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FINANCIAL PERFORMANCE MEASUREMENT USING DATA ENVELOPMENT ANALYSIS OF SELECTED FERTILIZER COMPANIES IN INDIA

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Abstract: *India is primarily an agricultural economy. The Indian economy is largely based on agricultural production. Fertilizers have been instrumental in agricultural production, providing essential nutrients to crops and increasing demand over the years. The increase in fertilizer consumption has made a significant contribution to the sustainable production of foodgrains in the country. The Indian fertilizer industry is comprised of various government and private fertilizer companies which produce a variety of fertilizers. DEA is a widely used technique for performance measurement at the international level, but India is still lagging behind other countries. Thus the present study is an attempt to analyze the financial statements and measure the efficiency of various DMUs selected by Fertilizer companies in India. To this effect, a sample of seven Decision-Making Units (DMUs) has been selected and the financial statements of selected DMUs were analyzed for a period of 2015-16 to 2019-20. The efficiencies of the selected DMUs were computed and significant differences between efficiency scores of DMUs during the period from 2015-16 to 2019-20 have been tested by using Kruskal – Wallis test.*

Key Words: *Data Envelopment Analysis, Decision Making Units, Efficiency Scores and Kruskal – Wallis test.*

1. INTRODUCTION :

India's fertilizer industry is one of the associated areas of agriculture. India is a very strong producer of nitrogen fertilizer in the world. The government has been paying huge subsidies to farmers, as it is a critical input in meeting the rising food demands. Indian manufacturers of chemical fertilizers are adopting some of the most advanced manufacturing processes to prepare new and innovative products that will complement Indian agriculture.

India's chemical fertilizer industry is rapidly developing in terms of utilizing the latest world-class technology. Indian manufacturers of chemical fertilizers are adopting some of the most advanced manufacturing processes to prepare new and innovative products that will complement Indian agriculture. India is among the largest consumers of fertilizers in the world, with domestic sales continually growing. This paper focuses on a new technique evolved, namely Data Envelopment Analysis (DEA). DEA is one such tool that evaluates the efficiency of firms that used multiple inputs to produce multiple outputs. The present study is an attempt to apply DEA for financial performance measurement of selected Decision-Making Units (DMUs) of Fertilizer companies in India for a period of 2015-16 to 2019-20.

The available literature on the DEA and its application, it was found that DEA is a rapidly growing technique for efficiency measurement and due to its non- parametric approach it has vast applications. Methodology of DEA is based on linear programming.. It was originally developed for performance measurement, which has been successfully employed to measure the relative performance of the DMU's. Based on Farrel's (1957) idea for measuring productive efficiency Charnes et al. (1978) successfully applied linear programming to measure efficiency of DMU's. Charnes et al. (1978) CCR model and Banker et al. (1984) BCC model proved as a corner stone in the development of DEA. Following reviews includes application of DEA for efficiency measurement in various fields.

2. REVIEW OF LITERATURE:

The theoretical works have produced developments based on CCR (Charnes et al. 1978) and BCC (Banker et al. 1984), and propose very sophisticated models such as dynamic DEA, network DEA and stochastic DEA, comprising categorical variables - discretionary and nondiscretionary, negative and undesirable variables, and many more. In practice, DEA has been applied in a wide range of applications such as banking, agriculture, transportation, health care, energy sectors, education and many other sectors.

The group of more specific reviews includes surveys of DEA applications to specific fields. Zhou et al. (2008) review the use of DEA in the fields of energy and the environment. Hollingsworth et al. (1999) examine work on the application of DEA to hospitals and the wider general health care context. Some works investigate the implications of frontier efficiency measurements (both parametric and non-parametric) in various fields. For instance, Hollingsworth (2003) presents the methods used in analyses and practical applications of measurement techniques (DEA and SFA).

Berger et al. (1993) reviews studies of efficiency in financial institutions and possible improvements. Berger and Humphrey (1997) review 130 studies on the application of frontier efficiency to financial institutions in 21 countries. Thanassoulis (1999) discusses application of DEA in the banking industry.

When a DMU is at the same time technically and allocatively efficient, it is characterized as cost efficient (Coelli, 1996). It is the most integrated concept of efficiency from all the above, that contributes to value creation, if prices of the output are high enough to cover costs and reflect the genuine utility to consumers who pay for.

Lin, Liu and Chu (2010) built a method to measure inefficient companies in the shipping industry at Taiwan by identifying the waste and causes. Researchers combined and integrated two separate but widely used models for measuring cost and efficiency performance namely Activity Based Costing and Data Envelopment Analysis. The results showed that a better management of shipping industry could achieve cost reduction and improve efficiency.

CRS/VRS measures scale efficiency attributed to the DMU scale-size. The value of scale efficiency denotes whether a DMU is operating under increasing – decreasing or not (Avrikan, 2011). Its values range between 0 and 1. When it is equal to 1, the VRS and CRS are equal and the DMU is operating at the optimal scale size. In every other case we have scale inefficiency. The firm is said to be scale efficient if it operates on a scale that maximizes productivity. Besides the concept of technically efficient when a set of outputs are attained using the smallest possible amount of inputs, there is also the concept of allocative efficiency that measures the ability of a firm to apply the inputs at optimal proportions in accordance with their existing prices.

Ghose (2014) estimated technical-efficiency scores(TE) of primary and upper-primary education in India using DEA for General-Category-States(GCS), Special-Category-States(SCS) and the union-territories(UT) over the period of 2005-06 to 2008-09. Technology-closeness-ratio (TCR) was computed, which showed that the proximity of the group-frontiers to the Meta-frontier and measured whether maximum educational--output producible from an input-bundle by a school in a group was as high as what could be produced if the school belongs to elsewhere in India. The results showed that all the states were not fully technically efficient an input oriented DEA approach, which indicates that an inefficient unit is made efficient through the proportional reduction of its inputs, while its outputs proportions are held constant (Ederer, 2015).

Agarwal (2016) attempted to provide an overview of the general status of the public transport sector in India. Researcher evaluated the efficiency and effectiveness of public transport sector of India using Data Envelopment Analysis (DEA). Data were collected for 34 State Transport Undertakings (STUs) for the year 2012-2013. Three different DEA models with the same set of inputs but with different outputs were used. Fleet size, Total staff and Fuel consumption were considered as inputs for all DEA models. Bus Utilization (BU) was considered as output for efficiency model, whereas in effectiveness model, Passenger kilometers (PassKm) was the output variable. In order to examine the relationship between efficiency and effectiveness, third DEA model was used with both BU and Pass Km as output variables. The results revealed that efficiency and effectiveness were positively related.

DEA is widely used in almost any sector of economic activity (hospitals, banks, Hotels, ports, education, agriculture, fisheries, etc. A comprehensive and enlightened review of the literature regarding DEA applications in sustainability can be found in Zhou et al. (2018), who allege that "DEA is is a valuable tool of sustainability performance evaluation".

3. OBJECTIVES OF THE STUDY

- To measure different efficiency scores using DEA models for the selected DMU's in the fertilizer companies in India.
- To test the significance of differences between the efficiency scores of the selected DMU's in the fertilizer companies in India.

3.1 THE DECISION-MAKING UNITS(DMU) CHOSEN FOR THE STUDY ARE AS FOLLOWS

- **DMU1 -** Chambal Fertilizers and Chemicals Limited (CFCL)
- **DMU2 -** Deepak Fertilizers and Petrochemicals Corporation Limited (DFPCL)

- **DMU3 -** Gujarat Narmada Valley Fertilizers & Chemicals Limited (GNFCL)
- **DMU4 -** Mangalore Chemicals & Fertilizers Limited(MCFL)
- **DMU5 -** Nagarjuna Fertilizers and Chemicals Limited (NFCL)
- **DMU6 -** Gujarat State Fertilizers & Chemicals Limited (GSFCL)
- **DMU7 -** Zuari Agro Chemicals Limited (ZACL)

3.2 PERIOD OF THE STUDY

This study has taken a period of five years from 2015-16 to 2019-20.

4. METHODLOGY OF THE STUDY:

The study is mainly based on secondary data. The required data were collected from annual reports of companies which are available on the web. The analysis techniques employed includes Percentages, Average, Standard Deviation, Coefficient of Variation, and Kruskal – Wallis test. Finally, the findings of the study are interpreted to draw the conclusion in relation to the efficiency and profitability of selected fertilizer companies in India.

4.1 HYPOTHESES OF THE STUDY

For attaining the objectives, the following hypotheses have been formulated:

- H_{01}: the Overall Technical Efficiencies (OTEFs) of the DMUs have no significant difference during the period from 2015-16 to 2019-20.
- H_{02}: the Pure Technical Efficiencies (PTEFs) of the DMUs have no significant difference during the period from 2015-16 to 2019-20.
- H_{03}: the Scale Efficiencies (SEFs) of the DMUs have no significant difference during the period from 2015-16 to 2019-20.

4.2 DEA MODELS

To achieve the objectives of the study, two DEA models have been used.

- CCR (Input Oriented) Model: based on Constant Returns to Scale (CRS) assumptions measures the Overall Technical Efficiency (OTEF) scores.
- BCC (Input Oriented) Model: based on Variable Returns to Scale (VRS) assumptions measures the Pure Technical Efficiency (PTEF) and Scale Efficiency (SEF) scores.

4.3 INPUTS AND OUTPUTS

There is no standard rule for the selection of inputs and outputs for DEA models. But the literature suggests that the number of DMUs should be at least three times the sum of the input and output variables chosen for the model. For the purpose of study 3 input variables, i.e. Capital, Non-current Assets and Employee Benefits Expense and 1 output variable i.e. Revenue from Operation were selected

4.4 DATA ANALYSIS AND INTERPRETATION

In addition to defining the level to which the DMUs are technical efficient (or inefficient), examining the technical efficiency of DMU allows one to classify the source of the inefficiency, i.e. whether the inefficiency is associated to wastage of resources or inappropriate size of operation. To this effect, the OTEF was estimated and disintegrated into its components, .i.e. PTEF and SEF. The overall technical efficiency of the DMUs and its decomposition into its modules have been presented here

4.5 OVERALL TECHNICAL EFFICIENCY (OTEF)

A measure of technical efficiency under the statement of constant returns-to-scale (CRS) is understood as a measure of Overall Technical efficiency (OTE). It measures, helps to work out inefficiency due to the input/output configuration, and therefore the size of operations. DEA is broadly used for estimating the technical efficiency of a set of decision-making units (DMUs) that accommodate multiple inputs and outputs. The DEA approach assumes that a set of DMUs is related to their consistent amount of inputs and outputs.

The following Table 1 shows the OTEF of selected DMUs of the Fertilizer Companies in India during the period from 2015-16 to 2019-20.

Table 1
Overall Technical Efficiency (OTEF) of selected Fertilizer Companies in India

DMU	2015-16	2016-17	2017-18	2018-19	2019-20
CFCL	1.00	1.00	1.00	1.00	1.00
DFPCL	0.24	0.66	0.91	0.82	0.39
GNFCL	0.24	0.37	0.43	0.41	0.89
MCFL	1.00	1.00	1.00	1.00	1.00
NFCL	0.52	0.58	0.59	0.29	0.74
GSFCL	0.61	0.68	0.71	0.95	1.00
ZACL	1.00	1.00	1.00	1.00	1.00
Summary Statistics					
Mean	0.66	0.76	0.81	0.78	0.86
Minimum	0.24	0.37	0.43	0.29	0.39
Maximum	1.00	1.00	1.00	1.00	1.00
Standard deviation	0.35	0.25	0.23	0.31	0.23
C.V (in%)	52.81	32.92	28.68	39.06	26.78

Source:Computed

The table 1 shows that the Overall Technical Efficiency ranges from 23% to 100% in 2015-16, 37 to 100% in 2016-17, 43% to 100% in 2017-18 , 28% to 100% in 2018-19, and 38% to 100% for the year 2019-20. The overall average technical efficiency for the study period ranges from 66% (2016-17) to 86% (2019-20). The standard deviation ranges from 0.23 to 0.35 and CV ranges from 26.78% to 52.81%.

As indicated in Table 1 only 3 DMUs (2015-16), 3 DMUs (2016-17), 3 DMUs (2017-18), 3 DMUs (2018-19), and 4 DMUs (2019-20) were found to be fully efficient, while the remaining DMUs were found to be ineffective on the basis of the OTEF.

Yearly Average Overall Technical Efficiency (OTEF)

The following Table 2 indicates yearly average OTEF and Overall Technical Inefficiency (OTIEF) of selected Fertilizer Companies in India for the period from 2015-16 to 2019-20

Table 2
Yearly Average Overall Technical Efficiency (OTEF) of selected Fertilizer Companies in India

Year	OTEF	OTIEF
2015-16	0.66	0.34
2016-17	0.76	0.24
2017-18	0.81	0.19
2018-19	0.78	0.22
2019-20	0.86	0.14
Average (2015-16 to 2019-20)		
Mean	0.77	
Minimum	0.34	
Maximum	1.00	
Standard deviation	0.27	
C.V (in%)	36.05	

Source:Computed

Table 2 shows that yearly average OTEF and Overall Technical Inefficiency (OTIEF). The average OTEF of the DMUs over the study period 2015-16 to 2019-20 was 77%, which indicates that an average inefficient DMU has used 23% extra inputs than is required to produce the same level of output it produced over the study period. In other words, this means that on an average inefficient DMU could have consumed about 23% fewer inputs than it actually used to produce the same level of outputs during the study period. In other words, on average, inefficient DMUs could have produced the same level of output with only 77% of the inputs actually used. Therefore, from 2015-16 to 2019-20, DMUs could have increased overall technical efficiency by an average of 23%. Besides, the reported overall average standard deviation of 0.27 and average CV 36.05% shows that there is 36.05% variability in terms of technical efficiency among the DMUs in selected Fertilizer Companies from 2015-16 to 2019-20.

It is interesting to note that the performance of the DMUs in terms of input utilization over the study period is inconsistent with that in some years the DMUs showed improvement, which in some other years. Especially, drastic decline in OTEF is experienced by the DMUs over the period 2018-19. Overall, the analysis indicates that there are rooms for the managers to curtail the quantity of inputs, without dipping the level of output of the DMUs, over the entire period under study. More specifically, the analysis reveals that the inefficient DMUs could have reduced the quantity of input used without making a reduction in the quantity of output on average by 34% in 2015-16, 24% in 2016-17, 19% in 2017-18, 22% in 2018-19 and 14% in 2019-20.

Pure Technical Efficiency (PTEF)

Pure Technical Efficiency measures the extent to which a firm can decrease its inputs (in a fixed proportion) while remaining within the VRS frontier. The following Table 3 shows the PTEF of selected DMUs of the Fertilizer Companies during the period from 2015-16 to 2019-20.

Table 3
Pure Technical Efficiency (PTEF) of selected Fertilizer Companies in India

DMU	**2015-16**	**2016-17**	**2017-18**	**2018-19**	**2019-20**
CFCL	1.00	1.00	1.00	1.00	1.00
DFPCL	0.72	1.00	1.00	1.00	1.00
GNFCL	0.27	0.57	0.86	0.60	0.70
MCFL	1.00	1.00	1.00	1.00	1.00
NFCL	0.70	0.70	0.70	0.70	0.78
GSFCL	1.00	1.00	1.00	1.00	1.00
ZACL	1.00	1.00	1.00	1.00	1.00
Summary Statistics					
Mean	0.81	0.90	0.94	0.90	0.92
Minimum	0.27	0.57	0.70	0.60	0.70
Maximum	1.00	1.00	1.00	1.00	1.00
Standard deviation	0.27	0.18	0.12	0.17	0.13
C.V (in%)	33.68	20.10	12.41	19.10	14.13

Source:Computed

Table 3 reveals that Pure Technical Efficiency ranges from 27% to 100% in 2015-16, 57% to 100% in 2016-17, 70% to 100% in 2017-18 , 60% to 100% in 2018-19, and 69% to 100% for the year 2019-20. Average PTEF ranges from 81% (2015-16) to 94% (2017-18) with a standard deviation range from 0.12 to 0.27 and CV ranges from 14% to 33.68%.

Table 3 shows that only 4 DMUs (2015-16), 4 DMUs (2016-17), 5 DMUs (2017-18), 5 DMUs (2018-19), and 5 DMUs (2019-20) were found efficient, while remaining were inefficient on the basis of PTEF.

Yearly Average Pure Technical Efficiency (PTEF)

The following Table 4 indicates yearly average PTEF and Pure Technical Inefficiency (PTIEF) of selected Fertilizer Companies in India for the study period of 2015-16 to 2019-20.

Table 4
Yearly Average Pure Technical Efficiency (PTEF) of selected Fertilizer Companies in India

Year	**PTEF**	**PTIEF**
2015-16	0.81	0.19
2016-17	0.90	0.10
2017-18	0.94	0.06
2018-19	0.90	0.10
2019-20	0.92	0.08
Average (2015-16 to 2019-20)		
Mean	0.90	
Minimum	0.57	
Maximum	1.00	
Standard deviation	0.18	
C.V (in%)	19.89	

Source:Computed

Table 4 shows the yearly average of Pure Technical Efficiency (PTEF) and Pure Technical Inefficiency (PTIEF). The average PTEF of the DMUs for the study period 2015-16 to 2019-20 was 90%, which indicates that 10% inefficiency due to the inappropriate use of resources or due to the managerial inefficiency. The average standard deviation was 0.18 and average CV was 19.89%, which shows there is 18.02% variability in the PTEF of the DMUs over the study period.

This indicates that about 8% of the technical inefficiency in 2017-18 is attributable to PTIEF (managerial inefficiency).

Scale Efficiency (SEF)

The following Table 5 indicates that the Scale Efficiency (SEF) of the DMUs of selected Fertilizer Companies in India over the study period 2015-16 to 2019-20.

Table 5
Scale Efficiency (SEF) of selected Fertilizer Companies in India

DMU	2015-16		2016-17		2017-18		2018-19		2019-20	
	SEF	Scale	SEF	Scale	SEF	Scale	SEF	Scale	SEF	Scale
CFCL	1.00	-	1.00	-	1.00	-	1.00	-	1.00	-
DFPCL	0.33	IRS	0.66	IRS	0.91	IRS	0.82	IRS	0.39	IRS
GNFCL	0.87	IRS	0.65	DRS	0.50	DRS	0.68	DRS	1.27	IRS
MCFL	1.00	-	1.00	-	1.00	-	1.00	-	1.00	-
NFCL	0.74	IRS	0.83	IRS	0.84	IRS	0.41	IRS	0.95	IRS
GSFCL	0.61	DRS	0.68	DRS	0.71	DRS	0.95	DRS	1.00	-
ZACL	1.00	-	1.00	-	1.00	-	1.00	-	1.00	-
Summary Statistics										
Mean	0.79	-	0.83	-	0.85	-	0.84	-	0.95	-
Minimum	0.33	-	0.65	-	0.50	-	0.41	-	0.39	-
Maximum	1.00	-	1.00	-	1.00	-	1.00	-	1.27	-
Standard deviation	0.25	-	0.17	-	0.19	-	0.22	-	0.27	-
C.V (in%)	31.96	-	20.32	-	22.00	-	26.82	-	28.39	-

Source:Computed

It reveals that table 5 Scale Efficiency **(**SEF) ranges from 33% to 100% in 2015-16, 65% to 100% in 2016-17, 50% to 100% in 2017-18, 41% to 100% in 2018-19, and 39% to 100% in 2019-20. Average SEF ranges from 79% (2015-16) to 95% (2019-20) with a standard deviation range from 0.17 to 0.27 and CV ranges from 20.32% to 31.96%.

Table 5 shows that only 3 DMUs(2015-16), 3 DMUs (2016-17), 3 DMUs (2017-18), 3 DMUs (2018-19), 5 DMUs (2019-20)were found scale efficient, while other DMUs were found scale inefficient.

4.6 RETURN TO SCALE

Returns to scale refers to the rate by which output changes if all inputs are changed by the same factor. The following Table 6 shows that the number of DMUs of selected Fertilizer Companies in India during the study period from 2015-16 to 2019-20.

Table 6
Number of DMUs of selected Fertilizer Companies in India by Return to Scale

Year	CRS	IRS	DRS
2015-16	3(42.86%)	3(42.86%)	1(14.28%)
2016-17	3(42.86%)	2(28.57%)	2(28.57%)
2017-18	3(42.86%)	2(28.57%)	2(28.57%)
2018-19	3(42.86%)	2(28.57%)	2(28.57%)
2019-20	4(57.14%)	3(42.86%)	-
Total	16(45.71%)	12(34.29%)	7(20%)

Source:Computed

Table 6 summarises the number of DMUs that exhibited Constant Return to Scale (CRS), Increasing Returns to Scale (IRS) and Decreasing Returns to Scale (DRS) during the study period. The findings of the study indicate that only 45.71% DMUs exhibited CRS over the period 2015-16 to 2019-20 and hence are scale efficient. The majority of DMUs

54.29% observed over the period 2015-16 to 2019-20 were found scale inefficient. Among those scale inefficient DMUs 34.29% exhibited IRS and DMUs 20% exhibited DRS.

Yearly Average Scale Efficiency (SEF)

The following Table 7 indicates yearly average SEF and Scale Inefficiency (SIEF) of selected Fertilizer Companies in India for the study period of 2015-16 to 2019-20.

Table 7
Yearly Average Scale Efficiency (SEF) of selected Fertilizer Companies in India

Year	SEF	SIEF
2015-16	0.79	0.21
2016-17	0.83	0.17
2017-18	0.85	0.15
2018-19	0.84	0.16
2019-20	0.94	0.06
Average (2015-16 to 2019-20)		
Mean	0.85	
Minimum	0.46	
Maximum	1.06	
Standard deviation	0.22	
C.V (in%)	25.90	

Source:Computed

Table 7 gives the yearly average SEF and SIEF. The average SEF of DMUs for the study period 2015-16 to 2019-20 is 85%, indicating a 15% inefficiency due to inappropriate scale of operations. Furthermore, the average standard deviation was 0.22 and the average CV was 25.90, indicating a 25.90% variability in the SEF of the DMUs over the study period. This indicates that 21% technical inefficiency in 2015-16 is due to the inefficiency of the scale. The technical inefficiency of 6% in 2019-20 is due to the SIEF or an inappropriate scale of operation.

Test of Significance of Differences in the OTEF, PTEF and SEF

In order to see whether there have been significant differences in the OTEF, PTEF and SEF of the DMUs between 2015-16 to 2019-20, the Kruskal-Wallis (K-W) test, which is a non-parametric test, has been employed. In effect, the following three null hypotheses were tested.

H_{01}: The Overall Technical Efficiencies (OTEFs) of the DMUs have no significant difference during the period from 2015-16 to 2019-20.

H_{02}: The Pure Technical Efficiencies (PTEFs) of the DMUs have no significant difference during the period from 2015-16 to 2019-20.

H_{03}: The Scale Efficiencies (SEFs) of the DMUs have no significant difference during the period from 2015-16 to 2019-20.

Table 8
KRUSKAL-WALLIS (OR) H-TEST
(Change in OTEF,PTEF and SEF)

Year	Observation	Mean Ranks		
		OTEF	PTEF	SEF
2015-16	7	20.9	22.1	22.3
2016-17	7	24.1	25.2	22.9
2017-18	7	26.3	27.0	24.7
2018-19	7	25.3	25.4	24.0
2019-20	7	29.4	26.3	32.1
Total	35			
Chi-square ($\chi 2$)		1.312	0.48	2.143
Degrees of freedom (df)		4	4	4
Significance		0.859	0.976	0.709

Source: Computed

The Kruskal-Wallis test results for null hypotheses H_{01}, H_{02} and H_{03} are given in Table 8. The test statistics $\chi 2$ (df = 4) are 1.312, 0.48 and 2.143 with a p- value of 0.859, 0.976, and 0.709 respectively for OTEF, PTEF and SEF. It is therefore concluded that the whole calculated P value is greater than the significant value at the 5 % level. Therefore, the null hypothesis is accepted.

5. CONCLUSION:

This study presented the financial performance of the DMUs of selected fertilizer companies in India over the period 2015-16 to 2019-20. On average OTEF was 77%, which indicates that on average inefficient DMUs could have consumed about 23% percent fewer inputs than actually used to produce the same level of output over the study period. The decomposition of the OTEF into PTEF and SEF indicated that the DMUs tend to lose production not only due to waste of resources but also due to inappropriate. Results revealed that on average 90% of technical inefficiency were due to the utilization of resources (PTIEF) and 10% was due to inappropriate choice of scale of operation (SIEF).

In addition, the analysis indicated that DRS is the most predominant scale inefficiency (SIEF) of DMUs. Of all the DMUs observed over the period 2015-16 to 2019-20, only 45.71% DMUs exhibited CRS, while 54.29% of the DMUs observed over the study period were found to be scale inefficient. Of those scale inefficient DMUs 34.29% DMUs exhibited IRS and 20% DMUs exhibited DRS. The study tests the overall technical efficiency, pure technical efficiency, and scale efficiency of the examination of managerial inefficiency or the choice of the firm about its scale of operation. The estimated scores show that management efficiency is higher than technical efficiency. It means that companies are technically inefficient and this inefficiency is due to the scale inefficiency. It is also noted that companies are working under an increasing return to scale which implies that still there is scope for the company operates to increase this production and in a position to achieve the optimal range of operation.

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