CHAPTER 5

TECHNICAL EFFICIENCY OF HIGHER EDUCATION INSTITUTIONS AND ITS DETERMINANTS

The technical efficiency (TE) of the higher educational institutions (HEIs) of Barak Valley is measured in this chapter. Technical efficiency during the period 2005-06 to 2011-12 is measured by using both parametric and non-parametric approach. The analyses are given sequentially in the following two sections 5.1 and 5.2. This chapter also identifies the possible determinants of technical efficiency and its influence on measuring technical efficiency or inefficiency. Influence of selected factors that determines inefficiency or efficiency of general degree colleges of Barak Valley and the behaviour of total factor productivity (TFP) growth of HEIs in the region along with its components viz; pure technical efficiency and scale efficiency is also discussed. The chapter also deals with construction of a composite index of efficiency for generalised conclusion related to efficiency of the colleges in section 5.3. Further the chapter deals with comparative analysis of technical efficiency scores between the two groups across the estimation techniques and then with NAAC ranking in section 5.4.

5.1 Technical Efficiency of Higher Education Institutions (HEIs) and its Determinants

Estimation of technical efficiency of higher education institution requires specification of higher education production function with its relevant inputs and outputs. While modelling a perfect form of production function for any level of education institutions is a matter of apprehension as there remains heterogeneity within the same set of institutions and capturing the quality perspectives of educational outputs and inputs are also very vague and complex. However, several attempts have been made for estimating education production function and their efficiency by employing data envelopment analysis

(DEA) which is a non parametric technique with assumption free specification of the error term or using a parametric technique with the help of stochastic frontier analysis (SFA). Recent literatures show the convergence of these two methodologies for measuring efficiency of education institution (Chakraborty et al. 2001, McMillan and Chan 2006, Kempkes and Pohl 2010). However, there is a lack of empirical evidence in the literature about the proximity of these two approaches in measuring technical efficiency. Policy formulations based on only one of these efficiency estimates may not be accurate because of the inherent limitations of each. Before taking any correctional measures, the stability of the technical efficiency estimates obtained from a parametric method should be evaluated by comparing them against those found when using the non-parametric method (Chakraborty et al. 2001). In this study, the technical efficiency estimates of HEIs in Barak Valley using the stochastic frontier analysis (SFA) method and Tobit residuals from the data envelopment analysis (DEA) model are used with help of following mentioned outputs and inputs.

Output in higher education can be defined as a function of services offered by the institutions in terms of teaching and research outcomes. Generally academic achievements are measured in terms average scores of the students or degree awarded, fulltime enrollment, research expender under several sponsored schemes, research publications, etc. as the outputs of higher education institution. Since the study is related to degree colleges where production of successful graduate is the prime output, so research output is not considered for this study. Related to teaching output some studies have considered number of successful graduates as a measure of the output of higher education institutions (Worthington and Lee 2006, Fathi et al., 2005, Rego and Sousa 1999 etc.) while some studies have included full-time equivalent undergraduate and graduate enrollments as a measure of educational output (Robst 2001, Mc.Millan and Chan 2006, Kou and Ho 2007, Abbott and Doucouliagos 2009, Chiu et al., 2009, Daghbashyan 2011, Sav 2012 etc.) and some other have considered output of HEIs as in terms of number of graduated with weighted score (Koshal and Nalcaci 2006, Johnes 2006, Johnes and Taylor 1990). While some other studies have considered these two or three outputs along with research related outputs as well (Koshal and Koshal 1999, Koshal et al 2001, Kuah and Wong 2011, Thanassoulis et. al. 2011). Beyond these, there are many tangible and non-tangible outputs provided by HEIs, but for the purpose of analysis of this study, it is assumed that general degree colleges of Barak Valley produce two outputs viz; the number of full-time equivalent undergraduate students measured in terms of total enrollment, and the number of regular successful graduate students with some justified weights for considering the quality of graduate measured weighted performance index (WPI) of the colleges is considered as the prime output of the study. However, there is also a kind of controversy in considering full-time enrollment of education institution, here one group has taken it as input and other as output, but in higher education it is mostly considered as output as entry into any higher education institution produces undergraduate who are assumed to have a higher knowledge than senior secondary pass students. In this study, for measurement of technical efficiency in case of DEA technique weighted performance index (WPI) and total full-time enrollment both are considered as outputs of the HEIs of Barak Valley, while in case of SFA technique weighted performance index per student (WPIPS) (obtained by dividing weighted performance index (WPI) by total full-time enrollment) is considered as measure of output for analysis.

Production of HEIs output requires employment on both teaching and non-teaching labours, specified basic set of physical assets, and above all characteristics of teachers as well students along with the curriculum structure of the educational institution. Enormous popular literatures have considered teaching strength as the key input of educational institution with or without considering its quality of it measured in terms of certain characteristics. Here, teaching strength is considered as one of the main input of the study. However, the quality of teachers is an important factor and expected to have a positive impact on efficiency and performance of the HEIs. The qualifications and experience related measures as indicators of teachers' quality are considered as determinants of efficiency or inefficiency. Non-teaching staff is not incorporated as an input variable because it has no direct link with output of the HEIs (also evident from Table 4.12) and also does not vary significantly across the groups of HEIs. The expenditure of the HEIs and teaching strength are taken as inputs for estimation technical efficiency of the colleges of Barak Valley. However, in case of SFA estimation these two inputs are normalized by total enrollment like output for avoiding the problem of scale biasness which is not captured by SFA, hence expenditure per students and teacher-student ratio are considered as inputs of Translog production frontier for Stochastic Frontier Analysis (SFA) estimation.

5.1.1 Technical Efficiency of the HEIs of Barak Valley using Stochastic Frontier Analysis

As mentioned earlier the measurement of technical efficiency is done by using parametric technique i.e., SFA requires pre specification of the production function with certain assumptions. Here, Translog production frontier is assumed for measuring the technical efficiency of the HEIs of Barak Valley. Unlike Cobb-Douglas production function single parameter in Translog production function do not explain the partial elasticity with respect to inputs, rather all the parameters are not constant and dependent on further change in variables. Translog production is advantageous as compared to other forms of production function like Cobb-Douglas, CES, etc. which imposes more restriction to the parameters. Hence, in this study Translog production frontier is applied to measure technical efficiency as it allows flexibility regarding partial elasticity coefficients of the outputs with respect to its inputs which is more practical in nature. Therefore, Translog production frontier (mentioned in equation 4 in the Chapter 3) is framed in the following:

$$\ln WPPS_{it} = \beta_0 + \beta_1 \ln(TSR_{it}) + \beta_2 \ln(EPS_{it}) + \beta_3 [\ln(TSR_{it})]^2 + \beta_4 [\ln(EPS_{it})]^2 + \beta_5 \ln(TSR_{it}) \ln(EPS_{it}) + \beta_6 T + (v_{it} - u_{it})$$

All the variables are in natural logarithmic form except T (trend variable) which measures change over time (Battesse & Coile 1992, 93). $WPPS_{it}$ is the weighted performance per students of the i^{th} college for t^{th} time period, which is obtained by normalizing WPI_{it} with total enrollment of the colleges. TSR_{it} is teacher-student ratio of i^{th} college for time period t. The definitions and justifications of the variables used in the above specification are given below.

Definitions and Justifications of the variables

Teacher-Student ratio (TSR) is measured by the ratio of total number of teachers to total number of students in Teaching strength of any educational institution plays most significant role in producing quality students (Abbott and Doucouliagos 2009 and Chiu et al. 2009). In this study, teacher-student ratio is taken as input variable to avoid the biasness of scale effect.

Expenditure per Student (EPS) is defined as total expenditure incurred by a college divided by the total number of students existed in the college during an academic session (Chakraborty 2009, Kemkhep and Phol 2010, Kirjavainen 2012). This variable has either positive and negative impact on the output based on relative situation of the HEIs near or far the frontier corresponding to input output combination.

Time variable (T) is used to check the impact on changes in the weighted performance over time.

For Translog production frontier, inefficiency effect model (mentioned in equation 5 in the Chapter 3) is specified as:

$$U_{it} = \delta_0 + \delta_1 YOE_{it} + \delta_2 TAD_{it} + \delta_3 CO_{it} + \delta_4 LD_{it} + \delta_5 CMH_{it} + \delta_6 CMP_{it} + \delta_7 T + W_{it}$$

Here, the independent variables are structural / environmental variables that might play an important role in the production of successful graduates and W_{it} is pure white noise error. Justifications of the variables are given in the following:

Justifications of the variables for inefficiency effect model

Environmental factors (Z_i's) are not the direct inputs but have influence in production and can affect performance and efficiency. For evaluation of performance of education institutions, environmental factors make differences in their performance among the units if the institutions are to be assessed on a comparable basis (Stevens 2001). Selected environmental factors in this study are mentioned in the following.

Years of establishment (*YOE):* There is a common perception that experienced institution is better than others and it generally attracts good quality students (Liu et al., 2012) which ultimately results in better performance. Years of establishment is considered here as crucial determinant of performance.

Type of Affiliation (TAD): Affiliating authority provides three types of affiliations to these colleges viz; permanently affiliated, permitted and temporarily affiliated. Permanent affiliation mainly depends on the institutional performance of the previous years; once an institution gets its permanent affiliation then the infrastructural setup improves which attracts the good quality students and ultimately that can improve better performance of it.

Courses offered by the colleges (CO) is also a crucial variable because it is observed that enrollment in a particular college is largely influenced by it, hence it is assumed that it will have an impact in determining output and technical efficiency (Tochkov et al. 2012).

Location of the College (LD) plays an important role in determining infrastructure and status of any educational institute and which is expected to improve efficiency of it (Kempkes and Pohl 2010 and Burney et al. 2013). In this study, location dummy for urban is considered; the value is one for colleges situated in urban area and zero otherwise.

Location dummy for rural is not considered to avoid dummy variable trap. In developing countries like India, it is found that urban regions are always characterised by much better socio-economic indicators in all respects, so it is expected that urban colleges have greater impact on their performance than rural colleges.

Cut-off marks for honours course (CMH) and for pass course (CMP): Cut-off marks at entry level from the last examination highlights quality checking process of the colleges before entry to that college. Quality of student is often judged by their performance in examination measured in terms of average scores secured in examination and hence the colleges considering minimum cut-off marks at entry level for both honours and pass course are expected to have positive impact on efficiency of the colleges.

Time variable (T) indicates the year or time period of the observation involved and examines the trend of inefficiency over the years.

Application of SFA provides estimated coefficients of these variables and two composite variance related parameters viz; $\sigma^2 = \sigma_v^2 + \sigma_u^2 \ and \ \gamma = \sigma_u^2/(\sigma_v^2 + \sigma_u^2)$ which show the presence of inefficiency. Consequently, if γ is zero, all deviations are caused by noise rather than inefficiency; if it is one, all deviations are due to inefficiency rather than other factors.

Additional Environmental Factors for Cross section Model and Students Background Related Models

There are several environmental factors related to teaching staffs which are assumed to have positive impact on determining output of the HEIs and hence negatively influences the inefficiency. These variables includes teachers quality related factors information related to which are cross sectional in nature and these variables are incorporated in the above model for the cross section data set of 27 affiliated general degree colleges. In this study teachers quality is measured in terms of teachers' quality index (defined in Chapter 4) for each HEI. In addition to that for examining the impact of some of the elements of teaching quality indicators variables like average teaching experience of the teachers, percentage share of teachers with teaching experience less than five years, percentage share of teachers with teaching experience between 5 to 20 years, percentage share of teachers with teaching experience more than 20 years, Percentage of teachers with Ph.D. Degree, Percentage of teachers with M.Phil. Degree and Percentage of teachers with NET / SLET in the HEIs are incorporated in inefficiency model. Further to examine the influence of physical infrastructure, physical resource index (defined in Chapter 4) as an indicator of physical resource of the HEI is also added in the effect model. Unlike panel data model in cross-sectional model rather than taking two separate variables for quality control viz; Cut-off marks for honours course (CMH) and for pass course (CMP) in past examination at entry level, cut-off marks for both courses as quality check variable is used to reduce the number of variables for few observations.

To examine the influence of students' background on technical efficiency of the HEI in the region, some important factors related to socio-economic and academic background of the students are examined. Result of the students in the higher secondary examination is considered as the performance of the student at the time of entry in higher education and reflects academic background of the students. Hence, entry grade (ENTRYGRD) is taken as one of the determinants of technical inefficiency of higher education which is expected to have negative influence on inefficiency by contributing base for production of quality graduate. Natural science dummy (NS) is taken here as another determinant of higher education related to academic background of the students. In general, it is observed that the students with good innate ability and better academic records are taking natural science as the branch for their further education. In institution specific analysis it is not possible to examine separate models for different schemes due to indivisibility of some inputs of the HEIs, hence in this model it is taken as determinants of technical efficiency or inefficiency. In addition to that role of private tutors is now considered as a crucial factor for performance of the students at any level of education, as they provide intensive care related to the course of the students for successful results. Therefore, number of private tutors for the students for pass papers (NPTP) and honours papers (NPTH) are also considered as environmental factors for inefficiency of higher education. Socio-economic factors are also expected to have significant influence on academic achievements of the students in higher education and hence on efficiency of the HEIs. In this study, a social factor like average parental education (APE) is measured in terms average years of study of both parents. The caste of the students also expected to have influential impact on efficiency of the HEIs. In publically funded institution in India, a certain percentage of seats are reserved for minority communities, like Schedule Castes, Scheduled Tribes and other backward castes, but unreserved category students need to enroll themselves on general basis with no special affirmative relaxation as they are already considered as superior to the backward castes. Hence, in order to examine the influence of reservation policy on higher education general caste dummy is considered as an environmental factor of higher education which is expected to have positive impact on efficiency of the HEIs. Further number of siblings (SIBLNGS) of the student is also considered as one of the social background related determinant of the students in higher education, because presence of one or more siblings is expected to have positive influence on the student. If a student has elder siblings then he or she can take guidance and if younger then in order to maintain a benchmark concentrates more on studies and hence may have positive outcome in higher education. Further economic status of a student is here measured in terms of per capita annual family income (converted into logarithmic for mere estimation purpose to avoid huge dispersion). Economic growth and educational attainments are closely related in general. A student with better economic affordability may have better resource for successful completion in higher education and a greater access to other related facilities. Hence, it is justified to consider this variable as one of the determinants of technical efficiency of higher education.

Table 5.1, 5.2 and 5.3 depict estimated results of stochastic production frontier for higher education in Barak Valley for measuring technical efficiency along with its determinants for three separate dataset with different specification for the above mentioned variables. From all these models it is clear that there is a presence of technical inefficiency in the colleges of Barak Valley as the composite variance related parameters related to inefficiency are significant for all the three models. Table 5.1 shows the estimated results of the above mentioned Stochastic Translog Production Frontier along with inefficiency effect model for three different samples by using Frontier 4.1.

The estimates of the variance parameter, Sigma-squared and Gamma are significantly different from zero and statistically significant for all the groups which indicate that the inefficiency effects are major in determining the level and variability of output among the degree colleges of Barak Valley. Unlike Cobb-Douglas production function single parameter in Translog production function do not explain the partial elasticity with respect to inputs, rather all the parameters are not constant and dependent on further change in variables. Partial elasticity (E_{jit}) of j^{th} input for i^{th} firm on time t is ($\beta_j+2\beta_{j1}lnx_{1it}+\beta_{j2}lnx_{2it}$) and scale elasticity ($\varepsilon_{it}$) for i-th firm on t^{th} time period is ($E_{1it}+E_{2it}$). The estimated coefficients of Translog production frontier is estimated for three different samples (i.e, group wise for NAAC accredited HEIs, non-NAAC accredited HEIs and combined data set) over the study period and from these estimated coefficients the partial elasticity of each HEI for each academic session is calculated (shown in Table 5.1A, Table 5.2A, Table 5.3A and Table 5.4A in Appendix).

Table 5.1 Stochastic Translog Frontier Estimates for General Degree Colleges of Barak Valley for Panel Data

		NAAC Accredited Colleges			Non-NAAC Accredited Colleges			All Affiliated colleges		
	VARIABLES	**β s**	SE of **β**	***t*-ratios**	**β s**	SE of **β**	***t*-ratios**	**β s**	SE of **β**	***t*-ratios**
PRODUCTION FRONTIER	CONSTANT	16.72***	0.95	17.68	-33.66***	1.39	-24.19	-3.03	3.40	-0.89
	LNTSR	-1.60*	0.90	-1.78	-2.52***	0.62	-4.04	-0.38	1.03	-0.37
	LNEPS	-4.55***	0.32	-14.35	6.62***	0.32	20.91	-0.31	0.68	-0.46
	$LTSR^2$	-0.88***	0.24	-3.75	0.28***	0.08	3.45	-0.04	0.10	-0.44
	$LNEPS^2$	0.19***	0.03	6.78	-0.36***	0.02	-17.94	0.02	0.04	0.65
	LNTSRLNEPS	-0.29**	0.12	-2.36	0.43***	0.04	11.19	0.02	0.07	0.31
	T	0.07***	0.00	37.65	0.18***	0.02	8.56	-0.01	0.02	-0.60
EFFECT MODEL	CONSTANT	-0.44	0.56	-0.79	-3.66***	1.14	-3.21	-8.09***	2.29	-3.53
	YOE	-0.02	0.01	-1.21	0.17***	0.05	3.60	0.03	0.04	0.80
	LD	-0.24	0.60	-0.41	-4.97***	1.50	-3.32	-10.71***	1.49	-7.17
	CO	0.30***	0.03	10.51	-11.48***	1.76	-6.51	-1.76	1.29	-1.37
	TAD	-0.44	0.56	-0.79	-2.27*	1.17	-1.94	-16.85***	2.56	-6.59
	CMH	-0.58	0.56	-1.04	-4.42***	1.35	-3.29	-2.94	2.81	-1.05
	CMP	-2.81***	0.22	-12.84	-4.42***	1.35	-3.29	-0.51	2.99	-0.17
	T	0.33	0.24	1.42	1.72***	0.36	4.83	-0.02	0.38	-0.04
VARIANCE PARAMETERS	σ^2	0.68***	0.07	9.99	20.29***	3.05	6.65	27.11***	3.43	7.92
	Gamma(γ)	0.99***	0.00	339029.27	0.99***	0.00	9066.47	0.99***	0.00	1649.73
Log Likelihood Function		-38.58			-194.10			-247.13		
LR test of the one-sided error		57.33			97.30			298.27		
Sample Size (N)		N = 84 (12X7)			N = 105 (15X7)			N = 189 (27X7)		

Source: *Source: Stochastic Frontier Estimates from the dataset of 12, 15 and 27 HEIs over the sessions 2005-06 to 2011-12*

*Notes: ***, ** and * denotes variables are significant at equal or less than one, five and ten percent level of significance respectively.*

The average partial elasticity of output with respect to teacher-student ratio for NAAC accredited colleges 0.124 which implies that the colleges with favourable teacher-student ratio are performing better in production of successful graduates while the average partial elasticity with respect to teacher-student ratio is negative (-0.024) revealing a reverse situation for non-NAAC accredited colleges (shown in Table 5.2A in Appendix). This may be due to the reason that these non-NAAC accredited colleges are newly established colleges and less attractive colleges for which they are failed to attract good quality students or may be due to the reason that these colleges are underutilising their resources compared to other colleges. Again the average partial elasticity of output with respect to teacher-student ratio for all colleges it is positive (0.057, shown in Table 5.4A) but somewhat less elastic compare to NAAC accredited colleges. Thus it can be argued that availability of more teachers per student has more favourable influence on quality output of the NAAC accredited colleges compared to all the colleges of the region. The partial elasticity of expenditure per student in all colleges (0.064, shown in Table 5.3A) and NAAC accredited colleges (0.04, shown in Table 5.1A) is positive, while negative in case of non-accredited colleges (-0.527, shown in Table 5.2A). This implies that non-accredited colleges with higher expenditure per student is producing lesser amount of quality graduate while NAAC accredited colleges are producing more with higher expenses per student. Thus increase in expenditure as well teaching strength in accredited colleges may increase the level quality graduate in those colleges, but may decline the same for non-accredited colleges as these colleges are failed to attract good quality students.

In case of NAAC accredited colleges courses offered by the HEIs are found significant and positively related with inefficiency, which implies that colleges offering more streams are less efficient as compared to these which are specialised in specific stream. However, cut-off marks at entry level in pass course is also found significant at less than one per cent level of significance and negatively related inefficiency which indicates that colleges with restriction at entry level even in pass course admission are better in terms of efficiency than the others.

In case of non-accredited colleges, both years of establishment of the colleges and the trend parameter are significant as less than one per cent level of significant and both are positively related which indicates that there is deterioration in efficiency over time. Location of dummy in case of non-accredited colleges and for all colleges it is negatively related with inefficiency and the coefficient of it for both models are found significant at less than one per cent level of significant compared to NAAC accredited group. The course offered by the non-accredited colleges is negatively related with inefficiency while insignificant for overall model. This implies that the course offered by colleges has different impact on efficiency for two groups of colleges and hence insignificant. Type of affiliation of the colleges is significant in cases of non-accredited colleges at less than ten per cent level of significance, while in case of all colleges the coefficient is less than one per cent level of significance. This indicates that permanently affiliated colleges are more efficient than others. The cut-off marks for accredited colleges for both in honours and pass courses are significant and negatively related with inefficiency. The variance related composite parameters are significantly different from zero in these three models which denote presence of inefficiency in affiliated colleges of Barak Valley.

Table 5.2 reveals the influence of some cross-sectional factors in determining inefficiency of the HEIs of Barak Valley. The teaching experience and qualification of the teachers in the HEIs of Barak Valley are significantly related to inefficiency along with location, courses offered and type of affiliation of the colleges.

Table 5.2: Stochastic Translog Frontier Estimates for Cross section data of the HEIs

SFA Estimates	Variables	Coefficient	Std. Error	t-ratio
Production Frontier	Constant	-17.890***	1.534	-11.664
	LNTSR	-0.716*	0.383	-1.872
	LNEPS	3.089***	0.469	6.580
	$LTSR^2$	-0.010	0.013	-0.805
	$LNEPS^2$	-0.177***	0.030	-5.895
	LNTSRLNEPS	0.030	0.047	0.638
Effect Model	Constant	-0.001	1.000	-0.001
	Average Teaching Experience of the Teachers	1.034***	0.291	3.551
	Share of teachers with Teaching Experience Less than 5 years	0.023	0.020	1.149
	Share of teachers with Teaching Experience between 5 to 20 years	-0.084**	0.037	-2.272
	Share of teachers with Teaching Experience more than 20yrs	0.013	0.059	0.224
	Percentage of teachers with Ph.D. Degree	-0.085	0.059	-1.441
	Percentage of teachers with M.Phil.	-0.119**	0.047	-2.543
	Percentage of teachers with NET/SLET	-0.118***	0.036	-3.296
	Physical Resource Index	0.890	1.037	0.859
	Teaching Quality Index	0.192	0.982	0.195
	Location of the HEI (LD)	-3.217**	1.534	-2.097
	Courses offered by the HEI (CO)	-1.042**	0.430	-2.422
	Type of affiliation of the HEI (TOA)	-2.099*	1.093	-1.919
	Cut-off Restriction at entry level	-2.106	1.506	-1.399
	Years of Establishment of the HEIs	0.060	0.073	0.826
Variance Parameters	σ^2	0.842**	0.291	2.896
	Gamma(γ)	0.752***	0.109	6.896
Log likelihood	-24.244		LR test	26.129

Source: *Stochastic Frontier Estimates from the dataset of 27 HEIs for the sessions 2011-12*
*Notes: ***, ** and * denotes variables are significant at equal or less than one, five and ten per cent level of significance respectively.*

Resembling the panel data model, in this case also location dummy and type of affiliation of the college is negatively related with inefficiency. Number of courses offered by the college is negatively related with inefficiency in case of non-accredited colleges similar to cross-section model, while positive in case of NAAC accredited colleges for panel data. Average teaching experience is here positively related to inefficiency which implies that colleges with greater proportion of senior teachers are technically less efficient compared to others. However, percentage share of teachers with teaching experience between five to 20 years is significant and negatively related with inefficiency. This implies that HEIs having greater share of teachers with teaching experience between five to 20 years are more efficient compare to others. However the percentage share of teachers having Ph.D. degree is statistically insignificant and the other two are significant. This implies that those colleges have more NET / SLET qualified teachers and teachers with M.Phil. degree have significant positive impact on production of quality graduate near the possible frontier by reducing inefficiency. Therefore, it can be argued that the colleges of Barak Valley can reduce their inefficiency by appointing qualified teachers. However, it would have been interesting to examine the influence of these variables for NAAC accredited and non-NAAC accredited colleges separately which is not possible in case of cross section data due to problem of degree of freedom with lesser observation for a particular period for this region.

Stochastic Frontier Estimates for students' background related determinants of technical efficiency of HEIs in Barak valley reveals that students' socio-economic and academic background are significant in determining technical efficiency of higher education in Barak Valley (shown in Table 5.3). Entry grade reflecting academic background of the student is negatively related with inefficiency. This implies that students with good academic background are naturally proofing better in higher education. Natural science dummy is also negatively influencing efficiency, indicating the fact that students pursuing higher education in natural science stream are better than others in reducing inefficiency of higher education institution. This may be due to the reason that in science stream there is more possibility of securing good marks than arts stream and hence reduces inefficiency where quality output is measured in terms of successful quality graduates' final examination results. Number of private tutors for honours and pass papers for each student are also negatively related with inefficiency, but statistically significant in case of number of honours tutors.

Table 5.3: Stochastic Frontier Estimates for Students' Background Related Determinants of Technical Efficiency of HEIs of Barak valley

SFA Estimates	Variables	Coefficients	Standard Error	t-ratio
Production Frontier	Constant	0.466	1.204	0.387
	LNTSR	0.053	0.139	0.382
	LNEPS	0.335	0.274	1.221
	$LTSR^2$	0.006	0.005	1.255
	$LNEPS^2$	-0.016	0.014	-1.077
	LNTSRLNEPS	0.007	0.009	0.827
Effect Model	Constant	3.526***	0.874	4.035
	ENTRYGRD	-2.290***	0.516	-4.436
	NS	-0.919***	0.199	-4.631
	GEN	-0.215*	0.114	-1.885
	APE	0.013	0.028	0.479
	SIBLINGS	-0.100**	0.044	-2.26
	LNPCFI	-0.168*	0.094	-1.79
	NPTP	-0.051	0.048	-1.06
	NPTH	-0.204*	0.118	-1.735
	σ^2	0.183***	0.029	6.363
	Gamma(γ)	0.99***	0.000	2305.19
Log likelihood function = 8.83		LR test of the one-sided error = 239.997		Mean efficiency = 0.64

Source: *Stochastic Frontier Estimates from primary dataset of 200 Students of Barak Valley during January 2014 to April 2014 at AUS campus, AUS Annual Reports, Primary data from the HEIs collected during September 2012 to September 2013*

*Notes: ***, ** and * denotes variables are significant at equal or less than one, five and ten per cent level of significance respectively.*

Private tutors play an essential role in higher education in this region as majority of the students of the region are following them for attainment extra knowledge in their graduation subjects for better performance in examination of the subjects concerned. Hence, it is expected to have a positive impact on efficient production of quality graduate by reducing inefficiency which is also marked from the above estimate of SFA for honours students in this region. The results also show negative influence of general category dummy and number of siblings of the students is also found significant in determining efficiency in higher education. This implies that if an HEI have greater share of students who belongs to unreserved group are more efficient and the students with one or more siblings are better in higher education compared to single child. Average family income of the students is also found significant here and helpful in reducing inefficiency in higher education. Thus in this region students with better socio-economic and academic background are helpful in reducing inefficiency in higher education. However, it is neither necessary nor desirable to reduce the number of socio-economically backward students from higher education rather special care is needed to be taken care off with proper monitoring without compromising with efficiency of the HEIs. Good quality student in all level of education perform better, however special care is needed to be taken for academically backward students to produce quality graduate in this region near technically efficient frontier.

The estimated technical efficiency (TE) scores of NAAC accredited colleges, non-NAAC accredited colleges and all colleges are displayed in Table 5.4, Table 5.5 and Table 5.6 respectively. During 2005-06 five accredited colleges viz; college C3, C9, C16, C19 and C6 have efficiency score more than mean value, college C26, C12, C21, C15, C30, C20 and C10 have TE score less than mean value are less than mean value 0.622. During 2006-07, efficiency score of five colleges (C3, C19, C16, C9 and C30) is more than mean value whereas C21, C10, C6, C15, C20, C26 and C12 have TE score less than mean value. While during the session 2007-08 six out of the total of 12 NAAC accredited colleges' have higher TE score than the mean value 0.706 and the rest (college C6, C19, C15, C16, C10 and C20) are producing below average line. In session 2008-09 college C26, C9, C3, C15 and C12 scored TE score higher than the mean value 0.689 which implies that NAAC accredited college during this period is also approximately 70 per cent efficient like the previous session.

Table 5.4: Technical Efficiency Scores of the NAAC accredited Colleges

HEI Code	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	Mean
C3	0.883	0.978	1.000	0.880	0.771	0.247	0.605	0.766
C6	0.640	0.585	0.667	0.502	0.528	0.046	0.241	0.458
C9	0.882	0.851	1.000	0.880	0.992	0.421	0.511	0.791
C10	0.261	0.649	0.459	0.445	0.524	0.047	0.247	0.376
C12	0.587	0.383	0.880	0.726	0.593	0.052	0.359	0.511
C15	0.552	0.510	0.589	0.859	0.625	0.230	0.991	0.622
C16	0.865	0.882	0.566	0.641	0.598	0.238	0.306	0.585
C19	0.818	0.969	0.591	0.663	0.531	0.388	0.540	0.643
C20	0.388	0.495	0.282	0.558	0.487	0.171	0.250	0.376
C21	0.560	0.658	0.900	0.573	0.463	0.237	0.315	0.529
C26	0.587	0.438	0.819	0.983	0.830	0.422	0.313	0.627
C30	0.439	0.705	0.720	0.552	0.415	0.368	0.431	0.519
Mean	0.622	0.675	0.706	0.689	0.613	0.239	0.426	0.567

Source: Calculated scores of Technical Efficiency obtained from Translog SFA model for the dataset of 12 HEIs over the sessions 2005-06 to 2011-12

Again there is almost ten per cent decline in technical efficiency score of NAAC accredited colleges during the session 2009-10 while drastic decline in TE score is observed during the year 2010-11; where the colleges are only 23 per cent technically efficient compared to other sessions. During the session 2011-12 the mean efficiency of NAAC accredited colleges in Barak Valley is 0.426 which is less than overall mean 0.585. Highest technical efficiency score over the study period is witnessed during session 2007-08 followed by session 2008-09 and 2006-07, while it is least during academic year 2010-

11 preceded by 2011-12. HEI C3 has scored highest TE score during three consecutive sessions but in C2 TE score is second best in terms of average score over the study period. HEI C9 and C26 have highest efficiency scores during session 2007-08 & 2009-10 and 2008-09 & 2010-11 respectively.

Table 5.5: Technical Efficiency scores of the Non-NAAC accredited Colleges

HEI Code	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	Mean
C1	0.346	0.510	0.634	0.427	0.422	0.156	0.251	0.392
C5	0.678	0.327	0.238	0.321	0.319	0.084	0.241	0.315
C7	0.931	0.782	0.814	0.320	0.631	0.095	0.671	0.606
C11	0.000	0.461	0.000	0.152	0.124	0.503	0.358	0.228
C13	0.375	0.000	0.932	0.000	0.000	0.000	0.000	0.187
C14	0.883	0.161	0.293	0.213	0.077	0.000	0.216	0.263
C17	0.930	0.795	0.303	0.345	0.390	0.244	0.301	0.472
C18	0.133	0.607	0.784	0.343	0.528	0.242	0.771	0.487
C22	0.438	0.229	0.283	0.267	0.844	0.321	0.087	0.353
C23	0.483	0.788	0.475	0.574	0.454	0.143	0.303	0.460
C24	0.158	0.912	0.673	0.980	0.435	0.037	0.041	0.462
C25	0.404	0.203	0.415	0.518	0.297	0.087	0.160	0.298
C27	0.762	0.459	0.739	0.471	0.223	0.065	0.363	0.440
C28	0.652	0.075	0.466	0.095	0.026	0.000	0.066	0.197
C29	0.280	0.218	0.197	0.281	0.210	0.084	0.888	0.308
Mean	0.497	0.435	0.483	0.354	0.332	0.138	0.314	0.365

Source: Calculated scores of Technical Efficiency obtained from Translog SFA model for the data set of 15 HEIs over the sessions 2005-06 to 2011-12

Table 5.5 depicts technical efficiency scores of the non-NAAC accredited colleges of Barak Valley. The mean efficiency scores of the colleges over last seven academic sessions is highest in HEI C7 followed by C18, C17 and C24 while lowest in case of C13 preceded by C28, C11 and C14. The mean efficiency score of most of the colleges is below 50 per cent. During academic session 2005-06 HEI C7 has scored has technical efficiency score while moderate in other session. HEI C11 is the least efficiency college during session 2005-06 and 2007-08; while HEI C13 with least efficiency score over the years is also least efficiency in four consecutive academic sessions from 2007-08 to 2011-12. Highest efficiency score for different academic session is scored by different college which implies that no college is consistent in terms of efficient production of near the best possible frontier.

Table 5.6: Technical Efficiency scores of the Affiliated General Degree Colleges

HEI Code	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	Mean
C1	0.188	0.372	0.496	0.44	0.589	0.255	0.467	0.401
C3	***0.79***	***0.877***	***0.899***	***0.889***	***0.852***	***0.306***	***0.387***	***0.714***
C5	0.518	0.46	0.408	0.602	0.675	0.217	0.444	0.475
C6	***0.626***	***0.541***	***0.533***	***0.558***	***0.712***	***0.069***	***0.39***	***0.49***
C7	0.429	0.423	0.53	0.408	0.691	0.126	0.907	0.502
C9	***0.824***	***0.879***	***0.907***	***0.896***	***0.926***	***0.675***	***0.819***	***0.847***
C10	***0.268***	***0.641***	***0.492***	***0.455***	***0.633***	***0.06***	***0.353***	***0.415***
C11	0	0.29	0	0.32	0.156	0.46	0.569	0.256
C12	***0.576***	***0.414***	***0.872***	***0.836***	***0.74***	***0.069***	***0.608***	***0.588***
C13	0.046	0	0.874	0	0	0	0	0.132
C14	0.447	0.086	0.183	0.201	0.094	0	0.171	0.169
C15	***0.546***	***0.514***	***0.707***	***0.867***	***0.82***	***0.337***	***0.857***	***0.664***
C16	***0.752***	***0.868***	***0.599***	***0.731***	***0.545***	***0.192***	***0.276***	***0.566***
C17	0.756	0.755	0.452	0.589	0.777	0.349	0.697	0.625
C18	0.095	0.591	0.708	0.408	0.756	0.33	0.621	0.501
C19	***0.71***	***0.846***	***0.678***	***0.793***	***0.746***	***0.572***	***0.821***	***0.738***
C20	***0.375***	***0.547***	***0.337***	***0.686***	***0.663***	***0.257***	***0.4***	***0.467***
C21	***0.518***	***0.589***	***0.807***	***0.64***	***0.627***	***0.378***	***0.544***	***0.586***
C22	0.305	0.189	0.259	0.473	0.746	0.426	0.454	0.407
C23	0.296	0.596	0.505	0.652	0.629	0.242	0.57	0.499
C24	0.076	0.591	0.645	0.915	0.617	0.064	0.087	0.428
C25	0.302	0.205	0.536	0.781	0.734	0.244	0.714	0.502
C26	***0.879***	***0.694***	***0.87***	***0.927***	***0.922***	***0.651***	***0.568***	***0.788***
C27	0.62	0.461	0.734	0.699	0.613	0.317	0.898	0.62
C28	0.269	0.063	0.444	0.115	0.033	0	0.084	0.144
C29	0.304	0.355	0.464	0.591	0.748	0.238	0.749	0.493
C30	***0.517***	***0.709***	***0.75***	***0.666***	***0.593***	***0.468***	***0.717***	***0.631***
Mean	0.446	0.502	0.581	0.598	0.616	0.27	0.525	0.505

Source: Technical Efficiency scores obtained from Translog SFA model for the dataset of 27 HEIs over the sessions 2005-06 to 2011-12

The technical efficiency score of non-accredited colleges is higher during academic session 2005-06 and least during 2010-11. During the academic session 2010-11 technically efficiency score in most of the colleges is bellow 0.5 and highest efficiency score for that year is 0.503. This may be due to the reason that during there is some sort of functional change in input combinations or evaluation system which major the quality of output. Or it may be due to the reason that the quality of students during that session are not up to mark compare to others session.

Out of 27 colleges of Barak Valley NAAC accredited college C9 has highest technically efficiency score (0.85). This college has maintained highest technically efficiency score during four different academic sessions (2006-07, 2007-08, 2009-10 and 2010-11). HEI C26 has scored highest technically efficiency score during 2005-06 and 2008-09 session with efficiency score 0.88 and 0.93 receptivity. This college has second highest technically efficiency score over the study period followed by C19 and C3. College C13 is the least technically efficient college in this region in relative to others and it remains approximately 13 per cent efficient over the study period and has score lowest technically efficiency score during five academic sessions.

Over the study period the lowest technically efficiency score is observed for 2010-11 session like other two groups. This implies that all colleges of the Barak Valley during the session have failed to produce maximum possible desirable level of quality graduate with given set of input combinations. Compare to all the academic session, colleges of Barak Valley are more efficient during the academic session 2009-10 session followed by 2008-09 and 2007-08 over all technically efficiency of the HEIS of Barak Valley is approximately 51 per cent, while in case of NAAC accredited colleges it is 57 per cent and 37 per cent for non-accredited colleges. Thus technically efficiency of NAAC accredited colleges is better than non-accredited colleges in separate and combined models.

5.2 Technical Efficiency of the HEIs of Barak Valley using Malmquist DEA

Application of DEA in case of Panel Data enable us calculation of the Malmquist Index (Caves, Christensen and Diewert 1982) with both constant returns to scale (CRS) and variable returns to scale (VRS) technical efficiency scores. The specific Malmquist index summary provides five different indices related to productivity change, with the help of which the possible source of productivity gain or loss can be easily analyzed.

The DEA-CRS output oriented overall average TE score for the affiliated general degree colleges of Barak Valley is 0.63 ranging from 0.01 to 1.0 over the study period for 27 HEIs, while in case of VRS output oriented TE score it is 0.73 with similar range.

The results of output oriented DEA Malmquist for NAAC accredited colleges, non-accredited colleges and all colleges are shown in Table 5.7, Table 5.8 and Table 5.9 respectively.

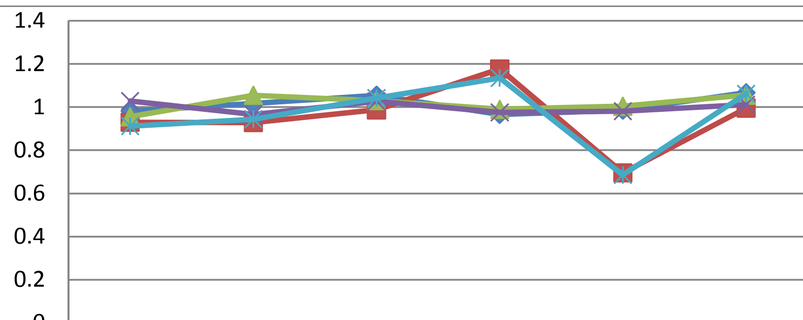
Table 5.7: Malmquist Index Summary of NAAC Accredited Colleges' Means

HEI Code	Efficiency Change	Technological Change	Pure Efficiency Change	Scale Efficiency Change	Total Factor Productivity Change
C3	1.000	0.989	1.000	1.000	0.989
C6	1.013	0.903	1.012	1.000	0.915
C9	1.026	1.018	1.000	1.026	1.045
C10	1.015	0.933	1.000	1.015	0.948
C12	0.981	0.984	0.998	0.983	0.965
C15	1.016	0.890	1.016	1.000	0.904
C16	0.996	0.916	1.000	0.996	0.912
C19	1.144	0.910	1.134	1.008	1.041
C20	0.977	0.981	0.980	0.997	0.958
C21	1.053	0.987	1.075	0.980	1.039
C26	0.920	0.805	0.929	0.990	0.741
C30	1.006	0.995	1.032	0.975	1.001
Mean	1.011	0.941	1.014	0.997	0.951

Source: From the dataset of 15 non-accredited colleges over the sessions 2005-06 to 2011-12
Note: All Malmquist index averages are geometric mean.

The results of output oriented DEA Malmquist indices for NAAC accredited general degree colleges are shown in Table 5.7, which reveals that there is overall productivity loss in the NAAC accredited general degree colleges of Bark Valley and it is mainly contributed by efficiency change resulted from pure efficiency change. Among these 12 NAAC accredited colleges four colleges have shown productivity gain over the last seven academic sessions while the rest eight have shown productivity loss. C30, C21 and C19 have shown productivity gain due to change in efficiency resulted from pure efficiency gain rather than technological change while only C9 has shown productivity gain resulted from efficiency gain due to scale effect. Among other eight colleges, six colleges viz; C15, C10, C6, C3, C16 and C26 have shown productivity loss due to change in efficiency while only C12 and C20 have shown productivity loss due to change in technology which is resulted from scale effect for C20 and pure efficiency for C12. Thus in case of NAAC accredited colleges, the main source of total factor productivity gain or loss is efficiency change only for two colleges and it is attributed by technological change. This may be due to the reason that in these two colleges there is a decline in performance or enrollment or rise in total number of teacher or expenditure, while for others it is mainly due to change in quality of inputs and output.

Figure 5.1: Malmquist Index Summary of NAAC Accredited HEIs Annual Means



	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12
Efficiency Change	0.981	1.017	1.055	0.965	0.985	1.067
Technological Change	0.929	0.928	0.987	1.176	0.695	0.995
Pure Efficiency Change	0.955	1.054	1.029	0.99	1.004	1.055
Scale Efficiency Change	1.028	0.965	1.026	0.975	0.981	1.011
Total Factor Productivity Change	0.912	0.944	1.042	1.135	0.685	1.061

Source: Malmquist index summary for the dataset of 12 NAAC accredited colleges over the sessions 2005-06 to 2011-12
Note: All Malmquist index averages are geometric mean. All the indices are relative to the previous year; therefore, no results for the initial sample period 2005-06.

Over the years for NAAC accredited colleges it is observed that there is overall decline in total factor productivity while gain is witnessed during three sessions only viz;

2008-09, 2009-10 and 2011-12 (depicted in Figure 5.1). Highest fall in total factor productivity is observed in the year 2010-11. Here productivity gain has occurred during 2009-10 due to technological change resulted from pure efficiency gain. However, in case of other academic sessions the main responsible factor of productivity gain or loss is pure efficiency gain rather than scale effect. This implies that in these colleges there is no such change in input combinations for which role of scale effect is very negligible while quality of student contributes more in these colleges.

From Figure 5.1, it is also cleared that there is a fluctuation in total factor productivity during the study period. Over the study period it is observed that there is negligible increase in total factor productivity growth with a drastic decline during the session 2010-11 and a further rise in the next session. The average annual growth of total factor productivity is approximately four per cent (Table 5.5A in Appendix).

Change in total factor productivity of non-accredited colleges is shown Table 5.8 which reveals that productivity gain has occurred to ten non-accredited colleges. Out of which C7, C22, C28, C18 and C23 have shown productivity gain due to change in efficiency resulted from change in pure efficiency gain for college C7 and C22 while for others it is due to scale effect. For college C5, C11, C27 and C29 productivity gain is due to technological change where for C27 and C29 both scale effect and pure efficiency gain are responsible factors but for C5 it is due to pure efficiency gain and C11 it is due to scale effect. C1, C13, C14, C17 and C24 have shown productivity loss over the sessions 2005-06 to 2011-12 and the main source of productivity loss in these colleges are technological change. Change in technology as responsible factor of productivity loss is resulted from efficiency change in case of college C1, while in case of others it is mainly due to scale effect.

Table 5.8: Malmquist Index Summary of Non-Accredited HEIs of Barak Valley during 2005-06 to 2011-12

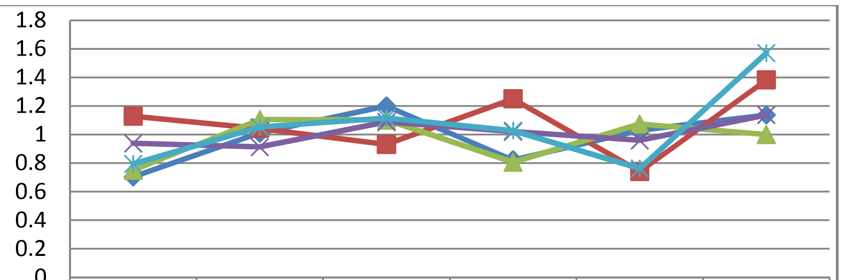
HEI Code	Efficiency Change	Technological Change	Pure Efficiency Change	Scale Efficiency Change	Total Factor Productivity Change
C1	0.91	1.07	0.971	0.937	0.973
C5	1.03	1.233	1.016	1.014	1.269
C7	1.104	1.086	1.112	0.993	1.198
C11	1.033	1.118	1	1.033	1.155
C13	0.703	1.092	0.712	0.988	0.768
C14	0.885	1.066	0.884	1.002	0.944
C17	0.93	1.001	0.942	0.987	0.931
C18	1.068	0.943	0.989	1.079	1.007
C22	1.104	0.957	1.073	1.029	1.057
C23	0.924	1.091	0.918	1.006	1.007
C24	0.83	1.054	0.835	0.993	0.874
C25	1.06	1.034	1.033	1.027	1.096
C27	1	1.083	1	1	1.083
C28	1.022	0.991	1.004	1.019	1.014
C29	1	1.079	1	1	1.079
Mean	0.967	1.058	0.961	1.007	1.023

Source: From the dataset of 15 HEIs over the sessions 2005-06 to 2011-12
Note: All Malmquist index averages are geometric mean.

Over the study period productivity loss in non-accredited colleges have occurred during the years 2006-07 and 2010-11 while for other academic session there is a productivity gain. In the year 2006-07, technological change is the main responsible factor for productivity loss resulted from scale effect and in the session 2011-12 scale effect for these colleges has lead to efficiency loss with loss in total factor productivity. During 2007-08 productivity gain has occurred due to change in technology while for 2008-09 it is due to efficiency gain, while both are contributed by pure technical efficiency gain.

Figure 5.2 represents total factor productivity change and other indices during the study period. Over the study period it is observed that there is an increase in total factor productivity growth like accredited colleges while the rate of change is higher than that of accredited colleges. A similar downfall during the session 2010-11 is also observed for this group and a further rise in the next session. The average annual growth of total factor productivity is approximately 15 per cent (Table 5.5A in Appendix), which is almost three times higher than the growth rate of accredited colleges. The main responsible factor for productivity gain in these non-accredited colleges is technological change in terms of scale effect. This may be due to the reason during initial period the enrollment in these colleges are less which results less production of quality graduate as well as undergraduates. While over the study period there is a significant increase in enrollment (also evident from Table 6.1 in Chapter 6) for which favourable change in scale of production is witnessed for this group.

Figure 5.2: Malmquist Index Summary of Non-Accredited HEIs Annual Means



	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12
Efficiency Change	0.703	1.009	1.199	0.821	1.029	1.136
Technological Change	1.128	1.043	0.93	1.25	0.741	1.382
Pure Efficiency Change	0.749	1.105	1.102	0.805	1.073	0.999
Scale Efficiency Change	0.939	0.913	1.088	1.021	0.959	1.137
Total Factor Productivity Change	0.794	1.053	1.115	1.027	0.762	1.57

Source: From the dataset of 15 non-accredited colleges in Barak Valley over the sessions 2005-06 to 2011-12.

Note: All Malmquist index averages are geometric mean. All the indices are relative to the previous year; therefore, no results for the initial sample period 2005-06.

Change in total factor productivity for all the degree colleges of Barak Valley is shown Table 5.9. Out of 27 colleges, productivity gain has been witnessed by 18 colleges while nine colleges have shown productivity loss over the study period. Among the NAAC accredited colleges college C19, C21, C9, C30, C15, C3, C6 and C16 have shown productivity gain over the study period, out of which all the colleges have shown productivity gain due to change in technical change rather than efficiency change.

Table 5.9: Malmquist Index Summary of both NAAC Accredited and non-NAAC Accredited HEIs of Barak Valley

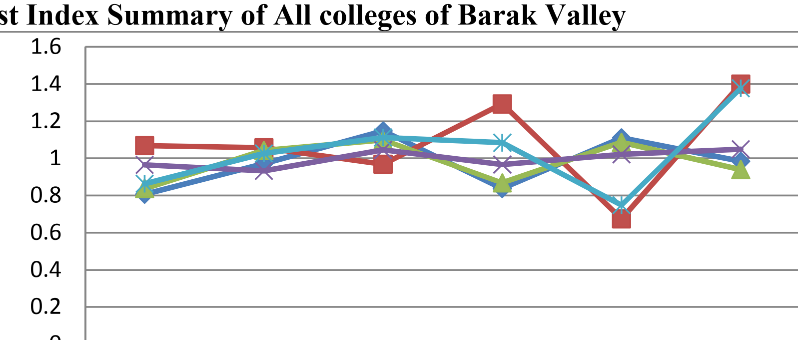
HEI Code	Efficiency Change	Technological Change	Pure Efficiency Change	Scale Efficiency Change	Total Factor Productivity Change
C1	0.912	1.054	0.997	0.915	0.962
C3	1	1.016	1	1	1.016
C5	1.037	1.222	1.024	1.012	1.266
C6	0.965	1.044	0.964	1.001	1.008
C7	1.122	1.066	1.125	0.997	1.196
C9	1.011	1.041	1	1.011	1.053
C10	0.958	1.024	0.965	0.993	0.981
C11	1.038	1.114	1	1.038	1.156
C12	0.921	1.057	0.919	1.003	0.974
C13	0.709	1.054	0.74	0.958	0.748
C14	0.905	1.058	0.89	1.017	0.957
C15	0.956	1.086	1.022	0.935	1.039
C16	0.974	1.03	0.994	0.98	1.003
C17	0.93	1	0.94	0.989	0.93
C18	1.068	0.94	0.979	1.091	1.003
C19	1.036	1.046	1.139	0.91	1.084
C20	0.923	1.053	0.923	0.999	0.972
C21	1	1.058	0.999	1.001	1.058
C22	1.102	0.96	1.073	1.027	1.058
C23	0.925	1.086	0.922	1.004	1.005
C24	0.829	1.054	0.835	0.993	0.874
C25	1.06	1.034	1.033	1.027	1.097
C26	0.88	1.024	0.898	0.98	0.902
C27	1	1.083	1	1	1.083
C28	1.022	0.993	1.013	1.01	1.015
C29	1	1.055	1	1	1.055
C30	0.962	1.09	0.974	0.988	1.049
Mean	**0.968**	**1.049**	**0.973**	**0.995**	**1.015**

Source: From the dataset of 27 colleges over the sessions 2005-06 to 2011-12
Note: All Malmquist index averages are geometric mean.

Here, technical progress in these colleges are attributed by pure efficiency change in case of college C30, C16, C15 and C19 while scale effect is responsible for technological gain in college C9, C6, C21 and C3 for total factor productivity gain. While other accredited colleges like C26, C20, C12 and C10 have shown productivity loss during the study period and deterioration in productivity in all these colleges have occurred mainly due to technological change resulted from change in the scale effect. These four colleges have shown decline in efficiency change, and out of which loss in productivity of college C9 is due to pure efficiency change and the rest are resulted from change in scale efficiency.

Among non-NAAC accredited colleges C18, C23, C28, C29, C22, C27, C25, C11, C7 and C5 have shown productivity gain and college C13, C24, C17, C14 and C1 have shown productivity loss. Productivity gain in college C22, C7, C28 and are caused by change in efficiency resulted from favorable scale efficiency change, while in case of C19 productivity gain has occur due to efficiency change resulted from pure efficiency gain. In college C29, productivity gain from efficiency is attributed by both scale efficiency and pure efficiency. Productivity loss in college C13, C24, C17, C14 and C1 are largely responsible due to technical change rather than loss in efficiency which is caused by unfavorable scale effect for C1 and for the rest due to pure efficiency loss.

Figure 5.3: Malmquist Index Summary of All colleges of Barak Valley



	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12
Efficiency Change	0.807	0.972	1.147	0.838	1.11	0.984
Technological Change	1.068	1.056	0.968	1.292	0.674	1.399
Pure Efficiency Change	0.837	1.042	1.099	0.868	1.086	0.939
Scale Efficiency Change	0.964	0.932	1.044	0.966	1.021	1.048
Total Factor Productivity Change	0.862	1.026	1.111	1.083	0.748	1.376

Source: From the dataset of 27 colleges over the sessions 2005-06 to 2011-12
Note: All Malmquist index averages are geometric mean. All the indices are relative to the previous year; therefore, no results for the initial sample period 2005-06.

The study reveals that over the academic sessions highest productivity gain with efficiency gain has occurred during the session 2011-12 which is largely attributed by technical change due to pure efficiency gain. This is due to the reason that compared to its previous period this session has shown a steep rise in quality output and since the Malmquist index is based on previous time period. Compared to the other periods 2010-11 session has shown lowest quality output per students and a rise in output in 2011-12 session as compared to its last year has lead to high productivity gain for that year. During the sessions 2006-07 and 2007-08 productivity gain have occurred due to efficiency gain resulted from pure efficiency change. Over the years productivity gain or loss of the colleges have occurred due to change in technological progress only the exceptional periods are 2007-08 and 2010-11 which shows productivity gain and loss respectively are resulted from pure efficiency change, which may be due to enrollment of quality students or due to performance of the students in the examination. In session 2009-10 there is a loss in productivity of the colleges due to productivity change and loss in productivity of the colleges during the session 2010-11 is caused by efficiency change due to change in scale efficiency. This may be due to the reason that during this period provincialisation of these colleges are under process and most of these colleges have shown a tremendous increase in the number of teachers to fulfill the requirement of the process. Out of these 11 colleges during the session 2012-13 nine colleges are provincialised while the rest two are still under process. But the NAAC accredited colleges are generally old and provincialised long back because of which the quantity of inputs in these colleges are more or less same and their productivity gain or loss is largely responsible due to change in pure efficiency change. Some colleges are clearly improved by moving towards their best practice frontier and some colleges have shown loss in their productivity, these are producing below their practice.

5.2.1 Determinants of Technical Efficiency by using Tobit Model

The estimated results of both CRS and VRS technical efficiency using DEA for two groups and combine data are shown in Table 5.7A to Table 5.12A (in Appendix). The average technical efficiency score of NAAC accredited colleges like SFA model both in case of combined and separate models are better than that of non-accredited colleges. The mean efficiency scores of DEA estimation are shows that colleges are producing near frontier over the study period unlike SFA estimation. This may be due to detergency in assumptions and specification of outputs in two different techniques. However, in order to examine the influence of selected environmental factors on technical efficiency of the HEIs of Barak Valley in case of DEA CRS and VRS technical efficiency following Tobit model (censored regression model) is used for estimated efficiency scores from DEA.

$$TE_{it} = \alpha + \delta_1 YE_{it} + \delta_2 LCN_{it} + \delta_3 CO_{it} + \delta_4 TOA_{it} + \delta_5 CMH_{it} + \delta_6 CMP_{it} + \delta_7 T + u_{it}$$

Where, TE indicates the technical efficiency scores of the colleges, all other variables are defined in case of SFA specification, i indicates the number of colleges or decision-making units (DMUs), α indicates a constant term, e_{it} indicates an error term which $u \sim N(0, \sigma^2)$.

Table 5.10 depicts determinants of technical efficiency of the colleges of Barak Valley for both CRS and VRS technical efficiency score both the model show significant and positive relationship between location and technical efficiency score of the colleges. This implies that colleges situated in urban area are more efficient as compared to those in rural areas. This may be due to the reason that colleges situated in urban areas have better infrastructural facilities in terms of availability of resources related to studies and private tutors which contribute highly in production of quality output of any HEI. Type of affiliation in case of CRS technical efficiency score is significant and negatively related.

Table 5.10: Tobit Regression Estimates for Determinants of Technical Efficiency

Variables	**For VRS TE scores**			**For CRS TE scores**		
	Coefficients	Std. Error	**t** value	Coefficients	Std. Error	**t** value
CONSTANT	0.750***	0.061	12.330	0.755***	0.042	18.090
YOE	0.000	0.001	-0.290	-0.001	0.001	-1.010
LCN	0.192***	0.054	3.540	0.091**	0.037	2.440
CO	-0.014	0.025	-0.570	0.008	0.021	0.380
TOA	-0.086	0.056	-1.520	-0.130***	0.036	-3.590
CMH	-0.024	0.060	-0.390	-0.016	0.043	-0.370
CMP	0.331**	0.113	2.930	0.194***	0.057	3.400
T	-0.005	0.007	-0.680	-0.010*	0.006	-1.720
σ_u	0.275***	0.019	14.450	0.308***	0.018	17.090
σ_e	0.171***	0.012	14.540	0.159***	0.009	16.950
rho	0.720***	0.035	20.772	0.788***	0.027	29.730
Model Summary	Observation summary: 128 uncensored observations 0 left-censored observations 61 right-censored observations Log likelihood = -22.849164 Wald $chi^2(7)$ = 32.22 Prob. > chi^2 = 0.000			Observation summary: 155 uncensored observations 0 left-censored observations 34 right-censored observations Log likelihood = 2.5522273 Wald $chi^2(7)$ = 39.78 Prob.> chi^2 = 0.000		

Source: Estimated results of MLE from the dataset of 27 HEIs over the sessions 2005-06 to 2011-12
*Notes: *** and ** denotes variables are significant at equal or less than one and five percent level of significance respectively. Here VRS stands for variable returns to scale and CRS for Constant Returns to scale.*

The trend parameter is significant for CRS model and insignificant for VRS model and it shows negative relationship between time and technical efficiency score. Cut-off marks at entry level in pass course are also significant and positively related with technical efficiency for both the models. This implies that colleges screening quality of student at entry level for admission are maintaining their efficiency in production of quality graduates.

The value of σ_u and σ_e are also significant for both these models indicating the fact that variation in technical efficiency scores of the colleges vary across the HEIs and are time variant in nature. The composite coefficient *rho* is also significant and it validates justification for panel data estimation.

5.3 Construction of Efficiency Index and Comparison of Technical Efficiency Scores

After estimating technical efficiency score for the colleges belonging to Barak Valley over the session 2005-06 to 2011-12 an efficiency index is constructed in order to assign final ranking to the HEIs in terms of technical efficiency. For construction of efficiency index, average technical efficiency scores of 27 colleges over the study period obtained from both SFA and DEA techniques for grouped and combined models are considered here. As the specifications of inputs and outputs are done on the basis of requisite of the methodologies the efficiency scores are across the specification are found different. Hence in order to assign proper weights to the efficiency scores to different specifications, principal component analysis is used in this study which is constructed on the basis of six sets of technical efficiency scores of the colleges' descriptive statistics (Table 5.11).

Table 5.11: Descriptive Statistics of Technical Efficiency Scores

Technical Efficiency Scores	All Colleges		NAAC Accredited Colleges		Non- NAAC Accredited Colleges	
	Mean	Std. Deviation	Mean	Std. Deviation	Mean	Std. Deviation
$DEACRS_G$	0.749	0.224	0.767	0.171	0.732	0.264
$DEAVRS_G$	0.700	0.254	0.814	0.179	0.609	0.273
SFA_G	0.454	0.161	0.579	0.129	0.355	0.106
$DEACRS_C$	0.630	0.243	0.673	0.190	0.595	0.279
$DEAVRS_C$	0.727	0.233	0.739	0.183	0.718	0.272
SFA_C	0.505	0.182	0.626	0.131	0.409	0.161

Source: Calculated from the dataset of 27 HEIs over the sessions 2005-06 to 2011-12 based on based on primary data collected from the colleges during September 2012 to September 2013, AUS's Result Books, and AUS's Annual Reports.
Note: Subscripts G and C denote group wise and combined data estimates of the HEIs for Barak Valley

Table 5.11 describes mean and standard deviations of technical efficiency scores for the above mentioned six sets of scores where it is observed there is presence of variation within the efficiency scores of group wise as well as combine dataset. However highest variation is observed in case non-NAAC accredited for DEA-CRS combined estimate of technical efficiency. The mean technical efficiency score of NAAC accredited score is higher in case of all the estimates; however the differences scores are negligible in some of the cases. Higher technical efficiency scored is obtained by HEIs of Barak Valley for DEA-CRS grouped estimates and lowest in case of SFA grouped estimates. The mean efficiency score of NAAC accredited colleges over different specifications ranges from 0.58 to 0.81, while for non-NAAC accredited mean technical efficiency score varies from 0.36 to 0.73.

Table 5.12 explains the correlation matrix of technical efficiency scores for different estimates. It is found that all these estimates are positive and statistically significant but high for DEA-CRS and DEA-VRS models while weak for SFA and DEA estimates. However the correlation coefficients of technical efficiency scores for estimates of SFA, DEA-VRS and DEA-CRS for grouped and ungrouped data are very high indicating uniformity in the specification and estimation technique.

Table 5.12: Correlation Matrix of Technical Efficiency Scores

TE Score	$DEACRS_G$	$DEAVRS_G$	SFA_G	$DEA\text{-}CRS_C$	$DEA\text{-}VRS_C$	SFA_C
$DEA\text{-}CRS_G$	1					
$DEA\text{-}VRS_G$	0.748***	1				
SFA_G	0.259*	0.523**	1			
$DEA\text{-}CRS_C$	0.796***	0.934**	0.39**	1		
$DEA\text{-}VRS_C$	0.989***	0.723**	0.274*	0.798***	1	
SFA_C	0.43***	0.687***	0.88***	0.564***	0.438***	1

Source: Calculated from the dataset of 27 HEIs over the sessions 2005-06 to 2011-12

*Note: Subscripts G and C denote group wise and combined data estimates of the HEIs for Barak Valley. ***, ** and * denote coefficients at one, five and ten per cent level of significance.*

Table 5.13 shows the validity of principal component analysis for constructing efficiency index of the colleges. Here, Kaiser-Meyer-Olkin Measure of Sampling Adequacy statistic reveals that the dataset is explaining 62 per cent of the population which is quite a satisfactory indicator of representative population. The Bartlett's Test of Sphericity is also significant indicating validity for the application of principal component analysis.

Table 5.13: KMO and Bartlett's Test for Efficiency Index

Kaiser-Meyer-Olkin Measure of Sampling Adequacy		0.623
Bartlett's Test of Sphericity	Approx. Chi-Square225.407	Significance Level 0.000

Source: Calculated from the dataset of 27 HEIs over the sessions 2005-06 to 2011-12

Table 5.14: Total Variance Explained by factors of TE scores

Component	Initial Eigen values			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	4.197	69.95	69.95	4.197	69.95	69.95
2	1.291	21.521	91.472	1.291	21.5217	91.4717
3	0.355	5.924	97.396			
4	0.097	1.613	99.009			
5	0.054	0.892	99.901			
6	0.006	0.099	100			

Extraction Method: Principal Component Analysis
Source: Calculated from the dataset of 27 HEIs over the sessions 2005-06 to 2011-12

The Principal Component analyses indicate that there exist only two principal components for the twelve indicators, which explain 91.47 per cent of the variation in the data. The first principal component accounted for 69.95 per cent of variation and the second principal component accounted for 21.52 per cent of the variation (Table 5.14). The percentage of variation explained by each factor is different and hence the importance of the factors is different. A composite index is developed as weighted sum of scores for each institution, the weight being the percentage of the variation explained by the factors.

This index measures the efficiency index of one HEI relative to the other on a linear scale. The index value is calculated for each HEI in Table 4.7 (in Chapter 4). For example, for the HEI C1, the composite index is (-0.382) X 69.95 + (-0.46) X 21.52 = -36.608. Similarly, the value of the index is computed for all the 27 HEIs of Barak Valley which is shown in Table 5.15.

Table 5.15: Efficiency Index and Average Technical Efficiency Scores of the HEIs of Barak Valley

HEI Code	Factor Scores		Efficiency Index		Average Technical Efficiency Score	Ranking of the HEIs	
	Factor1	Factor2	Composite	Normalised		Efficiency Index	Average Technical Efficiency
C1	-0.382	-0.46	-36.608	0.478	0.558	22	18
C3	1.484	0.731	119.529	0.94	0.898	2	2
C5	0.46	-1.17	6.975	0.607	0.715	14	10
C6	***-0.79***	***0.816***	***-37.677***	***0.475***	***0.481***	***23***	***25***
C7	-0.408	1.09	-5.074	0.572	0.552	16	19
C9	***1.639***	***1.166***	***139.774***	***1***	***0.924***	***1***	***1***
C10	***0.351***	***-0.823***	***6.837***	***0.607***	***0.696***	***15***	***11***
C11	-0.797	-1.902	-96.662	0.301	0.483	25	24
C12	***0.319***	***0.406***	***31.077***	***0.679***	***0.686***	***9***	***12***
C13	-2.972	0.445	-198.344	0	0.085	27	27
C14	-0.677	-1.53	-80.251	0.349	0.510	24	22
C15	***-0.028***	***1.405***	***28.243***	***0.67***	***0.619***	***10***	***15***
C16	***1.111***	***-0.221***	***72.975***	***0.802***	***0.833***	***4***	***4***
C17	0.608	-0.106	40.258	0.706	0.739	7	7
C18	-0.503	0.521	-23.977	0.516	0.535	18	20
C19	***0.207***	***1.523***	***47.242***	***0.726***	***0.662***	***6***	***13***
C20	***-0.354***	***-0.063***	***-26.156***	***0.509***	***0.564***	***19***	***17***
C21	***-0.608***	***1.303***	***-14.471***	***0.544***	***0.512***	***17***	***21***
C22	-0.309	-0.483	-31.995	0.492	0.572	20	16
C23	-0.7	0.706	-33.753	0.487	0.499	21	23
C24	0.526	-0.776	20.076	0.646	0.725	11	9
C25	0.587	-1.299	13.082	0.625	0.738	13	8
C26	***1.162***	***0.667***	***95.601***	***0.869***	***0.837***	***3***	***3***
C27	0.946	-0.582	53.636	0.745	0.802	5	5
C28	-1.764	-0.675	-137.906	0.179	0.307	26	26
C29	0.923	-1.537	31.508	0.680	0.800	8	6
C30	***-0.032***	***0.85***	***16.062***	***0.634***	***0.619***	***12***	***14***

Source: Calculated from the compiled primary dataset of 27 HEIs over the sessions 2005-06 to 2011-12 collected from the colleges during September 2012 to September 2013 and secondary data collected from AUS's Result Books and AUS's Annual Reports.

Note: Italic values are for NAAC accredited colleges

Further average of six set of technical efficiency indices which assigned equal weights to each set of estimates is shown in the next right row of Table 5.15. Both the indices show a similar approximation for composite technical efficiency measure for the HEIs of Barak Valley.

Table 5.15 shows the ranking of the HEIs in terms of efficiency index and average technically efficiency scores. In Barak Valley out of the 27 affiliated general degree colleges, HEI C9 has ranked the best in terms of both the efficiency indicators followed by C3, C26 and C16. Here it is interesting to note that all these tops are NAAC accredited with rank 4^{th}, 3^{rd}, 5^{th} and 10^{th} in terms of teachers' quality respectively while 2^{nd}, 3^{rd}, 6^{th} and 18^{th} in terms in production of total quality graduates. However there is some sort of discrepancy in terms of ranking for some HEIs in middle, but the best and worst technically efficient colleges are somewhat consistent in their position irrespective of the indices. HEI C13 and C28 are the least efficient colleges in this region and are ranked in the bottom two positions. It is also surprising to observe that these two HEIs are non-accredited HEIs. Here, the least efficient HEI C13's rank in terms of infrastructure is 2^{nd} in the region but last in terms of production of quality graduates. However non-accredited HEI, college C17 and C27 are at 5^{th} and 7^{th} position in both the indices with a higher efficiency value. In between rank 8^{th} to 25^{th} both accredited and non-accredited colleges have occupied their position with average and more or less than average scores. Only the extreme top three ranks are occupied by accredited colleges and the worst two are by non-accredited colleges.

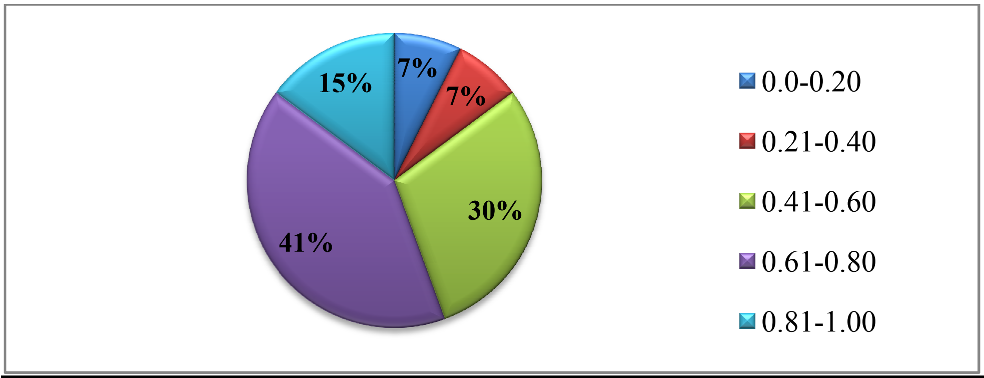
The technical efficiency score distribution among the HEIs of Barak Valley is shown in Table 5.16. In case of efficiency index, the estimated value is less than 0.4 for 26.66 per cent non-accredited colleges. However, not a single NAAC accredited colleges has efficiency score below 0.4. Here, three accredited and five non accredited colleges have average efficiency index value ranging from 0.41 to 0.6, i.e.; in total eight colleges are average in terms of efficiency. Five NAAC accredited and six non-accredited colleges have efficiency score ranging from 0.61 to 0.80. In case of NAAC accredited colleges four (33.33 per cent) colleges have high efficiency score. Average technical efficiency of two non-accredited colleges are bellow 0.4, seven between 0.41 to 0.6, four are between 0.61 to 0.8 and two colleges have higher efficiency average score greeter then 0.8 which implies that non-accredited colleges are average in terms of technical efficiency score with a very few exceptions. In case of NAAC accredited colleges average of technical efficiency score is higher than 0.6.

Table 5.16: Distribution of Efficiency Index and Average Technical Efficiency Score of the HEIs of Barak Valley

Scores	Efficiency Index			Average Technical Efficiency		
Scores	NC	NNC	All	NC	NNC	All
0.0-0.20	0 (0.00%)	2 (13.33%)	2 (7.41%)	0 (0.00%)	1 (6.67%)	1 (3.70%)
0.21-0.40	0 (0.00%)	2 (13.33%)	2 (7.41%)	0 (0.00%)	1 (6.67%)	1 (3.70%)
0.41-0.60	3 (25.00%)	5 (33.33%)	8 (29.63%)	3 (25.00%)	7 (46.67%)	10 (37.04%)
0.61-0.80	5 (41.67%)	6 (40.00%)	11 (40.74%)	5 (41.67%)	4 (26.67%)	9 (33.33%)
0.81-1.00	4 (33.33%)	0 (0.00%)	4 (14.81%)	4 (33.33%)	2 (13.33%)	6 (22.22%)

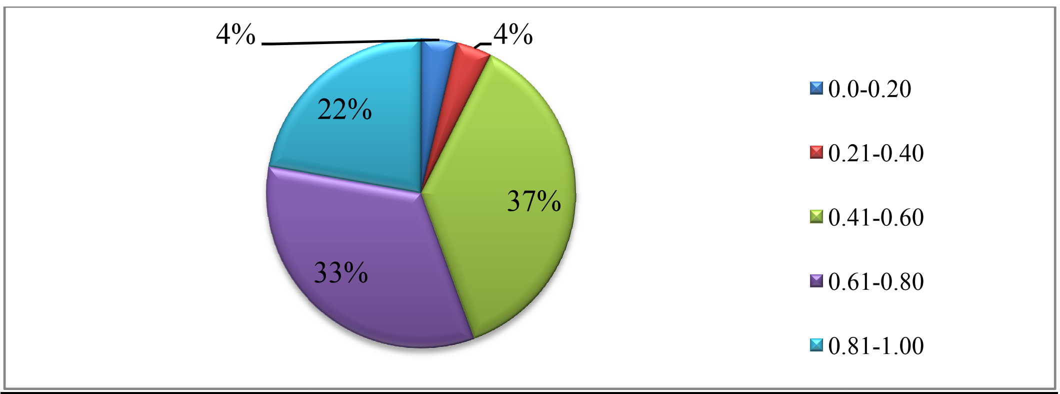
Source: Calculated Results from the compiled primary dataset of 27 HEIs over the sessions 2005-06 to 2011-12 collected from the colleges during September 2012 to September 2013 and secondary data collected from AUS's Result Books, and AUS's Annual Reports.
Note: Parentheses denote percentage

Figure 5.4: Efficiency Index Score Distribution of the HEIs of Barak Valley



Source: Adopted from Table 5.16

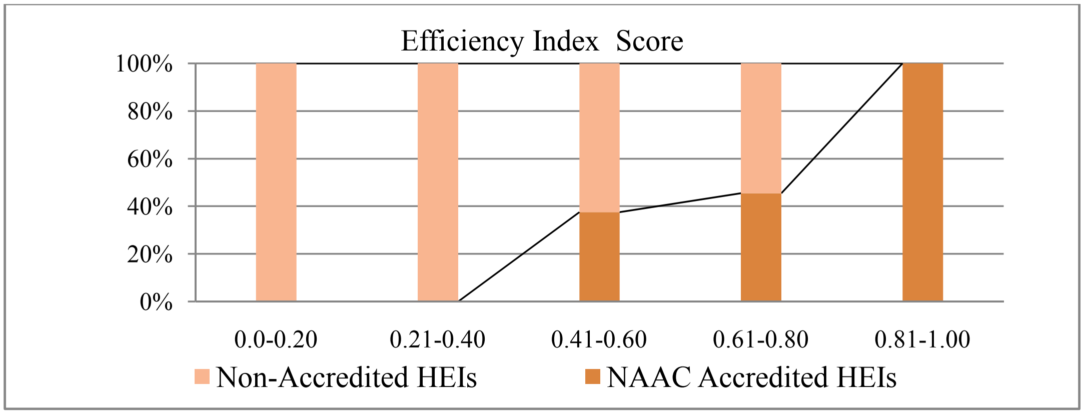
Figure 5.5: Average Technical Efficiency Score Distribution of the HEIs of Barak Valley



Source: Adopted from Table 5.16

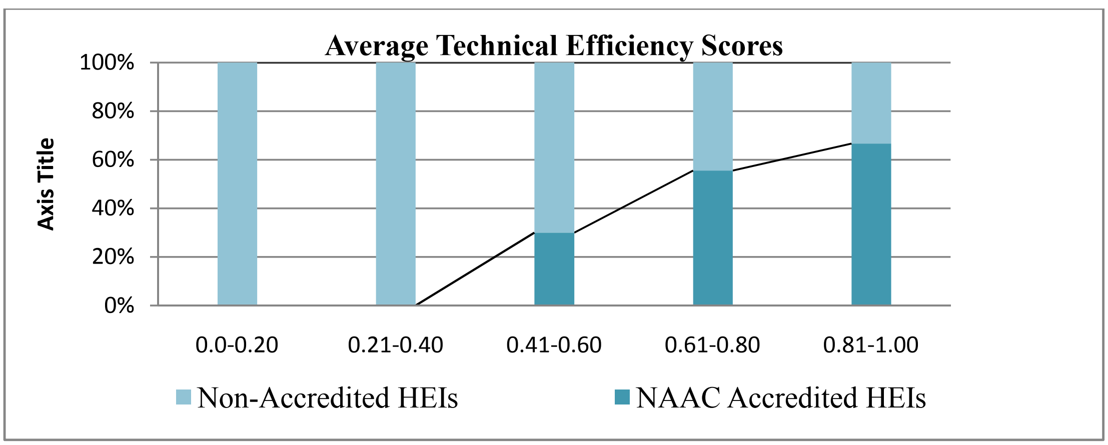
Overall efficiency score distribution of the colleges of Barak Valley for efficiency index value and average technical efficiency scores are shown Figure 5.4 and Figure 5.5 respectively. It is found that majority of the colleges (41 per cent) are moderately efficient with efficiency score ranging from 0.61 to 0.8 while only 15 per cent are efficient. 30 per cent colleges of Barak Valley are average in terms of efficiency and seven per cent have very poor efficiency. In case of average technical efficiency score 37 per cent are average, 33 per cent are moderated and 22 per cent are highly efficient. The distribution of NAAC accredited and non-accredited colleges are shown in Figure 5.6 and Figure 5.7 respectively with the help of percentage bar diagram from where it is clear that the share of accredited colleges are at a greater proportion for both efficiency index and average technical efficiency scores.

Figure 5.6: Efficiency Index Score of NAAC Accredited and Non-NAAC Accredited Colleges of Barak Valley



Source: Adopted from Table 5.16

Figure 5.6: Average Technical Efficiency Score of NAAC Accredited and Non-NAAC Accredited Colleges of Barak Valley



Source: Adopted from Table 5.16

In order to examine the variation in efficiency level of NAAC accredited and non-accredited HEIs of Barak Valley independent t-test for testing equality of means and Levene's test statistics for equality of variances between two groups are applied here and the results are shown in the following Table 5.16.

Table 5.17: Efficiency Index Score and Average Technical Efficiency Score Difference of NAAC Accredited and Non-NAAC Accredited HEIs of Barak Valley

	Levene's Test for Equality of Variances			*t*-test for Equality of Means		
	F	Sig.	Variances	Mean Difference	t	Sig (2-tailed)
ATHE	0.335	0.568	Equal	0.120	1.746	0.093
EI	0.174	0.680	Equal	0.213	2.865	0.008

Source: Calculated from the dataset of 27 HEIs over the sessions 2005-06 to 2011-12

Table 5.17 depicts the mean difference of average technical efficiency scores (ATHE) and efficiency index (EI) value for accredited and non-accredited HEIs, from where it is clear that the mean score of NACC accredited colleges are better than non-accredited colleges. The Levene's test statistics for equality of variances is in significant indicating equal variation in both the group however the mean difference is positive and significant for both efficiency index and technical efficiency scores which implies that NAAC accredited colleges are more efficient than non- accredited colleges in production of quality graduates.

Further the efficiency rankings of NAAC accredited colleges are compared with NAAC raking of the accredited colleges in this study. The NAAC in India has been set up to assist the volunteering institutions in assessment of their performance with some set parameters through introspection and a process that provides liberty for participation of the institution. In Barak Valley, out of 13 NAAC accredited general degree colleges only five colleges had opted for re-accreditation till date and one NAAC accredited HEI is excluded from efficiency analysis due to non availability of sufficient information. Table 5.17 shows efficiency rankings of the NAAC accredited HEIs along with their NAAC rakings.

It is also observed that there is variation in terms of ranking of the study and NAAC ranks. In terms of efficiency index and average technical efficiency score, college C9 stands on first position, followed by C3 on second position and C26 maintains third position respectively, and these three HEIs are ranked B+ given by NAAC (Table 5.17).

While during the same time college C6 and C21 have secured NAAC assessment result with rank C+, but in terms of efficiency C21 is better than C6, although position of both are below average position for both the efficiency indicators. Further college C9 and C26 has gone through second round accreditation process where the better college in terms of efficiency score has a comparatively lower NAAC rank. Here, college C19 has scored better in terms of technical efficiency compared to C20, but a lower rank in NAAC accreditation.

Table 5.18: Ranking of the HEIs in NAAC Assessment and Efficiency Scores

HEI Code	NAAC Ranks as per Annual Report-2011-12	Latest NAAC Ranks*	EI Rank	ATHE Rank
C3	B+		2	2
C6	C+		23	25
C9	B+	B	1	1
C10	C++		15	11
C12	B		9	12
C15	B	B	10	15
C16	C++		4	4
C19	B	B	6	13
C20	B+		19	17
C21	C+		17	21
C26	B+	A	3	3
C30	C++	B	12	14

Source: Estimated Results from the AUS Annual reports 2011 -12 & AUS Result Booklet 2012.
*Note: * Unpublished latest NAAC Ranks of five HEIs reassessed during 2010-2011 on a different scale unlike the previous one (collected from official website of the Colleges)*

The parameters selected for NAAC accreditation and efficiency analysis are not exactly similar and hence there is variation in NAAC ranks and efficiency ranking obtained from technical efficiency scores. After re-assessment of NAAC, it is observed that college C26 has scored better position in NAAC ranking instead of being third in terms of efficiency than the first and second technically efficient college. Hence, it can be argued that NAAC raking and efficiency raking are different even if both are dealing with quality assurance and proper management of resources of the HEIs. This may be due to the reason that NAAC accreditation is done for a particular period of time and its accreditation is valid for five years and concentrates more on infrastructural parameters, but efficiency scores for each college is obtained for seven year with strong focus more on optimal utilisation of available resources for providing a specific level of return which is very crucial from perspective of management.

Affiliated general degree colleges of Barak Valley are providing higher education and help to develop local community but there is presence of inefficiency in the colleges of Barak Valley and majority of these are producing quite far from the best practice frontier. Among the determinants of technical efficiency type of affiliation of the college is significant for different models which imply that the colleges which have went through some sort of monitoring for affiliation are better in production of quality graduates and under graduates than others. Location of the HEIs is also significant and positively related with technical efficiency implying the fact that colleges of urban region are more efficient than others. This may be due to the region that these colleges are situated in prosperous areas with better infrastructural facilities in terms of availability of resources related to studies and private tutors which contributes the production of high quality output of any HEI and significant in reducing inefficiency. Years of establishment is negatively influencing the level of technical efficiency for non-accredited colleges which indicates deterioration in technical efficiency over the years with significant trend parameters. Teachers' qualification and experience both are significantly influencing technical efficiency of the HEIs in the region. Students' academic and socio-economic factors are also influencing technical efficiency of the colleges here. The quality checking parameters at entry level with cut-off marks is also helpful for reducing technical inefficiency of the HEIs of Barak Valley.

The Malmquist indices suggest that the main responsible factor for change in technical efficiency has been both technological change and efficiency change. However, in case of non-accredited colleges technological change is the main responsible factor for majority of the non-accredited colleges resulted from change in scale and input combinations, while efficiency change is mainly influencing productivity change in NAAC accredited colleges contributed change in quality of students and other factors rather than input combinations. Over the study period the growth rate of total factor productivity of non-accredited colleges is almost three times higher than that accredited colleges. This may be due to the region the NAAC accredited colleges are somewhat consistent in terms of efficiency and there is less change in factor combination unlike non-accredited colleges. The mean efficiency score of NAAC accredited colleges are better than non-accredited colleges over the study period which indicates that NAAC accredited colleges are more efficient than non-accredited colleges.