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Measuring technical efficiency of government aided lower primary schools: A case study in Southern Assam, North Eastern India

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Abstract
This paper has estimated the school level technical efficiency of government aided lower primary schools in Hailakandi district of Assam based on primary data of a statistically robustly chosen sample of 95 schools. Selected non-input factors are modelled to explain school level technical inefficiency. A Cobb-Douglas stochastic production frontier with inefficiency effects is estimated. The estimated results indicate that both school infrastructure quality and teachers 'contact hours influence the composite output index positively and significantly. Among non-input factors, frequency of mid-day meals during the survey week, and average BMI of interviewed children, have positive impacts on technical efficiency, while remoteness and lack of accessibility have a negative influence on the same. Reachability and accessibility are two vital non-input factors that influence school performance and efficiency. The study concludes that school performance has an enormous scope of improvement, especially if school infrastructure is enhanced by providing independent classrooms along with appointment of teachers up to the full capacity of five per school.

Keywords: primary education, LP schools, enrolment, attendance, school infrastructure, contact hours, technical efficiency, stochastic production frontier and non-input factors

1. Introduction

Quality education is a vital goal of sustainable development. However the delivery of good and effective quality primary education requires basic minimum educational infrastructure - both physical and human, such that children can develop the fundamental skills. Most importantly the learning process must be effective in primary schools irrespective of who governs it.

The most important institutional mechanism for developing skill and knowledge in the society is the formal educational system. The rapid expansion of educational opportunities holds the key to long run growth development and development of nations. The higher the level of educational attainments, the more rapid is the anticipated or expected rate of development and growth. If global experience in basic education, per capita GDP and long run growth over the past five decades are observed, then undoubtedly high levels of formal education, high per capita GDP and high to moderately high long run growth rates go hand-in-hand.

Acceptably basic and primary education is one of the most important services provided by governments in almost every country. Unfortunately the present state of basic and primary education in India is quite contrary to the ideal situation. The 'Right to Education' is a fundamental right in India since many years now. However, almost no attention is paid towards promoting efficiency in the delivery system in primary education. The functional effectiveness and efficiency of primary educational institutions are also not addressed adequately by the local and state governments. One may argue that the principal cause of negligence of local governments with regard to the functional efficiency of primary schools is that basic education was never (and is still today not) a major political issue**.** In fact this negligence or indifference towards primary education has actually resulted in rising inequality across socio-economic strata along with impeding the prospects of over development and long run growth. Understandably skill levels and basic education are highly positively related. Moreover skill levels attained by the society primarily determine the rate of work participation in the formal sector. Basic education for all may help to shrink the size of the informal sector in India in the medium to long run. India's long run growth and development prospects depend heavily on how fast the people dependent on the informal sector can meaningfully participate in the economic activities of the formal sector.

Since the early 1990s a significant amount of research has been conducted in both developed and developing nations on (i) teaching quality and educational effectiveness, (ii) school infrastructure, attendance, drop outs and educational effectiveness, (iii) technical efficiency of school functioning, (iv) role of child health in learning, (v) drop outs and its socio-economic causes, especially girl child drop outs, among many other pertinent issues associated with the efficacy of basic education system.

According to NAEP (2007) more than a quarter of eighth graders in the United States scored 'below basic' in reading exam, which by the government's definition means that they are not able to "demonstrate a literal understanding of what they read" and "make some interpretations" Lips, (2006) [12]. Although the quality of education is hard to define precisely due to difficulties in measurement, generally it refers to the "knowledge base and analytical skills that are the focal point of schools" (Hanushek and Luque, 2002) [13].

Card and Krueger (1996) [14] find that school resources have strong and positive influence on students' educational attainment. Except the study by Currier (2007) [15] 'inefficiency effects model' has rarely been used in the education production function literature to assess productive efficiency. Currier (2007) [15] estimates technical efficiency for Oklahoma school districts using Battese and Coelli (1995) [2] model but the specification of the 'inefficiency effects function' is methodologically incorrect. Muvawala and Hisali (2012) [16] estimate the technical efficiency and its determinants for Uganda's primary education system using parametric models based on a panel data set on performance index and educational inputs of various categories of primary schools for the 2001-08 period. The findings suggest that improvements in learning outcomes for government-aided schools will require increased resources. Chakravarty (2001) [17] measured the efficiency of public education using a stochastic frontier model that estimates an educational production function and an inefficiency effects function that controls the socio-economic and environmental factors simultaneously under the Battese and Coelli (1995) [2] framework using panel data. The study finds that students' socioeconomic factors are found to have significant influence on their achievement scores.

Research on primary education in India has been arguably led by Amartya Sen's Pratichi Education Trust Reports. The Pratichi Education Trust Report II (2009) comes up with several interesting findings for government run primary schools in rural West Bengal that relate teaching and learning to the quality of school infrastructure, success of mid-day meal programme, social stigma and exclusion, teachers' commitments, guardians' involvements, children's health, drinking water quality and nutrition, among many others. The report clearly shows that active involvement of parents in day to day functioning of the school raise efficiency levels in terms of learning, enrolment and low drop outs.

Clearly, significant amounts of literature on school performance and efficiency have been reported in literature but none have been conducted in the state of Assam or in the north-eastern part of India in general. Furthermore, use of the stochastic production frontier with inefficiency effects (Battese and Coelli, 1995) [2] is rare. On the whole the number of school efficiency related studies in India is low. Even there the focus is usually on schooling effectiveness or educational effectiveness and the set of factors that influence it. No studies on measurement of technical efficiency of government run primary schools in the North eastern part of India are available in literature at present. Thus the present study is highly justified. No systematic reporting is done for school infrastructure, enrolment and attendance in the region. Naturally socio-economic factors that affect efficiency and educational effectiveness are also not studied. Studies estimating educational production function usually measure quality of education in terms of standardized test scores, a proxy for educational outcome. This paper presents a more comprehensive approach to measurement of school performance by employing a composite output index.

The objectives of the study are twofold. First, to estimate technical efficiency of government aided lower primary schools in the district in Hailakandi and second to identify and examine the impacts of the non-input socio-economic and physical factors that influence the level of technical efficiency. These factors may be associated with the immediate environment in the vicinity of the school or may be region specific that are beyond the control of either students or teachers.

The organization of this paper is as follows. After a brief introduction to the problem along with literature, research gap and objectives in section 1, the econometric models and data related issues are presented in section 2, while estimated results and analysis are presented in section 3. Finally summary and conclusions are presented in section 4.

2. Models, Methodology and Data

2.1 The stochastic production frontier with inefficiency effects

Technical efficiency for a particular production unit (a firm for instance) is defined as the ratio of actual output (or some indicator of output) to frontier level output as defined by the production frontier. The frontier gives the maximum for any given input level. In order to measure technical efficiency at the primary school level along with the impact of selected non-input determinants on the level of technical inefficiency, the present study adopts a Cobb-Douglas stochastic frontier model with inefficiency effects following Battese and Coelli (1995) [2] inefficiency effects framework. The production unit is the lower primary school in the present context. In other words the stochastic production frontier and the inefficiency effects parameters are simultaneously estimated, given appropriate distributional assumptions. This was originally proposed by Kumbhakar *et al.* (1991) [4], Reifschneider and Stevenson (1991) [5], and Haung and Lui (1994). Battese and Coelli (1995) [2] is an improvement over the previous methods as it is based on panel data. Moreover this one-stage maximum likelihood approach is statistically consistent with the Kumbhakar *et al.* (1991) [4] approach and leads to more efficient inference with respect to the parameters (Coelli and Battese, 1996) [7]. The approach has been applied empirically by, Coelli and Battese (1996) [7], Battese and Broca (1977).

Acceptably, a Cobb-Douglas form restricts the flexibility of the school performance by imposing the elasticity of scale to be constant and the elasticity of input substitution to be unity. However coefficients are easy to interpret as slope coefficient represents partial output elasticity i^{th} respect to inputs. A Cobb-Douglas production frontier with two inputs is specified below.

$$\ln(OI_i) = \ln\beta_0 + \beta_1 \ln SII_i + \beta_2 \ln TCHI_i + (v_i - u_i) \qquad (2.1)$$

Here (2.1) is the Cobb-Douglas technological specification assuming two inputs – School Infrastructure Index (SII), and Teacher Contact Hour Index (TCHI) and OI is the output index. Exact description of all relevant variables used in the study is essential. The list of variables with their units of measurement for the Cobb-Douglas production frontier model (2.1) is presented in section (2.2). The inefficiency random variable u_i has the distribution $u_i \sim N^+(\gamma' z_i, \sigma_u^2)$ which is the positive part of a normal distribution with a variable mean at $\gamma' z_i$. The z_i's are the inefficiency effects variables defined below.

Here

$$\gamma' z_i = \gamma_1 + \gamma_2 z_{2i} + \gamma_3 z_{3i} + \gamma_4 z_{4i} + \gamma_5 z_{5i} + \gamma_6 z_{6i} + \gamma_7 z_{7i} + \gamma_8 z_{8i} \qquad (2.2)$$

The list of variables with their units of measurement for the inefficiency effects model is outlined as follows. Here, the

z_i's are school specific non-input variables which may influence the technical efficiency of School. Specifically, z_{2i} is the Student Teacher Ratio (STR) of the schools as measured by that numbers of Students divided by the numbers of teachers in a school, z_{3i} is Alternative mode of reaching school without walk (AMRWW) measured as a dummy variable(if it is possible to reach to the schools by any other means except walk, the score assignedis 1, but if it requires compulsory walking for at least half a kilometre and no other means are available then 0 is assigned), z_{4i} is the dummy variable for Water Logged Area (WLA) where score 1 is assigned if theschool is located in a water logged area, 0otherwise, $z_{5i}$is Mean Body Mass index (MBMI) measured as a mean BMI of the sample students of the i^{th} sample school, z_{6i} is Mid-Day Meal (MDM) as measured bythe average number of days in a week lunch has been provided by the school authority over the past three months and z_{7i} is Mean of Formal Education of the Teachers (MTEDU) measured as the average number of years spent in formal education covering all teachers of the i^{th} sample school and z_{8i} is the indexed measure of remoteness or the remoteness index (IR). The remoteness index at the school level is measured by the distance of school from nearest motorable road and distance of nearest semi urban area measured in Km both taken in indexed form (using HDI dimension index formula) and averaged.

Testing the null hypothesis of no technical inefficiency is done by applying the Likelihood Ratio Test.

$$LR = -2\ln[L(H_0)/L(H_1)] \quad (2.3)$$

Where, $L(H_0)$ and $L(H_1)$ are the optimum values of the likelihood function under the null hypothesis (no technical inefficiency or OLS) and alternative hypothesis (presence of technical inefficiency under the Aigner*et al.* 1977, Normal–half-Normal error specification) respectively. But since the hypothesized value of λ lies on the boundary of the parameter space it is difficult to interpret the test statistic. It can be shown that the *LR* statistic in (2.3) follows a mixed χ^2 distribution that asymptotically approaches χ^2 distribution with degrees of freedom equal to the number of restrictions imposed in the model (Coelli, 1995) [2]. Similar is the test of the hypothesis that inefficiency effects are totally absent in the model. All estimations are done using the software package *FRONTIER 4.1* for WINDOWS (Coelli, 1996) [7].

2.2 Variable Construction and Measurement

In the present study, the sample primary schools have been considered as production units. The Output Index (OI) in the present study is a simple average of three indexes that are taken as basic performance indicators at the primary school level. The three indexes are (a) Enrolment Index (EI), (b) Attendance Index (AI) and (c) Exam Performance Index (EPI). EI is absolute enrolment as per the enrolment recorded in the register from which the index value is calculated using HDI dimension index formula. Attendance Index (AI) which is further composed of two vital attendance indicators. First, during the survey, class-wise headcount of students present is done and the average percentage of head count over all the 5 classes (grades) of the sample primary school is obtained. This score is normalize with respect to maximum attendance capacity possible in a class. Second, the previous month's attendance records are taken for each class and the average across classes calculated. The attendance index (AI) at the primary school level is then taken as the simple average of current attendance index (from head count during survey) and monthly attendance index (from the class attendance register records) computed on the basis of previous month's attendance. The computation of each index is done using the HDI dimension index formula.

$$\text{Dimention Index } (DI) = \frac{Actual\ y - Minimum\ y}{Maximum\ y - Minimum\ y}$$

Finally, student's Exam Performance Index (EPI) has been computed on the basis of a brief mock written examination conducted at each of the five classes where one male and one female student have been randomly chosen for examination from each class. A class where male student was not available 2 female students of the same class were selected for the written examination and vice versa (2 male students in case of no females). Ten simple questions carrying one mark each were set keeping in mind the course curricula covered till the previous month for each level of schooling. The simple mean of the marks scored (by all sample students) is taken as the exam performance at the LP school level. The dimension index formula is then applied to obtain the exam performance index (EPI) at the LP school level. The details of the key variables of the study are presented in table 1.

Table 1: Details of Variables

S. No.	Variables	Abbreviation	Description
1.	Enrolment Index	EI	Absolute enrolment of students in the LP school as recorded in the enrolment register
2.	Attendance Index	AI	Attendance of the student's in terms of both Headcount on survey day and no. of days attended during previous month.
3.	Exam Performance Index	EPI	Performance of sample students in the written test conducted during survey.
4.	School Infrastructure Index	SII	Quality of physical infrastructure of the schools. It is computed on the basis of 25basic physical indicators (presented below the table).
5.	Teachers' Contact Hour Index	TCHI	Numbers of hours a teacher spends in the school over a period of 30 days
6.	Student-teacher Ratio	STR	The number of students per teacher at the school level.
7.	Index of Remoteness	IR	The remoteness of a school measured by the distance of school from nearest motorable road and distance of nearest semi urban area measured in Km both taken in indexed form and averages.
8.	Alternative mode of reaching school without walk	AMRSWW (binary dummy)	A binary dummy variable that assumes 1 if walking for at least 500 meters is not a necessity to reach the school (means other than walking exist), but score 0 is assigned if at least 500 meters of walking is a necessity to reach school premises

9.	Water Logged Area	WLA (binary dummy)	If school is located in a water logged area score 1 is assigned, but 0 otherwise.
10.	Mean Body Mass Index	MBMI	A gross measure of overall health and nutritional status of sample students chosen for written exam. It is calculated as weight in Kg divided by square of the height in meters.
11.	Mid-Day Meal	MDM	The average number of days per week mid-day meal has been provided by the school authority during the month prior to the survey.
12.	Mean for Formal Education of Teachers	MTEDU	It is the educational qualifications of the teachers measured as the number of years spent by the teacher in formal education.

***Source*:** Authors' definitions.

The School Infrastructure Index (SII) in row number 4 of table (1), and its computation needs to be explained in detail. SII is basically a quantitative measure of the quality of physical capital stock at the school level. It captures the physical infrastructure quality of the sample LP school. The 25 criteria on the basis of which the school infrastructure score or the capital stock score is computed are detailed below. In each case score 1 is assigned if the criteria is fulfilled (or the facility is found to be present) for the sample LP school and score 0 is given otherwise. Thus a school can score a maximum of 25 if all the following criteria are fulfilled.

1. Partitioned Class room; 2.Classrooms having blackboard; 3.Classrooms having Chalk; 4.Classroom having Duster; 5.Classroom having Teachers Chair; 6.Classroom having Teachers Table; 7.Separate toilet for boys and Girls; 8. Separate toilet for Teachers; 9. School having running water facility at toilet; 10.School having toilet in useable condition; 11.Schools having Drinking water facility; 12.Availability of Drinking water; 13.Schools having Playground; 14.Schools having bicycle stand; 15.Schools with boundary wall; 16.Schools with CC floor; 17.Classroom capacity based on the numbers of students enrolled; 18.Sufficient availability of desk and benches; 19.Schools having electricity connection; 20.Schools having fans in a working condition; 21.Schools having light in working condition; 22.School with satisfactory visibility in the class room, 23.Use of LPG during Mid-day meal preparation; 24.Land available for school expansion; and 25.School having ausable approach path of acceptable quality.

The availability of all these 25 criteria of physical infrastructure is physically verified by observation during the survey and scores of 1 or 0 assigned accordingly.

2.3 Survey Methods and Data

The sample size for the study is fixed using the following generalized sample selection formula which is applicable even when the population size is not exactly known (in the present case the population size is known).

This is expressed as $n = Z^2.s^2/d^2$ where *n* is the minimum sample size to be chosen, *Z* is the value of the standard normal distribution function at 0.05 level, *s* is the population standard deviation of the variable, and *d* is an acceptable standard error of the mean of the variable of interest – the size of enrolment covering all 5 classes of an LP school. In this study, *s* is fixed through a pilot survey conducted on the basis of a sample of 15 purposively chosen LP schools in the neighborhood of Lala and Katlicherra. From the pilot survey data $s = s'.\sqrt{n'/(n'-1)}$ where n' = 15, is the sample size for the pilot survey, and s' is the standard deviation of enrolment computed from the pilot survey. In the present case, *s* = 19.368, s^2 = 376.36, $Z^2 = (2.09)^2$ = 4.18, d^2 = 17.20, which gives n = 95 (approximately). Thus the present sample size chosen is 95, which is 8.7 percent of the population size. This is a statistically sufficient sample under the present set up.

Survey period is from November 2016 to March 2017. Only the L.P schools which are under State Education Department are taken in to consideration. At first schools are marked out according to the Educational Blocks. Next around 8.7 percent of the LP schools at the block level are randomly chosen for the study. The random selection is done for each of the three educational blocks, i.e. Hailakandi, Lala and Katlicherra respectively. The subsamples turn out to be 40 for Hailakandi, 30 for Lala and 25 for Katlicherra giving an aggregate sample of 95 LP schools in the district.

Table 2: Block wise Distribution of Sample Schools

Name of the Block	Population	Sample Size (8.7% of population)
Hailakandi	461	40
Lala	344	30
Katlicherra	293	25
Total	1098	95

***Source*:** Compiled by the author.

For evaluating the degree of effective learning sample of 8 students are selected from each school. Purposively the targeted classes are Class II, Class III, Class IV and Class V. One male and one female student are selected systematically from Class II, Class III, Class IV and Class V each i,e, 4 boys and 4 girls are selected from each school. If the sample school is an entirely girls school than four girls are selected from the school systematically. Similar is the treatment for an entirely boy's school or even in case of absentee girls. The final sample size of students turned out to be 718 where 345 are males and 373 are females.

The written examination of the students was conducted within schools hours after taking permission from the head teacher. School wise performance evaluation in the present study is taken as a dimension of the performance of the school.

The students' aptitude was tested using a simple written examination sheet that focused purely on their effective learning and applied skills in, (i) their mother tongue – i.e., Bengali, (ii) numerical methods and (iii) elementary geography and science. An open ended interview of selected students was conducted focusing on their day to day activities. Weight and height of the sample students were routinely recorded in order to compute their BMI. The numbers of male and female teachers appointed at each school were also recorded. The teachers and other staff were routinely interviewed for necessary information that includes their personal educational and socio-economic profiles. Furthermore, school level information on frequency of mid-day meals, student attendance on the days of mid-day meals, educational aspects among other associated information were also collected from teachers.

Table 3 summarises some of the sample size and design related details and the dispersal across educational blocks.

Table 3: Sample Collection Details

No. of Schools Surveyed (sample size)			**95**
School Covered under Educational Block	Hailakandi	40	
	Lala	30	
	Katlicherra	25	
Urban Schools	22		
Rural Schools	73		
Total no. of Students interviewed			718
	Male	345	
	Female	373	
Total no. of teachers interviewed			270
	Male	111	
	Female	159	

***Source*:** Compiled by author

3. Empirical results and analysis

From the summary statistics presented in table 4 it is clear that all the index value of enrolment, attendance, exam performance index, output index, capital index, teaching contact hour index, index of remoteness are ranges between 0 to 1 as expected. Regarding student teacher ratio it is very clear that in some schools one teacher is covering 2 children (minimum level) and at the other extreme one teacher is covering 66 students (maximum), in both the cases the distribution of student teachers ratio is not maintained as per norms. From the table it is also clear that a significant numbers of teachers are suffering from chronic diseases. It is also clear that the frequency of mid-day meal is not maintained regularly. The qualification of the teachers in a primary schools ranges from H.S.L. C to Graduate.

Table 4: Descriptive Statistics of Some important variables

S. No.	Variables	Mean	Standard Deviation	Minimum	Maximum
1	Enrolment Index (EI)	0.42	0.24	0.00	1.00
2	Attendance Index (AI)	0.61	0.18	0.00	1.00
3	Exam Performance Index (EPI)	0.54	0.22	0.00	1.00
4	OI	0.52	0.16	0.19	0.89
5	School Infrastructure Index (SII) (Absolute Infrastructure Score/25)	0.48 (13.21)	0.17 (2.52)	0.00 (08)	1.00 (21)
6	Teaching Contact Hour Index (TCHI)	0.37	0.24	0.00	1.00
7	Student Teacher Raito (STR)	23.06	1.05	2.00	66.00
8	Index of Remoteness (IR)	0.23	0.22	0.00	1.00
9	Teacher SEX Ratio (TSR)	56.70	31.85	0.00	100.00
10	Percentage of Teachers Staying within 1 K.M of the school (DOTRFS)	15.58	18.72	0.00	80.00
11	Percentage of Teachers with Chronic Diseases in a school (TWCD)	35.09	36.04	0.00	100.00
12	Percentage of more than 50 age teacher in school (AGEDT)	29.71	30.66	0.01	100.00
13	Mean of BMI (MBMI)	15.78	2.26	12.11	21.08
14	Mid-day Meal (MDM)	5.40	0.79	3.00	6.00
15	Mean for Formal Education in years (MTEDU)	11.88	1.45	10.00	15.67
16	Mean Experience of teacher in years (MET)	17.90	7.35	2.00	31.50

Source: Authors calculation based on the primary data.

The descriptive statistics or the summary statistics are presented in table 4 while some of the variables have been directly used in the stochastic production frontier of equation 2.1 and other have not directly be used but have important consequences in the present study. The enrolment index has a mean value of 0.42 where the attendance has a mean value of 0.61. This show even with lower enrolment attendance is satisfactory high considering the socio economic backwardness and remoteness of the study region. The mean EPI is just above 0.5 which reflects very ordinary level of learning and cognitive skills. Not surprisingly the mean output index is consistent with EI, AI and EPI. The SII has a mean value of 0.48 which is poor as because the absolute infrastructure score out of 25 has mean value of 13.21 which is just above 50 percent. The lowest infrastructure score is 8 implying that there are 17 criteria unfulfilled for the schools with poorest infrastructure. The TCHI shows the poor mean value of 0.37 this indicates of low contact hours relative to minimum requirement of the one hand and existence of unfilled or vacant position on the other. Lower number of teachers in a school implies lower contact hour per class which in turn imply a lower value of TCHI at the school level. The mean student teacher ratio (STR) is just above 23 at the school level. This shows that there is ample scope of raising numbers of student per teacher. Low STR is consistent with low enrolment Index. Mean index of remoteness is found to be 0.23 which is on the lower side. Teachers' sex ratio in the sample of schools is almost 57 which imply there is a female dominance in LP school teaching in the region. Only around 15 percent of LP schools teachers on an average stay within one 1 km of the LP school premises. This shows that majority of LP schools teachers do not reside in the vicinity of the school. On an average almost 30 percent of the sample teachers are aged 50 years or more. Moreover, around 35 percent of the sample teachers are reported to suffer from some chronic diesis. Regarding student's health and nutrition levels as indicated by BMI is found that mean BMI is below 16. This shows that the sample children on an average are underweight. In fact the minimum BMI found in the sample is just above 12. It is found that mid meals are provided in the sample schools for more than 5 days on an average per week. On an average he sample teachers have spent almost 12 years in formal education which suggests green picture of educational qualification of LP teachers. Alarmingly the minimum years of formal years is found to be 10 which just up to matriculation standards. The average numbers of years of experience is found to be almost 18 with a wide variation as suggested from the high maximum and low minimum values.

Table 5: Cobb Douglas – Indexed variables: Stochastic Production Frontier with Inefficiency Effects

Variables (Dependent Variable: *lnOI*)	MLE Coefficient	t-ratio
Constant	-0.218 (0.003)	-3.057
lnSII	0.313(0.001)	3.560
lnTCHI	0.238(0.001)	3.544
Technical Inefficiency coefficients		
Constant	-11.609(0.324)	-0.992
STR	0.324(0.001)	3.580
AMRSWW	-7.825(0.000)	-3.681
WLA	5.595(0.009)	-2.660
MBMI	-0.735(0.085)	-1.740
MDM	-3.124(0.030)	-2.201
MTEDU	-3.126(0.000)	-3.681
IR	1.062(0.080)	1.768
Error variance parameters		
$\sigma^2 = \sigma_v^2 + \sigma_u^2$	0.26(0.002)	2.55**
σ_v^2	0.02	
σ_u^2	0.24	
$\gamma = \sigma_u^2 / (\sigma_u^2 + \sigma_v^2)$ (Batteseand Corra,1977)	0.912 (0.000)	21.91**
Log Likelihood Value	-47.312	
LR Test of the One-Sided Error [Kodd-Palm (1986) $\chi^2_{0.05,6}$ = 9.987]	19.421	
3rd Central Moment of OLS Residuals	-0.635	

Source: Author's estimates based on primary data using *FRONTIER 4.1* for Windows.

Notes: 1. Test for gamma=0 follows mixed chi-square distribution with critical value found in table 1 of Kodde and Palm [1986]. 2. * and **indicate statistically significant at the 0.05 and 0.01 level respectively. 3. P-values are in parentheses. 4. *ln* is natural logarithm.

The econometric estimation of the stochastic production frontier with inefficiency effect when the variables are indexed and are with log (log linear or Cobb-Douglas production function) is presented in the table 5. Here the dependent variable is output index. The constant and input variables are found to be statistically significant. In other words, both school infrastructure as well as teaching contact hours positively influences the OI. Coming to the estimates of the technical inefficiency effects coefficient the constant is insignificant, whereas AMRSWW, WLA, MDM and MTEDU are all statistically significant. The MBMI has a positive coefficient but is statistically insignificant. Coefficient of STR is positive and significant implying that higher the student teacher ratio the lower is attention devoted per child. This adversely influences educational effectiveness, output and technical efficiency. In case of AMRSWW the coefficient is negative and significant which implies that the reachability and accessibility is a vital non input factor that influences the individual components of OI and hence technical efficiency positively. Coefficient of WLA is positive and significant implying that schools located in water logged areas are relatively more inefficient. Coefficient of MBMI is found to be negative but insignificant. BMI roughly captures the health status of the sample students. Interestingly the coefficient of MDM is negative and significant implying that frequency of MDM has a significantly positive influence on technical efficiency. MTEDU has a negative and significant coefficient implying that schools with better qualified teachers are technically more efficient. Finally, the coefficient of IR is positive and significant at 8 per cent implying that remoteness plays a dampening or negative influence on technical efficiency of the LP school. In other words, schools that are locationally more remote are relatively technically less efficient.

Table 6: Heteroskedasticity Test: Breusch-Pagan-Godfrey for log Linear or Cobb Douglas Indexed

F-statistic	0.141	Prob. F(2,92)	0.970
Obs*R-squared	0.291	Prob. Chi-Square(2)	0.967
Scaled explained SS	0.383	Prob. Chi-Square(2)	0.927

Source: Author's estimates based on primary data using EVIEWS

The Breusch-Pagan- Godfrey Heteroskedasticity test confirms the absence of heteroskedasticity in the OLS estimates of the production function and accepts the null hypothesis of homoscedasticity. In this case the mean technical efficiency is found to be 77.38 per cent, the maximum being 93.25 per cent and the minimum being 63.17 per cent.

Table 7: Cobb Douglas – Unindexed Input variables: Stochastic Production Frontier with Inefficiency Effects

Variables (Dependent variable: *lnO*)	MLE Coefficient	t-ratio
Constant	-0.193 (0.003)	-2.709
Ln(SI)	0.277(0.001)	3.154
Ln(TCH)	0.211(0.001)	3.140
Technical Inefficiency coefficients		
Constant	-10.286(0.287)	-0.897
STR	0.287(0.001)	3.172
AMRSOW	-6.933(0.000)	-3.261
WLA	4.957(0.008)	2.357
MBMI	-0.651(0.075)	-1.542
MDM	-2.768(0.027)	-1.950
MTEDU	-2.770(0.000)	-3.261
IR	1.181(0.071)	1.593
Error variance parameters		
$\sigma^2 = \sigma_v^2 + \sigma_u^2$	0.31(0.002)	2.31**
σ_v^2	0.029	
σ_u^2	0.376	
$\gamma = \sigma_u^2 / (\sigma_u^2 + \sigma_v^2)$ (Batteseand Corra,1977)	0.88 (0.000)	18.22**
Log Likelihood Value	-32.212	
LR Test of the One-Sided Error [Kodd-Palm (1986) $\chi^2_{0.05,6}$ = 9.987]	16.250	
3rd Central Moment of OLS Residuals	-0.832	

Source: Author's estimates based on primary data using Frontier 4.1 for Windows.

Notes: 1. Test for gamma=0 follows mixed chi-square distribution with critical value found in table 1 of Kodde and Palm [1986]. 2. * and **indicate statistically significant at the 0.05 and 0.01 level respectively. 3. P-values are in parentheses. 4. *ln* is natural logarithm. 3. SI stands for school infrastructure and TCH stands for teachers' contact hours.

The results in table 7 are very similar to that obtained in table 5. This shows that with and without index formation the stochastic frontier estimates are quite similar. The mean technical efficiency is found to be very similar to that obtained from the estimations in indexed form. In case the maximum stood at 94.77 per cent while the minimum stood at 62.87 per cent.

Table 8: Heteroskedasticity Test: Breusch-Pagan-Godfrey for log Linear or Cobb Douglas Unindexed

F-statistic	0.154	Prob. F(2,92)	0.941
Obs*R-squared	0.317	Prob. Chi-Square(2)	0.938
Scaled explained SS	0.417	Prob. Chi-Square(2)	0.899

Source: Author's estimates based on primary data using EVIEWS 8

Moreover, Breusch-Pagan-Godfrey's Heteroskedasticity Test confirms the absence of heteroskedasticity and accepts the null hypothesis of homoscedasticity. This confirms the statistical robustness of the estimates. The following section summarises the entire study, presents the key findings along with the conclusions in a nut shell.

4. Summary and policy conclusions

To sum up, this paper has estimated the school level technical efficiency of government aided lower primary schools in Hailakandi district of Assam based on primary data of a sample of 95 schools LP schools. A host of non-input factors are hypnotized to explain school level technical inefficiency. A Cobb-Douglas stochastic production frontier with inefficiency effects is estimated where the selected non-input factors are modelled to explain variations in technical inefficiency across schools. The estimated results indicate that both school infrastructure quality and teachers ‘contact hours influence the composite output index positively and significantly. Among non-input factors, frequency of mid-day meals during the survey week, and average BMI of interviewed children, have positive impacts on technical efficiency, while remoteness and lack of accessibility have a negative influences on the same. Both location and presence of usable toilet has significantly influenced the girl child turn out. Children’s cognitive skills are significantly explained by teaching hours or contact hours, school infrastructure quality and their own BMIs. Further enrolment and attendance are positively influenced by school infrastructure quality. The study concludes that school performance has an enormous scope of improvement, especially if school infrastructure is enhanced by providing independent classrooms along with appointment of teachers up to the full capacity of five per school.

The paper has several alarming observations to report. Greater the remoteness lower is the performance of the LP school. Reachability, accessibility, or remoteness are associated with rural location. Remote location is also associated with poorer physical infrastructure. Quality of infrastructure is clearly better in the urban and semi-urban schools. Midday Meals are arranged on an irregular basis. This is clearly indicative of governance failure at the local or grass root level. Moreover midday meals in rural schools are less frequent than those in urban schools. A significant percentage of rural schools exist where compulsory walking for more than half a km is necessary to reach school premises.

Moreover understaffed schools are not able to function up to capacity and hence are inefficient. Schools where water logging takes place easily, have lower attendance on an average compared to other schools. Enrolment and attendance are weakly associated meaning that high enrolment does not automatically lead to high attendance (simple correlation turns out to be -0.06). There is a dominance of low BMI in the sample. It must be noted that higher BMI in the present context is a sign of better overall health and nutritional status. Not surprisingly students with higher BMI have better exam performance score (the correlation being 0.44). In other words students with higher BMI in the sample perform better. The presence of a usable toilet and safe drinking water provisions are far from satisfactory for the entire sample. Just 67 per cent of schools are found to have a usable toilet with piped water supply connections. A meagre 33 percent of schools are found to have safe drinking water supply facilities. The study comes up with the following policy suggestions.

First, enhancement and revamping of Government Aided LP School Infrastructure. This requires budgetary support with elimination of corruption. Special attention must be given to independent class-rooms, inside-classroom illumination, hygienic toilet facilities and clean drinking water supply facilities. Dedicated girls toilet have to be in place since all children’s’ institutions must be gender sensitive. Second, teachers’ appointments have to be made in proportion to the student’s intake so that students-teacher ratio norms are maintained. Third, midday meals must be regular and quality checking has to be done at the grass-root level taking parents/guardians into confidence. Besides, eliminating corruption in provision of midday meals is the other vital aspect that the local administration must delve into. To sum up, effective delivery with regard to primary education is a key issue in governance – especially local governance. Poor infrastructure facilities result in poor standards of effective learning and little or no skill development for millions of children belonging to socio-economically underprivileged sections. It is public awareness and activism that can almost singlehandedly put sufficient coercive pressure on the local governments to enhance the quality of primary education so that disadvantaged and the needy are not deprived of the right to acquire fundamental skills in particular and knowledge in general.

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