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RESEARCH ARTICLE

Relative Efficiency of Weaving Industry in India using Data Envelopment Analysis

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Abstract

In the globalization market, it is essential for the fabric manufacturers to produce fabrics with minimum cost of production. It can be achieved by improving the efficiency of the loomshed. For this, inter-loomshed comparison will be an effective way to evaluate the relative performance and assess themselves with the benchmarks. The purpose of this paper is to evaluate the efficiency of loomsheds in Indian weaving industry, using a linear programming based Data Envelopment Analysis technique. The study finds that the overall efficiency of the weaving industry has largely affected due to technical inefficiency in the loomsheds. Scale efficiency scores show that the small-scale loomsheds are less scale efficient than the large-scale category. Most of the small-scale loomsheds exhibit increasing returns to scale indicating requirement in the expansion of scale-size. Furthermore, some large-scale loomsheds are found to have decreasing returns to scale, indicating the downsizing of the existing production capacity. Slack analysis depicts that the loomshed have efficiently utilized the raw material but high amount of slacks are observed in the power & fuel consumption.

Keywords: DEA, loomshed, Technical efficiency, Weaving industry.

Introduction

Unlike in weaving preparatory of the fabric where emphasis is on the quality of fabric but in the loomshed, productivity has significant importance along with quality of cloth produced. The loomshed operation contributes largely while conversion of yarn into fabric. More importantly, a small increase in the productivity of the weaving industry will result considerable reduction in the manufacturing cost of cloth. This indicates that an increase in productivity will considerable rise in fabric realization. There is tough competition for Indian fabric manufacturer with the neighboring country like China and Bangladesh in terms of cost, quality and productivity in the weaving industry. To survive in such a competitive market, individual firm should make its regular assessment of the performance. Therefore, it is essential to evaluate the relative performance of the loomsheds of the weaving industry in India to produce a fabric with minimum cost of production. For this inter-firm comparison will be an effective way to evaluate the relative performances and appraising those against the best examples. This helps management to evaluate the ranking of the firm with the benchmarks and to understand the factors, which are contributing for the better performance. Nevertheless, the productivity of loomshed is always measured using length of cloth produced per machine or per labor in unit time. This ratio analysis is a simple two-dimensional measure and does not provide the complex nature of the factory. This ratio cannot capture the effects of all input factors, which affect the performance of the firm. Data Envelopment Analysis (DEA) is a non-parametric linear programming based technique, which is able to consider all inputs and outputs together. It is capable of distinguishing between efficient and inefficient loomsheds, setting targets and estimation of slacks in inputs and outputs for inefficient

loomsheds. The DEA technique is able not only to measure the efficiency of each manufacturing firm of an industry relative to the other ones [1], but also to suggest, corrective measures, which could make the operationally inefficient firms efficient. DEA is a well-established multi-criteria decision technique to evaluate the relative efficiency of the firms which exhibits similar characteristics with several inputs and outputs [2]. It has been used successfully for the evaluation of a performance of manufacturing industries. As far as the evaluation of textile industry concerns, many researchers have applied DEA successfully. A firm level study [3] measured the levels of technical efficiency in the Indian textiles industry using DEA. The firms are selected from the different sub-sectors of textiles, such as, cotton, woolen, silk, synthetic and other natural fibers. Another study by [4] measures the relative efficiency, input-output slacks, and target for 40 Indian textile-spinning firms in the year 1997-98, using CCR and BCC models. The works of Kumar [5] and Mallikarjun and Thakur [8] studied the impact of economic reform process on the technical efficiency of the Indian textile industry. These researchers have studied the performance of Indian textile industry at firm level and aggregate level. However, this paper attempts to evaluate the relative efficiency of individual loomshed of the weaving industry in India using DEA technique.

Methodology

Data and Variable Selection

The current analysis of DEA is carried out using secondary data for the input and output parameters of 50 loomsheds of weaving industry in India for the year 2009. DEA is a most appropriate tool to evaluate the relative performance of homogenous units. The study is limited to loomsheds, which are fabric-manufacturing firms. As our selected firms are in the same business, the DEA is the most suitable technique to be applied for assessing the relative efficiency of these firms and setting benchmarks for the inefficient firms to improve their performance. We extracted unit level data and information of 50 weaving firms from the PROWESS database for the year 2009 provided by Centre for Monitoring Indian Economy. After reviewing appropriate studies of efficiency analysis using DEA, investment in plant & machinery (PM), wages & salaries (WAGE), raw material consumption (MAT), and power & fuel consumption (FUEL) are considered as input variables and annual gross sale (SALE) of the company is taken as an output variable. To provide a sound analytical basis for the selection of variables, a statistical analysis has been carried out. Descriptive statistics related to inputs and output is presented in Table 1. Significant differences exist among various firms, as indicated in the last two rows of Table 2.

Brief Overview of Data Envelopment Analysis

In recent periods, DEA has become one of the popular techniques for evaluation of performance of profit and non-profit making organizations. Through DEA, it is possible to gain new insights in the performance of the organizations because it is extremely difficult to study because of the number and nature of parameters involved. DEA make use of mathematical programming technique to evaluate the efficiency of homogeneous firms, which can be bank, hospital, manufacturing firm, education institute, etc. The efficiency is measured as the ratio of the weighted sum of outputs to the weighted sum of inputs. In the present case study, the main objective of the analysis is to find the benchmark loomshed. Then the performance of other loomshed can be relatively compared to understand their rank with respect to benchmark. The procedure of determining the efficient loomshed can be formulated as a linear program.DEA technique was first formulated by Charnes, Cooper and Rhodes (CCR) in 1978 [6], based on constant returns to scale and further extended by Banker, Charnes and Cooper (BCC) in 1984 [6], based on variable returns to scale. These are the two basic DEA models. To describe DEA efficiency evaluation, first assume that

Table 1: Descriptive statistics of inputs and output

Statistics	SALE (Rs. crore)	MAT (Rs. crore)	FUEL (Rs. crore)	WAGE (Rs. crore)	PM (Rs. crore)
Mean	325.88	189.23	22.59	18.08	255.48
Minimum	2.90	1.43	0.01	0.11	1.10
Maximum	2370.48	1236.50	270.84	203.04	2123.87
Std dev	476.16	279.60	42.35	37.40	439.86

the performances of n DMUs (DMU $_j$; j =1,…,n) be measured by DEA. The performance ofDMU $_j$ is characterized by a production process of m inputs (x_{ij} for i = 1,…,m) to yield s outputs (y_{rj} for r = 1,…,s). The following notations are used to describe the DEA models used in the study. y_{rk} = the amount of the r^{th} output of the k^{th} DMU, x_{ik} = the amount of the i^{th} input of the k^{th} DMU, n = number of firms, s = number of outputs, m = number of inputs, ε = non-Archimedean constant, u_{rk} = weight given to the r^{th} output of the k^{th} DMU, v_{ik} = weight given to the i^{th} input of the k^{th} DMU, S_{rk}^{+} = slack in the r th output of the k th DMU, S_{ik}^{-} = slack in the i th input of the k th DMU, μ_{jk} = dual variables known as intensity variables $Z_k^{'}$ = output oriented efficiency of k^{th} DMU; (k = 1, 2, …,n)The dual of the CCR model 2 is:

$$Max \quad Z_k^{'} = \phi_k + \varepsilon \sum_{r=1}^{s} S_{rk}^{+} + \varepsilon \sum_{i=1}^{m} S_{ik}^{-} \qquad (1)$$

subject to

$$\sum_{j=1}^{n} \mu_{jk} y_{rj} - S_{rk}^{+} = \phi_k \, y_{rk} \qquad \forall r = 1,..., s$$

$$\sum_{j=1}^{n} \mu_{jk} x_{ij} + S_{ik}^{-} = x_{ik} \qquad \forall i = 1,..., m$$

$$\mu_{jk} \geq 0 \qquad \forall j = 1,..., n$$

Model 1 is known as CCR model with output orientation. In BCC model μ_{jk}'s are now restricted to summing to one (i.e. $\sum_{j=1}^{n} \mu_{jk}$ =1) which is known as convexity constraint. The primary difference between these two models is the convexity constraint, which represents the returns to scale. Efficiency score achieved by BCC model is technical efficiency and the efficiency assessed by CCR model is overall efficiency. The impact of scale-size on efficiency of a DMU is measured by scale efficiency, which is a ratio of overall efficiency to technical efficiency.

Results and Discussions

Overall Technical Efficiency

Overall efficiency is the efficiency measured against the constant returns to scale of the frontier. The overall efficiency scores of the respective loomshed are shown in Table 3 and their descriptive statistics in Table 2. This overall efficiency score of the weaving industry exhibits the existence of inefficiency and the extent of that inefficiency. Among the performance of loomshed in the year 2009, 14 firms are found to be efficient. Nagreeka Exports Ltd. and Seasons Textiles Ltd. are found to be the most efficient loomsheds. These firms, which appear frequently in the reference set, are likely to be loomshed that are efficient with a large number of factors and is probably a good example of best performer. The minimum efficiency score of some loomsheds is only around 50 percent in the year 2009. The average efficiency score for the loomsheds in the year of analysis is found to be around 78 percent, which clearly shows the inefficiency of the loomsheds under investigation.

Table 2: Descriptive statistics of efficiency scores

Statistics	Overall Technical Efficiency	Pure Technical Efficiency	Scale efficiency
Mean	0.78	0.86	0.91
Minimum	0.45	0.47	0.60
Maximum	1.00	1.00	1.00
Std dev	0.18	0.16	0.11

variations in the overall efficiency scores are also of interest. The standard deviation of the score is 0.18, which indicates the variability in the efficiency scores across the loomsheds. The overall efficiency score of the firm is as low as 0.44 and as high as 1.00. Orbit Exports Ltd. is one of the most inefficient loomshed in the tested sample. To be on the frontier, this firm has to follow the best practices of firms Kamadgiri Synthetics Ltd., Nagreeka Exports Ltd., Seasons Textiles Ltd. and Siyaram Silk Mills Ltd, which are the reference firms as shown in Table 3.

Pure Technical Efficiency

In the present study, we have considered the loomsheds of weaving industry in India. It is found that there is variation in the scale-size of most of the firms covered in the sample, since investment in plant and machinery is in the range of 1.1-244 crore as shown in Table 1. Observed that as the scale of operations increases [7], labor requirement per loom decreases drastically. The level of modernization of looms varies across the clusters and this is a major factor affecting the productivity of looms and the quality of fabric produced by the looms. Merely, Cloth production by mill sector showed an increase of one percent during 2008-09 [8]. The management of the loomsheds, in general, does not have control over their scale of operation due to their downward and upward linkage with the spinning and garment industry respectively. Therefore, it is considered appropriate that efficiency be assessed relative to the variable returns to scale frontier. Therefore, the technical efficiency of loomsheds is measured against the variable returns to scale frontier. Technical Efficiency reflects the work and management practices of these units.The technical efficiency scores of individual firms are summarized in Table 3.In the tested sample, 20 loomsheds have a relative efficiency score of 100 percent. The average technical efficiency of loomsheds is found to be in the range of 47 to 100 percent in the year 2009. The variation in technical efficiency score of different loomsheds for this fiscal year is 19 percent. Based on the VRS efficiency scores and their peer counts in the fiscal year, the loomsheds are ranked and presented in Table 3. Out of these 20 efficient loomsheds, Arvind Ltd., Bombay Dyeing Ltd., Bombay Rayon Fashions Ltd., Jay Dee Fabrics Ltd. and Mafatlal Industries Ltd. are scale inefficient. This clearly indicates that these firms are capable of converting their inputs into outputs with 100 percent managerial efficiency, but their overall efficiency scores are low due to low scale efficiency scores. This demonstrates that if the effect of scale-size is neutralized, these firms can become efficient. All of them are operating on decreasing returns to scale, implying that they need to decrease their scale-size. This suggests that these firms should bring down their size of operation to the optimum plant size in order to attain cost benefits. Average technical efficiency score of all 50 firms is 0.89, which implies that an individual firm can be comparatively efficient for increasing an output by about 11 percent. The Oxford Industries Ltd. is the most inefficient firm, scoring technical efficiency only 0.47. This firm can increase output by 53.0 percent with the existing level of inputs to be on the efficiency frontier. It can follow the best managerial practices of the benchmark company i.e. Kamadgiri Synthetics Ltd., Nagreeka Exports Ltd., Seasons Textiles Ltd. and Siyaram Silk Mills Ltd..

Table 3: Efficiency scores of Indian weaving firms for 2009-10

Firm	Name of loomshed	Rank	OE	TE	SE	RTS	Peer count	Benchmarks
LS1	Anant Syntex Ltd.	21	0.97	0.99	0.98	Increasing	0	LS49,40, 20
LS2	Anjani Fabrics Ltd.	31	0.83	0.83	1.00	Increasing	0	LS3, 10, 37
LS3	Anjani Synthetics Ltd.	8	1.00	1.00	1.00	Constant	12	-
LS4	Ankita Knit Wear Ltd.	16	1.00	1.00	1.00	Constant	3	-
LS5	Arvind Ind. Ltd.	4	0.73	1.00	0.73	Decreasing	0	LS27, 20, 40
LS6	Ashima Ltd.	44	0.54	0.67	0.81	Decreasing	0	LS27, 20, 40
LS7	Bombay Dyeing Ltd.	17	0.68	1.00	0.68	Decreasing	0	LS3, 27, 37
LS8	Bombay Rayon F. Ltd.	18	0.72	1.00	0.72	Decreasing	0	LS40, 38,43,49
LS9	Chiripal Industries Ltd.	28	0.72	0.85	0.84	Decreasing	0	LS3, 37, 27
LS10	Eskay India Ltd.	11	1.00	1.00	1.00	Constant	1	LS10
LS11	Flora Textiles Ltd.	3	0.68	1.00	0.68	Increasing	0	LS3, 27, 20
LS12	Hindoostan Mills Ltd.	35	0.80	0.81	0.99	Increasing	0	LS3, 27, 20
LS13	India Denim Ltd.	46	0.48	0.62	0.77	Increasing	0	LS40, 27
LS14	Indus Fila L.	32	0.80	0.82	0.97	Decreasing	0	LS27, 3, 37, 4
LS15	J C T L.	40	0.56	0.72	0.78	Decreasing	0	LS40, 27,20
LS16	Jay Dee Fabrics Ltd.	14	0.60	1.00	0.60	Increasing	0	LS35,27,20,43
LS17	Jindal Texofab Ltd.	37	0.74	0.76	0.97	Increasing	0	LS40,27,20
LS18	K G Denim Ltd.	41	0.64	0.69	0.92	Decreasing	0	LS3,20,27
LS19	K S L & Industries Ltd.	19	1.00	1.00	1.00	Constant	0	LS19
LS20	Kamadgiri Synthetics L.	2	1.00	1.00	1.00	Constant	18	LS 20
LS21	Loyal Textile M. L.	36	0.67	0.80	0.83	Decreasing	0	LS 27,40
LS22	Mafatlal Industries Ltd..	20	0.91	1.00	0.91	Decreasing	0	LS 3,20
LS23	Mecords India Ltd.	22	0.94	0.94	1.00	Increasing	0	LS 38,43,31,49
LS24	Modern Denim Ltd.	49	0.52	0.52	1.00	Increasing	0	LS 3,27,20
LS25	Morarjee Textiles Ltd.	30	0.71	0.83	0.86	Decreasing	0	LS 40,27,20
LS26	Mudra Lifestyle Ltd.	39	0.73	0.74	0.99	Decreasing	0	LS 43,40,49,38
LS27	Nagreeka Exports Ltd.	1	1.00	1.00	1.00	Constant	25	LS 27
LS28	Nandan Exim Ltd.	25	0.80	0.88	0.92	Decreasing	0	LS 27,40
LS29	NTC Ltd	42	0.46	0.68	0.69	Decreasing	0	LS 20,49
LS30	Om Shanti Satins Ltd.	48	0.47	0.54	0.86	Increasing	0	LS 27,37
LS31	Orbit Exports Ltd.	15	1.00	1.00	1.00	Constant	2	LS 31
LS32	Oxford Industries Ltd.	50	0.45	0.47	0.95	Increasing	0	LS 20,40,43,27
LS33	Pratibha Fabrics Ltd.	33	0.81	0.81	1.00	Decreasing	0	LS 49,40,20
LS34	Ramaraju Mills Ltd.	43	0.61	0.67	0.91	Decreasing	0	LS 27,40
LS35	Reid & Taylor Ltd.	9	1.00	1.00	1.00	Constant	3	LS 35
LS36	Ruby Mills Ltd.	29	0.72	0.84	0.85	Decreasing	0	LS 40,49
LS37	S E L Manu. Co. Ltd.	5	1.00	1.00	1.00	Constant	8	LS 37
LS38	S Kumars Ltd.	12	1.00	1.00	1.00	Constant	5	LS 38
LS39	Sanrhea Textiles Ltd.	34	0.71	0.81	0.88	Increasing	0	LS 4,35,31,43
LS40	Seasons Textiles Ltd.	6	1.00	1.00	1.00	Constant	19	LS 40
LS41	Selection Synth. Ltd.	27	0.81	0.86	0.95	Increasing	0	LS 27,20,40
LS42	Shri Lakshmi Cots Ltd.	23	0.78	0.91	0.86	Decreasing	0	LS 3,37,27,4
LS43	Siyaram Silk Mills Ltd.	10	1.00	1.00	1.00	Constant	6	LS 43
LS44	Somany Evergreen Ltd.	47	0.51	0.56	0.92	Increasing	0	LS 27,20,40
LS45	Sravya Textiles Ltd.	24	0.70	0.89	0.79	Increasing	0	LS 40,37,38
LS46	Subh Laxmi Syntex Ltd.	26	0.85	0.87	0.98	Increasing	0	LS 35,27,40,38
LS47	Trinity India Ltd.	38	0.75	0.76	1.00	Increasing	0	LS 3,20,27
LS48	V T M Ltd.	45	0.66	0.67	0.99	Increasing	0	LS 3,27,37
LS49	Ventura Textiles Ltd.	13	1.00	1.00	1.00	Constant	7	LS 49
LS50	Western India Ltd.	7	1.00	1.00	1.00	Constant	0	LS 50
	Mean		0.78	0.86	0.91			

Table 4: Slack evaluation for input and output variables

Loom Shed	Slacks in output and inputs (Rs. Mn)					Improvement required (%)				
	SALE	MAT	FUEL	WS	NFA	SALE	MAT	FUEL	WAGE	NFA
LS1	0.00	0.00	9.87	0.00	0.00	1.53	0.00	107.00	0.00	0.00
LS2	0.00	0.00	2.90	0.00	0.00	17.29	0.00	24.58	0.00	0.00
LS3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
LS4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
LS5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
LS6	0.00	0.00	0.00	4.71	56.83	33.01	0.00	0.00	26.82	24.87
LS7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
LS8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
LS9	0.00	0.00	28.27	0.00	0.00	15.30	0.00	123.61	0.00	0.00
LS10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
LS11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
LS12	0.00	0.00	1.32	0.00	0.00	19.55	0.00	35.11	0.00	0.00
LS13	0.00	0.00	0.15	0.00	31.71	38.12	0.00	33.33	0.00	81.94
LS14	0.00	0.00	0.00	0.00	0.00	17.67	0.00	0.00	0.00	0.00
LS15	0.00	0.00	28.03	0.00	0.00	28.49	0.00	42.23	0.00	0.00
LS16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
LS17	0.00	0.00	5.15	0.00	0.00	24.06	0.00	312.12	0.00	0.00
LS18	0.00	0.00	4.30	0.00	0.00	30.66	0.00	26.66	0.00	0.00
LS19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
LS20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
LS21	0.00	0.00	3.02	0.00	0.00	19.76	0.00	11.02	0.00	0.00
LS22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
LS23	0.00	0.00	0.00	0.00	0.00	5.96	0.00	0.00	0.00	0.00
LS24	0.00	0.00	2.63	0.00	0.00	48.21	0.00	45.66	0.00	0.00
LS25	0.00	0.00	5.51	0.00	10.02	16.97	0.00	31.17	0.00	6.73
LS26	0.00	0.00	0.00	0.00	51.76	26.29	0.00	0.00	0.00	19.64
LS27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
LS28	0.00	0.00	4.09	0.00	40.87	12.41	0.00	20.63	0.00	16.54
LS29	0.00	0.00	8.20	89.60	101.57	32.35	0.00	12.67	165.50	16.61
LS30	0.00	0.00	0.67	0.00	15.34	45.79	0.00	88.16	0.00	59.57
LS31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
LS32	0.00	0.00	0.00	0.00	0.00	52.79	0.00	0.00	0.00	0.00
LS33	0.00	0.00	13.76	0.00	4.59	19.10	0.00	99.00	0.00	17.09
LS34	0.00	0.00	11.01	0.00	149.12	32.89	0.00	134.15	0.00	70.15
LS35	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
LS36	0.00	0.00	16.06	0.00	302.87	15.87	0.00	198.03	0.00	82.28
LS37	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
LS38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
LS39	0.00	0.00	0.00	0.00	0.00	19.07	0.00	0.00	0.00	0.00
LS40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
LS41	0.00	0.00	0.00	0.00	0.00	13.87	0.00	0.00	0.00	0.00
LS42	0.00	55.02	2.32	0.00	0.00	9.01	8.33	9.15	0.00	0.00
LS43	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
LS44	0.00	0.00	0.79	0.00	0.00	44.04	0.00	146.30	0.00	0.00
LS45	0.00	0.00	0.16	0.00	0.00	10.99	0.00	64.00	0.00	0.00
LS46	0.00	0.00	0.00	0.00	0.00	13.27	0.00	0.00	0.00	0.00
LS47	0.00	0.00	1.13	0.00	0.00	24.37	0.00	27.76	0.00	0.00
LS48	0.00	0.00	0.38	0.00	0.00	33.50	0.00	5.76	0.00	0.00
LS49	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
LS50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	1.10	2.99	1.89	15.29	14	0	32	4	8

Scale Efficiency and Returns to Scale

Scale efficiency estimate requires the measure of both CRS efficiency score and VRS efficiency score. If there is a difference in these two efficiency scores for a particular firm, then this indicates that the firm has scale inefficiency [9]. A scale-efficient loomshed operates on constant returns to scale. The scores of scale efficiency do not suggest whether the loomshed is operating on increasing or decreasing returns to scale. This can be decided by running an additional DEA model with non-increasing returns to scale. If a loomshed is experiencing decreasing returns to scale then it indicates the underutilization of existing scale-size. Similarly, if it operates on increasing returns to scale then loomshed requires expansion in the scale-size.The mean scale efficiency score for loomsheds is found to be around 91 percent. This clearly indicates that most of the loomsheds are not operating at optimal size. Generally, the smaller loomsheds like Flora Textiles Ltd., India Denim Ltd., Hindoostan Spinning & Wvg. Mills Ltd. and Jay Dee Fabrics Ltd. show relatively lower scale efficiency scores. Anjani Synthetics Ltd., Kamadgiri Synthetics Ltd., Orbit Exports Ltd., Ventura Textiles Ltd., and Western India Cottons Ltd. are an exception, which are operating at optimum scale. In the large scale category, Arvind Ltd., Bombay Dyeing & Mfg. Co. Ltd., Bombay Rayon, Fashions Ltd. and National Textile Corpn. Ltd. have their scale efficiency score well under 75 percent. Loomsheds like Anant Syntex Ltd., Anjani Fabrics Ltd., Hindoostan Spinning & Wvg. Mills Ltd., Modern Denim Ltd., Morarjee Textiles Ltd., Pratibha Fabrics Ltd., Trinity India Ltd. and V T M Ltd. have their scale efficiency scores equal or close to 100 percent, indicating that scale inefficiency is not significantly affecting the overall efficiency but the technical efficiency do affect the overall efficiency of these loomsheds. There are altogether 13 loomsheds having the scale efficiency score of 100 percent, thus representing constant returns to scale. There are five loomsheds, which have technical efficiency scores higher than the scale efficiency scores. This indicates that these loomsheds should adjust their scales of operation to improve the scale efficiencies as well as overall efficiencies. Similarly, there are some loomsheds that have technical efficiencies less than the scale efficiencies like Indus Fila Ltd., K G Denim Ltd., Oxford Industries Ltd. and Somany Evergreen Knits Ltd. This means that these loomsheds should improve their performance and make better use of their resources. Most of the small loomsheds exhibit increasing returns to scale, which indicates that these loomsheds require expansion in the scale-size. Furthermore, some loomsheds are found to have decreasing returns to scale, suggesting that these loomsheds have exceeded their most productive scale-size.

Slack Analysis

After the slack analysis, the directions for improvement in the inputs and output of each inefficient unit have been calculated by considering the actual and target values for each variable. These improvements in target values are calculated for CRS efficiency score of the firms under consideration. The results shown in Table 4 indicate that most of the weaving firms in India are technically inefficient, which means that they are using excess resources than required to produce the given level of output. It can be observed that slacks for efficient firms with an efficiency score of 100 percent are obviously zero. There are 26 loomsheds that are not showing any slacks in the use of resources and their production. However, there are 24 loomsheds show excess use of inputs. One of the most inefficient loomshed LS30 should reduce fuel consumption and plant & machinery by 88 percent and 60 percent respectively; similarly, this firm has to increase its output by 46 percent to appear on the efficient frontier. On an average, all inefficient firms have to increase their output by 14 percent from their existing output level; simultaneously they should reduce inputs such as fuel consumption, wages & salaries and plant & machinery by 32 percent, 4 percent and 8 percent respectively. This depicts that these firms are effective in the use of yarn since they have not shown any slack in this input. Nevertheless, high amount of slacks are observed in the power & fuel

consumption. Besides, there is a slack of 8 percent in the use of plant & machinery. It suggests that the loomsheds, which are operating on DRS, may downsize their production capacity.

Peers Identification

For each inefficient loomshed, DEA identifies a set of corresponding efficient loomsheds. The efficient loomsheds are said to form a reference set for the inefficient unit. The efficient unit that appears in the reference set of most of the inefficient units gives the optimal input-output mix for the inefficient units. There are 14 efficient loomsheds with 100 percent efficiency score as shown in Table 3. These 14 units will appear in the reference set for the all of the inefficient ones. The loomshed that appears in the reference set for most of the loomshed is considered to be benchmark. Nagreeka Exports Ltd appeared in the reference set of most of the inefficient loomsheds followed by Seasons Textiles Ltd, Kamdgiri Synthetics Ltd and Anjani Synthetics Ltd could be used as benchmarks for raising the level of efficiency of the inefficient loomsheds [10-11].

Conclusions

In this study, DEA technique is applied in order to assess the efficiency of loomsheds of the Indian weaving industry. Relationships between efficiency scores and various input and output parameters are examined and identified. An attempt has made to study slacks in inputs and output of the individual loomshed. Benchmarks have also identified for inefficient firms to follow the best practices to improve the performance. This study finds that the average overall efficiency score for the loomsheds in the year of analysis is found to be around 78 percent, which clearly shows the inefficiency of the loomsheds under investigation. The technical efficiency has largely affected the overall efficiency of the weaving industry in India than the scale efficiency. It suggests that the loomshed should first focus on proper utilization of inputs with good managerial control, after that they can expand their production capacity. Firm level analysis shows that the Nagreeka Exports Ltd, Seasons Textiles Ltd, Kamdgiri Synthetics Ltd. and Anjani Synthetics Ltd could be used as benchmarks for inefficient loomsheds to raise the level of efficiency. Orbit Exports Ltd. is one of the most inefficient loomshed in the tested sample. It can follow the best practices of firms Kamadgiri Synthetics Ltd., Nagreeka Exports Ltd., Seasons Textiles Ltd. and Siyaram Silk Mills Ltd. Scale efficiency scores shows that the smaller loomsheds like Flora Textiles Ltd., India Denim Ltd., scored low efficiency scores than the large-scale category like Arvind Ltd., Bombay Dyeing & Mfg. Co. Ltd., Bombay Rayon and Fashions Ltd. Most of the small-scale loomsheds exhibit increasing returns to scale indicating requirement in the expansion of scale-size. Furthermore, some large-scale loomsheds are found to have decreasing returns to scale, suggesting that they have exceeded their most productive scale size. Slack analysis depicts that the loomshed have efficiently utilized the raw material but high amount of slacks are observed in the power & fuel consumption.

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