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A Two Stage Technical Efficiency of Primary Schools in Ethiopia: The Case of Harari Regional State

Salah Mohammed Abdulahi
Department of Economics,
College of Business & Economics, Haramaya University;
P.O.BOX: 138; Dire Dawa, Ethiopia, Email: nnazero324@gmail.com,
ORCID ID = https://orcid.org/0000-0001-8818-4788

Abstract
This study aims to estimate relative technical and scale efficiency of primary schools in Harari Region. To measure change in productivity of school for the period 2013-2019 and to determine factors that affecting the technical inefficiency of schools, quantitative approach with a two stage Data Envelopment Analysis (DEA) employed for measuring technical efficiency of schools. Malmquist Total Factor Productivity (MTFP) index was implemented to determine overall productivity growth of school within the given period. Censored Tobit regression model was used to determine factors affecting school's inefficiency. The result of the Constant Return to Scale DEA model shows that 10(21.7%) schools were found technically efficient, while 36(78.3%) were inefficient. The VRS DEA model indicated that fourteen (30.4%) schools were technically efficient and thirty two (69.6%) schools were technically inefficient. Out of the total schools, 47.8% schools were found to be scale efficient, while 52.2% were scale inefficient. Further, non-government schools have higher efficiency scores (99.6 %) than their counterpart government schools (91.6%). The Tobit model regression result indicated that school's ownership and location have a significant and negative sing, while coefficients of student-teacher ratio, student-class ratio and teacher's qualification and experiences had a positive singe with inefficiency of schools.
Keywords: Data envelopment analysis, technical efficiency, productivity, Tobit model.
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Background

The primary objective of Ethiopian education and training strategy is to develop individuals with a broad education who are capable of participating actively in the country's economic, social, and political life at all levels. Ethiopia's government has put in a lot of effort to meet the educational goals set out in the country's education and training policy. Massive investment in the education system, notably in elementary schools, has raised the total number of schools in the nation to 37,039 in 2019, resulting in a considerable rise in gross enrolment to 100% and female net enrolment to 96.2 percent (MOE, 2018/19). However, only 57.7% of students who begin grade 1 finish grade 8 without interruption (MOE, 2018/19). Furthermore, the quality of education has been a serious problem for the country, particularly at the basic school level. In terms of internal efficiency, the primary school dropout rate has grown from 7.8 percent in 2013/2014 to 17.5% in 2018/19. However, within the same time span, the repeat rate fell from 8.4 percent to 4.1 percent. This also indicates that the presence of a greater dropout rate paired with a higher repeat rate is a symptom of the sector's poor resource use.The performance of the education sector in Harari Regional State above the national average. Access to education in the area has reached 100%, and female net enrolment in primary schools has increased from 79% in 2013 to 9899.6% in 2017/2019, which is higher than the national average (96.2 percent). Overall literacy has grown from 68.05 percent in 2011 to 72.9 percent in 2015/16, which is higher than the national average of 54%. (HBOE, 2017; Demographic, 2016).

Despite the rapid expansion of education sector in the region, there is still a need for further improvement in quality of education particularly in primary school level. This can be more reflected in terms of student average score, dropout rate and repetition rates in the region. The national learning assessment (NLA) result indicates that the average score for Grade 8 students in the region has increased from 34.46 present in 2012 to 40.64 per cent in 2015, indicating an average improvement in each subject by 6.18 present over the period 2012-2017. However, student achievement score was not reached the minimum score as stipulated by the Ethiopian Training Police (MoE, 2018). Furthermore, the region has one of the highest repetition rate of 10.3 per cent at country level and registered 6.6 per cent dropout rate which is below the national average (17.5 per cent) (MOE, 2018/19). Hence, despite massive investment in educational sector, the expected output which is explained by student's performance has not improved over the last decades. One explanation for low educational output can be inefficient utilization of resources. Therefore, measuring the efficiency of primary school irrespective of resource utilization is a serious concern.

There are many literatures undertaken by different scholars to measure efficiency of schools using different methodological approaches. For instance, Levin (1974), Bessent (1980), Bessent et al. (1982), and Grosskopf and Weber (1989), Agasisti et al. (2012), Agasisti et al., (2014), Kinara (2014), Santın and Sicilia(2015), Andersson et al., (2017) and Günay and Haliloğlu (2018). Most of these studies and others have employed Data Envelopment Analysis method to estimate the efficiency of public education. Nonetheless, many of these literatures are concentrating on single output variable (achievement score) in measuring efficiency of schools while neglecting other outputs like attrition rate and promotion rate of school production. Furthermore, the analysis of earlier studies was based in cross sectional data type which does not capture the change in efficiency of schools through some time intervals. As far as the researcher's knowledge, there are no studies that attempted in examining the technical efficiency of primary schools at country as well as regional level. Hence, this study aimed at measuring the technical efficiency of primary schools in Harari Region. The study especially addresses the following issues; What is the degree of school productivity, and what factors influence school inefficiency. The study used two-stage DEA: (i) to estimate efficiency of the schools; and (ii) explain the inefficiencies using Tobit regression.

Methodology of the study

Types and Sources of Data

For the purpose of measuring technical efficiency of primary schools, the study employed both primary and secondary data.

Sample size

The study focuses on the entire population of primary schools in the region (N = 46) which includes both private and public schools. The schools are distributed over six urban and three rural woreda of the region.

Methods of Analysis

In order to meet the objectives of the study, three different methods of analysis were applied, the first objective of the study was addressed by the first stage-DEA method which describes the level (score) of technical and scale efficiency of schools. For the second objective, Malmquist index was used to measure the changes in productivity of schools. Lastly, censored Tobit regression model was used to address determinants of school inefficiency.

Input output variables

Initially data was prepared for 12 different inputs and 4 outputs. However, final selection of the variables was based on the completeness of the available data. Hence, variables are squeezed to 4 input and 2 output variables. The inputs include teacher student ratio, book student ratio, class student ratio and expenditure student ratio whilst the outputs consist of percentage of student score and promotion rate. The input and output variables are described in Table 1

Table1: Description of first stage input-out variables

VARIABLES	DESCRIPTION
INPUTS	
Teacher-student Ratio	The average number of teachers per hundred students at the same level of education
Book-student Ratio	The average number of books per student in a primary school
Class-student Ratio	The average number classes per hundred students at a given educational level
Expenditures-student ratio	The average expenditure per student
OUTPUTS	
Percentage of student scores	It is the average percentages of student who scores 50 and above on five science subjects
Promotion rate	Rates of students' promotion from one grade level to the other grade levels.

Source: own computation

The choice of the above-mentioned input output variables was based on two considerations. Past studies undertaken on efficiency of schools in African and Asian countries which employed similar inputs and outputs (Kinara 2014; Huguenin 2015; Santın and Sicilia 2015; and Aminarh, 2017).The availability of relevant data from the report of regional education bureau.

Explanatory variables

Based on past literatures, the study identified some explanatory variables from school's inputs and uncontrollable variables that determine the inefficiency scores of primary schools. These include; School type, Locations, Teachers' Experience below five years, Teachers' Experiences above five years, Teacher's qualification stated as Certificate, Diploma and Degree, Student Teacher Ratio, Student Class Ratio, and School's Ages (Emmanuel 2016; MacNeil et al., 2009; Kola and Sunday 2015).

Data management and analysis methods
The input output variables are used to generate the efficiency scores of schools using DEAP version 2.1 linear programming packages. The efficiency scores are also presented in three different DEA models; CRS, VRS and Scale efficiency. Further, Malmquist index was applied to observe changes on productivity of schools for the last seven years. STATA 13 was used in second stage DEA to identify factors which affects inefficiency of schools.

Model specification
Data Envelopment Analysis (DEA) is a non-parametric, data driven approach that uses linear programming techniques to compute the efficiency scores for each DMU in a data set. DMUs that are technically efficient have a score of 1 or 100 %, whereas inefficient ones have efficiency scores of less than 1 (i.e. less than 100 %). In DEA, the efficiency of a DMU (schools) is measured relative to a group's observed best practice. This implies that the benchmark against which to compare the efficiency of a particular school is determined by the group of schools in the study and not a value fixed by schools outside of the group. DEA easily accommodates multiple inputs and outputs without the requirement for a common denominator of measurement. This makes it particularly suitable for analysing the efficiency of schools as they use multiple inputs to produce many outputs.

First Stage DEA Model
Constant Returns to Scale (CRS) Model
The CRS DEA model is used to measures the overall efficiency for each school. The objective function is to maximize the efficiency of a school subject to constrain that no school will be more than 100% efficient. Furthermore, the coefficient values are assumed to be positive and non- zero, when the same set of coefficients (weights) are applied to all other schools being compared. To define the DEA model,
Let:

h_i: Technical efficiency for school.
Yr_i: Amount of output r produced by school i .
Xj_i: Amount of input j used by school i.
U_r : Weight given to output r.
V_j: Weight given to input j.
i : indicates n different schools.
r : indicates the s different outputs.
j : indicates the m different inputs.
U_r And V_j are variables to be estimated.

Under the restriction that each school's efficiency is judged against its individual weight system, efficiency of a school can be obtained as a solution to the following problem: Maximize the efficiency of school *i* under the restriction that the efficiency of all units $\leq$ 1. The algebraic model is (for school k as an example):

$$Max_{U,V} h_k = \frac{\sum_{r=1}^{s} Ur_k Yr_k}{\sum_{j=1}^{m} Vj_i Xj_i} \quad \ldots\ldots\ldots\ldots (1)$$

$$S.t \quad \frac{\sum_{r=1}^{s} Ur_i Yr_i}{\sum_{j=1}^{m} Vj_i Xj_i} \leq 1, \quad \text{for each unit } i$$

$$U_r, V_j \geq 0$$

Equation (1) is a fractional programming model, and to solve, it needs to convert into linear form. Thus, following Charnes and Cooper's transformation of fractional programming into linear programming the following constraint is introduced.
That is,

$$\sum Vj_i Xj_i = 1$$

Thus, the multiplier forms the linear programming problem for school k become:

$$Maxh_k = \sum_{r=1}^{s} Ur_k Yr_k \quad \ldots\ldots\ldots (2)$$

$$S.t \quad \sum_{r=1}^{s} Ur_i Yr_i - \sum_{j=}^{m} Vj_i Xj_i \leq 0,$$

For each unit i

$$\sum_{r=1}^{m} Vj_k Xj_k = 1$$
$$U_r, V_j \geq 0$$

The Variable Returns to Scale (VRS) and Scale Efficiency Model

The VRS model, measures pure technical efficiency and returns to scale for each of the schools. A simple relaxation of the assumption of the CRS model enables us to change the CRS model into VRS model. This is done by adding another constraint, convexity constraint, to equation (2) of the CRS model. This convexity constrain is not imposed in the CRS case.

Hence, in a CRS-DEA, a firm or a school may be benchmarked against firms, which are larger (smaller) than it. Thus, the convexity constraint enables a school to be benchmarked or compared with school of a similar size.

Therefore, the VRS model is:

$$Max\ h_k = \sum UrYr_h + W_k \ldots\ldots\ldots\ldots\ldots (3)$$

$$S.t \qquad \sum Ur_i Yr_i - \sum Vj_i Xj_i + W_k \leq 0$$

$$\sum Vj_k Xj_k = 1$$

$$U_r, V_j \geq 0$$
$$\sum W_i = 1$$

Where: w_k is the convexity constraint and its sign determines the returns to scale. If $w_k < 0$ it indicates increasing returns to scale, if $w_k > 0$ it is decreasing returns to scale and, if $w_k = 0$ it is constant returns to scale. The other notations are as given in the case of CRS model. The difference between the efficiency scores of CRS and VRS DEA models show SCALE efficiencies of school. Thus;

$$SCALE\ Efficiency = \frac{CRS}{VRS}$$

Scale efficiency measures size of DMUs. The size of a school may sometimes be a cause for inefficiency. This is referred to as scale inefficiency and takes the forms – Decreasing Returns to Scale, Increasing Returns to Scale and Constant Return to Scale.

Total Factor Productivity

Total Factor Productivity (TFP) represents the change of productivity in a multiple input-output firm. It is the average product of all inputs used in production. Basically TFP is measured by Malmquist index named after a Swedish Economist Malmquist on 1953.

Malmquist productivity index can be defined using the technology of period t as well as that of period $t+1$, it is defined as the geometric mean of the two indices based on periods t and $t+1$ technologies. It is estimated as the ratios of distance functions of observations from the frontier (Coelli et al, 1998).

Fare et al., (1994) specified the output oriented Malmquist productivity change index as:

$$M_o^{t+1}(x^{t+1}, y^{t+1}, x^t, y^t) = \left[\frac{D_o^t(x^{t+1}, y^{t+1})}{D_o^t(x^t, y^t)} \times \frac{D_o^{t+1}(x^{t+1}, y^{t+1})}{D_o^{t+1}(x^t, y^t)}\right]^{1/2}$$

Fare et al., (1994) further decomposed the Malmquist index into two parts:

$$M_o^{t+1}(x^{t+1}, y^{t+1}, x^t, y^t) = \frac{D_o^{t+1}(x^{t+1}, y^{t+1})}{D_o(x^t, y^t)} \times \left[\frac{D_o^t(x^{t+1}, y^{t+1})}{D_o^{t+1}(x^{t+1}, y^{t+1})} \times \frac{D_o^t(x^t, y^t)}{D_o^{t+1}(x^t, y^t)}\right]^{1/2}$$

The terms outside the brackets measure relative technical efficiency at t and t + 1,capturing changes in relative efficiency overtime, that is, whether production is getting closer (catching up) or farther from the frontier. The geometric mean of the two ratios inside the brackets captures the shift in technology between the two periods evaluated at x^t and x^{t+1}, thatis,

$$\frac{D_o^{t+1}(x^{t+1}, y^{t+1})}{D_o^t(x^t, \ y^t)} = Technical\ Efficiency\ change$$

$$\left[\frac{D_o^t(x^{t+1}, y^{t+1})}{D_o^{t+1}(x^{t+1}, y^{t+1})} \times \frac{D_o^t(x^t, \ y^t)}{D_o^{t+1}(x^t, \ y^t)}\right]^{1/2} = Technological\ change$$

Where the subscript indicates output-orientation, M is the productivity of the production point (x^{t+1}, y^{t+1}) relative to the earlier production point (x^t, y^t) and D is the output distance while x^t and y^t are the inputs and outputs respectively.

According to Coelli et al (2003) and Lovell (1993), If $x^t = x^{t+1}$ and $y^t = y^{t+1}$ (i.e., there has been no change in inputs andoutput between the periods), the productivityindex signals no change: $M_o^{t+1} = 1$.

Improvements in productivity yield Malmquist indexes greater than unity $M_o^{t+1} > 1$. Deterioration in performance over time is associated with a Malmquist index less than unity.

Input-output orientation

Technical efficiency attempts to address two questions depending on whether it has output or input orientation. Output-oriented technical efficiency the focus is on expanding output quantities without changing the quantity of input used. On the other hand, input-oriented technical efficiency focuses on reducing input quantities used without changing the quantity of output produced. In this study, output-oriented analysis was applied since schools input resources are more or less fixed relative to school outputs.

Second Stage (Tobit Regression) DEA Model

To examine the DEA scores against the stated inefficiency determinants, the adopted model is based on Zere et al., (2006), Jehu-Appiah et al., (2014), Mujasi, et al 2016,and Ali et al., (2017) model specification. Like these studies, the study transforms the DEA scores in to inefficiency scores using the following formula:

$$\textbf{Inefficiency score} = \left(\frac{1}{DEATE\ score}\right) - 1$$

Since the dependent variable (inefficiency scores) is continuous between one and zero, the study used a censored Tobit model for the given seven year periods. The model is specified as:;

$$y_i^* = x_i\beta_i + \mu_i$$
$$y_i = y_i^* if y_i^* > 0$$
$$y_i = 0\ if y_i^* \leq 0$$

$where,\ \ \mu_i \sim N(0, \sigma^2)$

y_i^*: a latent (unobservable)Variable

y_i: observable inefficiency score

β_i: Kxl Vector of unknown parameters which determines the relationship between the independent variables and the latent variable

x_i: *K x l* vector of explanatory variables

Therefore, the model for estimating the determinants of inefficiency of schools specified as:

$$ineff_{it} = \beta_{oit} + \beta_{1it}NONGOV + \beta_{2it}URBAN + \beta_{3it}EX1 + \beta_{4it}EX2 + \beta_{5it}STR + \beta_{6it}SCR + \beta_{7it}CERT + \beta_{8it}DIPL + \beta_{9it}DEGR + \beta_{10it}SCAG + \varepsilon_{it}$$

The variables in the model are defined as:

Ineff: inefficiency scores of school *i* in time *t*

$NONGOV$: represent the types of school which is dummy variables, 1 if the i^{th} school is non-government, 0 otherwise.

$URBAN$: shows the location of schools, that is dummy variable. 1 if the i^{th} school is located in urban area, 0 otherwise.

$EX1$: Represents the number of teacher in i^{th} school who has teaching experiences up to seven years.

$EX2$: indicates the number of teacher in i^{th} school who has teaching experiences above seven years.

STR : Represents the average number of students per teacher at i^{th} school. Measured by dividing the total number of students by the total number of teachers

SCR: signifies the average number of student at a given classes in i^{th} school. It is calculated by dividing the total number of students by the total number of classes.

$\boldsymbol{CERT}$: Shows the number of teachers who has certificate as a qualification in *i^th^* school.

$\boldsymbol{DIPL}$: Shows the number of teachers who has Diploma as a qualification in *i^th^* school.

$\boldsymbol{DEGR}$: Shows the number of teachers who has Degree as a qualification in *i^th^* School.

$\boldsymbol{SCAG}$: Represents the Length of time or years in operation of *i^th^* school.

Where; $\beta_0, \beta_1, \beta_2, \beta_3, \beta_4, \beta_5, \beta_6, \beta_7, \beta_8, \beta_9, and \beta_{10}$ are coefficients to be estimated ε_{it} random disturbance.

Results and Discussion

Descriptive analysis of inputs and output variables

Data are gathered for 46 primary schools of the region over a period of seven years with an aggregation of 322 observations.

Table 2: Statistical description of input-output variables

Variable	Observation	Mean	Standard Deviation	Minimum	Maximum
Input Variables					
Teacher Student Ratio	322	4.9	3.1	1	23
Book Student Ratio	322	1.0	0.0	1	1.0
Class Student Ratio	322	2.9	2.2	1	18.0
Expenditure Student ratio	322	461.65	1,157.62	40.50	10,000.00
Output Variables					
Percentage of Student Score	322	16.8	24.3	0.1	97.4
Promotion Rate	322	87.4	10.5	55.0	100.0

Source: own computation

Table2 indicates the overall description of schools' input and output variables which includes; number of observations, mean, standard deviation, minimum and maximum values for the specified variables. Thus the average percentage of Teacher student ratio is 4.9 teachers per hundred students which vary between schools with minimum ratio of 1to a maximum of 23teachers. Similarly, the average Book student ratio, Class student ratio, and Expenditure student ratio are 1, 2.9 and 461.65 respectively with variations among school on intervals.

Regarding to school output variables, the average percentage of student scores was very low as observed in a given school which remained16.8 percent. This implies that about 83.2 percent of students are scored below 50 percent in sciences subjects. Further, it ranges from schools were there are few students that scored above 50 percent in basic science courses to school that scores the maximum value of 97.4 percent. However, the average promotion rate of school is 87.4 percent that ranges from a minimum of 55 to a maximum of 100 percent.

First Stage DEA Analysis

Table3 shows the individual school DEA scores for constant returns to scale technical efficiency (CRSTE), variable returns to scale technical efficiency (VRSTE) (pure technical efficiency), scale efficiency, and returns to scale (RTS). According to CRS model, ten (21.7 percent) schools have technical efficiency score of one (100 percent) that implies they are found on the production frontier. The remaining thirty six (78.3 percent) schools have efficiency scores below one, which implies that they are found below the efficient frontier and considered to be inefficient. The average technical efficiency score in CRS model is 0.930 (93 percent), with standard deviation of 7.3 percent.

The VRS model result reveals that fourteen (30.4 percent) schools have scored technical efficiency of one (100 percent) and the remaining thirty two (69.6 percent) schools are technically inefficient by scoring below 100 percent as compared to their peer school. The average VRS technical efficiency score is 0.936 (93.6 percent), with standard deviation 0.075 (7.5 percent).

Table 3 Primary school technical and scale efficiency for 2013/14 to 2018/19

S.N	(Schools)	CRSTE	VRSTE	SCALE	RTS	S.N	(Schools)	CRSTE	VRSTE	SCALE	RTS
1	ABOKER	0.947	0.947	1	CRS	24	KELADANBA1	0.977	0.984	0.993	DRS
2	ABOKERM.	0.916	0.916	0.999	DRS	25	KILEGONA	0.827	0.827	1	-
3	ALHABESH	0.971	0.981	0.99	DRS	26	KOROMI	0.767	0.769	0.996	DRS
4	AWABDAL	1	1	1	CRS	27	KUNDUDU	1	1	1	CRS
5	AWBERKELE	0.93	0.93	1	CRS	28	LIFELIN	0.955	1	0.955	DRS
6	AWDIGDIG	0.891	0.893	0.998	DRS	29	LUTRANT	0.953	0.96	0.992	DRS
7	AWMUJAHDIN	0.919	0.922	0.997	DRS	30	MEKANES	0.957	0.997	0.961	DRS
8	AWUMER	0.766	0.771	0.994	DRS	31	MENFESAWI	1	1	1	CRS
9	BETHELEHEM	1	1	1	CRS	32	MIYAYE	0.794	0.794	1	CRS
10	BIYOARAB	1	1	1	CRS	33	MODEL	0.97	0.97	1	CRS
11	BURKA	0.96	1	0.96	IRS	34	NICOLAS	0.941	0.943	0.998	DRS
12	DEKER	0.857	0.859	0.997	DRS	35	RAINBOW	1	1	1	CRS
13	DIRTAYRA	0.985	0.985	1	CRS	36	RASMEKON	0.921	0.922	1	CRS
14	ERERDOD	0.993	0.993	1	CRS	37	SOF	0.976	1	0.976	DRS
15	ERERWELDIA	1	1	1	CRS	38	SENA	0.935	0.937	0.998	DRS
16	GELMASHIRA	0.78	0.78	1	CRS	39	SHENKOR	0.83	0.838	0.99	DRS
17	GEYMEDRESA	0.966	0.983	0.983	DRS	40	SIGICHA	0.895	0.895	1	CRS
18	HARAWEE	0.851	0.855	0.996	DRS	41	SOFI	0.983	0.983	1	CRS
19	HASENGAE	0.799	0.8	0.998	DRS	42	SOS	1	1	1	CRS
20	HIRA	0.984	1	0.984	DRS	43	SUKUL	0.874	0.876	0.998	DRS
21	HITECH	1	1	1	CRS	44	ULANULA	0.84	0.845	0.995	IRS
22	JEGNOCH	0.991	0.991	1	CRS	45	WISDOM	0.957	0.997	0.96	DRS
23	JIBRAILL	1	1	1	CRS	46	YESHMEBET	0.918	0.922	0.996	DRS

	CRSTE	VRSTE	SCALE	
Mean	0.93	0.936	0.994	CRSTE = Constant Return to Scale Technical Efficiency
Standard Deviation	0.073	0.075	0.012	VRST = Variable Return to Scale Technical Efficiency
				DRS =Decreasing Return to Scale,
Minimum	0.766	0.769	0.955	IRS = Increasing Return to Scale
Maximum	1	1	1	CRS = Constant Return to Scale, Scale Efficiency = CRSTE/VRSTE

Source: own computation

Regarding to scale efficiency, twenty two (47.8 percent) schools were found to have technical efficiency score of one (100 percent). This implies that they were at the optimal size for their particular input-output combinations. The remaining twenty four (52.2 percent) schools had scale efficiency score less than one (100 percent) that deemed scale inefficient. Thus, schools are operating below their optimal size.

Furthermore, scale efficiency provides us with the rate of return at which schools are associated with proportionate change in input variables to a proportionate change in their output variables. According to table3, there are twenty two (47.9 percent) schools exhibits constant return to scale; implying that schools output would increase in the same proportion as of their inputs. In other words, these schools are operating at their most productive scale size. Only two schools (BURKA and ULANULA) are operating at increasing return, implying that educational outputs would increase by a greater proportion as compared to educational inputs. Thus, the school needs to increase its size of operations to achieve optimal scale. This means the school should continue its increment until it reaches at constant return to scale level. Decreasing return to scale observed from twenty two (47.9 percent) schools, this reveal that educational output would increase by a small proportion as compared to educational inputs. Therefore, schools should reduce their size of operation so as to achieve optimal scale. Since any increase in educational inputs would translate to a less than the proportionate increase in output.

Efficiency score also vary between government and non-government schools. From thirty four government schools, five (10.9percent), six (13 percent) and seventeen (37 percent) schools have technical efficiency score of one (100 percent) in terms of CRS, VRS and SCALE models respectively. The average technical efficiency scores are 91.2%, 91.6% and 99.7% for CRS, VRS and SCALE models, respectively. Therefore, government schools on average could increase their educational outputs by 8.8 percent, 8.4 percent and 0.3 percent to be technically efficient with their current resource endowment in CRS, VRS and SCALE models respectively.

Similarly, out of twelve Non-government schools, five (41.7 percent), eight (66.7 percent) and five (41.7 percent) schools were found to have technical efficiency score of one (100 percent) for CRS, VRS and SCALE models, respectively. On average non-government schools could raise their efficiency by 2.1%, 0.5% and 1.5% so as to reach to the most efficient level of production according to the measure of CRS, VRS and SCALE models respectively. Thus, technical efficiency score varies in accordance with school ownership.

Total Factor Productivity

Using the Malmquist index, the study aimed to quantify total factor productivity and its related changes from 2013 to 2019. there are different components which are used in performance measurement, that include; change in technical efficiency, technological change, change in pure technical efficiency, change in scale efficiency and change in total factor productivity. Numbers greater than one implies that productivity is improving or progressing. Values less than one, on the other hand, indicate deterioration or regression. Values equal to one indicate that no progress was made in prior periods. Table 4 presents the Malmquist index summary of annual means.

Table 4: Malmquist index summary of annual means

Year	**(1)=(3)*(4) △ Technical Efficiency**	**(2) △ Technological efficiency**	**(3) △ Pure Efficiency**	**(4) △ Scale Efficiency**	**(5)=(1)*(2) △ Total Factor Productivity**
2014	0.964	1.068	1.001	0.963	1.03
2015	1.015	0.47	1	1.015	0.477
2016	0.956	1.079	1	0.956	1.031
2017	1.055	0.949	1	1.055	1.001
2018	0.962	1.094	1	0.962	1.052
2019	1.03	0.741	1	1.03	0.763
Mean	**0.997**	**0.900**	**1**	**0.997**	**0.892**

Source: own computation

The average total factor productivity changes by 0.892 which is less than one and hence signifies that there was a deterioration of 0.108 (10.8%) in productivity of schools during this periods. This is mainly caused by deterioration of technical efficiency change by 0.3 percent and technological changes by 10 percent. Moreover, the deterioration of technical efficiency change is due to majorly by scale efficiency by 0.3 percent than pure efficiency change which has shown no improvements.

The largest decline in school productivity was recorded in the 2015 fiscal year, when the index dropped below one. That is, total factor productivity decreased by 52.3 per cent, while technical efficiency dropped by 53%. This is because there was a huge mobilization at the national level to limit and control the practice of exam cheating in Grades 8 and 10. As a result, the percentage of students scoring fifty or above has decreased considerably. As a result, the overall performance of the school's productivity decreases. Table 5 below summarizes the Malmquist index for school means.

Table5: Malmquist Index for School Means

DMUs	Effch	Techch	Pech	Sech	Tfpch	DMUs	Effch	Techch	Pech	Sech	Tfpch
1	1.008	0.802	1	1.008	0.808	24	1.004	0.81	1	1.004	0.813
2	0.998	0.798	1	0.998	0.796	25	0.968	0.801	1	0.968	0.775
3	0.998	1.002	1.002	0.996	1	26	0.987	0.817	1	0.987	0.807
4	0.985	0.796	1	0.985	0.784	27	1.082	0.799	1	1.082	0.865
5	0.936	0.794	1	0.936	0.743	28	1	1	1	1	1
6	1.017	0.8	1	1.017	0.813	29	1.014	0.991	1.005	1.008	1.004
7	1.017	0.793	1	1.017	0.806	30	1.003	0.979	1.001	1.002	0.982
8	0.965	0.8	1	0.965	0.772	31	0.973	0.795	1	0.973	0.773
9	1	0.95	1	1	0.95	32	0.999	0.802	1	0.999	0.801
10	0.981	0.772	1	0.981	0.758	33	0.983	0.805	1	0.983	0.791
11	0.983	0.87	1	0.983	0.855	34	0.995	0.797	1	0.995	0.793
12	0.997	0.801	1	0.997	0.798	35	1	1.003	1	1	1.003
13	0.977	0.795	1	0.977	0.777	36	0.983	0.801	1	0.983	0.788
14	0.97	0.808	1	0.97	0.784	37	1	1.001	1	1	1.002
15	1.013	0.827	1	1.013	0.838	38	1.013	0.815	1	1.013	0.826
16	1.066	0.771	1	1.066	0.822	39	1.003	0.806	1	1.003	0.809
17	0.961	0.795	1	0.961	0.764	40	1.019	0.795	1	1.019	0.809
18	1.036	0.796	1	1.036	0.825	41	0.988	0.796	1	0.988	0.786
19	1.054	0.803	1	1.054	0.846	42	1	1.013	1	1	1.013
20	1	1.103	1	1	1.103	43	0.968	0.801	1	0.968	0.775
21	1	1.007	1	1	1.007	44	0.951	0.792	1	0.951	0.753
22	0.996	0.799	1	0.996	0.796	45	1	1.05	1	1	1.05
23	0.982	0.794	1	0.982	0.78	46	0.986	0.802	1	0.986	0.791
Mean	**0.997**	**0.847**	**1**	**0.996**	**0.844**						

Source: Own Computation

Note: Effch = Technical Efficiency change, Techch =Technological efficiency change, Pech = Pure Efficiency change, Sech = Scale Efficiency change, Tfpch = Total Factor Productivity change

Second Stage DEA Analysis

The second stage DEA analysis examines the determinants of technical inefficiency of school which are calculated in first stage DEA analysis. There are different internal, socioeconomic and environmental factors that determine the efficiency of school performance. However, this study concerns about those factors which are measureable and have an easy access for obtaining the required data.

Thus, factors like; School locations(urban), ownership (Non-government), school age (SCA), number of teachers with; certificate (CERT), diploma(DIPL) and degree(DGR), Experiences of teachers below five years (EX1), Experiences of Teacher above five years(EX2) and student teacher ratio(STR), and student class ratio (SCR) are considered as independent variables. To scrutinize the DEA scores against the stated independent variables, VRS DEA efficiency scores are transformed into inefficiency scores as shown in methodology.

Pooled regress model also consider as a comparison to our result for Tobit model. Table 6 shows results for both Pooled and Tobit models.

Table 6: Pooled and Tobit result on determinants of school inefficiency

	Pooled			Tobit		
Variables	Coefficient	Std. Error	t- values	Coefficient	Std. Error	z
NON-GOV.	-0.2327***	0.0412	-3.23	-0.1932*	0.0723	-3.45
URBAN	-0.0553	0.0445	-1.43	-0.0563	0.0712	-0.75
STR	0.0024**	0.0021	2.96	0.0032*	0.0015	2.12
SCR	0.0033**	0.0009	-2.85	0.0029**	0.0006	-2.67
CERT	0.0084	0.0062	1.83	0.0076	0.0055	2.48
DIPL	0.0064***	0.0018	3.99	0.0054*	0.0024	3.08
DEGR	0.0097**	0.0045	2.51	0.0051	0.0048	0.57
EXP1	0.0153***	0.0034	5.26	0.0173***	0.0040	4.75
EXP2	0.0045**	-2.7500	2.75	0.0087**	0.0025	4.18
SCAG	0.0007	0.0006	0.94	0.0007	0.0015	0.67
Cons	-0.9563	1.1451	-0.96	-1.4356	1.8321	-0.63
				Sigma _u 0.1048	0.1733	4.41
				Sigma _e 0.1471	0.0086	17.1
				rho	0.4351	0.0732
				40 : left-censored observations		
				190 : uncensored observations		
				0 : right-censored observations		
				Number of groups = 46		
				Wald chi2(10) = 179.06		
				Prob> chi2 = 0.0000		
				Log likelihood = 36.84		

***, ** and * indicates the level of significance at 1, 10 and 5 percent, respectively.

According to the table above, the signs and coefficients of explanatory variables are most likely comparable in both models. The standard error and level of significance of the coefficients, on the other hand, varies. One limitation of Pooled regression is that when the variables are censored, the regression provides inconsistency estimates of the parameters, which means that as the sample size increases, the coefficient from the analysis will not necessarily approach the true population. (Long, 1997).

The sign of the coefficient NON-GOV is negative. This means that the inefficiency of non-government schools is 0.193 lower than that of government schools. To put it differently, non-government schools are more efficient than government schools. This is because non-government schools have better school infrastructures and amenities than their government counterparts. They also have a strong administrative system, as well as highly trained and experienced instructors and personnel.. This result is consistent with the findings of Cebada et al., (2004).

Student – teacher ratio (STR) indicates that there is a positive sign as expected, and is statistically significant at 10 per cent level of significance. A unit increase in the ratio of STR would lead to an expected increment of school's inefficiency by 0.0032, holding all other explanatory variables constant. In other word the higher STR the higher the inefficiency scores. Aminrah (2017); Hu et al.,(2012) and Muvawala and Hisali (2012) show that efficiency of schools are negatively affected by student- teacher ratio. This is due the fact that, high student-teacher ratio suggest that each teacher has to be responsible for the management of a large number of student in a class which makes it difficult to supervise the class.

Similarly, the coefficient for student-class ratio (SCR) assumed a positive sign as expected, and is statistically significant at the 5 per cent level of significance. An increase in the ratio of SCR would lead to an expected increase in school inefficiency by 0.0029, holding all other parameters constant; in other words, as the number of student in a class decreased then the efficiency of student would be improved. This is because; class size has an effect on the performance of student. In small classes it is easy to manage the class and teachers would communicate and interact effectively with student. These in turn affect performances of students. This finding is confirmed by Daga (2015),

From the coefficients of teacher qualifications, only teacher with diploma (DIPL) could influence inefficiency of schools than teachers with certificate and degrees. One reason could be, most teachers in primary school are qualified with diploma status. According to the coefficient of DIPL, there was a positive sign which is unexpected and statistically significant at the 5 percent level of significance. This implies that as the number of teacher qualified with diploma increased by a unit then the expected inefficiency of schools would increase by 0.0054, holding other parameters constant. Similarly, the coefficient for teacher's experience for below five years (EX1) and above five years (EX2) shows un expected positive sing with inefficiency result, and statistically significant at 1 and 5 percent level of significances respectively. This is to say that as number teacher experience increased the inefficiency of schools would raises. In other words, when the number of teachers experience increased by a unit the expected inefficiency would rise by 0.0173 and 0.0087 respectively. However, this result is related with findings of study undertaken by British Council in the region (British Council, 2017)

Conclusions

One of the goals of Ethiopia's education strategy was to enhance physical and mental capacity for problem-solving abilities through effective resource use. This study met its objectives by (ii) estimating the technical efficiency of 46 primary schools in the region, (ii) measuring school total factor productivity using the Malmquist index, and (III) estimating the impact of institutional and contextual/environmental variables on school inefficiencies using Tobit regression analysis. According to the results of the first stage analysis, approximately 30.4 percent, 21.7 percent, and 47.8 percent of schools are technically efficient while employing CRS, VRS, and scale efficiency models. These findings show that more than half of all schools are inefficient. As a result, regional policymakers must have a strong monitoring and inspection program in place to control inefficiencies of school..

Furthermore, as compared to government schools, non-government schools are more effective and efficient in utilizing their resources to achieve the desired educational outcomes. In terms of school scale operation, 47 percent of schools have a decreasing return to scale. As a result, a change in school inputs leads in a smaller proportionate change in school outputs. As a consequence, actions are needed for schools that are too large for the current operation, such as decreasing school inputs and reshuffling to other small-sized schools. The Malmquist DEA analysis shows that the average productivity of schools is deteriorated in last seven years of operation by 10.8 per cent. Poor performance of school management was identified as the major factor for declining of productivity. Hence, policy maker should consider improvement school management and provision of capacity building.

The second DEA stage demonstrates that school ownership has a detrimental impact on inefficiency. Teacher-student and class-student ratios, on the other hand, have a positive and statistically significant impact on inefficiency. As a result, increases in student numbers should be proportional to increases in the number of teachers and classes. Nonetheless, the element of teacher qualification and experience shows unexpected positive signs and has a considerable impact on inefficiency. This means that while teachers are competent and experienced, school inefficiencies may increase. The outcome differs from the general consensus on teacher quality and school efficiency. According to the opinions of those interviewed, efficiency is influenced by variables other than teacher qualifications and experience. As a result, policymakers must focus on variables that boost teacher motivation and commitment. This involves providing recognition and incentives, as well as housing amenities, allowances, and bonuses, among other things. These are all elements that increase teacher effectiveness, which affects total school efficiency.

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