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Evaluating Technical Efficiency of Textile Firms in Pakistan: An Application of Data Envelopment Analysis (DEA) Approach

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This study evaluates the technical efficiency of listed spinning firms in Pakistan Stock Exchange (PSX). For this purpose, Data Envelopment Analysis technique under Variable Return to Scale (VRS) assumption has been applied. The balanced panel data of 55 firms has been collected for the period 2011 to 2016. The research findings reveal that out of 55 firms only 1 firm can attain efficiency score of 1 throughout the 6 years of the analysis period. These empirical results indicate that available resources are not being properly utilized and there is a considerable scope to improve efficiency of the Pakistani spinning industry. Therefore, managements of these firms need to investigate their present scenario and make concrete efforts for bringing efficiency to the optimum level for better performance. It is also recommended that the government may introduce a special package in the form of subsidy for this industry. This will not only enable spinning industry to compete globally but will also be helpful to retrieve its lost market share.

Keywords**:** Efficiency, Spinning Industry, Data Envelopment Analysis, Pakistan.

INTRODUCTION

For most developing countries, efforts to boost the manufacturing sector can play a pivotal role in increasing the production and in bringing improvement in economic growth. To achieve these objectives, developing countries offer lucrative incentives to the investors for the growth of their manufacturing sector (Jelassi & Delhoumi, 2017). In Pakistan, manufacturing sector is the 2nd largest and is considered the backbone of economy. Its contribution in Gross Domestic Product (GDP) is 13.5% and it also provides widespread employment opportunities in the country (Pakistan Economic Survey 2016-17).

Textile sector is one of the most important segments of manufacturing sector in Pakistan. There are some special features of Pakistani economy that enable the textile sector to play a vital role in the economic development. Firstly, enough raw material for textile sector is available because of agri-based economy of Pakistan. Secondly, it is a labour intensive sector and can utilize less skilled labour. Thirdly, it does not require much capital; therefore, textile business can be initiated with small amount of investment. In addition, textile sector has enough potential to add value in its products and provide ample amount of foreign exchange reserves for the country (Mahmood, 2012).

The processing capacity of Pakistan textile sector is 5.2 billion sq. m, 350,000 power looms, 1.3 million spindles, 03 million rotors, 700,000 industrial and domestic stitching machines and 18,000 knitting machines. Pakistan's textile sector has distinctive advantage of complete setup of value chain, which is exceptional in the world. It has significant impact on economy by contributing 8% to the GDP and 40% in employment of industrial labor force. Furthermore, its contribution in country's exports is approximately 57% and 46% share in total output (Textile policy, 2015).

Although Pakistan textile sector possesses assertive strengths including ample raw material base, cheaper labour, major contribution in employment, export and foreign exchange; however, there are certain weaknesses which significantly affect its performance. These include higher inflation, low investment in research and development and load shading of gas and electricity. The biggest threat is from the competitors like India, China, Bangladesh, and Sri Lanka because of their close ties with international buyers. Therefore, importer countries prefer to purchase the textile goods from Pakistani competitors (Jaleel, Ishfaq, Saleemi, & Samin, 2014). These issues are deteriorating the market share of Pakistan textile sector locally as well as internationally. To address these issues, there is need of a detailed analysis of this sector and it can accomplish through measurement of its performance. This study is an attempt to evaluate the performance of Pakistani textile industry to provide greater insights and take adequate steps for its improvements.

In previous studies, researchers have used different tools to measure the firm performance, for instance; ratio analysis, market share and exports. But these tools are incapable to assess adequately how efficiently a firm is utilizing its resources. A tool that measures how much input has been utilized to produce a given level of output is known as efficiency (Staníčková & Melecký, 2012). Efficiency is a relative concept and it refers to compare the performance of a firm with the optimum utilization of resources at its disposal. (Verma, Kumavat, & Biswas, 2015). Researchers suggest that decisions taken without efficiency measurement can prove irrational, therefore, it is critical to determine the efficiency of business organizations during the process of production, allocation and utilization of resources (Farzianpour, Emami, Foroushani, & Ghiasi, 2016).

A technique that has been widely applied in the previous researches to measure the efficiency of profit as well as non-profit organizations is the Data Envelopment Analysis (Goyal, Kaur, & Aggarwal, 2017). This study thus uses DEA to examine the technical efficiency of listed spinning firms which are the largest segment of textile sector in Pakistan. This study will be useful for the spinning firms' management to find ways to improve their efficiency, for policy makers to frame the policies accordingly and for academicians to probe this area further. Coelli, Rao, O'Donnell, and Battese (2005) stated that technical efficiency refers to the capacity of a firm to produce maximum output through given level of input.

Significance of the Study

This study undertakes the measurement of the efficiency of spinning firms in Pakistan and is useful in several ways. Results of the study can help the management of the studied firms in examining their performance with respect to efficient utilization of their resources and production capacities. It provides the direction to inefficient firms to improve their efficiency by adopting the practices of more efficient firms included in the analysis. From the empirical findings so obtained, policy makers can formulate better policies to support the spinning industry to improve their efficiency. Moreover, this study is also useful for the research scholars to conduct in-depth analysis through identifying the determinants of spinning firm's efficiency and extending input and output variable sets further.

Objectives of the Study

The objectives of the present study are:

- To evaluate the technical efficiency of listed spinning firms in the context of Pakistan.
- To identify the benchmarks for the inefficient firms to improve their efficiency.

The remaining paper has been ordered as follows: Section-II provides a review of the previous research, while Section-III is regarding source of data, sample selection, analysis approach and variables used in the current study. The following section provides the DEA based empirical findings about sample firms. The last section concludes the study with policy recommendations and scope of future research.

LITERATURE REVIEW

Charnes, Cooper, and Rhodes (1978) introduced a linear programing tool to evaluate the efficiency and called it Data Envelopment Analysis (DEA). This method has been widely applied in the previous research to examine the relative efficiencies of homogenous units (Fried, Lovell, & Schmidt, 2008). In measuring the efficiency of different industries, Data Envelopment Analysis has become a popular approach among the scholars since mid-1980. Data Envelopment Analysis (DEA) has been used to assess the efficiency of a Decision Making Unit (DMU) in relation to other similar DMU's (Atici & Podinovski, 2015). The original DEA model as proposed by Charnes et al. (1978) is known as CCR Model and assumes constant return to scale (CRS), which means that changes in the outputs of a DMU are direct proportion to any changes made in the inputs of that DMU. The BCC model was presented by Banker, Charnes, and Cooper (1984) and it is based on the assumption of variable returns to scale (VRS), which implies that changes in outputs of a DMU may not occur with same proportion of changes made in its input levels.

Initially, DEA method was applied to assess the efficiency of non-profit oriented entities like hospitals, educational institutions and public departments (Kundi & Sharma, 2016). Later on, the scope of DEA application increased, and this technique is now also being applied in profit-oriented organizations to evaluate their performance. For instance, the performance of service sector firms like banks, software companies and manufacturing sector firms like textile, mining firms are measured by adopting DEA. Furthermore, DEA is also used to measure the efficiencies of different nations (Goyal et al., 2017).

The DEA is an approach that has been regularly used by scholars to measure the efficiency in manufacturing (Castiglione, 2012; Le, Vu, & Nghiem, 2018; Söderbom & Teal, 2004; Verschelde, Dumont, Rayp, & Merlevede, 2016), health (Du, Wang, Chen, Chou, & Zhu, 2014; Mollahaliloglu et al., 2018; Valdmanis, Rosko, Leleu, & Mukamel, 2017), education (Ali, Rana, Pant, Jauhar, & Mogha, 2018; Johnes & Tone, 2017; Kuah & Wong, 2011) , banking (Fernandes, Stasinakis, & Bardarova, 2018; Silva, Tabak, Cajueiro, & Dias, 2017; Wang, Huang, Wu, & Liu, 2014), and stock evaluation (Lim, Oh, & Zhu, 2014; Zhou, Jin, Xiao, Wu, & Liu, 2018).

One of the earliest studies to assess the efficiency of textile sector through DEA technique was conducted by Pitt and Lee (1981) in Indonesia. Later, various scholars evaluated the performance of textile firms by adopting DEA technique in developed as well as in developing countries. An overview of some major studies which employed DEA technique to measure the performance of textile industry from time to time is given in the following paragraphs.

Jaforullah (1999) examined Bangladesh handloom textile industry. The data was obtained from census report for the year 1990 published by the Bangladesh Bureau of Statistics. The technical efficiency and production technology were estimated through Cobb-Douglas production models of SFA. It was observed that the technical efficiency of the industry was only 41%. It was proposed that the mix of labour and capital currently being used in the industry may be changed to improve the technical efficiency.

Chandra, Cooper, Li, and Rahman (1998) took sample of 29 Canadian textile firms for the year 1994 to investigate their efficiency through DEA method. The calculated results indicated that most of the firms did not perform well and were below the efficiency frontier because of underutilization of existing resources. Scholars suggested corrective measures such as changes in strategy and existing structure to be made to improve the efficiency.

Bhandari and Ray (2012) evaluated Indian textile industry through two stage DEA method. In the first stage, technical efficiency was evaluated and in the second stage determinants of efficiency were identified. To achieve the objectives of the study, scholars selected three input variables and one output variable. Total number of worked days, net value of fixed assets and material were input variables while output variable was value of the product. The empirical findings revealed that firms from private sector were technically more efficient as compared to public sector firms. In the second stage results, it was observed that size has positive impact on technical efficiency while impact of firm's age was insignificant.

In Indian context, another study was conducted by Verma et al. (2015) to examine the technical efficiency with different prospective. For this purpose, they selected 10 textile firms and took the sample period for the year 2012-13. Input variables of the research were raw material, fuel and power consumption, employee expenses while net production and profit was included as output variable. To draw empirical findings based on data, they adopted DEA technique. Average technical efficiency of selected textile firms for the year 2012 was 90% which improved in the year 2013 with average efficiency score 96%.

Rakhmawan, Hartono, and Awirya (2015) selected Indonesian textile firms to examine their technical efficiency. This study took the sample period from 2004 to 2008 and DEA method was employed. They added multiple input variables in the study like net fixed asset, raw material, electricity, fossil fuel and workers' salary; while sales were considered as output variable. DEA results revealed that only 40 percent sample firms were able to achieve the efficiency score 1. Goyal, Singh, Kaur, and Singh (2018) studied the efficiency levels of the Indian textile industry and its sub-sectors keeping in view the changing global and national business environment. It was found that textile industry of India was inefficient and required the special attention of policymakers to bring the improvements in terms of efficiency.

In Pakistan, there have been a few studies to examine the textile sector. For example, Din, Ghani, and Mahmood (2007) measured the efficiency of textile industry under the umbrella of manufacturing sector. Data was obtained from the census of manufacturing industries for the period 1995-96 and 2000-01. Researchers used DEA and stochastic frontier analysis to conclude the results. The average efficiency of textile industry was low in contrast to overall manufacturing sector. Textile industry average efficiency was 0.12 and 0.30 in the year 1995-96 and 2000-01 respectively; while the score was 0.23 and 0.42 for overall manufacturing sector for the same period.

Mahmood (2012) estimated efficiency of textile industry by adopting DEA method under constant return to scale and variable return to scale assumptions. Data was collected from Census of Manufacturing Industries (2005-06) which is published by the Pakistan Bureau of Statistics regularly and 27 industries were selected for final analysis. The input variables of the study were capital, labour, raw material, energy and non-industrial cost while contribution to Gross Domestic Production (GDP) was included as output variable. Empirical results drawn based on collected data showed 0.73 average technical efficiency under constant return to scale (CRS); whereas the score was 0.81 under variable return to scale (VRS) assumption.

Usman, Hassan, Mahmood, and Shahid (2014) measured the efficiency of Pakistani textile firms and investigated the determinants of efficiency. To get objective of the study, scholars selected sample of 100 textile firms for the period 2006-11 and used Data Envelopment Analysis technique. Study included sales as output variable; whereas capital, cost of sales and operating expenses were included as input variables. Results revealed technical efficiency of 0.82 under constant return to scale (CRS) and 0.86 under variable return to scale (VRS). To see the determinants of efficiency, they applied generalized least square estimation technique. Findings of the study predict that firm age, market share and sales growth have positive impact on efficiency whereas firm size, export participation and financial leverage had a negative effect on efficiency

Kuşakçı, Jasmin, and Bushera (2018) examined the technical efficiency of listed vertically integrated composite firms of textile sector. They employed Data Envelopment Analysis under the assumption of constant returns to scale (CRS) and variable returns to scale (VRS). To achieve the objectives of the study, 29 firms were selected for analysis and data were collected for the period of 2014-16. Researchers used current asset, production cost and administration cost as input variables and gross profit, total sales and net income were output variables. Empirical results drawn from the sample firms show 0.572 technical efficiency from constant returns to scale and 0.731 under variable returns to scale.

Based on aforesaid findings, particularly those related to Pakistan, it is evident that large scale inefficiencies are still prevailing in the textile industry. Therefore, a research in this area is required which can not only help to identify weak areas of performance but may also provide a framework to the policymakers for betterment of the textile sector in future. This study is an attempt to fill the existing research gap by examining the technical efficiency of listed spinning firms in Pakistan through Data Envelopment Analysis (DEA) technique and offer recommendations to improve the performance.

DATA AND METHODOLOGY

There were two main sources of data that were utilized in this study. The first comprised of audited annual financial statements of spinning firms listed on Pakistan Stock Exchange. In addition, the study utilized publications by State Bank of Pakistan that includes financial statements analysis of non-financial companies listed at Pakistan Stock Exchange.

The population of the present research is the spinning firms listed on Pakistan Stock Exchange. Only those firms which data for which data for the whole period ranging from 2011-16 was available were selected which led to a total sample of 55 spinning firms. Boussofiane, Dyson, and Thanassoulis (1991) recommended that it is necessary the number of DMU's should be two times more when input and output variable of the study are added. As per this rule, in the current study there should be at least 12 DMU 10(=2*(3+2).

Specification of DEA Model

When an analysis is conducted under a DEA model, it can be undertaken with an input orientation or an output orientation. How much reduction in inputs is required to maintain the current level of output for an inefficient DMU to become efficient is called as input orientation. While how much output can be increased while maintaining the current level of input for an inefficient DMU to become efficient is called an output orientation (Mostafa, 2016).

There are certain reasons due to which input orientation model is preferred over the output orientation in this study. First, input quantities used in the process are primary decision variable, as managers have more control over inputs as compared to outputs (Akhtar & Asif, 2017; Chapelle & Plane, 2005). Second, input oriented models are appropriate to measure the resource efficiency of enterprises (Buyukkeklik, Dumlu, & Evci, 2016). Third, manufacturing firms generally try to reduce their cost (an input) and achieve efficient utilization of available resources. Hence, these inputs are critical determinant of the efficiency and it can be achieved by controlling cost as well as efficient management of resources (Akhtar & Asif, 2017; Saranga, 2009). The study has employed the BCC model because spinning firms are operating in the international competitive environment and their management desires to produce maximum outputs with minimum resources to capture the existing market share. In addition, other factors like new production method, technology and specialization compel the firms to take out of box decisions and maximize their production with minimum utilization of scarce resources. The opinion of expert from the textile sector also suggested utilization of BCC Model for the Pakistani spinning industry. Therefore, in the present scenario, it is more practical to use the BCC model instead of CCR model as empirical findings will be robust under the said model.

The mathematical presentation of the BCC Model with input orientation is as under:

Min θ

Subject to

$$\sum_{j=1}^{n} \mu_j x_{ij} \leq \theta x_{ijo} \qquad (i = 1,2,\ldots,m)$$

$$\sum_{j=1}^{n} \mu_j y_{rj} \geq \theta y_{rjo} \qquad (r = 1,2,\ldots,s)$$

$$\sum_{j=1}^{n} \mu_j = 1 \qquad (j = 1,2,\ldots,n)$$

$$\mu_j \geq 0$$

$$\theta \ sign \ free$$

Variables of the Study

A set of input variables utilized in the present study are Assets, Cost of Sales, General Administrative and Other Expenses while output variable is Earnings after Taxes. These variables have been selected based on previous research in the literature as described in Table-1.

Table 1: Input and Output Variables

Category	Name of Variable	Use of Variables in Previous Studies
Inputs	Assets	(Erdumlu, 2016)
	Cost of Sales	(Memon & Tahir, 2011), (Usman et al., 2014)
	General, Administrative and other expenses	(Hosseinzadeh, Smyth, Valadkhani, & Le, 2016)
	Earnings after Taxes	Memon and Tahir (2011), (Ahmad, Ishtiaq, Hamid, Khurram, & Nawaz, 2017; Majumdar & Asgari, 2017)

Empirical Findings

The descriptive statistics of input and output variables including Mean, Standard Deviation, Minimum and Maximum values are calculated from the values given in the financial statement of selected firms and are presented in Table 2. On average, Pakistani spinning firms invest an amount of Rs.3,840,237 in Assets with standard deviation of Rs. 5,415,278. Moreover, the minimum investment in Assets is Rs. 70,806, while maximum investment in Assets is to the tune of Rs. 35,279,646 The Cost of Sales on average remains Rs. 3,571,273 with standard deviation of Rs.3,888,626. The maximum amount of Cost of Sales is Rs 24,613,636 and minimum cost to produce the goods during sample period is Rs 180,151. The descriptive results indicate that average General Administrative and Other Expenses during the sample period is Rs. 162,646 with a maximum value of Rs. 19,663,909; while minimum value of Administrative, General and Other Expenses is Rs. 2,515 and standard deviation is Rs. 202,630. The Earnings after Taxes (EAT) on average is Rs. 9,630 with standard deviation of Rs. 446,411. Minimum and maximum amount of EAT during the period 2011-16 is Rs. -2,688,570 and Rs.2,169,597 respectively.

Table 2: Descriptive Statistics (Thousand Rupees)

Variable	Mean	Std.Dev.	Min	Max
Assets	3,840,237	5,415,278	70,806	35,279,646
Cost of Sales	3,571,273	3,888,626	180,151	24,613,636
Administrative, General and Other Expenses	162,646	202,630	2,515	19,663,909
Earnings after Taxes	9,630	446,411	(2,688,570)	2,169,597

Table 3 provides technical efficiency obtained by each spinning firm included in the analysis. It is evident that on average, Pakistani spinning industry remains inefficient over the period 2011-16; as average technical efficiency scores are lesser than one. Empirical results indicate that spinning firms' average technical efficiency in the year 2011-16 varies from 0.25 to 0.56.

Table 3: Firm Wise Technical Efficiency

Sr	DMU Name	2011	2012	2013	2014	2015	2016
1	Al-Qadir Textile Mills Ltd.	0.22	0.21	0.37	0.19	0.18	0.18
2	Allawasaya Textile & Finishing Mills Ltd.	0.50	0.68	0.56	0.38	0.16	0.17
3	Amtex Ltd.	0.03	0.07	0.08	0.07	0.08	0.10
4	Asim Textile Mills Ltd.	0.82	0.82	0.98	0.62	0.25	0.27
5	Ayesha Textile Mills Ltd.	0.06	0.07	0.27	0.09	0.16	0.74
6	Babri Cotton Mills Ltd.	0.61	0.41	0.97	0.73	0.16	0.20
7	Bilal Fibres Ltd.	0.17	0.13	0.49	0.15	0.17	0.23
8	Chakwal Spinning Mills Ltd.	0.23	0.3	0.37	0.35	0.14	0.22
9	Colony Textile Mills Limited	0.21	0.02	0.07	0.01	0.02	0.02
10	Crescent Cotton Mills Ltd.	0.07	0.33	0.51	0.29	0.08	0.08
11	Crescent Fibers Ltd.	0.54	0.45	0.85	0.93	0.16	0.28
12	D.S. Industries Ltd.	0.16	0.23	0.91	0.26	**1**	0.98
13	Dewan Farooque Spinning Mills Ltd.	0.11	0.15	0.23	0.19	0.30	0.28
14	Dewan Khalid Textile Mills Ltd.	0.15	0.18	0.18	0.24	0.35	0.52
15	Dewan Mushtaq Textile Mills Ltd.	0.14	0.15	0.17	0.2	0.28	0.34
16	Dewan Textile Mills Ltd.	0.05	0.06	0.14	0.09	0.12	0.40
17	Din Textile Mills Ltd.	**1**	0.03	**1**	0.03	0.03	0.27
18	Elahi Cotton Mills Ltd.	**1**	**1**	**1**	**1**	**1**	**1**
19	Ellcot Spinning Mills Ltd.	0.8	0.57	0.89	**1**	0.14	0.47
20	Fatima Enterprises Ltd.	0.44	0.04	0.04	0.92	0.09	0.16
21	Fazal Cloth Mills Ltd.	0.54	**1**	**1**	**1**	**1**	0.19
22	Gadoon Textile Mills Ltd.	**1**	0.49	**1**	0.92	0.01	0.01
23	Glamour Textile Mills Ltd.	0.21	0.33	0.57	0.13	0.11	0.16
24	Globe Textile Mills (OE) Ltd.	0.43	0.36	0.35	0.55	0.84	0.83
25	Gulistan Textile Mills Ltd.	0.25	0.02	0.07	0.13	0.13	0.12
26	Gulshan Spinning Mills Ltd.	0.34	0.04	0.18	0.22	0.21	0.21
27	Hira Textile Mills Ltd.	0.48	0.40	0.33	0.54	0.24	0.90
28	Ideal Spinning Mills Ltd.	0.78	0.33	0.26	0.15	0.12	0.12
29	Idrees Textile Mills Ltd.	0.50	0.48	0.32	0.23	0.14	0.19
30	Ishtiaq Textile Mills Ltd.	0.95	0.38	**1**	0.52	0.49	0.63
31	Island Textile Mills Ltd.	**1**	0.81	**1**	0.90	0.15	0.07
32	J.K. Spinning Mills Ltd.	0.42	0.43	0.48	0.55	0.09	0.27

33	Janana De Malucho Textile Mills Ltd.	0.40	0.45	**1**	**1**	0.14	0.26
34	Kohinoor Spinning Mills Ltd.	0.51	0.28	0.37	0.31	0.05	0.07
35	Maqbool Textile Mills Ltd.	0.56	0.60	0.50	0.16	0.07	0.07
36	N.P. Spinning Mills Ltd.	0.39	0.12	0.21	0.17	0.20	0.23
37	Nadeem Textile Mills Ltd.	0.24	0.24	0.31	0.22	0.06	0.06
38	Nagina Cotton Mills Ltd.	0.90	**1**	**1**	0.98	0.20	0.07
39	Premium Textile Mills Ltd.	0.71	0.76	**1**	0.2	0.29	**1**
40	Reliance Cotton Spinning Mills Ltd.	**1**	0.41	0.64	0.48	0.30	**1**
41	Resham Textile Industries Ltd.	0.65	0.98	**1**	0.58	0.44	0.16
42	Ruby Textile Mills Ltd.	0.12	0.22	0.21	0.27	0.42	0.67
43	Saif Textile Mills Ltd.	0.58	0.17	0.44	0.34	0.04	0.05
44	Sajjad Textile Mills Ltd.	**1**	0.72	0.89	0.24	0.24	0.27
45	Salfi Textile Mills Ltd.	0.77	0.41	0.47	0.16	0.07	0.06
46	Sally Textile Mills Ltd.	0.96	0.49	0.55	0.08	0.09	0.12
47	Salman Noman Enterprises Ltd.	0.67	0.15	0.21	0.21	0.23	0.27
48	Sana Industries Ltd.	**1**	0.91	0.79	**1**	0.67	**1**
49	Saritow Spinning Mills Ltd.	0.57	**1**	0.68	0.33	0.12	0.11
50	Service Industries Textiles Ltd.	0.35	0.41	0.98	0.89	0.71	0.60
51	Shadab Textile Mills Ltd.	0.69	0.36	0.97	0.6	0.29	0.89
52	Shadman Cotton Mills Ltd.	0.04	0.05	0.11	0.11	0.25	0.33
53	Shahzad Textile Mills Ltd.	0.41	0.36	0.45	0.78	0.1	0.08
54	Sunrays Textile Mills Ltd.	0.58	**1**	**1**	**1**	0.15	0.30
55	Tata Textile Mills Ltd.	0.38	0.17	0.42	0.32	0.06	0.06
Average Technical Efficiency		**0.50**	**0.40**	**0.56**	**0.44**	**0.25**	**0.33**

It is observed from Table-3 that average treats all DMUs equally and does not provide about the individual performance of a DMU. In case of DEA, average technical efficiency of sample DMUs may be higher but it may be possible that number of DMUs near to efficient frontier may be lower, therefore, conclusion drawn only based on calculated average may be misleading for managers and policy makers. Hence, it is, necessary to examine the industry average technical efficiency in conjunction with efficiency score of selected spinning firms individually.

It is pertinent to mention that a DMU is fully efficient, if it attains efficiency score of 1; but a DMU whose efficiency score is near to 1, we may say that its performance is better than a DMU with lower efficiency score like 0.30, 0.40 or 0.50. Keeping in view this element of performance, a DMU with efficiency score of 0.90 or above is included in the ambit of fully efficient. By adding a DMU near to efficiency, the results reveal that efficient DMUs out of sample are 10, 7, 15, 11, 3, and 6 during the year 2011-16. The year wise details of efficient and inefficient DMUs are provided in Figure 1.

The results of efficiency score calculated through DEA predict that maximum DMUs of spinning industry were unsuccessful to utilize their installed manufacturing capacities and remain inefficient during the sample period. The causes of such deviation from the efficiency frontier is investigated in the prospective of economic conditions that were prevailing during the sample period, it is found that Pakistan was facing various problems internally as well as externally which have obstructed spinning industry and adversely affected to exports. The major internally factors which hampered the spinning industry are fluctuations in raw material prices, interrupted gas and electricity supplies, unstable power rates, high cost of doing business and security issues.

The main destinations of Pakistan textile exports are United States of America (USA), European Union (EU) and China, due to slowdown in international economies, shrinkage of demand from China have significantly negatively impact on spinning industry. In addition, India, Bangladesh emerged as regional competitors in textile due to cheaper inputs, low interest cost, larger capacities, rebate on exports and effective marketing eroded Pakistan textile industry share in the international market.

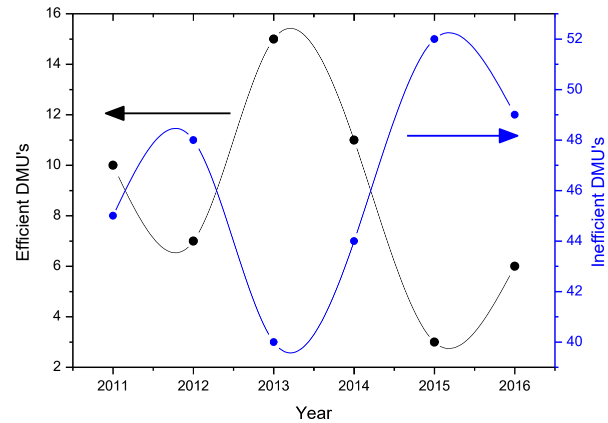

Fig 1 Year Wise Efficient and Inefficient DMUs

The discussion on the findings of the study is divided into two parts i.e. DMUs with worst efficiency scores and DMUs with best efficiency scores. We look at some salient points regarding DMUs with worst efficiency scores during the sample period in the following paragraphs.

DMUs with Worst Efficiency Scores

The calculated efficiency score reveals that Al-Qadir Textile Mills Limited efficiency scores are 0.18-0.37 during the sample period. The major causes of inefficiency are higher production cost, energy crisis and underutilization of manufacturing capacities. The results found that Amtex Limited technical efficiency score during the sample period remain between 0.03-0.1. The departure from the efficiency frontier is primarily due to underutilization of manufacturing capacities because of fluctuations in cotton prices, high cost of gas and electricity. Furthermore, enough financial support was not available from the financial institutions which have also impact adversely on the efficiency of Amtex Limited. Empirical findings reveal that efficiency score of Ayesha Textile Mills Limited are very low. The inefficiency is mainly attributed to higher production cost, decrease in sales and underutilization of available resources.

The distress in the efficiency score of Bilal Fibres Limited is found during the sample period. The major factors responsible for low efficiency are decrease in sales, increase in raw material prices, decrease in yarn prices and shortage of gas and electricity. The efficiency scores of Chakwal Spinning Mills Limited during the sample period are not encouraging. The causes of adverse efficiency are drastic decline in sales, acute shortage of gas and electricity supplies and underutilization of installed capacity. The empirical findings of the study show that Colony Textile Mills Limited efficiency scores are 0.01-0.21. During the sample period deviation from efficiency frontier is fluctuations in demand, energy crisis and higher production cost. Dewan Farooque spinning Mills Limited efficiency scores are less than 1 during the sample period. The reasons behind the inefficiencies are higher production cost, underutilization of installed capacity as well as overall adverse economic environment faced by the Pakistani spinning industry.

Dewan Mushtaq Textile Mills Limited performance is not better during the sample period. The scrutiny of results indicates that there is high production cost and underutilization of installed capacity. In addition, distress macroeconomic environment, energy crisis, fluctuations in prices and slowdown in exports contributed towards inefficiency. The results of Dewan Textile Mills Limited indicate adverse efficiency during the sample period. The decline in product demand, decrease in exports, increase in salary and wages, fluctuations in raw material prices and energy crisis are responsible for low efficiency scores. Gulistan Textile Mills Limited and Gulshan Spinning Mills limited efficiency scores are not satisfactory and remained less than 1 during the sample period. Both firms belong to Gulshan Group and litigation of Group with financial institutions adversely affected the performance. The factors that are distressing the efficiency of firms are shortage of working capital which contributed to higher production cost, operating cost and underutilization of installed capacities.

The efficiency results of N.P Spinning Mills limited for the sample period are not encouraging. The higher production cost, operating cost, underutilization of installed capacity, fluctuations in raw material prices, sluggish economic growth and energy crisis deteriorated the efficiency of firm. Nadeem Textile Mills limited experienced of worse efficiency scores during the period under analysis. Empirical findings reveal that major causes contributed towards less efficiency are higher production cost, operating cost and energy crisis. Furthermore, distressed situation of the spinning industry during the sample period also hampered the efficiency of the firm. The technical efficiency score during the period 2011-16 of Shadman Cotton Mills Limited are from 0.04 to 0.33. The reasons of inefficiency are investigated and found that slump in Pakistan spinning industry badly affected firm manufacturing capacities. During the sample period, the Tata Textile Mills Limited efficiency is below the efficiency score of 0.50. The major causes of exodus from efficiency frontier are higher production cost, operating cost, energy crisis, security issues, low price of finished goods and sluggish economic growth.

DMUs with Best Efficiency Scores

The major reasons of efficiency during the sample period pertaining to DMUs with best efficiency score are given in the subsequent paragraphs.

D. S Industries efficiency score in the year 2013 is 0.91, in 2015 is 1 and in the year 2016 is 0.98. Major reason of higher efficiency score is better utilization of manufacturing facilities and another factor that attributed towards efficiency score 1 is the receipt of notional income (reversal of impairment on investment in associated undertaking). The efficiency results of Din Textile Mills Limited are mixed. During the year 2011 and 2013, firm efficiency score is 1 because of control on the production cost and through wise management of economic shocks.

There is only Elahi Cotton Mills Limited which attains efficiency 1 because of controlled production cost and best utilization of installed capacities. Fazal Cloth Mills Limited efficiency score is 1 in the year 2012, 2013, 2014 and 2015. The major factor contributed towards efficiency is low production cost. Empirical findings pertaining to Gadoon Textile Mills Limited reveal that firm performs better in the year 2011, 2013 and 2014. The major cause of efficiency is the low production cost and wise procurement of raw material by the management. Ishtiaq Textile Mills Limited efficiency score show encouraging results in the year 2011 and 2013 because of low production cost. The efficiency score of Island Textile Mills Limited are higher in the year 2011, 2013 and 2014. The investigation of empirical findings predicts that reasons of efficiency are low production cost and effective utilization of resources. Next DMU that performed well during the sample period is Janana De Malucho Textile Mills Limited. The sales volume of the firm has been increased which significantly contributed towards efficiency in the year 2013 and 2014. The performance of Nagina Cotton Mills Limited for the year 2011-14 is excellent despite of severe crisis in the industry. The major factors responsible for efficiency are low production cost due to timely purchase of raw material and investment in diversified products.

Premium Textile Mills Limited attains efficiency score 1 in the year 2013 and 2016 because of optimum utilization of resources and decrease in financial charges. Reliance Cotton Spinning Mills Limited efficiency in the year 2011 and 2016 is very encouraging due to increase in sales volume and efficient utilization of installed manufacturing capacities. The efficiency score of Resham textile Industries Limited in the year 2012 and 13 are 0.98, 1 respectively. In spite of adverse situation prevails in the industry, firm managed its performance through getting higher prices of its products, intelligent marketing and loans from the financial institutions at competitive rates. Sana Industries Limited is efficient in the year 2011, 2014 and 2016 due to low production cost and efficient utilization of assets. The efficiency score of Sunrays Textile Mills Limited in the year 2012, 2013 and 2014 is 1 due to control on production cost and optimum utilization of manufacturing capacities.

Table 5: Year Wise Technically Efficient DMUs

Description	No of DMU	Percentage
Fully efficient* in all years of sample period	1	2%
Fully efficient in five years	0	0%
Fully efficient in four years	1	2%
Fully efficient in three years	2	5%
Fully efficient in two years	7	13%
Fully efficient in one year	6	11%
Fully efficient in zero years	38	68%

**Fully efficient mean with efficiency score 1.*

In Table 5 further analysis of efficiency is undertaken and findings designate the trend of efficient DMUs during the sample period. It is found that only Elahi Cotton Mills Ltd attains efficiency score 1 during entire sample period from 2011 to 2016. This firm is benchmark for other firms who are below the efficient frontier. The inefficient firms may improve their efficiency by following the policies of efficient firms and business practices. No firm is efficient in consecutive five years while in four years is 1 (2%) firm, in three years are 2 (5%), in two years are 7 (13%) and in one year are 6 (11%) firms. It is astonishing to note that 38 (68%) DMUs never fall on efficient frontier during the analysis period 2011-16 which requires change in existing policies to achieve efficiency score 1. Reference sets for each firm during the period under analysis are given in appendix-I.

CONCLUSION

This research measures the technical efficiency of 55 listed spinning firms in Pakistan for the period 2011-16 through a nonparametric technique called Data Envelopment Analysis. Researchers assume variable return to scale (VRS) and input orientation approach for this study. The observed results reveal that only Elahi Cotton Mills Ltd attained efficiency score 1 consecutively in the years 2011 to 2016 through optimum utilization of their resources. On the other hand, 38 (68%) firms never reach on efficiency frontier during the entire sample period under observation. From the empirical findings of the present study, it can be inferred that large-scale inefficiencies are prevailing in the spinning industry of Pakistan and concrete efforts are required for efficiency improvement. The following recommendations are suggested to bring the spinning industry on the right track.

- The management of inefficient spinning firms should reduce production cost to achieve the efficiency.
- Assets were underutilized during the study period; this suggests that management should pay attention to restructure the combination of inputs.
- Shortfall in earnings after taxes was noted, it implies that profit volume can be increased with best utilization of available resources allocated for the spinning industry.
- Inefficient firms need to adopt the business practices of efficient firms to achieve the efficiency and ensure optimum employment of resources.
- Government may offer the subsidies to the farmers, so that the raw material may be available to the industry at cheaper rates.
- Adoption of modern technology and the replacement of the outdated machinery are desirable to compete in the international market.
- The textile industry from the import tariffs may be exempted to produce the competitive products.
- Incessant supply of gas and electricity may be ensured for textile industry.
- Loans may be granted on special interest rates for further expansion of the textile industry.

Future Research

There are number of interesting avenues which can be explored through future research in this area. For example, study across different related industries through different models can be tested based on diverse selection of inputs and outputs. These research dimensions are also our future research agenda.

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Appendix-I

Table 6: Benchmarks of Spinning Firms for the period 2011-16

DMU	2011(Reference Set)	2012 (Reference Set)	2013 (Reference Set)	2014 (Reference Set)	2015 (Reference Set)	2016 (Reference Set)
1	18 (0.95) 31 (0.05)	18 (0.97) 54 (0.03)	18 (0.92) 38 (0.08)	18 (1.00)	18 (1.00)	18 (1.00)
2	18 (0.83) 31 (0.17)	18 (0.84) 38 (0.13) 54 (0.03)	18 (0.62) 30 (0.13) 38 (0.07) 41 (0.18)	18 (0.72) 19 (0.06) 48 (0.22)	18 (1.00)	18 (1.00)
3	44 (1.00)	18 (1.00)	18 (1.00)	18 (1.00)	18 (1.00)	18 (1.00)
4	17 (0.05) 18 (0.95)	18 (0.83) 49 (0.17)	18 (0.14) 30 (0.70) 41 (0.16)	18 (0.66) 48 (0.34)	18 (1.00)	18 (1.00)
5	18 (0.97) 44 (0.03)	18 (1.00)	30 (0.97) 41 (0.03)	18 (1.00)	18 (1.00)	18 (1.00)
6	17 (0.01) 31 (0.06) 48 (0.93)	18 (0.88) 54 (0.12)	30 (0.32) 31 (0.52) 33 (0.08) 38 (0.08)	33 (0.02) 48 (0.98)	18 (1.00)	18 (1.00)
7	18 (0.91) 31 (0.04) 48 (0.05)	18 (1.00)	18 (0.00) 30 (0.93) 38 (0.04) 41 (0.03)	18 (1.00)	18 (1.00)	18 (1.00)
8	17 (0.04) 18 (0.94) 48 (0.01)	18 (0.89) 54 (0.11)	18 (0.78) 30 (0.00) 31 (0.03) 38 (0.19)	18 (0.36) 19 (0.00) 48 (0.64)	18 (1.00)	18 (1.00)
9	17 (0.32) 18 (0.68)	18 (1.00)	30 (0.66) 33 (0.15) 41 (0.19)	18 (1.00)	18 (1.00)	18 (1.00)
10	18 (0.75) 31 (0.07) 44 (0.18)	18 (0.67) 54 (0.33)	30 (0.32) 31 (0.24) 33 (0.35) 38 (0.09)	33 (0.09) 48 (0.91)	18 (1.00)	18 (1.00)
11	17 (0.02) 31 (0.11) 48 (0.87)	18 (0.78) 38 (0.01) 54 (0.21)	18 (0.31) 38 (0.14) 41 (0.54)	19 (0.38) 48 (0.56) 54 (0.06)	12 (0.27) 18 (0.73)	18 (0.50) 48 (0.50)
12	18 (0.87) 44 (0.13)	18 (1.00)	18 (0.38) 30 (0.43) 31 (0.12) 38 (0.08)	18 (1.00)	18	18 (0.70) 48 (0.30)
13	18 (0.61) 44 (0.39)	18 (1.00)	18 (0.98) 31 (0.02)	18 (1.00)	12 (0.13) 18 (0.87)	18 (1.00)
14	18 (0.83) 44 (0.17)	18 (1.00)	18 (1.00)	18 (1.00)	18 (1.00)	18 (1.00)
15	18 (0.88) 44 (0.12)	18 (1.00)	18 (1.00)	18 (1.00)	18 (1.00)	18 (1.00)
16	18 (1.00)	18 (1.00)	18 (0.68) 30 (0.21) 31 (0.11)	18 (1.00)	18 (1.00)	18 (1.00)
17	22	18 (1.00)	1	18 (1.00)	18 (1.00)	18 (0.06) 48 (0.94)
18	33	49	34	34	52	47
19	17 (0.11) 31 (0.68) 48 (0.21)	18 (0.58) 49 (0.02) 54 (0.41)	18 (0.05) 38 (0.29) 41 (0.66)	15	12 (0.32) 18 (0.68)	39 (0.08) 40 (0.00) 48 (0.91)
20	17 (0.23) 18 (0.77)	18 (1.00)	18 (1.00)	19 (0.50) 48 (0.50)	18 (1.00)	18 (1.00)
21	17 (0.94) 22 (0.06)	1	0	2	0	39 (0.68) 40 (0.32)
22	4	21 (0.15) 54 (0.85)	0	19 (0.55) 21 (0.45)	18 (1.00)	18 (1.00)
23	17 (0.01) 18 (0.78) 48 (0.21)	18 (0.89) 49 (0.02) 54 (0.09)	18 (0.66) 30 (0.04) 38 (0.11) 41 (0.19)	18 (1.00)	18 (1.00)	18 (1.00)
24	18 (0.98) 40 (0.02) 44 (0.00)	18 (1.00)	18 (1.00) 31 (0.00)	18 (1.00)	18 (1.00)	18 (1.00)
25	17 (0.20) 31 (0.19) 48 (0.61)	18 (1.00)	18 (1.00)	18 (1.00)	18 (1.00)	18 (1.00)
26	17 (0.06) 31 (0.28) 48 (0.66)	18 (1.00)	18 (1.00)	18 (1.00)	18 (1.00)	18 (1.00)
27	17 (0.30) 18 (0.70)	18 (0.51) 49 (0.23) 54 (0.26)	30 (0.66) 31 (0.07) 33 (0.27)	19 (0.25) 48 (0.75)	12 (0.55) 18 (0.45)	40 (0.51) 48 (0.49)
28	18 (0.60) 31 (0.40)	18 (0.89) 38 (0.09) 54 (0.02)	18 (0.94) 38 (0.06)	18 (0.98) 48 (0.02)	18 (1.00)	18 (1.00)
29	18 (0.60) 31 (0.21) 44 (0.19)	18 (0.92) 54 (0.08)	18 (0.20) 30 (0.72) 31 (0.08)	18 (0.63) 48 (0.37)	12 (0.03) 18 (0.97)	18 (1.00)
30	17 (0.04) 18 (0.96)	18 (1.00)	24	18 (1.00)	18 (1.00)	18 (1.00)
31	25	18 (0.60) 54 (0.40)	15	33 (0.22) 48 (0.78)	18 (1.00)	18 (1.00)
32	22 (0.04) 31 (0.96)	18 (0.25) 54 (0.75)	18 (0.02) 38 (0.98)	19 (0.63) 21 (0.00) 54 (0.37)	12 (0.67) 18 (0.33)	39 (0.15) 48 (0.85)
33	18 (0.18) 31 (0.07) 48 (0.75)	18 (0.76) 49 (0.02) 54 (0.21)	9	6	12 (0.10) 18 (0.90)	18 (0.75) 48 (0.25)
34	18 (0.18) 31 (0.82)	18 (0.68) 38 (0.01) 54 (0.31)	18 (0.32) 30 (0.12) 38 (0.33) 41 (0.23)	19 (0.07) 48 (0.80) 54 (0.13)	18 (1.00)	18 (1.00)
35	18 (0.59) 31 (0.41)	18 (0.59) 38 (0.28) 54 (0.14)	18 (0.53) 38 (0.22) 41 (0.25)	18 (0.70) 19 (0.05) 48 (0.25)	18 (1.00)	18 (1.00)
36	18 (0.81) 31 (0.19)	18 (1.00)	18 (0.83) 30 (0.12) 31 (0.03) 38 (0.02)	18 (0.89) 48 (0.11)	18 (1.00)	18 (1.00)
37	17 (0.01) 18 (0.57) 48 (0.42)	18 (0.86) 49 (0.05) 54 (0.08)	18 (0.24) 30 (0.54) 41 (0.22)	18 (0.80) 19 (0.18) 48 (0.02)	18 (1.00)	18 (1.00)
38	22 (0.03) 31 (0.97)	7	26	19 (0.24) 48 (0.16) 54 (0.59)	12 (0.80) 18 (0.20)	18 (1.00)
39	17 (0.11) 31 (0.26) 48 (0.63)	18 (0.31) 49 (0.33) 54 (0.36)	1	18 (0.17) 48 (0.83)	12 (0.97) 18 (0.03)	3
40	1	18 (0.79) 54 (0.21)	30 (0.32) 31 (0.10) 33 (0.27) 38 (0.31)	19 (0.03) 33 (0.40) 48 (0.58)	12 (0.85) 18 (0.15)	3

41	17 (0.15) 18 (0.85)	18 (0.37) 49 (0.25) 54 (0.38)	19	19 (0.05) 48 (0.95)	12 (0.62) 18 (0.38)	18 (0.89) 48 (0.11)
42	18 (0.64) 44 (0.36)	18 (1.00)	18 (1.00)	18 (1.00)	18 (1.00)	18 (1.00)
43	22 (0.14) 31 (0.86)	18 (0.77) 54 (0.23)	30 (0.04) 33 (0.27) 38 (0.42) 41 (0.27)	33 (0.15) 48 (0.54) 54 (0.31)	18 (1.00)	18 (1.00)
44	12	18 (1.00)	18 (0.40) 30 (0.47) 31 (0.12)	18 (1.00)	18 (1.00)	18 (1.00)
45	17 (0.24) 31 (0.26) 48 (0.50)	18 (0.63) 54 (0.37)	30 (0.18) 31 (0.81) 33 (0.01)	18 (0.58) 48 (0.42)	18 (1.00)	18 (1.00)
46	17 (0.17) 31 (0.00) 48 (0.82)	18 (0.51) 49 (0.49)	18 (0.53) 38 (0.15) 41 (0.32)	18 (1.00)	18 (1.00)	18 (1.00)
47	17 (0.05) 18 (0.95)	18 (1.00)	18 (1.00)	18 (1.00)	18 (1.00)	18 (1.00)
48	16	18 (0.75) 49 (0.13) 54 (0.12)	18 (0.48) 30 (0.37) 38 (0.02) 41 (0.13)	26	12 (0.53) 18 (0.47)	10
49	17 (0.14) 18 (0.86)	10	30 (0.70) 33 (0.10) 38 (0.03) 41 (0.17)	18 (0.49) 48 (0.51)	18 (1.00)	18 (1.00)
50	18 (0.77) 44 (0.23)	18 (1.00)	18 (0.43) 30 (0.51) 31 (0.04) 38 (0.02)	18 (0.69) 48 (0.31)	12 (0.18) 18 (0.82)	18 (1.00)
51	18 (0.82) 31 (0.18)	18 (0.95) 38 (0.01) 54 (0.04)	18 (0.67) 38 (0.06) 41 (0.27)	18 (0.79) 19 (0.11) 48 (0.10)	12 (0.15) 18 (0.85)	18 (0.46) 48 (0.54)
52	18 (0.90) 44 (0.10)	18 (1.00)	18 (0.92) 38 (0.01) 41 (0.07)	18 (1.00)	12 (0.08) 18 (0.92)	18 (1.00)
53	18 (0.14) 31 (0.33) 48 (0.53)	18 (0.68) 38 (0.10) 54 (0.22)	18 (0.57) 38 (0.34) 41 (0.09)	19 (0.47) 48 (0.36) 54 (0.17)	12 (0.21) 18 (0.79)	18 (1.00)
54	17 (0.08) 31 (0.31) 48 (0.61)	27	17 (0.05) 38 (0.63) 39 (0.05) 41 (0.27)	7	12 (0.45) 18 (0.55)	18 (0.39) 48 (0.61)
55	17 (0.04) 31 (0.68) 48 (0.28)	18 (0.83) 54 (0.17)	30 (0.16) 31 (0.81) 33 (0.01) 38 (0.02)	33 (0.17) 48 (0.81) 54 (0.02)	12 (0.01) 18 (0.99)	18 (1.00)