'Z19', as a government funding reflecting variable, shows negative significance whereas its square term shows positive significance in determining TEF_{out} of H.S. stage of the school, denoting a non-linear U-shaped relation of this variable with TEF_{out} which basically indicates that only after a certain level of Z19, TEF_{out} will be positively impacted by this variable. The calculated marginal effect at mean value of 'Z19' being positive is suggesting that for the sample schools relation between these two variables is lying at the rising part of the curve and hence the result is actually reflecting a positive role of government funding in determination of TEF_{out} of H.S. stage of the schools**.** Additionally, a positive significance of 'Z20' in determination of TEF_{out} of H.S. stage is also evident for these schools, implying the positive role of Kanyashree in enhancing TEF_{out} of schools corresponding to H.S. level.

The comparison of TEF_{out} results between Secondary-stage and H.S. stage indicates that 52% sample schools are inefficient referring to Secondary-stage while 56% sample schools are inefficient referring to H.S. stage, indicating relatively greater extent of (output-oriented) inefficiency at H.S. level in comparison to the Secondary-level of schools.

Since the result of the determinant analysis reveals that 'Z33' explains the larger segment of variation in TEF_{out} for secondary-stage as well as for H.S. stage, therefore investigating the residual segment of variation in TEF_{out} for both stages, excluding the contribution of Z33 is crucial and it ranges from 1.5% to 23.8% with the average value 8.28% for Secondary-level while for H.S. level of schools it ranges between 0.40% and 8.64% with the average value 3.72%. This result is an indication of very low TEF_{out} score attainment by the schools in absence of the contribution of private tuition; however, it is further lower for H.S. level than Secondary-level.

The comparison between the determinants of TEF_{out} of Secondary-level and H.S. level, reveals that some factors can commonly determine TEF_{out} of both Secondary and H.S. levels like, private tuition receiving students' percentage, frequency of HM's interaction with state-education department, HM's interaction with teachers and students while taking policy

decision, proportion of students receiving Kanyashree, amount of funding received by school from government, librarians presence on duty and the number of smart classroom in the school.

However, other than these common determinants, the specific to Secondary-level determinants of TEF_{out} are also evident like, full-time teachers' experience, class size, reserve category students' proportion, HM's experience, proportion of students possessing textbooks at home; though any such specific to level determinants of TEF_{out} are not found for H.S. level.

7.2.2.2 Findings on TEF_{inp} : School-Level Analysis

With reference to Secondary-level and H.S. level of the schools, the TEF_{inp} results reveal that 56% sample schools are operating inefficiently (at both the levels of school education), indicating the capability of these schools of producing the existing output levels utilizing lesser inputs. The variations of TEF_{inp} scores amongst the different sample schools concerning both the stages of school education are also observed.

The findings on the extent of variation of TEF_{inp} excluding the role of the guidance received by the students from private tuition (i.e. Z33) convey that as Z33 explains the considerable part of variation in TEF_{inp} of the schools for both Secondary and H.S. levels (separately), therefore the residual part of variations, which are remaining unexplained by Z33 at both levels of education, are nominal ; and for Secondary-level it ranges between 0.09 % and 28.61% with the average value 5.71% while for H.S. level it ranges between 0.34% and 19.24% with the mean representation of 6.30%. Such results are the revelation of very less TEF_{inp} score attainment by the schools at these two concerned levels of education, in absence of private tuition's contribution.

The above stated consequences are arising because of the fact that Z33 (at the respective level of school education) is playing a highly significant favourable role in determining TEF_{inp} of schools at the respective stage of school education (i.e. Secondary-stage or H.S. stage). However, apart from the crucial determinant, 'Z33', the TEF_{inp} score can be explained in terms of several other affecting factors at both Secondary-level as well as H.S. level of school.

The TEF_{inp} of schools for Secondary-level is determined by the following factors:

(i) 'Z21' appears as a positive and significant determinant of TEF_{inp} for the Secondary-stage of the schools, supporting the positive role of HM's interaction with students and teachers of the school while taking any school-related decision, in enhancing TEF_{inp}. (ii) Policy variable, 'Z20'

validates the existence of non-linear inverted U-shaped relationship with TEF_{inp} of Secondary-level as the coefficient of 'Z20' indicates positive significance and the coefficient of its square term indicates negative significance, implying that even though 'Z20' i.e. 'proportion of students receiving Kanyashree' leads to an increase in TEF_{inp} of Secondary-level initially, however, after reaching a threshold level of this variable, TEF_{inp} reduces with the rise in 'Z20'. For the present sample of schools, the average representation of Z20 turns less than the threshold level, therefore the present sample exists on the upward rising portion of the curve, resulting in a positive marginal effect of Z20. This finding implies that for the present sample, TEF_{inp} arises following the rise in Z20. Another policy variable, 'Z19' positively impacts on TEF_{inp} of Secondary-stage of the schools, implying the positive role of receipt of the amount of government fund by the school in fostering TEF_{inp} score relating to Secondary-level. (iii) For Secondary-level at schools, 'whether the HM is present on duty' (Z6) and 'Z8' are noted as positively affecting administration and infrastructure variables for determining TEF_{inp}. These findings reflect: (a) the favourable effect of HM's on-duty presence in the school on TEF_{inp} in comparison to the schools where HM's absence is observed during the duty hours; (b) the schools featuring more smart classrooms are associated with higher TEF_{inp} score at Secondary-level (low significance level). (iv)School characteristic variable 'Z15' positively impacts on TEF_{inp} of Secondary-level, revealing the fact that the greater level of TEF_{inp} is gained by those schools where size of the class is greater. (v) Quality of school attribute describing variable, 'student's perception about quality of laboratory' (Z45) evidences its favourable influence in determining TEF_{inp} of Secondary-level of schools, denoting that the schools featuring a relatively better quality of laboratory, achieve an improved level of TEF_{inp} at Secondary-stage.

In addition, the determinants of TEF_{inp} at H.S. level of schools are identified as:

(i) HM's school managerial role describing variable, 'Z21' is determining TEF_{inp} of H.S. stage at the school level positively, expressing the favourable role of HM's interaction with students and teachers while reaching any school-related decision in fostering TEF_{inp} relating to H.S. stage. (ii) Again, 'Z19' exerts a positive impact in determination of TEF_{inp} of H.S. stage of the schools, indicating the favouring role of government funds allocated to the school in enhancing its H.S. level's TEF_{inp} score. (iii) Infrastructure variable, 'Z8' positively impacts on TEF_{inp} of H.S. stage which basically expresses that the schools with greater count of smart classrooms, attain a greater level of TEF_{inp}. (iv) 'Z15' as a school-characteristic variable, reflects positive effect in determining TEF_{inp} of H.S. level of the schools, implying the importance of the 'size

of the class' in fostering TEF_{inp} of H.S. level (low significance level). (v) 'Student's perception regarding teaching quality' (Z44) appears as a favourably influencing factor of TEF_{inp} at H.S. stage, declaring that the schools with better teaching quality, attain higher TEF_{inp} at H.S. level. (vi) 'Student's characteristics' reflecting variable, 'study hours at home' (Z35) imparts a positive effect on TEF_{inp} at H.S. level, reflecting that the schools, educating the students with more study duration at home are capable of achieving higher TEF_{inp} score. (vii) 'Z25' as a HM's characteristic defining variable, reveals the evidence of the male-headed schools attaining a greater level of TEF_{inp} in comparison to those schools, not under male headship.

In the act of comparing TEF_{inp} results between Secondary-level and H.S. level it is noted that 56% sample schools are operating inefficiently at both Secondary and H.S. levels. Nevertheless, for capturing the true situation of TEF_{inp} of the schools excluding the contribution of Z33 (as considerable proportion of students avail private tuition at both levels), the residual part of variations in TEF_{inp} which is remaining unexplained by Z33 are obtained for both secondary and H.S. levels. For secondary-level it ranges between 0.09 % and 28.61% with the average figure 5.71% while for H.S. level it ranges between 0.34% and 19.24% with the average representation of 6.30%. These outcomes are the reflections of very less TEF_{inp} score attainment by the schools at both of these levels of education in exclusion of the contribution of private tuition, although it is noted as even little less for Secondary-level.

Simultaneously comparing the determinants of TEF_{inp} between Secondary-stage and H.S. stage at school-level, it is observed that some determinants of TEF_{inp} are common in both Secondary and H.S. contexts; for example, HM's interaction with student and teacher in developing school-related policies, percentage of private tuition receiving students, the quantity of government funding received by the schools, number of smart classroom and class size.

However, besides such commonly affecting determinants, there are some factors which solely determine TEF_{inp} of Secondary-level of school, such as Kanyashree receiving students' proportion, HM's presence on duty and students' opinion regarding quality of laboratory. Similarly, TEF_{inp} of H.S. level is exclusively impacted by students' opinion regarding teaching quality, gender of HM and study duration of the students at home.

Relevantly, the degree of inefficient utilization of inputs, indicated by each input in the respective process of education production is crucial to obtain based on the combined values of radial & slack movements added together for each of the inputs focusing on Secondary-stage and H.S. stage of the schools separately. The result relating to the Secondary-level of schools,

on combined movement for the four inputs expresses that the average inefficiency is noted to be greatest for the input 'teachers-student ratio' (17.62%), followed by the inputs, classrooms-pupil ratio (15.90%) and per student expenses of school on a monthly basis (12.21%) respectively; and lowest for the input, percentage of teachers with master's degree and above academic qualification (6.61%). In addition to this, referring to the H.S. level of the schools and analyzing the respective combined estimates of inputs, the average inefficiency level is found to be greatest for 'teachers-student ratio' (34.63%), followed by 'classroom-pupil ratio' (34.54%) and 'per student expenses of school on a monthly basis' (23.01%) respectively; and lowest for 'percentage of teachers with master's degree and above academic qualification' (8.38%). The estimate of average inefficiency level corresponding to each input in education production is useful for recognizing the inputs with different extent of inefficient utilization.

The determinant analysis of TEF (from both perspectives: output and input oriented) for Secondary and H.S. levels are the essential aspects of this entire analysis as such findings can help in identifying the determining factors of TEF at the concerned levels of education and thereby in accordance with such empirical evidences accurate TEF improving policies are suggested.

7.3 Policy Suggestions

7.3.1 Policies for improving TEF_{out} at State-Level

While designing the policy with the objective of improving TEF_{out} it should be taken into consideration that some policy variables are such that change in which in the proper direction may create a greater impact on the aspect of TEF_{out} in the sense of improving TEF_{out} in each state category (i.e. GCS and SCS&UT) corresponding to the Secondary and H.S. education system. Contextually, raising 'education expenditure' by the government can act as a common policy for boosting TEF_{out} at both Secondary and H.S. education levels in GCS as well as in SCS&UT. A crucial finding reveals for SCS&UT group and for H.S level that because of the non-linear 'U' shaped relation as exist between 'government education expenditure' and TEF_{out} of H.S. education in SCS&UT, there exists a threshold level after which the positive effect of Government expenditure on $TEF_{out.}$ is felt and the sample value of the government expenditure on education is below that of the threshold level. Thus, the government should prioritize more on increasing GEXPOE for experiencing the favourable influence of GEXPOE on TEF_{out} score corresponding to H.S level in such a way to overshoot the threshold point. Additionally, government policy of appointing teachers to a sufficient extent and a policy of

encouraging the girls students for enrolling at Secondary-level can enhance TEF_{out} of Secondary-stage of education in GCS and SCS&UT.

Apart from these common policies, there exists some specific policies for fostering TEF_{out} scores of a particular level of education in a specific state group. In particular, for GCS, construction of the buildings in the school premises and the policy for growing PCNSDP can enhance TEF_{out} of Secondary education. On the other hand, in SCS&UT, TEF_{out} of Secondary education can be improved by the policies of incentivizing tribal community for enrolling their children in formal Secondary education, reconstructing those classrooms remaining in bad condition, offering the facility of drinking water and providing the electric power inside the school. Since more number of lack of infrastructure defining variables influence TEF_{out} of Secondary education in SCS&UT as compared to GCS, therefore for improving infrastructural conditions, SCS&UT seeks more attention from government. Further, concerning the H.S. education, fostering TEF_{out} in GCS can be performed through adopting several policies like, construction of the buildings along with toilets for the girl students in the school, encouraging girls for enrolling at H.S. level of formal education and appointing sufficient quantities of the teachers. However, for enhancing TEF_{out} level of H.S. education in SCS&UT, the polices like, incentivizing ST, SC community for enrolling their children in formal H.S. education, building more classrooms and appointing greater number of female teachers in comparison to the male teachers can be suggested.

7.3.2 Policies for improving TEF_{inp} at State-Level

It should be noted that a number of policy prescriptions are specific to 'GCS' and a few are to 'SCS&UT' for enhancing TEF_{inp} at the concerned level of education and also some policies are advised for both the levels of education at a particular state group. However, a few policies, common to both 'GCS' and 'SCS&UT' are also evident. As the common policies, for both the groups of states, raising government education expenditure and appointing full-time teachers (for mitigating the deficit of teaching-staffs) by the authority at both Secondary and H.S. education levels can raise TEF_{inp}. Moreover, a 'U' shaped relation between 'government education expenditure' and TEF_{inp} of H.S. education in SCS&UT, indicates the priority of raising education expenditure by government in such states, as argued in case of TEF_{out}. Besides, the existence of school building must be ensured in the school premises by establishing building, specially, in those schools, functioning without any building in both 'GCS' and 'SCS&UT' for improving TEF_{inp} at H.S. education; and also such a policy is

capable of enhancing TEF_{inp} of Secondary education in GCS. In addition to this, implementation of incentivizing policy, targeting the girls at the appropriate age cohort for leading them in formal education, by the government may elevate TEF_{inp} of H.S. level in both the groups of states and this policy also remains beneficial for improving TEF_{inp} of Secondary-level in GCS. Coming to the specific policy, any government initiative aiming at stimulating the PCNSDP will lead to an increase in TEF_{inp} of Secondary-level in GCS. In contrast, referring to the Secondary education system in SCS&UT, the policy of reconstructing the classrooms remaining in bad condition, providing the availability of electric power, offering the facility of drinking water inside the school and incentivizing tribal people for enrolling their children in formal Secondary education will elevate TEF_{inp}. Further, for H.S. stage of education, the policy of building toilet exclusively for girl students inside the school property, offering the internet and computer using facility in the school will raise TEF_{inp} in GCS whereas an enhancement of TEF_{inp} at this stage of education in SCS&UT will be achieved through the policy of appointing more number of female teachers in comparison to the male teachers at H.S. education system.

7.3.3 Policies for improving TEF_{out} at Schools

Based on the school-level analysis, the following policies are prescribed for promoting TEF_{out} of schools at Secondary-stage and H.S. stage:

Some policies are common for fostering TEF_{out} at both Secondary and H.S. levels: (i) Since more funding from the government can increase TEF_{out} of the Secondary-level of the school and the positive marginal effect of government funds is evident at its sample average value (on TEF_{out}) for H.S. level, it is therefore recommended that the government should increase the amount of funding for the schools for fostering TEF_{out} at both Secondary and H.S. levels. (ii) As TEF_{out} of Secondary-level may increase as a result of an increase in Kanyashree because of the empirical findings suggesting, Kanyashree having a positive marginal effect at its sample average value and for H.S. level, Kanyashree being identified as a favourably TEF_{out} determining variable, therefore, outreach of Kanyashree should be improved for improving TEF_{out} of the schools at both the education levels. (iii) Since interaction of HM with teachers and students while taking any policy decision for the school and also interaction frequency with state education department are influencing TEF_{out} of both Secondary-level and H.S. level positively, it is therefore recommended that while framing policies for school, HM should always interact with teachers & students and should also interact frequently with education department of the state in order to promote TEF_{out} at both the education levels of school. (iv)

As the school where the librarian is on duty reflects relatively higher TEF_{out} at Secondary-level and H.S. level than that of the school running without librarian's presence, therefore the schools should make arrangements of part-time or temporary librarians in absence of the full-time librarian from duty to promote TEF_{out} at both the levels. (v) Since the empirical finding indicates that more smart classrooms in the school can lead to higher TEF_{out} at Secondary and H.S. levels of the school, it is thereby advised that the schools should take initiative for making arrangements of smart classrooms in the school premises in order to increase TEF_{out} at both the levels. (vi) Since the percentage of students opting for private tuition is determining TEF_{out} of Secondary-level and H.S. level of the school positively, it is therefore implying that schools cannot meet the students' requirements of deriving academic benefits from their schools which is supported by very less extent of TEF_{out} variation at both the mentioned education levels, in absence of the role of private tuition. It is therefore suggested that school authorities should arrange some interactive sessions between teachers and students for discussing the problems of the students followed by possible solutions so that the students can eventually stop taking private tuition.

Further, some policies which can exclusively enhance TEF_{out} of Secondary-level, are discussed below:

(i) As full time teacher's service experience and also HM's service experience are adversely affecting TEF_{out} of Secondary-level of the school, it is suggested that new appointments of full-time teachers as well as of HM should be offered by the Government for enhancing TEF_{out} at Secondary-level. (ii) Since a positive relation is found between the reserve category students' proportion in class and TEF_{out} level of the school relating to Secondary-stage, the government is suggested to carry out social inclusion policy continuously in case of formal education. (iii) As the student's percentage, possessing textbooks at home is positively influencing TEF_{out} score at Secondary-level, it is therefore prescribed that school should pay attention to provide textbooks to those Secondary-level students who do not possess it.

The study of the school-level TEF_{out} analysis contains interesting findings that : (a) for Secondary-level of schools, (i) the interaction variable between the student's opinion regarding the regularity of class and the proportion of vacant teaching-position, (ii) educational qualification of mother; and (b) for H.S. level of schools, (i) proportion of vacant teaching-position, (ii) teaching experience of part-time teachers, and (iii) percentage of students possessing textbook at home are determining 'Z33' significantly and consequently also

determining TEF_{out} of the corresponding education level of school. At Secondary-level, more number of teaching-position remaining vacant or class irregularities induce the students to opt for private tuition and hence schools are advised to pay attention to recruit in the vacancy for teaching-positions and also to improve class regularities. Specifically, for monitoring and ensuring class regularities, school authorities can arrange student feedback systems. Again, as higher academic qualifications of mother's lead to a decline in percentage of private tuition taking students at Secondary-level of the school, the government is advised to take some favourable measures for further improving the scenario of female education. Referring to H.S. level of school as well, more vacancy in teaching-position causes more number of students opting for private tuition, thus it is important for the school to fill the vacancy by aiming to improve such scenario. Additionally, since more teaching experience of part-time teachers causes less taking of private tuition by the H.S. level students, therefore for retention of experienced part-time teachers in the school, designing a better salary structure for them is recommended. Likewise, as the schools with higher percentages of H.S. level students possessing textbooks can lead to a lesser percentage of private tuition taking students, the government should monitor and assure the reception of the textbooks by all the students at the beginning of the session.

7.3.4 Policies for improving TEF_{inp} at Schools

The TEF_{inp} analysis at school-level sets the ground for suggesting some (input oriented) efficiency-enhancing policies at both Secondary and H.S. levels. However, some policy prescriptions are common to these two levels while some are specific to the particular level of school-education.

The common policies for increasing TEF_{inp} at both Secondary-level and H.S. level of the[1] schools are : (i) As the 'extent of government funding received by the school' impacts positively on TEF_{inp} at both the levels of the schools, hence it is advised to increase the extent of government funding at schools for improving TEF_{inp}. (ii) 'HM's interaction with teachers & students for taking school-related decisions', positively influences TEF_{inp} scores of schools for Secondary & H.S. levels. Hence, the recommendation of carrying out interaction with teacher & student is given to HM while taking any policy decision, for elevating TEF_{inp} at both the levels. (iii) As the schools featuring greater count of smart classrooms have been able to gain higher TEF_{inp} scores at both Secondary & H.S. levels, it is hence advised that the schools should extend the count of smart classrooms (to possible extent) in order to enhance TEF_{inp} at both the

levels of the schools. (iv) Since the schools operating with larger class size can attain higher TEF_{inp} at both the levels, it is therefore recommended that schools should arrange for more sections in the class, for improving TEF_{inp} scores at both the levels.

Suggested specific policies for improving TEF_{inp} at Secondary-level of schools are:

(i) For the present sample 'proportion of students receiving Kanyashree' imparts a positive effect on the level of TEF_{inp} corresponding to the Secondary-stage and thus a rise in the proportion of Kanyashree will lead to an improvement in TEF_{inp} at Secondary-level of school. (ii) The school where the HM is present on duty is able to attain higher TEF_{inp} at Secondary-level, hence it is advised that if HM is absent from duty at any school then HM must nominate an alternative teacher for performing his responsibilities in his absence. (iii) Since 'quality of laboratory' (based on student's opinion) is favourably impacting on TEF_{inp} score of schools for Secondary-level, therefore the school authority is advised to offer improved laboratory quality at school premises.

Again, the recommended specific policies for enhancing TEF_{inp} at H.S. level of schools are:

(i) As student's study duration at home positively impacts on TEF_{inp} of schools for H.S. level, thus the schools are suggested to engage students more in studying at home by giving them assignments or conducting continuous assessments, in order to elevate TEF_{inp} at H.S. level. (ii) As 'quality of teaching' (based on student's opinion) is favourably influencing TEF_{inp} score of schools at H.S. level, hence the schools are advised to ensure good quality of teaching by monitoring the teaching hours through students' feedback, for enhancing TEF_{inp} at H.S. level of schools.

As significantly influencing factors of 'percentage of students taking private tuition' also indirectly affects $TEF_{inp,}$ thus based on such results several policies can also be suggested: at (a) Secondary-level (i) schools need to arrange classes regularly, (ii) recruit for a vacancy in the teaching-position and (iii) the government should formulate more policies to rectify the scenario of female education for enhancing the academic qualification of the mother of the student; similarly, for (b) H.S. level, it is advised to (i) design a better salary structure for retaining experienced part-time teachers in the school, (ii) recruit for a teaching-position vacancy, and (iii) schools must offer textbooks to H.S. level students, in case they do not possess any of the textbooks.

7.3.5 Common Policy Prescriptions based on the Overall Study

On the ground of the overall State-level analysis (of TEF) segment of the present thesis, several common policies for upgrading the level of TEF of the concerned stages of education may be formulated.

Precisely, the common policies for enhancing TEF_{out} as well as TEF_{inp} at both Secondary and H.S. levels in GCS would be (i) Promoting government education expenditure, (ii) Encouraging girl student's enrolment, (iii) Appointing sufficient teachers (in terms of the numbers) and (iv) Constructing more buildings in the school premises.

Similarly, the common policies for improving TEF_{out} at Secondary and H.S. levels in SCS&UT are: (i) Raising government education expenditure and (ii) Encouraging ST population for enrolling their children in formal education; additionally, for promoting TEF_{inp} at Secondary and H.S. levels in SCS&UT, a few common policies can be suggested like, (i) Escalating government education expenditure and (ii) Appointing sufficient count of the teachers.

Therefore, summarizing the policies, designed for enhancing efficiency of Secondary and H.S. education at the state-level, a single common policy can be prescribed with the objective of simultaneously improving TEF_{out} as well as TEF_{inp} at both Secondary and H.S. levels, in both GCS and SCS&UT; and such a policy suggestion is 'raising government education expenditure'.

Moving towards the school-level analysis (of TEF) segment of the present thesis, several common policies can possibly be prescribed for simultaneously promoting TEF_{out} as well as TEF_{inp} of the schools both at Secondary & H.S. Levels; and such policies would be (i) Allocating more government funds to the schools, (ii) Increasing HM's interaction with teachers and students while formulating school-related policies, (iii) Providing more smart classrooms (to a possible extent) and (iv) Arranging teachers-students discussion (by school) regarding the problems of the students and suggesting possible solutions.

Although the present thesis intended to shed light on the substantial aspects of TEF particularly focusing on Secondary and H.S. levels of education, however, it is not completely free from the limitations. In accordance with the literature, the estimation of TEF rests on the production relation between output and input variables. Relevantly, it is essential to point out an important deviation of education production function from the conventional micro-economic idea. The output of education sector is intangible. Therefore, representation of output by appropriate measures is essentially required. Thus the analysis is contingent upon the assumed measures of output variable. The obtained results may be sensitive to the assumed measures of output.

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