

TECHNICAL EFFICIENCY OF JUTE INDUSTRY IN INDIA: A NONPARAMETRIC APPROACH

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ABSTRACT

The paper examines the extent of Output Oriented technical efficiency of Jute industry in India using firm level panel data over the period 1991 to 2015 in a single-output, multi-input model, inputs being capital, labour, raw material and power & fuel, employing Data Envelopment approach. The paper also attempts to find out the determinants of Output Oriented technical efficiency of Jute industry in India. The result suggests that average Output Oriented technical efficiency varies between 30-97% across these years. Firm size and Firm age positively and significantly affect technical efficiency. There exists a non-linear relationship between Output Oriented technical efficiency and capital Intensity as well as Output Oriented technical efficiency and Employees' contribution in Jute industry in India.

Keywords: Data Envelopment Analysis, Indian Jute Industry; Multi Fiber Agreement, Output oriented Technical Efficiency, Technical Efficiency

1. INTRODUCTION

The Jute industry occupies an important place in the Indian economy. It is one of the major industries in the eastern region and more specifically one of the major industries in West Bengal. Jute, the golden fibre, meets all the standards for safe packaging which is a natural, renewable, biodegradable and eco-friendly product. The uses of jute are manifold, although the traditional use remains in packing, such as carpet backing, sacking and hessian. There are a large number of persons engaged in the jute sector.

The literature review reveals that efforts have been taken to analyse Jute industry in India. In this connection some names can be mentioned like Bhattacharyya and Ghosh (2018), Kalita and Bhuan (2018), Kumar (2017), Bag (2017), Bag, Kumar and Pal (2016), Bagchi and Das (2014), Banik and shil (2014), Ahmad and Parrey (2013), Tandon and Reddy (2013), Pal and

Chakraborti (2011), Dey, Choudhary, Fenske and Bharadwaj (2010) and Ganguly, Bhadury and Day (2004) among others.

The perusal of the literature suggests that there dearth in the study analyzing technical efficiency of Jute industry in India. Also little attempt has been taken to analyse the different firms of the Jute industry in India in terms of technical efficiency. The present paper adds the literature in this direction by measuring Technical Efficiency of Jute industry in India using firm level panel data employing Data Envelopment Method (DEA) approach. Side by side the major determinants of technical efficiency that can promote the efficiency level of the industry is tried to be found out.

Farrell has distinguished efficiency into two: Technical Efficiency (TE) and Allocative Efficiency (AE). The present paper deals with the concept of TE.

Again TE can be divided into two types- Output oriented TE and Input oriented TE. The present paper uses the concept of Output oriented TE (OTE).

Efficiency estimation can be broadly classified into two groups based on the technique used. These are (i) Parametric approach to efficiency analysis using stochastic frontier production approach and (ii) Non-parametric approach to efficiency analysis using Data Envelopment Method.

The present study uses the idea of Output oriented Technical Efficiency (OTE) and is estimated by using Non-parametric approach to efficiency analysis using Data Envelopment Method.

Thus the main objective of the present paper is to find out the efficiency score of Indian Jute industry as well as the factors affecting technical efficiency over time.

The rest of the paper is structured as follows:

Section 2 discusses the methodology used and data source. The results of estimation are presented in section 3. Section 4 makes the conclusion.

2. METHODOLOGY AND DATA SOURCE

This section presents the methodology and the data used in the analysis.

2.1. Methodology

Measurement of Efficiency Score

The present paper estimates OTE for the Jute Industry in India employing Data Envelopment Analysis (DEA) Approach.

By using the non-parametric Data envelopment analysis (DEA) approach which is a Linear Programming Problem, calculates a mean efficiency within a group of organizations. Fried, Lovell and Schmidt (1994) concluded that by using Data Envelopment analysis one can obtain appropriate role models which can act as possible benchmarks for a program of performance improvement and also as the most efficient production facilities and they further argued that by using DEA, the optimum scale and size of output can be obtained if all inputs are to perform according to their best practice. Thus by using the non-parametric DEA method, one can identify inefficient inputs and outputs.

In this method some general assumptions are made about the underlying technology but regarding the functional form of the production function, there is no explicit assumption. By virtue of Charnes, Cooper, and Rhodes (CCR) (1978) and latter due to Banker, Charnes, and Cooper (BCC) (1984), DEA allows empirical construction of the production possibility set from the available observed data.

Determinants of Technical efficiency

A second-stage regression using the OTE scores using non parametric DEA helps to recognize factors that may enhance or hinder efficiency. This is very much helpful for policy making for improving efficiency.

In the present paper, the factors affecting OTE are found out by using panel regression analysis which has been done under a seemingly unrelated regression (SUR) framework, adjusted for contemporaneous correlation (across units) and cross section heteroscedasticity. Contemporaneous covariance has also been taken into consideration in the present paper.

The possible determinants of OTE for jute industry in India in the present paper considered are Firm size (FS), Capital intensity (CI), Firm age (FA) and employees' contribution (EC).

In the literature, there exists a debate between firm size and efficiency of the firm. Some studies found a positive relationship between the two whereas some postulated a negative relationship. Thus it is interesting to test the relationship between firm size and efficiency. The present study uses share of a firm's sales in total industry sales as a measure of firm size.

Relative degree of mechanization (CI) is captured by the ratio of capital to labour input. With higher degree of mechanization, technical efficiency of an industry can be enhanced by using advanced and sophisticated technology into the production process. But higher degree of mechanization can also deter efficiency due to poor management of more capitalistic and sophisticated technology (Jeanneney and Hua, 2003). Thus the choice of capital-intensive production process i.e. rise in CI may hinder technical efficiency score over the years.

Employees' contribution (EC) to production is measured by the number of Employees per unit of sales. A higher ratio of number of employees to sales generally may indicate a higher degree of bureaucratic control within the firm which may result in inefficiency in the production unit which suggests a negative relation between Employees contribution (EC) and technical efficiency. Also it may be possible that there exists a positive relation between the two i.e. between Employees contribution (EC) and technical efficiency if the ratio of employees to sales is just exact to operate the production process well.

According to Lall and Rodrigo (2001), older firms may have more experience and may have easier access to finance and smooth buyer-supplier linkage which may result in higher efficiency level. On the other hand it may be the case that young firm may have a fresher work force and may have assets of latter generations leading to higher efficiency.

Along with the above mentioned possible determinants of technical efficiency, a dummy variable has been defined for capturing the effect of dismantling of Multi Fiber Agreement (MFA). It has been assigned 0 over the period 1991 to 2004 and 1 for the period 2005 to 2015.

2.2. The Data

All the data has been obtained from the Centre for Monitoring Indian Economy (CMIE) database. The study period is from 1991 to 2015.

Data of 32 firms of Jute industry in India have been collected and those firms are selected for which all the data of inputs and output and the determinants are available and positive over the sample period. On the basis of this fact, 21 firms have been selected for the Jute Industry in India.

The variables used are sales value, raw material expenditure, salaries and wages, Power and Fuel expenditure, Capital Expenditure and changes in stock value of output at the firm level.

3. RESULTS OF ANALYSIS

3.1. Results of Estimation of OTE Score of Jute industry in India

The result of analysis suggests that there is no distinct pattern in the average Output Oriented technical efficiency (OTE) scores of the different sample Jute firms over the years. The result shows that the OTE score of Jute sector is fluctuating over the sample periods. The OTE score varies from 30 to 97%, the minimum being in the year 1991 and maximum in 2000. These results can be found in Table 1.

Table 1: Mean Output-Oriented Technical Efficiency values of Jute industry in India

Year	Mean Efficiency	Year	Mean Efficiency
1991	0.299	2005	0.854
1992	0.358	2006	0.921
1993	0.443	2007	0.928
1994	0.911	2008	0.873
1995	0.934	2009	0.692
1996	0.945	2010	0.758
1997	0.907	2011	0.896
1998	0.925	2012	0.871
1999	0.953	2013	0.791
2000	0.97	2014	0.787
2001	0.925	2015	0.84
2002	0.949	Min.	0.299
2003	0.926	Max.	0.97
2004	0.891		

3.2. Determinants of OTE of Jute industry in India

After getting the OTE scores, a panel regression analysis has been done under a seemingly unrelated regression (SUR) framework where each regression was adjusted for contemporaneous correlation (across units) and cross section heteroscedasticity, for identifying the possible determinants of OTE of Jute industry in India,. The Fixed effect model is found to be the better fitted one. The possible determinants of OTE of Jute industry considered are Firm size, Capital intensity, Firm age and employees’ contribution. The result of estimation is presented in Table 2.

It is found that Firm size is positively related to technical efficiency of Jute industry. Also Firm age is positively related with the efficiency for Jute industry. The coefficient of Employees’ contribution (EC) is inversely related with Output Oriented technical efficiency (OTE) which implies that a decrease in EC will improve the output oriented technical efficiency. But, a positive coefficient with the square of employees’ contribution suggests that beyond certain threshold limit, efficiency of the industry will rise with increase in employees’ contribution.

The coefficient of the determinant, Capital Intensity has a negative impact on TE which implies that a decrease in CI will improve TE, but a positive coefficient with the square of CI implies that beyond certain critical value, the efficiency of the firm will rise with increase in CI. Both the coefficients of product terms i.e CI and EC and FS and EC are found to negative. This may be

due to the fact that increase in employees’ contribution leading to more degree of mechanization may hinder technical efficiency. Along with it, increase in employees’ contribution may increase firm size which may also hinder technical efficiency. One interesting result obtained is that MFA has a negative impact on OTE of Jute industry in India.

Table 2: Determinants of Output-Oriented Technical Efficiency of Jute industry in India

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.088101	0.107801	0.817253	0.4142
FS	1.741571	0.121333	14.3537	0
CI	-6.72E-05	0.00011	-0.61368	0.5397
FA	0.014944	0.002076	7.19769	0
EC	-0.02547	0.000382	-66.6758	0
D1	-0.22614	0.028695	-7.88101	0
CI*CI	3.14E-08	1.81E-07	0.174089	0.8619
EC*EC	0.000382	1.58E-05	24.17207	0
CI*EC	-0.03802	0.008749	-4.34491	0
FS*EC	-5.40192	0.255139	-21.1725	0
R-squared	0.89594	Durbin-Watson stat		1.880578
Adjusted R-squared	0.889844			
S.E. of regression	1.014848			
F-statistic	146.9612			
Prob(F-statistic)	0			

4. CONCLUSION

The present paper employing firm level panel data over the period 1991 to 2015 and using the non parametric Data Envelopment Analysis approach examines the extent of Output Oriented technical efficiency of Jute industry in India in a single-output, multi-input model, the inputs being capital, labour, raw material and power & fuel. The paper also tried to find out the major determinants of OTE.

The main results of the present paper can be summarized as under:

- The mean Output oriented Technical Efficiency of Jute industry in India varies between 30 to 97 %.
- The major determinants of Output oriented Technical Efficiency of Jute industry in India turned out to be Firm size, Capital intensity, Firm age and employees’ contribution.

- Firm size and Firm age are found to be positively related to output oriented technical efficiency. There exists a non-linear relationship between Output Oriented technical efficiency and capital Intensity as well as Output Oriented technical efficiency and Employees' contribution for the Jute Industry in India. Initially increase in capital intensity decreases the technical efficiency but beyond certain threshold limit the technical efficiency of the industry will rise with increase in Capital intensity. Employees' contribution is also inversely related with Output Oriented technical efficiency upto certain critical limit but after that efficiency of the industry will rise with increase in employees' contribution.

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