DOI: https://doi.org/10.52131/pjhss.2022.1002.0251

Pakistan Journal of Humanities and Social Sciences

Volume 10, Number 2, 2022, Pages 862–890
Journal Homepage:
https://journals.internationalrasd.org/index.php/pjhss

PAKISTAN JOURNAL OF HUMANITIES AND SOCIAL SCIENCES (PJHSS)
INTERNATIONAL RESEARCH ASSOCIATION FOR SUSTAINABLE DEVELOPMENT

Decomposition of Total Factor Productivity into Efficiency Components: An Empirical Analysis of District Level School Performance

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ARTICLE INFO

Article History:

Received:	May 24, 2022
Revised:	June 28, 2022
Accepted:	June 29, 2022
Available Online:	June 30, 2022

Keywords:
Educational Efficiency
Total Factor Productivity
Fare-Primont Index

JEL Classification Codes:
D61, H52

Funding:
This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

ABSTRACT

Access to quality education is the intellectual right of every child, and it was first acknowledged in December 1948 in the Universal Declaration of Human Rights (UDHR). Recently, Millennium Development Goals (MDGs) and the Sustainable Development Goals (SDGs) reinforced the importance of education as a universal right regardless of color, language, race, gender, economic condition, and social origin. It is possible to improve the quality of education by efficiently using inputs. This study aims to measure the performance so that it can analyze how much chance of improvement is available. The total factor productivity uses the inputs and output at the district and then at the individual school student level, decomposed into its efficiency components. This study implements Data Envelopment Analysis (DEA) using the DPIN software for the analysis. Panel information from 2013 to 2016 of the 112 districts is used for this study. Technical, mix, and scale mix efficiency is calculated, and the determents that can explain the difference in the performance are measured. Results show that the health and education index are the key indicators that can explain the high performance of some districts. Whereas the living standard shows a negative effort on efficiency.

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1. Introduction

Education plays a significant role in growth and development. Education provides people with the knowledge, skills, and equal opportunities that they require to make a decent living (World Bank, 2011). As per Sustainable Development Goals 2030 (SDGs) each country is trying to update education system and achieve the development goals. One of the main goals of institutional economics is to analyze the performance of educational institution because it is the baseline and fundamental unit, which can create change in the development process. Since sometime, Pakistan has been struggling to provide quality education across to country to school aged children .The progress of the education sector over the past decade is extremely below desired level, with a low literacy rate of 58 percent, as reported by the Pakistan Economic Survey (2017-18). Pakistan is part of E9 countries representing more than half of the world population with 70 percent of the illiterate adult population[1]. Slow progress of education sector is multi-faceted.

Amongst many challenges, the first major problem that the education sector is facing is the low enrolment rate. There are economic and gender disparities in enrolment across the country with the highest proportion of out of school children in Baluchistan. Most of the out of school children are resident in rural areas. This gap widens and the figures are become alarmingly high in the middle and high school level[2]. Another challenge is providing uniform

[1] National Education Policy Framework (2018)
[2] Economic Survey of Pakistan (2017-18)

eISSN: 2415-007X

and quality education across all the regions. Extensive literature is available which is evident that quality of education is affected by multiple factors including textbooks, curriculum, and infrastructure, human and financial resources (Adkins & Moomaw, 2005; Ewell, 2010; Hanushek, 2005; Hanushek & Rivkin, 2007; Harvey & Williams, 2010; Huguenin, 2014; Scheerens, Luyten, & Ravens, 2011; Singh, 2010; Young, 2005). Policymakers need to regularly review the learning outcomes and take the necessary steps to improve the efficiency in the educational system because budget allocated to education sector is extremely small.

While we discuss improvement in efficiency in education sector, we need systematic approach to measure efficiency. To measure efficiency, we need data on the input and outputs used in the educational process so that it can be compared with the idea or benchmark performance criteria, i.e., production frontier. The main advantage of this technique is that after inefficiency is identified, we can begin to ascertain the root cause and sources of inefficiencies and address it to improve performance. Following are two approaches widely discussed in the literature to measure the production frontier

- Data Envelopment Analysis (DEA)
- Stochastic Frontier Analysis (SFA)

DEA is a non-parametric model which does not require to be functional for the production frontier that is estimated. Besides, there is no statistical issue attached when we are evaluating multiple inputs and output models. However, it does not allow for statistical noise that cannot distinguish between the inefficiencies and the noise. Therefore, it is difficult to estimate reliably efficiency scores .Technical efficiency scores may be more sensitive to the outlier and is upward biased, in case the selected sample is too small. The alternative approach to estimate the production frontier is the SFA that allows for other sources of inefficiencies in the statistical noise. However, the estimated efficiency score is sensitive to the choice of the functional form used to predict the production frontier (O'Donnell, 2012). In case of the educational economics both the DEA and SFA model are applied in many studies to estimate the efficiencies at different levels of educational institutions (Banker & Natarajan, 2008; Davutyan, Demir, & Polat, 2010; Heshmati & Kumbhakar, 1997; Houck, Rolle, & He, 2010; Z. Hussain, Mehmood, Siddique, & Afzal, 2015; G. Johnes & Johnes, 2009; Primont & Domazlicky, 2006; Worthington, 2001; Wossmann, 2007).

Other studies approach the Malmquist Index method to measure the Total Factor Productivity (TFP) in the DEA framework, developed by Caves, Christensen, and Diewert (1982)[3]. Many other researchers to measure the total factor productivity change, technical efficiency change, technological change, scale efficiency change, and pure efficiency change have used precisely this technique. Like (Agasisti, Bonomi, & Sibiano, 2014; Agasisti & Dal Bianco, 2009; Bradley, Johnes, & Millington, 2001; Flegg, Allen, Field, & Thurlow, 2004; Z. Hussain et al., 2015; G. Johnes & Ruggiero, 2017; Ouellette & Vierstraete, 2010; Rayeni & Saljooghi, 2010; Worthington, 2001). The advantage of the Malmquist Index is that it does not require to assume any functional form for the productivity frontier and assumes that all the decision-making units are efficient. However, it is not multiplicative complete and requires information on the input/output prices, which is difficult, especially in institutional economics, where data availability is an enormous issue. Also, the Malmquist index cannot be represented as the ratio of aggregate input and output index (O'Donnell, 2012) and does not satisfy the property of transitivity; therefore, it can only be used for the comparison of two units at a time. Färe, Grosskopf, Norris, and Zhang (1994) proposed using the distance function as an alternative to the Malmquist methodology. Thus, the efficiency measure defined by Farrell (1957) can be measured as the reciprocal of the distance function. The advantage of this measure is that they do not require the data on the input and output prices. (O'Donnell, 2012) used the distance function approach proposed by Fare-Primont Index to decompose the TFP into technical efficiency change, mix-efficiency change, scale efficiency change, and scale mix-efficiency change[4]. Therefore, this comprehensive decomposition helps us explore the benefits of scale and scope of efficiency change in the production process. Any improvement in the scale and mix-efficiency will increase overall TFP, enhancing social welfare. Thus, this

[3] This approach was based on the early idea of (Malmquist,1953)
[4] Mix-efficiency change and scale mix-efficiency change are not discussed in the Malmquist Index.

methodology can be used for multilateral and multi-temporal comparisons of different decision-making units (DMUs).

Efficiency in education is essential, given that available resources are scarce, and it gives us the foundation of the economic prosperity of a developing economy. However, there are very few studies available in the area of school efficiency in Pakistan. Few studies evaluated the student and measured school-level performance. A study is available where primary school level efficiency was calculated by Z. Hussain et al. (2015) using a Malmquist Index. They used annual data disaggregated into the rural and urban areas of primary schools. Another study by Ahmed (2012) used district-level data for two provinces to estimate efficiency using DEA. However, this study does not use the role of mixed efficiency in explaining TFP. This study uses the district-level data on input and output for Pakistan throughout 2013-16[5]. Due to geographical, cultural, and socio-economic differences, it is more meaningful to analyze the data for each province separately. Each of the provinces is an amalgamation of small and large districts, with some districts performing better than the other. Since the efficiency scores obtained from the first stage ranges from zero to one, they are censored variables and thus an estimation using the ordinary least squares (OLS) will provide biased estimates as suggested by Agasisti et al. (2014). A limited dependent variable model is used to avoid this problem in this case the Tobit model is used to estimate the regression equation.

There are multiple objectives that we intend to achieve through this research; the primary purpose objective is to calculate the efficiency of 113 districts by using a sophisticated econometric technique called Data Envelopment Analysis (DEA). Secondary Purposes is to identify the TFP of underperforming districts, to calculate the technical, mix and scale efficiencies for each district by decomposing the TFP, to identify the district/division that is sufficiently efficient and to investigate the uncontrollable environmental factors that can explain the differences in the efficiency level. Investigation of the overall TFP and the TFP for the four provinces separately can help policymakers make better policy-related decisions for each province.

Although the research in educational efficiency is very vast, the policy outcomes that can be extracted from it are limited. We can find consistency in the research findings; however, the schools differ drastically because a single policy cannot be implemented in all the schools. Policymakers are more interested in the factors that explain the difference in the performance due to changes in the expenditure, physical and human resources, where the differences are mainly due to some external factors including the geographical difference, living standard, and health conditions. Most of the research in education is empirical; therefore, it is crucial to understand the conceptual model. Production theory has been widely discussed in textbooks; however, its implication in educational production is limited. Thus, it is imperative to discuss the concept of efficiency in the area of education, which has not been extensively discussed.

This paper contributes to the literature by using the Fare-Primont index to calculate TFP and its components to analyze the district-level data of educational input and outputs. Further, in the area of education, only a few research papers have followed the idea of non-parametric modeling to estimate the scale and mix-efficiency using the technique developed by O'Donnell (2012); O'Donnell (2010). This study additionally extended the methodology by analyzing the effect of environmental factors in explaining the difference in the efficiency level of each district in each province of Pakistan. Section 1 provides a brief introduction, Section 2 discusses Literature review, Section 3 discusses the methodology, Section 4 is about Data and results, and Section 5 reports Conclusion along with recommendations.

2. Literature Review

The idea about the educational efficiency is not new and was first discussed in the early '50s, however, formally discussed in the Coleman-report (Coleman et al., 1966). Though the

[5] Punjab, Sindh, Khyber Pakhtunkhwa and Baluchistan and this study excludes the districts in Azad Jammu and Kashmir (AJK), Gilgit-Baltistan and Federal Administrated Tribal Area (FATA) due to the unavailability of district-level data on the educational input/output variables.

idea of efficiency seems quite simple, it is complicated in the educational sector. Fried, Schmidt, and Lovell (1993) define educational efficiency by comparing the optimal level of inputs to the observed input levels used in the school's productivity. The comparison can be in terms of the ratio between the observed and the maximum potential value produced with the given inputs. On the other hand, the ratio could also be between observed values for the minimum input required to produce the given level of output. Another study discusses the input-output ratio as technical efficiency only if we can increase the output by decreasing the output of other production processes (Koopmans, 1951). However, the definition of technical efficiency by Koopmans (1951) was revisited and was defined in relative notations by Farrell (1957). Thus, comparing the observed technical efficiency with the best-practiced reference group helped to distinguish between efficient and inefficient production units. However, this definition ignored the discussion on how efficient production can be identified. Moreover, on how the degree of inefficiency compared to the efficient unit can be determined.

Debreu (1951) discussed productive efficiency by introducing the concept of the utilization of resources. Debreu's measurement of efficiency is based on technical efficiency (Koopmans, 1951). He stated about the feasibility and equi-proportionate minimum inputs used to produce the given output maximum feasible and equi-proportionate output that can be produced with the given input levels. Extending the work of Debreu (1951) believes there is a second component in the productive efficiency and the technically efficient input-output vector, i.e., the prices of inputs and outputs. Therefore, referring to the fact that production efficiency is the combination of both allocative and technical efficiency. The majority of the economist's focus is on the market, and thus prices work as an invisible hand in the allocation of resources. Although most economists are more concerned about allocative efficiency, but it is difficult to accurately measure the price that can result in a fair distribution of resources. According to Hoxby (1996), allocative efficiency in education refers to the quality, type, and amount of schooling provided (optimal number), whereas the technical efficiency refers to the objective of cost minimization through the given set of goals. Adnett and Davies (2002) defined school efficiency as the maximization of outputs based on the given level of resources. Another study defines scholarly output as allocative efficiency based on revenue maximization, given that the schools are technically efficient (Kirjavainen, 2009). However, this definition seems narrow as a set of inputs used in calculating efficiency is limited and ignores many dimensions that need to be considered: family background, social infrastructure, students' behavior, and other aspects (Hoxby, 1996; G. Johnes & Ruggiero, 2017).

Efficiency in education depends on multiple inputs and results in multiple outputs, whereas the single output is produced in other production processes. These unobserved dimensions (factors) correlate with educational performance and affect the efficiency of the school. Thus, provide biased results at the time of comparison of educational systems and raises serious concerns. Many studies in the educational literature discussed the issue of efficiency; however, in this study, we focus on district-level analysis. Heshmati and Kumbhakar (1997) is one of the earliest contributors in the efficiency literature. This study uses the Stochastic Frontier Analysis for the measurement of productivity and cost function. Maximum likelihood estimation was used for parameters, based on which the efficiency score was predicted. Data from 286 municipalities were collected for primary and secondary schools for the year 1993-94. The analysis concludes that most of the schools in the sample operate in the efficiency level from 85 percent to 100 percent. The average efficiency is found to be in the interval 90-92 percent, which indicates that Swedish Municipal School can improve the production capacity by 8 to 10 percent through the policy change.

Another group of researchers discussed the efficiency in student achievement and its tradeoff with equality. Some also considered the budget constraint in the estimation process (Anderson & Silver, 1984; Benito, Alegre, & Gonzàlez-Balletbò, 2014; Domovic & Godler, 2005; Grosskopf, Hayes, Taylor, & Weber, 1997; Thomas, Wang, & Fan, 2002). These researchers are of the view that efficiency and equality are keys to educational policies. In an analysis by Grosskopf et al. (1997), they view that even in the inefficient district school, financial reforms can play an important role and can guarantee gains in the student's efficiency. Verstegen (1994) investigated the same issue in American schooling and concluded that irrespective of the outliers, not all state schools show the same increase in efficiency after the financial reforms. Moreover, it can be seen that richer states have more influence on the decision-making and have more revenues that are eventually increasing the gap between equality and efficiency for the rich and poor states.

The level of efficiency measure defined by Koopmans (1951) is very much similar to what is estimated using the Farrel index. The main idea is that the production possibilities cannot be increased without increasing the inputs. The DEA approach is based on the Farrell Index, in which a reduction in observed input is necessary for the given level of output. Although the efficiency is achieved, some slack may exist due to the implicit restrictions on the model assumption, i.e., restrictions on the weights of the input and output variables. Slack model is applied in many different fields to measure the efficiency of the decision-making unit (Agha, Kuhail, Abdul Nabi, Salem, & Ghanim, 2011; Ahec Šonje, Deskar-Škrbić, & Šonje, 2018; Koltai & Uzonyi-Kecskés, 2017; Morita, Hirokawa, & Zhu, 2005; Soteriou, Karahanna, Papanastasiou, & Diakourakis, 1998; Sueyoshi, Ohnishi, & Kinase, 1999; Tali, Padi, & Dar, 2016). However, in the case of school efficiency, few studies could be found, e.g. Agha et al. (2011); Ahec Šonje et al. (2018); Soteriou et al. (1998).

McEwan and Carnoy (2000) a comparison of public and private school achievement is performed for Chili. This study initially used a complete set of student achievement and background data than other studies. Second, it divides voucher schools into three categories—Catholic, Protestant, and non-religious—instead of lumping them together (as it turns out, their effectiveness and costs are quite different). Third, it is the only comprehensive analysis of costs and efficiency. A comparison of public and private schools is made using the multi-product cost function, and the Cobb Douglas production function was used for the analysis. The study concluded that a privately run school is slightly less effective than public schools. Non- religious private voucher schools, when they are located outside of the capital, are even less effective than public schools. Performance differences can be explained by the higher fraction of teachers who have short-term contracts.

Additionally, Catholic schools are observed to be more effective than public schools, as similar students achieve a higher rate of productivity. However, there is a possibility that selection bias could have contaminated the selection of private school effects. Eventually, if the peer affects the student performance, then sorting such an outcome effect could not be measured. Another study by Primont and Domazlicky (2006) measured the effect of supplemental tutoring and school transfer under no child left behind policy. School efficiency was calculated by using the two-step Data Envelopment Analysis. During the first stage, regression analysis was performed using the seemingly unrelated model (SUR) model on 355 schools out of 522 at the district level. In the 2^{nd} stage, DEA analysis was conducted in 309 districts out of 355 school districts selected at stage 1. The targeted output at stage 1 was test scores of arts, science, and reading. The input used the test scores for 1998 of all these subjects to control the student's ability, socio-economic background of a family (students receiving free lunch, occupation). Student demographics (minority, non-white, population per square mile, the population in 2000 and 1995) and Incident rate involving student suspensions were also considered for the analysis. In the 2^{nd} stage, Quasi fixed inputs used are the characteristics of the teacher (master's degree) and admin (average years of experience), Facilities (number of computers), capital expenditure per student, transportation services, purchased services, and other expenditure. Variable inputs are admin staff per student, no. of teachers per student.

Further, for the estimation of allocative efficiency, input prices, i.e., admin salary, average annual teacher salary, amount of spending on teachers, and administrators per student, are considered. The study concludes that technical inefficiency is significantly higher for failing schools than the passing schools, while there was no significant difference in allocative inefficiency in the two groups of schools. The transfer of a student's sanction is more likely to improve managerial efficiency than the tutoring services sanction. However, the question arises that why any federal government is willing to invest in schools that are already failing.

Oliveira and Santos (2005) investigated the efficiency of Secondary Education in Portugal and used FDH with Bootstrapping to measure efficiency score and slacks, by relaxing the assumption of convexity. Student's data from 42 public schools for the year 1999-2000 was considered for the analysis. Student performance for 1st, 2nd, and 3rd year was used as the dependent variable, and explanatory inputs considered are from the domines like educational environment, 26 items; education, teaching, and learning, 26 items; organization, and management, 97 items. The study concludes that at the district level analysis, living infrastructures, adult education, access to health, and the unemployment rate are significant determinates of school efficiency. Hence, the schools in major coastal metropolitan areas are more efficient than others.

Some researchers, including Grosskopf and Moutray (2001) and Smith and Street (2006) also used the DEA to decompose changes of efficiency over time into technological progress and efficiency gains, using a Malmquist index approach. The analysis mainly focused on calculating the Technical and allocative inefficiency in the education sector (Aparicio, Crespo-Cebada, Pedraja-Chaparro, & Santín, 2017; Essid, Ouellette, & Vigeant, 2014). Cross-sectional data of 2928 schools for the year 2003-04 was considered. The value-added attainment of pupils of grade forth compared to grade third is considered as the performance measure (Smith & Street, 2006). Several teachers, the number of learning support staff, admin and clerical staff, expenditure of learning resources are the explanatory variables used. In addition, the set of control variables used are pupils with no free lunch, special needs, and English as an additional language. The findings of the study suggest that neither the fact that the magnitude of allocative efficiency is no doughty relatively high, but the technical inefficiency is a more critical factor that needs to be tackled (Smith & Street, 2006).

Consequently, if the study could use the DEA estimates for inter-school benchmarking, then in doing so, the limitations of data and modeling assumptions need to be explained very carefully. If additional years' data become available, the DEA could also serve as a basis for examining productivity gains using the Malmquist index approach. Z. Hussain et al. (2015) also used a similar technique to decompose the productivity into the technical scale and total factor productivity change, to analyze if the educational resources are being properly utilized or not. The analysis was disaggregated for the urban and rural areas. The results conclude that under a constant return to scale (CRS) and variable return (VRS) to scale public schools were observed to be technically inefficient. However, the performance is satisfactory overtime when the scale, pure efficiency, and the technical efficiency change was measured.

Houck et al. (2010) examined the productive efficiency of school districts by using a modified quadratic form method, where both the graphical and quantitative differences are considered while making analysis. The fundamental question they tried to answer was why one school or district produces more than another, and what a hypothetical "most efficient" school or school system would look. This study revealed persistently efficient and effective districts; there were no persistently ineffective or inefficient districts overall five outcome measures (Houck et al., 2010). Spending on instructions has a positive effect on efficiency and effectiveness. Like the other states who applied the same methodology, efficiency is affected by the demographics, local wealth, and school district performance. However, a panel data analysis could provide a clearer picture of overtime changes.

Student performance is the outcome of an individual's effort, family characteristics, and school-level resources. Raposo and Menezes (2011) view that efficiency can only be explained, if the explanatory variables can be separated from the school resources and practices followed in schools. The DEA two-stage model is used to estimate the efficiency of 4th-grade students on the math test. Exogenous inputs include student enrollment, school physical resources, the faculty member's characteristics, and grade progression. The results suggest that in a 2 stage DEA model, the ranks for estimating efficiency scores are much more homogenous than the one-stage model. However, the literature showed mixed results to support this finding as operating conditions and practices need to be considered while making performance comparisons (Johnson & Kuosmanen, 2012).

There are four primary methods used in the literature to measure efficiency. The first one is the least square econometric production models, and the second method is through total factor productivity indices, the third one is the data envelopment analysis, and the last one is the stochastic frontier method. The first and the second methods are more commonly applied to the time series data to measure the productivity change over time; however, they can also be used to measure the relative productivity of cross-sectional data at one point in time. Hence, the productivity measure does not assume that the DMU is technically efficient. The DEA and SFA are more commonly used for cross-sectional analysis; however, they can also be used to measure the efficiency changes over time if the cross-sectional data are available. In this study, we use the decomposition of total factor productivity to measure different components of the school's efficiency. Traditional educational inputs and outputs have an impact on the efficiency level in the field of education, which has been explained by Witte and López-Torres (2017), in their study. They held a view that the impact of standard inputs, outputs, and variables in the educational field are because of teachers and the learning environment, which in turn affect the entire efficiency level. Hence, it is crucial to accurately figure out the outcomes of environmental variables on student learning and to present a basic structure which sources the efficiency level and make efficiency processes more effective and accurate. Nonparametric (DEA, FDH, order-m frontiers) and parametric (SFA) frontier methods have been used to analyze the education efficiency at district-level schools. To establish a systematic link between institutional economics and educational efficiency, they both used recent models such as the conditional efficiency and meta-frontiers, quantile regressions, and partial frontier's method. Investigations exhibited that the research on school effectiveness demands to consider all variables which affect educational institutions and student learning outcomes for academic and social development in particular, and the entire educational system, in general.

Here, both scholars have elaborated that what we could learn from institutional economics and educational efficiency and how we can compare certainly, those methodological techniques used by the other scholars of educational efficiency. They both also analyzed the resemblances between matching and conditional efficiency, at different levels, including the district-level analysis along with the determinants of education, which affect the efficiency level. It has been observed that insights into the resemblances can aid in developing further research on educational efficiency. Unlike the above-mentioned literature, in Pakistan, yet no direct studies have been conducted on TFP while taking into account the performance of schools at district level analysis. A voluminous literature could be found to analyze the performance and quality of district-level schools in Pakistan; however, researchers have conducted most studies on specific districts, e.g., Case study of a province or a district rather than the entire Pakistan district-level school's analysis.

To assess the school performance and efficiency and to understand which schools are doing better (Khan, 2003), led the research to equate the quality of education and school performance at the district level. This study's critical attention was to evaluate the learning outcomes of students of both public and private schools in Pakistan through grade five student's achievements. For this purpose, he randomly selected 12 districts from all over the country from each district (12 primary schools, 8 governments, and four private schools were sampled), and from each school, (20 students of 5th class were sampled) for the assessment process. The overall sample consisted of 3442 (boys 1943 and girls 1499 students). For more effective assessment, he also concerned the rural and urban ratio in which (1724 urban students and 1718 rural students) were involved. Thus, to gauge the opinion of teachers about the quality of education was also involved in the assessment process. This research mainly tried to evaluate the learning achievement and outcomes of grade-5 students of both public and private schools in Mathematics, Science, and Language (Urdu).

In this study, the researcher tried to identify crucial aspects that affect the quality of education and performance of a school, e.g., teachers' characteristics, the availability of physical facilities in the school, and other socio-economic factors. Along with the quest to find the rapport between scores and the independent variables, the study correlated not only teachers' characteristics, but also the parental characteristics, and school attributes. In comparison, he also included teachers' qualifications, socio-economic status of the students, and the accessibility of infrastructure in the schools. He projected a detailed outline of those aspects that stimulus student performance and suggested that the availability of improved and modern facilities and infrastructure could enhance the internal efficiency of the education system as these elements have had a direct link with the performance of the students. Another district-level case study designed by Salfi and Saeed (2007) elaborated that school culture has a linkage with students' achievement and performance. To study this linkage, they divided the districts into four cultural areas and sampled 2,924 government high schools (from 36 districts) of the Punjab province (besides with a sample of 90 head teachers and 540 teachers). In addition, to study the variable cultural effects on students' performance, they employed a stratified and simple random sampling technique and divided the more than a half sample into rural and less than half into urban areas. The outcome of this assessment proves that cultural variables impose an immense impact not only on the efficiency and on performance of students and schools, but on the teacher's performance, also which then affects the entire efficiency level of a school.

To study the effect of the teacher's performance (Amin & Atta, 2013), exhibited another district-level case study to explore the performance of teachers at secondary school level in the Khyber Pakhtunkhwa district. They involved a random selection of the inhabitants from four districts (i.e., Kohat, Karak, Bannu, and LakkiMarwat). The analysis of the collected data accomplished through mean and standard deviation methods to serve the research questions while keeping the teacher's performance as a variable. For evaluation of the teacher's performance, a self-rating questionnaire (TJPSQ) was established. The researchers evaluate the teacher's performance to monitor and gauge quality, efficiency, and school performance, and through this, they provide an extensive data analysis on the teacher's job performance. It is obvious that there are several factors which hinder the performance of schools and for this purpose Nadeem et al. (2011) made a detailed descriptive examination for the identification of all those factors which influence the performance of teachers (specifically for female teachers) in rural and urban areas of Bahawalpur. They adopted the survey method for data collection and for the identification and analysis of those factors. They concerned the sample of 1020 students and 204 teachers of higher secondary schools to generate the results, and thus they found that most factors and the performance of teachers have had an association between them. They viewed that teacher performance acts as a catalyst in the field of education, and they also recognize some factors that influence teacher performance, e.g., External and internal factors, and studied that internal factors and many external factors can affect the teacher's success. It is evident that the availability of resources plays a decisive role in increasing or decrease school performance. Thus, their analysis concluded that adequate pre- and in-service teacher training courses should be employed in the education sector, which will source the effectiveness, creativity, and improvement in the field of pedagogy. And the closest attention should be paid to the utilization of the latest, relevant techniques and technologies in teacher education to enhance the school performance.

For the evaluation of school performance of District Sukkur S. Hussain (2018), calculated the student's performance in mathematics and science subjects. Through standardized achievement tests, the researcher tried to discover the attributes of government primary schools and make an evaluation of class IV student's performance in Mathematics and Science subjects. He conducted these tests in 55 public primary schools of Sukkur. The researcher examined the testes (in girls' schools, boys, schools, and mixed-gender schools), and after analyzing the obtained results, he suggested that all physical and infrastructural resources should be provided at primary levels for the expansion of school performance. Although, there are still many other variables and factors which hinder the efficiency, quality, and specific performance level. Students learning achievement are considered as one of the indicators to measure school characteristics, although the evaluation process possesses many gaps. However, to reduce the gaps in the evaluation of academic performance in Pakistan government schools (Hayat, Nisar ul Haq, Muhammad Sajjad, Abbas, & Raza, 2018), the study analyzed the students' academic performance concerning social media usage, physical activity, and motivation. A sample of 204 students was selected who were studying in different government schools in district Lahore. Both stratified random sampling and simple random sampling techniques are adopted to draw the sample. To analyze the performance of ninth and tenth grade students both correlation and regression analysis were used to analyze the data. All the predicted variables were measured in quantitative terms and evaluated with statistical techniques. This study just focused on a few factors to determine the students' academic performance and not include other factors like demographic factors. They concluded that, generally, different factors could influence the performance, such as the attitude of students, the teacher's attitude, family background, school environment, and school location.

The other factors and variables which affect the school outcomes are explained by Asim and Dee (2016), who provided evidence that how the critical school outcomes influence the entire curriculum period (e.g., Average enrolment of a student, functioning of school facilities, and teacher attendance). They primarily collected data from the publicly available school-level administration and regularly collected by the Program Monitoring and Implementation Unit (PMIU) of the Punjab School Education Department. They calculated the data from 26 (primary and middle schools) out of the 36 districts of the Punjab. To measure critical school outcomes and to estimate the effects of factors, "intent to treat" (ITT) method employed on a "difference in differences" specification. The comparative data collected for the untreated 21 districts provided information on the existing and the potential direction of biases in DD inferences. On the contrary, data collected from the 26 districts facilitate a "triple difference" (DDD) approach that isolates the impact of interest while considering the SCMP participation as a dependent variable. This unique calculation also examines the SCMP's effects on student and teacher attendance, school enrolment, and school facilities by using an SCMP based "difference in difference in differences" (DDD) design. Furthermore, this concise study discusses and evaluates a scalable, low-cost program that was designed to improve the administration and performance of primary and middle schools in Punjab.

Similarly, another paper presented by Mujahid and Noman (2015) analyzed the efficiency of 48,865 Government schools. They both investigated that a disciplined and efficient allocation and resource utilization can boost up a specific efficiency level. The exclusiveness of this research work is that it assimilates a wide range of microdata variables for the year 2011-12. Both scholars explored that increased Total factor Productivity (TFP) depends upon the skilled human resources and high literacy rates and also expands the economic growth of the country. To recognize the authentic performance and condition of primary schools, Laghari, Abro, and Jamali (2013) contributed through a stratified random sampling technique and selected (500 students, 200 teachers, 200 parents, and 80 officers), from the public primary schools of Sindh. The researchers discuss the contributions of students, teachers, parents, and officers towards the promotion of a school's performance. They pointed out that the infrastructure of the school and physical facilities, medium of instruction, drop out of students, curriculum introduction and implementation, teacher's attributes, the system of examination, the performance of students are some significant variables. All these have a progressive impact on school performance; thus, schools should be equipped with proper infrastructure along with other resource availability.

Researches have articulated that some micro and macro variables contribute towards the education system performance. Aimed to explore the macroeconomic variables Kiani (2013), examined the significance of some key macroeconomic variables on Pakistan's economic growth during 1980-2009. She evaluated the variables at four different education levels (i.e., Primary, Middle, and High school) and identified some other variables, including import and export, and Basic health unit (BHUs) as main macroeconomic variables. In the output evaluation process, a simple growth model is used to equate the macroeconomic variables. She also led a factual inquiry of the factors that have an immense effect on economic growth in Pakistan from 1980 through 2010. Eventually, she generated the consequences through the linear regression model and provided a strong impact of these variables on school performance. For the quest, to provide and assess the learning outcomes of children aged between 5-16 and the reflection of educational outcomes among urban and rural areas. Annual Status of Education Report (ASER) directed in 2019 (across 155 rural and 20 urban districts) of Pakistan. ASER Pakistan, Saeed and Aslam (2019), the largest citizen-based survey, works to gather primary data to evaluate key education outcomes since 2010 from across Pakistan. This survey articulates a concise outline of the learning competencies of out of school and in-school Pakistani children. This ASER survey generated data from 155 rural districts and 20 to 21 urban districts in 2018-2019. The research team of ASER has spent over 15 years examining ways to improve learning outcomes in Pakistan, and for this purpose, they initiated a Learning and Achievement in Pakistan Schools (LEAPS) program. Through, LEAPS program, they investigated and presented some findings on how learning outcomes for children in contemporary education can be enhanced.

In some of the more recent studies, Komariah et al. (2022) aimed to study the implementation of integration and cooperation models amongst educational institutions to improve the quality and efficiency of education in the rural areas of Russia and Indonesia. The study has used primary data collection based on a questionnaire to accomplish its goals. Different factors such as the working environment, vocational education, financial incentives, integrated curriculum, and webbed network system are examined. The results show that an integrated curriculum and webbed network system are the most critical factors for enhancing education quality and efficiency in the educational institutes of rural Russia and Indonesia. Shinta and Solikin (2022) examined the efficiency of translating the capital into to economic growth in case of Indonesia. The allocation of educational budget is human capital is substantial in the growth of the economy. They examined the relationship between capital efficiency and educational spending for 34 provinces using the data for the year 2015- 2019. The results shows that the incremental capital output ration has negative effect on the economic growth for most of the provinces, while educational spending shows a positive relationship.

Mergoni and De Witte (2022) published a systematic review of the studies that used the concept of efficiency in education, health, agriculture and other domains. The paper discusses in the detailed the methodology chosen to measure efficiency. Further, input out variables used in different domains and levels are also discussed in details. As it is evident from the above-mentioned gray literature, we could not find enough studies to measure the performance of schools using total factor productivity or efficiency. Thus, this research is a contribution to develop a study to analyze the performance of schools in Pakistan at the district level through total factor productivity measures using O'Donnell (2008) methodology.

3. Methodology

3.1 Total Factor Productivity and Fare Primont Index

Increasing the efficiency in educational production by using the same amount of resources to produce a higher level of output is critically essential for improving social welfare. TFP is used to measure the efficiency of the educational system at the district level. The productivity of a firm with 1 input and 1 output is defined as the ratio of output to input. However, with multiple inputs and multiple outputs, the concept of total factor productivity is defined as the ratio of aggregate output to aggregate input. Following O'Donnell (2010), we can define Fare-Primont TFP index using the set of *i= 1… Ni decision*-making units (DMUs) over the period t = 1. . . T. Each DMUs is using $x_t \in \Re_+^X$ inputs to produce $q_t \in \Re_+^Q$ level of output. The benchmark technology set for a period can be defined as follows;

$$\Psi^t = \{(x_t, q_t): x_t \in \Re_+^X, q_t \in \Re_+^Q, x_t \; can \; produce \; q_t\} \qquad (1)$$

Where $x_t \in \Re_+^X$ is the vector of inputs quantities and $q_t \in \Re_+^Q$. Thus, the TFP for the i^{th} DMU at period t is as below;

$$TFP_{it} = Q_{it}/X_{it} \qquad (2)$$

Where Q_{it}= Q (q_{it}) represents the aggregate output and$X_{it} = X(x_{it})$ represents the aggregate input of the i^{th} DMU at period t. Further, the aggregating functions Q(.) and X(.) are non-decreasing, non-negative, and homogeneous of degree 1. O'Donnell (2012) is of the view that different types of aggregate functions result in different types of index numbers. The TFP index for the i^{th} DMU in period t and h^{th} DMU in period s can be defined as the;

$$TFP_{hs,it} = \frac{TFP_{it}}{TFP_{hs}} = \frac{Q_{it}/X_{it}}{Q_{hs}/X_{hs}} = \frac{Q_{it}/Q_{hs}}{X_{it}/X_{hs}} = \frac{Q_{hs,it}}{X_{hs,it}} \qquad (3)$$

Where $Q_{hs,it}$ is the index of output quantity, which is the ratio of aggregate output of the ith DMU in period t and h^{th} DMU in time s. Similarly, $X_{hs,it}$ is the index of input quantity, which is the ratio of aggregate input of the i^{th} DMU at time t and h^{th} DMU at time s. It can be seen that if the index of input quantity is fixed, then the TFP index depends on the index of output quantity; if the DMU is fully efficient, then it is referred to as the output-based productivity index. Similarly, if the output quantity index is fixed, then the change in the TFP index depends on the index of input quantity. If the DMU is fully efficient, then it is referred to as the input-based productivity index (Caves et al., 1982). The aggregation function used the distance function following Shephard (1970) and defined the output (D_O^t) and input (D_I^t) distance function as follows;

$$D_I^t(x_t, q_t) = \max_{\rho}\{\rho > 0: (x_t/\rho, q_t) \in \Psi^t\} \text{ (Input oriented distance function)}$$

$$D_O^t(x_t, q_t) = \min_{\delta}\{\delta > 0: (x_t, q_t/\delta) \in \Psi^t\} \text{ (Output oriented distance function)}$$

The input distance function refers to the minimum level of input that can be used to produce the same level of output. In other words, the most significant factor by which the DMU can reduce its input vector to produce the fixed level of the output vector. Similarly, output distance function refers to the maximum level of output that can be produced with the given level of inputs. Alternatively, it can be defined as the maximum factor by which DMU can scale up its output vector with the fixed level of the input vector. For a fully efficient and technically feasible DMU the combination output (D_O^t) and input (D_I^t) distance function should be equal to unity. As discussed, earlier TFP index (TFPI) is the ratio of the aggregate output quantity index and the aggregate input quantity index, thus it can be defined in terms of the distance function as;

$$Q_{hs,it} = \frac{D_O(x_0, q_{it}, t_0)}{D_O(x_0, q_{hs}, t_0)} \quad (4)$$

$$X_{hs,it} = \frac{D_I(x_{hs}, q_0, t_0)}{D_I(x_{it}, q_0, t_0)} \quad (5)$$

Fare- Primont productivity index based on the distance function can be defined as;

$$TFPI_{hs,it} = \frac{D_O(x_0, q_{it}, t_0) D_I(x_{hs}, q_0, t_0)}{D_O(x_0, q_{hs}, t_0) D_I(x_{it}, q_0, t_0)} \quad (6)$$

Where,$x_0 \in \Re_+^X$ and$q_0 \in \Re_+^Q$ represents the fixed weights for the input x and q, which is the sample mean and $t_0 \in \Re_+$ is the fixed period for the sample under analysis. The $TFPI_{hs,it}$ thus defined satisfied the set of axioms, including weak monotonicity, homogeneity, identity, proportionality, time-space reversal, transitivity, and circularity (O'Donnell, 2014, 2017).

3.2 Decomposing Total Factor Productivity and Measuring Efficiency

Many different approaches, discuss the decomposition of TFP index. However, two main approaches got prominent (Balk & Zofío, 2018; Caves et al., 1982; Diewert & Fox, 2014; Grifell-Tatjé & Lovell, 1995; Nemoto & Goto, 2005; Peyrache, 2014). The first approach combines the efficiency and technical change to form the TFP index (Balk & Zofío, 2018). This approach is also referred to as the bottom-up approach. The second approach discusses the decomposition of a recognizable TFP index into technical and efficiency change components (Grosskopf & Moutray, 2001). However, the methodology developed by O'Donnell (2008) uses the main features of both approaches by first using the input and output aggregation functions to define the measures of efficiency and technical change and defined the TFP index. Further, the multiplicatively complete TFP index thus obtained is decomposed into different components of technological, technical, scale and scope efficiency change. In this study, we are using the output-oriented decomposition of the TFP under the variable return to scale (VRS) in the education sector as the government wants to maximize the output level with the given input level of human and physical capital inputs.

The idea about the educational efficiency is not new and was first discussed in early 50's however, formally discussed in the Coleman-report (Coleman et al., 1966). Though the idea of efficiency seems quite simple, but it is complicated in the case of the educational sector. Fried et al. (1993) defines educational efficiency by comparing the optimal level of inputs to the observed input levels used in the school's productivity. The comparison can be in terms of the ratio between the observed and the maximum potential value that can be produced with the given inputs. On the other hand, the ratio could also be between observed values to the minimum input required to produce the given level of output. Consider the DMU at point A with that it produces an aggregate output ofQ_{it} with the aggregate input of X_{it} (Figure 1). The point A is clearly an inefficient point to operate as it is below the maximum possible production possibility frontier. O'Donnell (2008) defines the TFP at point A as the slope of 0A (Q_{it}/X_{it}) and the TFP at point C as the slope of 0C ($\bar{Q}_{it}/X_{it}$) (Figure 1) i.e., the point on the efficient frontier. Thus, the output oriented technical efficiency (OTE_{it}) can be defined as;

$$OTE_{it} = \frac{Q_{it}/X_{it}}{\bar{Q}_{it}/X_{it}} = \frac{Q_{it}}{\bar{Q}_{it}} \leq 1 \quad (7)$$

Where, $\bar{Q}_{it}$ is the maximum level of aggregate output possible using the x_{it} level input to produce scaler multiplier ofq_{it}. The range of efficiency components lie between 0 and 1 i.e., 0 is the lower limit representing the inefficient unit and 1 represents the fully efficiency DMUs that lie on the production possibility frontier. O'Donnell (2008) associated the TFP with economies of scale and scope and defined the Output-oriented Scale Mix Efficiency as ($OSME_{it}$) as the product of Output-oriented Mix Efficiency (OME_{it}) and Residual Output-oriented Scale Efficiency ($ROSE_{it}$). The maximum TFP_{it} output mix that can be achieved by given level on input X_{it} is represented by the slope of 0V ($\hat{Q}_{it}/X_{it}$). Thus, the distance between the TFP at point C and the TFP at point V represents the mix inefficiency. OME_{it} can thus be represented as ratio between slope of 0C ($\bar{Q}_{it}/X_{it}$) and the slope of 0V ($\hat{Q}_{it}/X_{it}$) as follows;

$$OME_{it} = \frac{\bar{Q}_{it}/X_{it}}{\hat{Q}_{it}/X_{it}} = \frac{\bar{Q}_{it}}{\hat{Q}_{it}} \leq 1 \qquad (8)$$

Where, $\hat{Q}_{it}$ is the maximum level of aggregate output that is produced using technically feasible x_{it} and achieved output vector. It can be seen from figure 1 that an inefficient firm starting from point A can move improve its TFP by moving to a technically efficient point C and even a higher point V through mix efficiency but both these points do not represent the maximized TFP. Rather, TFP is maximized where the ray through the origin is tangent to the production possibility frontier (in our case PPF_2). Thus, a movement from mixed efficient point V to a maximized TFP* is represented by point E, also referred to as the $ROSE_{it}$. The mathematical representation is as below;

$$ROSE_{it} = \frac{\hat{Q}_{it}/X_{it}}{TFP^*_{it}} \leq 1 \qquad (9)$$

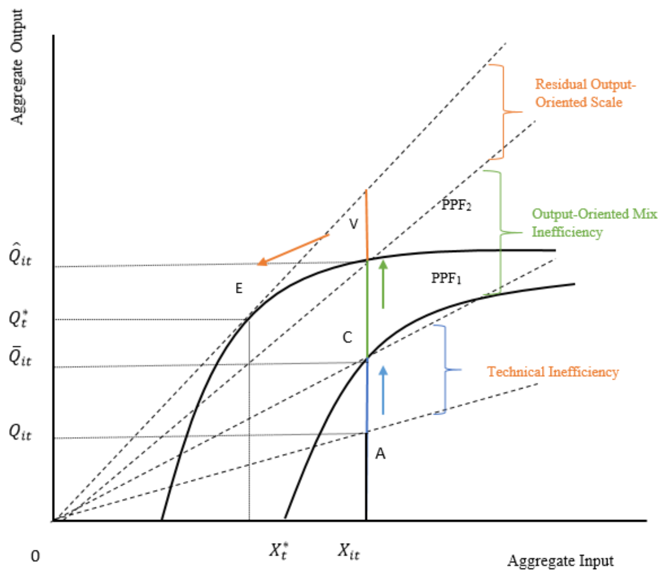
where, $TFP^*_{it} = Q(q^*_{it})/X(x^*_{it})$ and $ROSE_{it}$ is the component remaining after accounting for the technical and the mix efficiency. With the help of efficiency measure defined about we can now measure the Total Factor Productivity Efficiency ($TFPE_{it}$) as;

$$TFPE_{it} = OTE_{it} \times OME_{it} \times ROSE_{it} \qquad (10)$$

$$TFPI_{hs,it} = \left(\frac{TFP^*_{it}}{TFP^*_{hs}}\right) \times \left(\frac{OTE_{it}}{OTE_{hs}}\right) \times \left(\frac{OME_{it}}{OME_{hs}}\right) \times \left(\frac{ROSE_{it}}{ROSE_{hs}}\right) \qquad (11)$$

Equation 10 shows the efficiency measures of *i^th^* DMU in time *t.* Whereas the equation 11 shows the technological change, technical change, mix efficiency change and residual scale efficiency change of i^{th} DMU in time *t* and the s^{th} DMU in time *h.* The decomposition of the TFPI is said to be complete in a sense that there is not there is no unexplained component left.

Figure 1: Output Oriented Decomposition of Total Factor Productivity



3.3 Tobit Model

There are many methods discussed in the literature regarding the inclusion of environmental variables. However, the researchers do not agree to one method which is preferred to an alternate methodology that is available. However, the two-step DEA model has been employed widely in the literature. This approach used the efficiencies calculated in the first step, and the non-discretionary variables are than regress on the efficiency score. Simar and Wilson (2019) suggested to use the truncated model based on the drawback that Tobit model does not necessarily include/identifying the important variables that are used in the model. In another study by Simar and Wilson (2019) they suggested to use the two-stage estimator based on bootstrapping. Daraio and Simar (2005) in another study used the robust conditional estimators like alpha-quantile and order-m frontier approaches to analyze the effect of environmental variables. Similar approaches were also used by De Witte and Kortelainen (2013); J. Johnes (2015) and others. The robust approach of conditional estimators is also used for the non-parametric models (De Witte & Kortelainen, 2013). Since the efficiency scores obtained from the first stage ranges from zero to one, they are censored variables and thus an estimation using the ordinary least squares (OLS) will provide biased estimates as suggested by Agasisti et al. (2014). A limited dependent variable model is used to avoid this problem in this case the Tobit model is used to estimate the regression equation. Tobit Model is a discrete model where some of the observations are missing out of a certain range of variables in the regression model, so unavailability of observations limits the range of variations in the dependent observed variable. The censored model is available when at least the independent variables are observable and available (Üçdoğruk, Fahamet, & Hamdi, 2001). Therefore, Tobit model is used in the study, which is as follows:

$$y_i^* = x_i^T\beta + u_i \qquad (12)$$

Where y_i^* is the dependent variable, and x represents the vector of dependent variables, β is the vector of unknown parameters. The range of $y_i^*$is defined as follows:

$$y_i^* = \begin{cases} y_i^* = x_i^T\beta + u_i\,, & y_i^* > 0 \\ 0, & y_i^* < 0 \end{cases} \qquad (13)$$

The Maximum Likelihood estimation is used to obtain the estimated parameter values, and the error term is assumed to be normally distributed, further is consistent and asymptotically normally distributed (Üçdoğruk et al., 2001).

4. Data and Results

All the districts in Pakistan are considered as the targeted population to measure efficiency. This study excludes the districts in Azad Jammu and Kashmir (AJK), Gilgit-Baltistan and Federal Administrated Tribal Area (FATA) [6] due to the unavailability of district-level data on the educational input/output variables. There are 156 districts across all regions/territories of Pakistan. However, for this study only 112 districts are selected as a sample. Distribution of districts across all the regions and territories in Pakistan is presented in Table 1. Further, the table shows the total schools based on the population and the area of the region.

Table1: Overview at All the Regions and Territories in Pakistan

Sr#	States/Provinces	Districts	Density (people/km^2)	Total number of schools
1	Balochistan	32	18.9	13,279
2	Khyber Pakhtunkhwa	25	238.1	28,178
3	Punjab	36	358.52	52,986
4	Sindh	29	216.02	46,039
5	Islamabad Capital Territory	1	880.8	391
6	Federally Administered Tribal Areas	7 tribal agencies 6 frontier region	116.7	6,011
7	Azad Jammu and Kashmir	10	258	5,985
8	Gilgit-Baltistan	10	24.8	1,275

Source: Pakistan Bureau of statistics (2017)

[6] Due to the unavailability of data, 44 districts are dropped from the sample.

Baluchistan is the largest province in terms of the area followed by Punjab, Sindh, and Khyber Pakhtunkhwa (KPK). However, the population of Punjab is the highest among the four provinces. The population density is the highest in the Islamabad Capital Territory, with an area of 906 square kilometers, as there are many migrants from other areas to access the quality education and higher job opportunities available there[7]. Approximately 91 percent of the total schools lie in the four provinces, and 9 percent of schools are in the Islamabad Capital territory, tribal areas, Azad Jammu and Kashmir and Gilgit-Baltistan. Previous literature can be divided based on studies that discuss the output that is used in the education sector. Most commonly number of graduates (enrolment), average test score in different subjects and passing rate is used at individual student and institution level to measure efficiencies (Case & Deaton, 1999; Chen, 2015; Cheng, 2011; Hurtado & Ponjuan, 2005; Makri-Botsari, 2015; Mayston, 2003; Scheerens et al., 2011). However, most policymakers are more interested in the quality of the educational outcome. On the other hand, measures like enrolment and passing rate only provide information regarding the quantity of educational output rather than the quality. Therefore, most studies in educational efficiency agree on using the average test score as a better measure of educational output. In this study, panel data for the year 2013-15 is collected for the selected districts using the published data sources. Data on the output variable is taken from the report of the District Education ranking published by Alif Aliaan. However, the calculations of these output variables are based on the data published by the National Education Management Information System (NEMIS) and Annual Status of Education Report (ASER) for the panel under observation.

Table 2: Input/ Output Variables and Data Sources

Variable	Description	Years	Source
	Input Variables		
Pupil-Teacher ratio (Primary school)	It is the ratio between the total number of students and teachers—the average number of students per teacher.	2013-2016	Pakistan Educational Atlas
Teacher/school ratio	The total number of teachers available per school	2013-2016	Pakistan Educational Atlas
Size (pupil/ classroom ratio)	It is the ratio between the total number of students and the total number of rooms, i.e., average class size	2013-2016	Pakistan Educational Atlas
Classroom/ school ratio	The average number of classrooms available in each school at the primary level.	2013-2016	Pakistan Educational Atlas
Infrastructure score	It represents the percentage of schools with drinking water, electricity, latrine, and boundary wall facility.	2013-2016	Pakistan Educational Atlas
	Output variables		
Learning score	The learning score is a weighted average of the literacy rate of the population age 10 and above and percentage of class 5 students who can read in Urdu, English, and can perform a two-digit division. Equal weights are given to these 2 indicators.	2013-2016	AlifAliaan
Retention score	Retention scores is the proportion of children enrolled in class 1 who can reach Class 5	2013-2016	NEMIS

The literature on efficiency in education can also be divided based on four different categories based on the input variables that may be used at a different level of study. i.e., individual level, institution level, family-related, and community-related factors that may have an impact on the output. For the institutional level analysis, physical resources like teaching material and textbook, library, laboratory, number of classrooms, transport and other facilities are commonly considered (Banker & Natarajan, 2008; Davutyan et al., 2010; Carla Haelermans & Ruggiero, 2013; Houck et al., 2010; Z. Hussain et al., 2015; G. Johnes & Johnes, 2009; G. Johnes & Ruggiero, 2017; Naper, 2010; Wossmann, 2007). Further, not only the role of human capital, but their quality is also considered by including the indicators like teacher qualification, year of experience, teacher training and teachers' attendance is also considered contributing factor in calculation efficiency. However, this study is using the institutional variables aggregated at the district level. Data on the input variables are collected from Pakistan Educational Atlas published by the Ministry of Federal Education and Professional Training. The data on the uncontrollable environmental factor for each province is taken from the Provincial Development Statistics. Due to the unavailability of the data on the private

[7] Pakistan Bureau of Statistics (2017)

schools, this study is only considering the data on input and output variables of primary public schools aggregated at the district level (see Table 2 and 3).

The data used in this study is taken from various data sources like Pakistan Education Statistics, District Education Profile, Pakistan Education Atlas, National Education Management Information System (NEMIS) and Academy of Educational Planning and Management (AEPM). Additionally, some data have been taken from the Sustainable Development Policy Institute (SDPI), AlifAilaan, Annual Status of Education Report (ASER), and Pakistan Social and Living Standards Measurement Survey (PSLM).

Table 3: Control Variables

Variable	Description	Source
Number of Institution	The total number of public schools.	Provincial Development statistics
Literacy rate	It shows that the adult literacy rate of age 15+ year and above, who has the essential skill of reading, writing and numeracy.	PSLM (2014-15)
Population density	Total area divided by the total population in the area	Provincial Development statistics
HDI	Geometric mean of Health Index, education Index and Living Standard Index	UNDP Report (2017)
Immunization rate	The percentage of the children aged between 12 to 23 months who have been fully immunized.	PSLM (2014-15)
Satisfaction with health facility	Households that lack access to quality healthcare Facility	PSLM (2014-15)
Mean years of schooling	Lifetime education of Adult	PSLM (2014-15)
Expected years of schooling	Number of years a child is expected to spend in school based on current enrolment rates.	PSLM (2014-15)
Living standards	Taken from the Multidimensional Poverty Index: Electricity Drinking water Sanitation Infrastructure Household Fuel, Household assets	PSLM (2014-15)

4.1 Descriptive Statistics

Descriptive statistics estimate for input/output variables at the district level are presented in table 4. In the case of education, there are multiple outcomes given the multiple-input. This study considers learning and retention scores amongst the many possible educational outcomes to measure the performance of the selected districts. Large variations in the average learning score can be observed across the four regions. Punjab has the highest mean learning score amongst the regions (60) followed by KPK (45), Sindh (35), and Baluchistan (32). Retention score based on the enrollment is also used in literature to evaluate the performance of the education system. Retention score is defined as the proportion of students enrolled in class 1 who can reach class 5[8]. Alternatively, it is also considered as the indicator of students' achievement and experience during the year. Thus, a positive and increasing retention score is the indicator of the current environment in the educational institution that is a contribution towards the student's success indicated through a high learning score (Bingham & Solverson, 2016). We can observe that the institutional environment is more favorable for learning in KPK as the retention score is highest amongst the four regions, i.e., 65, followed by Punjab (59). However, the institutional learning environment seems unfavorable in Sindh and Baluchistan, which is indicated by its lower average retention score (see Table 4). Therefore, a retention rate below the mean retentions is the indication that there is room for improvement in the overall learning environment, and thus the policymakers should focus more on it[9]. Further, student enrolment can be improved by re-engaging the dropout students in the education system. Despite the recognition of the issue, there appeared to be few concert strategies that exit to reduce the drop-out and increase improvement enrolment (Ahmad, Rauf, Rashid, ur Rehman, & Salam, 2013).

Table 4 shows that on average, one teacher is available for every 31 pupils in Baluchistan, 45 pupils in KPK, 40 in Punjab, and 31 in Sindh. The teacher school ratio (TSR) is 3 in the case of Punjab and KPK, i.e., on average, 3 teachers are available in each primary school in a district. The average teacher school ratio is the lowest in the case of Baluchistan,

[8] As defined by the National Education Management Information System (NEMIS), which is the primary data source for retention score.

[9] Annual Status of Education Report (ASER)- Pakistan (2018)

i.e., 1 with a standard deviation of 1. Further, the class school ratio (CER) is the same for Punjab and KPK, i.e., on average, 3 classrooms per school; however, the pupil class ratio is the highest in KPK (44) as compared to Punjab (37). Moreover, the infrastructure index, which shows the availability of the necessities in school, is lowest Baluchistan (25) and Sindh (47), which could be the reason of the lowest retention score in these provinces. Descriptive statistics for the primary school panel data is evident that Pakistan has a diverse education sector, and large variations can be seen between the student performance, retention score, and the different input levels (Table 4).

Table4 : Descriptive Statistics for Output Variables, 2013-16

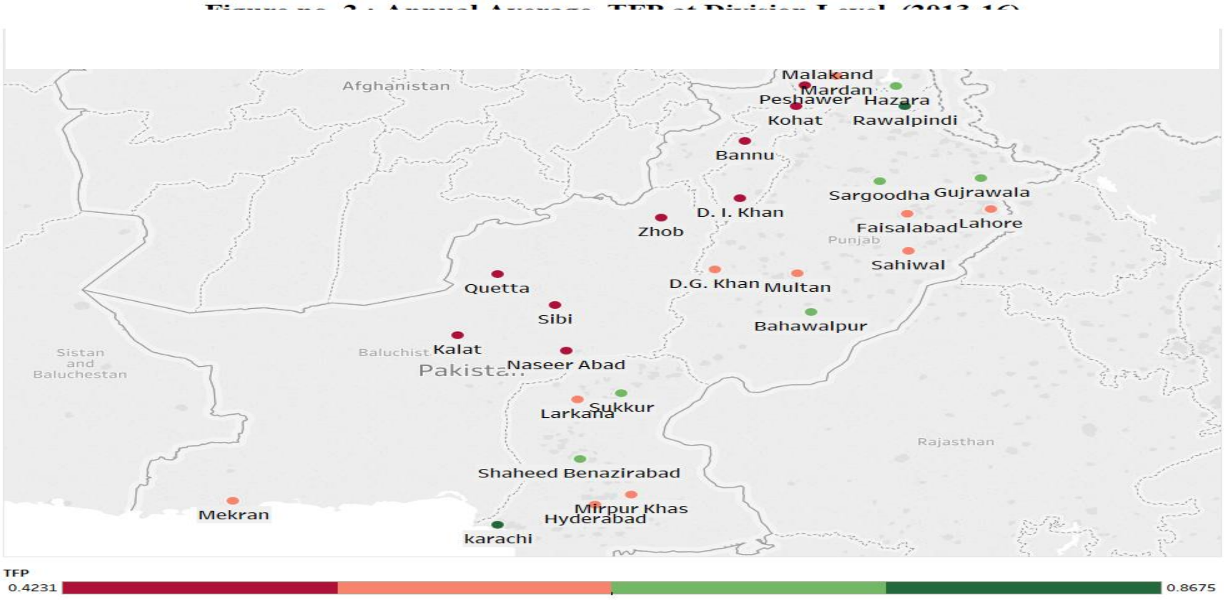
Region		Variables	Mean	Std Dev	Min	Max
Baluchistan	Output	Learning Score	32	15	8	70
		Retention Score	37	17	8	78
	Input	Pupil Teacher ratio (PTR)	31	9	16	54
		Teacher School Ratio (TSR)	1	1	1	4
		Pupil Class ratio (PCR)	27	8	13	51
		Class School ratio (CER)	2	1	1	4
		Infrastructure	25	8	5	44
Khyber Pakhtunkhwa (KPK)	Output	Learning Score	45	11	25	67
		Retention Score	65	18	18	96
	Input	Pupil Teacher ratio (PTR)	45	8	30	62
		Teacher School Ratio (TSR)	3	1	1	5
		Pupil Class ratio (PCR)	44	11	15	74
		Class School ratio (CER)	3	1	2	6
		Infrastructure	71	17	23	96
Punjab	Output	Learning Score	60	9	11	76
		Retention Score	59	18	18	95
	Input	Pupil Teacher ratio (PTR)	40	7	23	56
		Teacher School Ratio (TSR)	3	1	2	5
		Pupil Class ratio (PCR)	37	7	18	53
		Class School ratio (CER)	3	1	2	4
		Infrastructure	88	10	42	96
Sindh	Output	Learning Score	35	9	17	68
		Retention Score	47	16	15	77
	Input	Pupil Teacher ratio (PTR)	31	6	20	47
		Teacher School Ratio (TSR)	2	1	1	6
		Pupil Class ratio (PCR)	35	10	22	66
		Class School ratio (CER)	2	1	1	5
		Infrastructure	47	14	19	72
Full Sample	Output	Learning Score	46	15	8	76
		Retention Score	52	20	8	96
	Input	Pupil Teacher ratio (PTR)	37	9	16	62
		Teacher School Ratio (TSR)	2	1	1	6
		Pupil Class ratio (PCR)	36	11	13	74
		Class School ratio (CER)	2	1	1	6
		Infrastructure	61	26	5	96

4.2 Total factor Productivity across the regions

Figure 2 shows the average TFP of all the divisions of four provinces, thus help to identify the relative performance of divisions across the regions. The dark green color indicators the districts with the highest productivity across the country. Low productivity is shown in red color. It can be observed that the majority of high performing districts are located in the province of Punjab. Within country differences in the level of productivity are large, which can be due to differences in the regional income, population, administration, resources, culture, institutional quality, and geographical conditions (Holmes-Smith, 2006). Thus, the regional heterogeneity can be controlled by calculating the regional TFP. Thus, this study complements the earlier literature by considering the spatial dimensions as an important factor behind the regional differences in the TFP. Thus, this implies that the regional policies should focus more on facilities and transferring knowledge across the district. More specifically, policymakers should focus more on the efficient utilization of the existing resources by exploring economies of scale and scope (McCann & Ortega-Argilés, 2015).

Table 5 presents the primary school's productivity, efficiency level, and growth rate for all the divisions in 2013 and 2016. These figures are calculated using the Fare-Primont Index, assuming that all the primary schools have a variable return to scale (VRS). Division Rawalpindi has the highest productivity level of 81.3 percent and 78 percent in both the years, which is approximately 45.1 percent and 30 percent more productive than the overall average. The most productive schools lie in Punjab provinces like Rawalpindi, Bahawalpur, Sargodha, and Lahore. The least productive divisions belong to the Baluchistan division, including Quetta, Kalat, Zhob, and Mekran. Particularly, if we consider the Quetta division, it can be seen that it considers of five districts: Chaghi, Killa Abdullah, Noshki, Pishin, and Quetta. Amongst these districts, Killa Abdullah, Pishin, Noshkil is the lowest-performing, and Chaghi and Quetta show a high TFP[10]. The Chaghi and Quetta are considered urban area with dense population, further, being the capital city of the province, the performance is also high.

Figure 2: Annual Average TFP at District Level (2013-16)



Output oriented efficiency estimates reported in Table 5 shows that most of the divisions the technical efficiency and mix efficiency estimates are generally high; however, only a few are fully efficient. It can also be observed that for these low performing divisions the mix efficiency is higher[11] than the technical efficiency D. I Khan (ME = 0.976 and TE = 0.573), Kalat (ME = 0.973 and TE = 0.726) and Quetta (ME = 0.987 and TE = 0.783), which is an indicator that to improve the school performance technical efficiency should be improved. For which the government should focus more on teacher training and skill development. Educational spending has never been more than 2.3 percent of GDP[12], out of which, on average, 7 percent is spent on primary education. Approximately an average of 97 percent of the total budget is spent on the recurring expenditure that mostly constitutes salary expenses from 2013-16, and the rest is spent on the development[13]. The estimated growth rates of TFP and its components are also reported in table 5.

The average annual growth rate for TFP between periods 2016 and 2013 can be calculated as $\Delta TFP = (TFP_{2016}/TFP_{2013})^{\frac{1}{4}} - 1$. For example, the TFP growth rate for Kalat division for the period of 2013-16 is $\Delta TFP = (0.412/0.376)^{\frac{1}{4}} - 1 = 0.023$ or 2.32 percent. Similarly, the annual average growth rate of OME can also be calculated for Kalat as $\Delta OME = (0.973/0.940)^{\frac{1}{4}} - 1 = 0.008$ or 0.86 percent. More specifically, a 2.32 percent rate of growth in TFP of Kalat is due to 0.016 percent growth in TFP*, 0.77 percent growth in OTE, 0.86 percent growth in OME, and negative growth of 0.83 percent in ROSE. Further, the total factor productivity of 65 percent of the divisions showed growth over time, and 35 percent showed negative growth[14]. However, although the Rawalpindi division shows a negative growth rate over the four years, TFP was still the highest in 2016. The highest growth in TFP was observed in Karachi. Bannu, Quetta, Kalat, and D.I. Khan is amongst the division, which shows a low technical efficiency.

[10] School district TFP and efficiency levels are in the appendix.
11 The mix efficiency level is high but it's still inefficient.
12 Pakistan Economic survey, 2017-18. The educational expenditure as percentage of GDP was 2.1, 2.2, 2.2 and 2.3 in 2012-13, 2013-14, 2014-15 and 2015-16, respectively.
[13] Financing in Education Sector (2018)
[14]Constant average percentage Growth rate is calculated by following Christopher J. O'Donnell's (2018), "Productivity and Efficiency Analysis: An Economic Approach to Measuring and Explaining Managerial Performance", pp. 398

However, positive growth can be observed for Bannu, Kalat, and Quetta over the four years (9.34 percent, 2.87 percent, and 0.77 percent), whereas the overall position deteriorated for D. I. Khan is indicated by a negative growth rate of 5.24 percent.

The interesting feature of the estimates of the annual average growth rate is that they are additive, i.e., the growth in the TFP is the sum of the growth in TFP* and the efficiency growth. It can be seen that the annual average growth rate of TFP of Kalat from 2013 and 2016 is negative 0.0232, thus $\Delta \mathrm{TFP} = \Delta \mathrm{TFP} * + \Delta \mathrm{OTE} + \Delta \mathrm{OSME} = \Delta \mathrm{TFP} * + \Delta \mathrm{OTE} + \Delta \mathrm{OME} + \Delta \mathrm{ROSE} = 0.0150 + 0.0077 + 0.0086 - 0.0083 = 0.0232 \text{ or } 2.32 \text{ percent}.$ Theannual average growth rate calculated using the Fare Paramount index reported in table 5 is both multiplicatively and additively complete, so it can also be calculated using arithmetic averages. To make an indirect comparison of the output mix efficiency between different divisions, we can compute the transitive Fare Prominent Index for Lahore, Quetta, and Peshawar. The selected three-division is the capital of three provinces, i.e., Punjab, Baluchistan, and KPK. Such comparison is to illustrate the regional differences in the efficiency level. It can be seen that the change in OME of Lahore in 2016 compared to 2013 was 7 percent lower than Quetta[15], whereas the change in OME of Quetta over the same period was 11.1 percent higher than that of Peshawar[16]. Through the transitivity axiom, we can also compare the OME of Lahore to Peshawar via Quetta. It implies that the change in OME of Lahore is 3.3 percent higher than that of Peshawar[17].

Table 5: Annual Geometric Rate of Total Factor Productivity and its Components

		TFP			OTE			OME			ROSE			OSME		
Obs	**Divisions**	**2013**	**2016**	**Δ**	**2013**	**2016**	**Δ**	**2013**	**2016**	**Δ**	**2013**	**2016**	**Δ**	**2013**	**2016**	**Δ**
1	**Kalat**	0.376	0.412	2.32	0.704	0.726	0.77	0.940	0.973	0.86	0.784	0.758	-0.83	0.737	0.738	0.03
2	**Mekran**	0.475	0.642	7.82	0.976	1.000	0.62	0.998	1.000	0.04	0.672	0.834	5.52	0.671	0.834	5.56
3	**Naseer Abad**	0.519	0.606	3.95	0.972	1.000	0.71	0.917	0.931	0.38	0.804	0.846	1.30	0.737	0.788	1.69
4	**Quetta**	0.370	0.448	4.89	0.700	0.783	2.87	0.869	0.987	3.23	0.840	0.753	-2.69	0.730	0.743	0.45
5	**Sibi**	0.521	0.502	-0.95	1.000	1.000	0.00	1.000	0.974	-0.65	0.719	0.669	-1.78	0.719	0.652	-2.41
6	**Zhob**	0.399	0.491	5.33	0.783	0.973	5.56	0.913	0.994	2.17	0.769	0.659	-3.79	0.702	0.656	-1.70
7	**Bannu**	0.494	0.555	2.93	0.672	0.961	9.34	0.971	0.866	-2.83	0.834	0.803	-0.94	0.809	0.695	-3.74
8	**D. I. Khan**	0.496	0.424	-3.85	0.711	0.573	-5.24	0.923	0.976	1.39	0.833	0.913	2.33	0.769	0.891	3.76
9	**Hazara**	0.629	0.656	1.06	1.000	0.946	-1.38	0.986	0.995	0.22	0.702	0.839	4.56	0.693	0.835	4.79
10	**Kohat**	0.533	0.541	0.35	0.775	0.908	4.02	0.936	0.876	-1.63	0.810	0.819	0.29	0.757	0.717	-1.35
11	**Malakand**	0.567	0.439	-6.18	0.906	0.805	-2.91	0.944	0.879	-1.77	0.729	0.746	0.59	0.689	0.657	-1.19
12	**Mardan**	0.601	0.610	0.39	0.915	0.988	1.92	0.994	0.952	-1.07	0.727	0.781	1.82	0.722	0.744	0.72
13	**Peshawar**	0.507	0.531	1.16	0.795	0.851	1.72	0.982	0.964	-0.45	0.715	0.779	2.16	0.703	0.752	1.70
14	**Bahawalpur**	0.755	0.747	-0.27	0.929	1.000	1.86	0.976	1.000	0.60	0.921	0.826	-2.69	0.899	0.826	-2.10
15	**D.G. Khan**	0.648	0.606	-1.65	0.925	0.932	0.20	0.988	0.991	0.08	0.784	0.725	-1.94	0.775	0.719	-1.86
16	**Faisalabad**	0.602	0.617	0.62	0.977	0.930	-1.22	0.923	0.972	1.30	0.738	0.754	0.55	0.681	0.733	1.85
17	**Gujranwala**	0.699	0.672	-1.01	0.954	0.953	-0.03	0.963	0.939	-0.62	0.842	0.829	-0.37	0.811	0.779	-0.99
18	**Lahore**	0.670	0.649	-0.81	0.950	0.951	0.01	0.999	0.974	-0.62	0.781	0.774	-0.22	0.780	0.754	-0.84
19	**Multan**	0.616	0.593	-0.94	0.866	0.831	-1.01	0.962	0.977	0.38	0.817	0.807	-0.32	0.786	0.788	0.06
20	**Rawalpindi**	0.813	0.780	-1.02	0.965	0.992	0.70	0.998	0.976	-0.56	0.933	0.890	-1.17	0.931	0.869	-1.72
21	**Sahiwal**	0.627	0.617	-0.41	0.872	0.861	-0.32	0.987	0.991	0.10	0.806	0.799	-0.21	0.795	0.791	-0.11
22	**Sargodha**	0.673	0.687	0.53	0.867	0.972	2.89	0.986	0.999	0.33	0.870	0.782	-2.64	0.858	0.781	-2.31
23	**Hyderabad**	0.539	0.625	3.79	0.929	0.915	-0.37	0.980	0.972	-0.21	0.866	0.921	1.54	0.849	0.895	1.33
24	**Karachi**	0.529	0.763	9.59	1.000	1.000	0.00	1.000	1.000	0.00	0.775	1.000	6.59	0.775	1.000	6.59
25	**Larkana**	0.506	0.534	1.32	0.898	0.798	-2.90	0.925	0.944	0.50	0.892	0.928	0.98	0.825	0.876	1.49
26	**Mirpur Khas**	0.487	0.599	5.31	0.865	0.910	1.27	0.981	0.978	-0.07	0.841	0.882	1.20	0.825	0.863	1.13
27	**Shaheed Benazirabad**	0.606	0.722	4.48	0.933	1.000	1.74	0.990	0.969	-0.52	0.960	0.976	0.41	0.950	0.946	-0.11
28	**Sukkur**	0.574	0.676	4.14	0.941	0.991	1.30	0.964	0.937	-0.69	0.927	0.952	0.68	0.893	0.893	-0.01
Geometric Mean		0.56	0.60	1.53	0.88	0.91	0.79	0.96	0.96	0.00	0.81	0.82	0.39	0.78	0.79	0.38
Min		0.37	0.41	-6.18	0.67	0.57	-5.24	0.87	0.87	-2.83	0.67	0.66	-3.79	0.67	0.65	-3.74
Max		0.81	0.78	9.59	1.00	1.00	9.34	1.00	1.00	3.23	0.96	1.00	6.59	0.95	1.00	6.59
Efficient school divisions					3	6		5	4		0	1		0	1	

4.3 Annual Average Indexes of Changes of Total Factor Productivity and its Components

The change indices are obtained by dividing all the values of the district each year, considering the Awaran 2013 as a base for the rest of the districts. The geometric mean of change is then represented for each division: for instance, the technical efficiency change of each division is the geometric mean of four years (2013-16) values of technical change of all the divisions. The resultant change indices are represented in table 6. The value of a change index above one represents the improvement of development in the particular division,

[15] $\Delta OME_{Lahore}^{2016}/\Delta OME_{Quetta}^{2016} = (OME_{Lahore}^{2016}/OME_{Lahore}^{2013})/(OME_{Quetta}^{2016}/OME_{Quetta}^{2013}) = (1.002/1.078) = 0.930$

[16] $\Delta OME_{Quetta}^{2016}/\Delta OME_{Peshawar}^{2016} = (OME_{Quetta}^{2016}/OME_{Quetta}^{2013})/(OME_{Peshawar}^{2016}/OME_{Peshawar}^{2013}) = (1.078/0.970) = 1.111$

[17] $\Delta OME_{Lahore}^{2016}/\Delta OME_{Peshawar}^{2016} = (\Delta OME_{Lahore}^{2016}/\Delta OME_{Quetta}^{2016}) * (\Delta OME_{Quetta}^{2016}/\Delta OME_{Peshawar}^{2016} = (0.930)*(1.111) = 1.033$

whereas the value equal to 1 represents the stagnation. An index value above 1 is a representation of improvement in a division. Many studies show that technical change has a significant effect on school productivity and the economic development of the country (Taylor, Grosskopf, & Hayes, 2006). In another study by Lu, Kweh, Nourani, and Huang (2016), he examined the socio-economic efficiency and technology development and found that technology is the critical driving force for development. When all the division are taken together, the selected sample experience an improvement of 50.8 percent in the TFP over the period 2013-2016, mostly due to efficiency improvement (47.2 percent), while the technology change index is 1.024 representing a 2.43 percent improvement in the technological change for the same period. Thus, technological change is minimal in the selected period, suggesting that the government should evaluate the technological development in the education sector, and more resources should be utilized in technological improvement.

Table 6: Annual aggregated Indexes of changes of total factor Productivity and its Components

Obs	Division	dTFP	dTFPE	dOTE	dOME	dROSE	dOSME
1	**Bahawalpur**	1.707	1.666	1.241	1.171	1.146	1.342
2	**Bannu**	1.410	1.377	1.051	1.201	1.090	1.310
3	**D. I. Khan**	1.169	1.141	0.830	1.225	1.123	1.376
4	**D.G. Khan**	1.243	1.214	1.051	1.129	1.023	1.155
5	**Faisalabad**	1.618	1.580	1.217	1.206	1.076	1.297
6	**Gujranwala**	1.879	1.834	1.245	1.206	1.222	1.474
7	**Hazara**	1.584	1.546	1.152	1.210	1.109	1.342
8	**Hyderabad**	1.351	1.319	0.984	1.186	1.130	1.341
9	**Kalat**	1.280	1.249	1.020	1.144	1.071	1.225
10	**Karachi**	2.118	2.067	1.359	1.213	1.255	1.522
11	**Kohat**	1.334	1.303	1.099	1.126	1.053	1.186
12	**Lahore**	1.679	1.639	1.251	1.182	1.109	1.311
13	**Larkana**	1.160	1.132	0.980	1.153	1.002	1.155
14	**Malakand**	1.167	1.139	1.110	1.124	0.913	1.026
15	**Mardan**	1.481	1.446	1.193	1.212	1.001	1.212
16	**Mekran**	1.669	1.629	1.341	1.186	1.025	1.215
17	**Mirpur Khas**	1.360	1.327	1.066	1.219	1.021	1.245
18	**Multan**	1.497	1.461	1.141	1.127	1.136	1.281
19	**Naseer Abad**	1.618	1.580	1.309	1.196	1.010	1.207
20	**Peshawar**	1.241	1.212	1.036	1.208	0.969	1.170
21	**Quetta**	1.361	1.329	0.982	1.130	1.198	1.353
22	**Rawalpindi**	2.436	2.378	1.309	1.221	1.487	1.816
23	**Sahiwal**	1.419	1.385	1.090	1.195	1.063	1.271
24	**Sargodha**	1.769	1.727	1.174	1.203	1.222	1.471
25	**Shaheed Benazirabad**	1.622	1.583	1.135	1.158	1.204	1.395
26	**Sibi**	1.649	1.610	1.359	1.247	0.950	1.185
27	**Sukkur**	1.496	1.460	1.047	1.201	1.161	1.394
28	**Zhob**	1.565	1.528	1.248	1.223	1.000	1.224
	Geometric Mean	1.508	1.472	1.136	1.185	1.093	1.296
	Min	1.160	1.132	0.830	1.124	0.913	1.026
	Max	2.436	2.378	1.359	1.247	1.487	1.816

It can be seen from Table 6 that there is a large variation in the TFP change of all the divisions ranging from 1.160 to 2.436. The results also show that for all the divisions, the change is efficiency improvement is greater than the improvement in the technological change. The overall improvement in the educational performance is due to the policy change in 2012-13, according to which a national action plan was developed so that the educational related Millennium Development Goals (MDGs) till 2015-16 can be achieved. Results also indicate that during 2013-2016, all the divisions showed on average TFP progress. However, a small increase was observed for Larkana (16 percent), Malakand (16.7 percent), and D.I Khan (16.9 percent), while a visibly large improvement can be seen in division Rawalpindi (143.6 percent) and Karachi (111.8 percent). As the change in efficiency component is the major component in improvement in the TFP, however its worth mentioning that the magnitude of change in the components of efficiency does not show the same pattern for all the regions. For example, the 37 percent annual average increase in the TFPE in the Rawalpindi division is due to a 30 percent improvement in technical efficiency, 22 percent due to mix efficiency, and 48 percent due to residual scale efficiency. Therefore, for the Rawalpindi amongst the known factor, change in technical efficiency is more relevant. However, if we consider Larkana, the 13 percent increase in TFPE can be explained by a 2 percent deterioration in the technical efficiency, a 15.3 percent improvement in the mix efficiency, and a 0.2 percent increase in the residual scale efficiency. In case of Larkana division mix efficiency is more relevant in explaining 16 percent TFP improvement ($\Delta TFP = \Delta Tech \times \Delta\ OTE \times \Delta OSME = \Delta Tech \times \Delta\ OTE \times \Delta OME \times \Delta ROSE = 1.024 \times 0.980 \times 1.153 \times 1.002 = 1.160$).

Despite the importance of the figures, which are explaining the reason for the annual average change, it explains litter about the regional differences. Therefore, it is important to take into account the cross-regional differences. The efficiency results show that the divisions that tend to cluster on the lower end belong to the Sindh (e.g., Larkana) and Khyber PukhtumKhaw province (e.g., Makakand, D.I Khan). At the same time, the majority of high performing divisions belong to Punjab province (e.g., Rawalpindi), except for the Karachi division that belongs to Sindh. Further, insights into changes can be obtained by analysis of the district-level data[18]. Overall, the estimated changes in the technical efficiency and the mix-efficiency show that mix efficiency has been the major driver of change in TFPE for the majority of the divisions.

4.4 Frequency Distribution of Efficiency Level

Table 7 shows the detailed frequency distribution for the selected type of efficiencies. The technical efficiency score of 25 percent of the districts lies in the interval of 95 percent and above. Out of 112, only 13 districts are fully efficient. Kharan, Killa, Saifullah, Kohlu, Musakhail, Sibi, Ziarat, Chitral, Chakwal, Rawalpindi, and Karachi are amongst the high performing regions. They are fully efficient simply means that the district has optimally used the resources and reached its full capacity. Higher productivity frontier can be attained; however, additional resources are needed. Further, it also indicates that to increase the TFP, a technological shift is required. Approximately 38 percent of the districts lie below the mean value of OTE, indicating that educational policies need to be revisited so that some actions can be taken to reduce the number of underperforming districts. In the case of OSME, only district Chakwal lies in the interval of highest productivity level i.e., 95 percent and above. Again, referring to the fact that Chakwal can achieve the maximum productivity level of 99 percent by using the economies of scale and scope. In case of output mix efficiency, it can be seen that eight districts out of total shows that they are fully efficient in term of allocation of resource mix, there as 42 percent are in the performance interval of 95 percent and above. Further, 58 percent of the district may change the input mix so that they can also reach a higher productivity level. This analysis is recommending to change the allocation of resources within the school district so that higher productivity level can be achieved.

Table 7: Frequency Distribution Table

	OTE		OSME		OME	
Interval	**Frequency**	**Percentage**	**Frequency**	**Percentage**	**Frequency**	**Percentage**
0.35-0.40	0	0	1	1	0	0
0.40-0.45	1	1	4	4	0	0
0.45-0.50	0	0	5	4	0	0
0.50-0.55	0	0	10	9	0	0
0.55-0.60	5	4	18	16	0	0
0.60-0.65	3	3	25	22	0	0
0.65-0.70	5	4	20	18	0	0
0.70-0.75	12	11	17	15	0	0
0.75-0.80	17	15	5	4	3	3
0.80-0.85	11	10	5	4	7	6
0.85-0.90	14	13	0	0	16	14
0.90-0.95	16	14	1	1	39	35
0.95-1.00	28	25	1	1	47	42
Total	112	100	112	100	112	100
Mean	0.8301		0.6283		0.9294	
Min	0.4471		0.3473		0.7750	
Max	1.0000		0.9959		1.0000	

4.5 Tobit Model: Determents of Change in the Efficiency Level

The landscape of Pakistan provides potential demographical advantage to some of the districts while other districts has to face critical challenges for providing the jobs and services opportunities. The sustainable development of the country is mainly depending on the policy makers and the society, largely how they take the development process. The measure the district level developmental difference, there are many control variables available in literature. Like competition, number of educational institutions, neighborhood characteristics, location

[18] See appendix

(rural/urban), mortality rate, crime-violence, employment opportunities, poverty rate, population/district size, immigrants and others (Cordero, Santín, & Sicilia, 2013; Crespo-Cebada, Pedraja-Chaparro, & Santín, 2014; De Witte & Kortelainen, 2013; Grosskopf, Hayes, & Taylor, 2014; Grosskopf, Hayes, Taylor, & Weber, 2001; Grosskopf & Moutray, 2001; CMG Haelermans, 2012; J. Johnes, 2015). However, the three main dimensions that are considered to measure the development of a country includes, education, health and the living standard, which will be used in this section to measure the differences across the district. Therefore, if these areas are developed effectively, can play a major role in ensuring the sustainable development of the economy. In addition to these dimensions, total number of primary schools, population density and location is also considered. The table below shows that indicators that are used to measure the dimension of Human development index.

Other indicators like Multidimensional poverty index can also be considered to explain the regional difference in the performance however, no significant relationship was observed with the efficiency score, so it was dropped. Further, to measure the population division at district level, Population in MPI Intensity (percent) and Population in MPI Intensity (percent) can be considered however the correlation between the variable was found to be weak and was dropped from the analysis. Objective is to differentiate between the districts based on socio economic and geographic factors, thus a simplified population density measure is used in this section.

Table 8 : Indicators Used to Measure the Dimensions of HDI

Dimensions	Indicators
Health	Immunization rate
	Satisfaction with health facility
Education	Mean years of schooling
	Expected years of schooling
Standard of Living	Living standards from the Multidimensional Poverty Index: Electricity Drinking water Sanitation Infrastructure Household Fuel Household assets

Source: Pakistan National Human Development Report (2017)

Table no. 9 shows the Tobit regression results[19]. The overall model tries to explore the factors explaining the differences in the efficiency score. Model (1) reports the results for the technical efficiency and shows that district level literacy rate and living standard are significant and can explain the variations. Literacy rate has a significant positive effect on the output technical efficiency. Thus, indicating that the literate population is more aware about the efficient use of all the available resources. Further, the living standard is negatively linked with the technical efficiency, indicating that the focus should be more on the development of the soft skill and trainings. Literature stressed that teachers' training programs are more critical in this age than ever and the role of good teachers cannot be ignored while integrating technology. Researchers also emphasized that teachers are needed both as the facilitator for students to process the immense knowledge coming towards them and also to evolve as think tanks for societal development. In Model (2) output-oriented scale mix efficiency is the dependent variable, which is the measure of the maximum total factor productivity that can be achieved by availing the economics of scale and scope. It can be seeing that literacy rate (percent of literate population), education index (expected year of schooling and mean year of schooling) and health index has a significantly positive effect on OSME. Thus, health facilities and education is a key indicator to achieve high level of productivity for district as a whole. The high OSME can be achieved by improving the health and educational accessibility in the low performing districts. Further, Model (2) shows that population density has significantly negative effect on OSME, however the impact is too small to be considered (Table 9).

Further, model (3) shows that the output mix efficiency is negatively affected by the living standard. Health index shows a positive effect on the mix efficiency, thus overall improvement in the health facilities can help in improving the overall productivity/performance of the student that can lead to sustainable development in the society. Overall model shows that district location and total number of primary schools in the district do not have any effect on the district level performance. Further, the results also indicate that the rather than spending money on improving the living standards of the district, focus should be on providing better health and education facilities through which students can be a valuable part of the work force. Pakistani youth (15-29 years) represent the one third of the total population[20]. Therefore, better educational provide can lead to better job opportunities and can play a role in the development and growth.

Table 9: Exploring the Determinants of Change for the Efficiency

VARIABLES	Model (1) OTE	Model (2) OSME	Model (3) OME
Total Primary Schools	0.0001	0.0001	0.0001
	(0.0001)	(0.0001)	(0.0001)
Literacy rate	0.0042***	0.0058***	0.0009
	(0.0016)	(0.0009)	(0.0006)
Location (rural)	-0.0032	-0.0284	-0.0008
	(0.0433)	(0.0270)	(0.0169)
Population Density	0.0001	0.0001***	-0.0001
	(0.0001)	(0.0001)	(0.0001)
Health Index	0.0015	0.0071***	0.0026*
	(0.0036)	(0.0022)	(0.0014)
Education Index	0.0024	0.0080**	0.0033
	(0.0052)	(0.0032)	(0.0020)
Living Standard	-0.0015*	-0.0008	-0.0007**
	(0.0008)	(0.0005)	(0.0003)
Constant	0.6165*	-0.0532	0.7179***
	(0.3133)	(0.1932)	(0.1224)
Sigma	0.1320***	0.0830***	0.0519***
	(0.0096)	(0.0056)	(0.0037)
Observations	112	112	112

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

5. Conclusion

This study measures the efficiency of districts in Pakistan using non-stochastics estimation method. Total factor productivity was decomposed into its components to get the estimates of efficiency. In the estimation, substantial variation of technical, scale mix and mix efficiency among school districts is observe, with an average efficiency score of 83%, 62% and 92% respectively. The results also indicate that the single most important variable is the literacy rate that explain the variation in the efficiency scores across district. The two stage DEA model indicates that the health and socioeconomic factors have a strong influence on the district level performance. Improving education in the countries that are still developing, will improve both the growth and the benefits that can be achieved from the improved growth. Thus, nationally and internationally the government has started to invest more in the opportunities and resources that can improve the attainment and outcome in developing countries. This focus is reflected by the increase in the overall enrolment across the country. However, the primary motive is not just to improve the enrolment rather; efforts are needed in terms of improving the quality of education. As the analysis shows that the average learning and retention score is too low for the four the regions of Pakistan, much attention is needed to improve the overall quality of education. It is also evident that the increase in retention score does not guarantee that these students will be part of the work force.

In the past few year, there are many studies which reported that the change in the policies resulted in increased learning outcomes, retention and enrolment. However, we need to reconsider the fact that this sharp increase does not have a significant effect on increasing the overall total factor productivity and efficiency at regional and district level. Further, the analysis in this chapter will help research to find the gap and organize their research based on these findings. The TFP and efficiency level provide a benchmark for the overall performance of each district, where do they stand and how can the performance be improved. The results show that there are only few districts that are operating at the full efficacy level. Whereas the majority are operating lower than the means average. Thus, it proves insights to the policy makes that major districts are not utilizing their resources efficiency. The findings also guide the policy makers about the maximum total factor productivity that can be achieved by using the same resources, thus recommending an efficient resource mix. In addition, the districts with high socioeconomic status can improve their efficacy by better managing the teaching

[20] Censes, 2017

staff and workload for students, adoption of new teaching styles. Districts with low socio economic status face more challenges in terms of support at home. In these districts more resources should be allocated towards pre-school programs that can better prepare children for entering schools. Activities that may increase greater parent teacher interaction should be encouraged. Further, it is recommended to search in detail the teaching and operating practices of the fully efficient districts and implement the same in underperforming districts. Most of the urban area are operating at their full potential, but the attention is needed in the low performing rural districts. Moreover, potential of improve is also high in such low performing district. Further, there is dire need to improve the classroom instruction method i.e., the teaching method. Also, a significant difference in the infrastructure score can be seen for the province Punjab, confirming it as the indicator that guarantee higher productivity.

The results of the Tobit show that for different type of efficiency, education and health play a significant role in improving the efficiency at the district level. However, living standard affect the overall efficiency score negatively, but the magnitude of change is small. High Population density do play negative role in achieving optimal level of productivity. It can be seen form the results that district location in the urban or rural geography do not have any effect on the efficiency score of the district. The findings of the study suggests that the student's enrolment and retention rate at the district can be improved by providing better educational access and health facilities. Further, the practices of districts with high efficiency score should be carefully observed and implemented in the underperforming districts. The major limitation of district level studies is the use of aggregated data. However, there are many earlies studies who used the district level data, but few are found in case of Pakistan. Aggregation of the inputs and outputs at the district level may have caused some specification errors that have been transmitted while calculating the efficiency score. However, the observations and results are almost consistent with the findings of other similar studies. The limitation of this section also indicated the need for a more comprehensive analysis at the school level, which can help to identify the factors that can explain eventually the difference in the students' performance. The finding of this study shows that we should also focus on using existing resources effectively rather than requiring more resources to improve outcomes.

- At international level, decision-makers focus on resource planning and public management, as a significant proportion of public expenditure is devoted to education. However, Pakistan still needs to focus on resource planning and develop a standard framework to measure the efficiency of the education sector on which public resources can be managed.
- Governments should focus on improving the learning environment in order to improve retention. Because of social and economic barriers, disadvantaged students are less likely to succeed in school. Thus, a better learning environment and teacher support can improve their performance.
- The difference in district level development indicators such as health and standard of living is visible in the school's efficiency as well. These differences should also be considered while allocating educational resources.
- Teacher training with a specific focus on the teaching methods is necessary to improve technical efficiency. They will lead to improvements in student and school performance.

Considering the current education crisis, government need to put more effort on the learning of children as they have suffered a lot. According to report "Learning Losses" issued by ASER (2021) shows that COVID-19 have directly impacted an estimated 40 million school-going learners from pre-primary to higher secondary levels, in a context where school enrolment, completion and quality of learning are already low, especially for girls. The results shows that the high ranked districts survived while the Low-performing districts on the AlifAilaan ranking from 2017 have experienced the greatest learning losses. Student enrolled in governmental schools face a greater decline in learning as compare to private schools. Closure across competencies and classes halt or even reversed the increasing trends in learning outcome. National Education Policy Framework (2018) did focused on the distance and online learning but the efforts made are not enough. The report by ASER also showed that during the covid scenario, 60 percent of the enrolled students spent less than one hour learning. While 40 percent children used the smart phone for learning, 32 percent watched the broadcast by PTV i.e. Tele-School programs. While the difference do exist in terms of the availability of the technologies to individual student that affected the learning. In addition their capacity to benefit from the use of technology, with low ‘digital literacy’ and/or low “digital motivation”. The recommendations for government based on the Learning Losses are as follows:

- Programs should be devised that can support the learning of all the children despite the geographical local and gender and should focus on young children and girls.
- The factors that lead to education inequities must be tackled, such as through social protection programs for girls’ education and targeted support for children in the poorest households using low-tech and no-tech modalities.
- A new social compact for learning is needed to build connections between families, communities, and schools to collectively support children’s schooling.
- EdTech should be explored for its potential to provide solutions for innovative learning.

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