

A Stochastic Frontier Production Function Approach to Indian Textile Industry

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This study examined the efficiency of Indian textile industry during 1991/92 - 2009 /10. The maximum likelihood estimates for productive efficiency showed that in the single output case, parameters of capital input were positive and statistically significant. Hence capital was the main input factor for these industries as its value was higher than labor. The coefficients were statistically significant though their signs differed. The estimated levels of output considerably differed from their potential levels due to factors which are within the control of the industries. The summation of the elasticities of factors of production of 1.8419 indicated increasing returns- to -scale. The industry recorded an average technical efficiency of 0.941. The average technical inefficiency was negligible.

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India's Manufacturing Sector

Manufacturing sector is the backbone of any economy. It fuels growth, productivity, employment, and strengthens agriculture and service sectors. Astronomical growth in worldwide distribution systems and IT, coupled with the opening of trade barriers, has led to stupendous growth of global manufacturing networks, designed to take advantage of low-waged yet efficient Indian work force. Though agriculture has been the main pre-occupation of the bulk of the Indian population, the founding fathers saw India becoming a prosperous and modern state with a good industrial base. Programs were formulated to build an adequate infrastructure for rapid industrialization. India is fast emerging as a global manufacturing hub. Be it automobiles or computer hardware, consumer durables or engineering products, all are being manufactured by multinationals in India. India's cheap, skilled manpower is attracting a number of companies, planning diverse industries, making India a global manufacturing powerhouse (Adhikary Maniklal & Ritwik Mazumder, 2009). Indian Textile industry is presently one of the largest and most important industries in the

Indian economy in terms of output, foreign exchange earnings and employment generation. The diversity and richness of Indian culture reflects in its textile products in terms of variety, colours and patterns it offers to the world. India has a diverse and rich textile tradition. Contemporary Indian textiles not only reflect the country's rich and splendid past, but also cater to the demands of the modern day. In fact, today India is one of the world's leading manufacturers of man-made textiles. India is the world's second largest producer of textiles and clothing after China. The textile and clothing industry forms a major part of India's manufacturing sector and has contributed enormously to the country's impressive economic development in recent years. Furthermore, India has a huge and growing domestic market which is expected to be worth US\$140 billion in 2020 as the population increases in size and consumers become wealthier. This huge growth could provide significant opportunities for foreign exporters to India and potential foreign investors in the country, as well as for the Indian textile and clothing industry itself. This report looks at the development of the textile and clothing industry in India and its size and structure as well as textile and clothing production and consumption.

The textile and clothing industry forms a major part of India's manufacturing sector and has contributed enormously to the country's impressive economic development in recent years.

With the introduction of economic reforms since July, 1991, many changes have come upon industrial structure in India. Introduction of various reforms and gradual liberalisation of both domestic and international trade marked the beginning of the end of the earlier regulatory regime and recognition of the urgency on the part of the Indian industries to become efficient so as to be able to withstand successfully the pressure of foreign competition. Over the years several measures have been taken by the government to help domestic industries achieve efficiency. These include not only the fiscal and financial measures such as rationalisation of excise duties, liberalisation of tax laws and rates, reduction in interest rates and so on, but also such physical measures as those meant to remove infrastructural constraints in power, transport and telecommunications sectors.

India's Textile Industry

Indian textile industry largely depends on textiles manufacturing and export. It also plays a major role in the economy of the country. India earns about 27 per cent of its total foreign exchange through textile exports. Further, it contributes about 14 per cent to industrial production, 4 per cent to the gross domestic product (GDP), and 17 per cent to the country's export earnings. The sector is the second largest provider of employment after agriculture. It not only generates jobs in its own industry, but also opens up scope for other ancillary sectors. The industry currently generates employment to more than 35 million people.

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The textiles sector has witnessed a spurt in investment during the last five years. The main engine of investment has been the Technology Upgradation Fund Scheme (TUFS). The increased investment will help to upgrade technology, strengthen infrastructural facilities and also increase the installation of additional spindles and looms. Besides, it will provide a fillip to the garment, technical textiles and processing segments of textiles industry, which have great potential for value addition and employment generation. The industry attracted foreign direct investments (FDI) worth ₹ 61.36 crores (US\$ 11.02 million) in the month of May 2012 as compared to 24.75 crores (US\$ 4.44 million) during the corresponding month in 2011. The Indian textile industry saw three mergers and acquisitions (M&A) deals worth US\$ 455 million in the month of July 2012.

The Indian textile sector is also well placed globally, in terms of installed capacity of spinning machinery, it ranks second after china while in weaving it ranks first in plain handlooms and fourth in the shuttle looms. India has around 40 million spindles (23% of world) and 0.5 million rotors (6% of world capacity). India has 1.8 million shuttle looms (45% of world capacity), 0.02 million shuttle less looms (3% of world capacity) and 3.90 million handlooms (85 % of world capacity). Organised sector contributes to almost 100% of spinning but hardly 5

% of weaving of fabric. Cotton products are the stronghold of India. The Indian textile industry is also globally well placed, in terms of installed capacity of spinning machinery, it ranks second after china, while in weaving it ranks first in plain handlooms and fourth in the shuttle looms. In terms of all these positive aspects of textile sector in India, it is imperative to study the efficiency aspect of this sector.

Production Efficiency

The efficiency term describes the maximum outputs attainable from utilizing the available inputs. A production is efficient if it cannot improve any of its inputs or outputs without worsening some of its other inputs or outputs. Efficiency can be increased by minimizing inputs while holding output constant or by maximizing output while holding inputs constant or a combination of both may increase efficiency (Alias Radam et al, 2010). Productive efficiency (also known as technical efficiency) is defined as a situation in which the most production is achieved from the resources available to the producer. It occurs when the economy is utilizing all of its resources efficiently, producing most output from least input.

Productive efficiency can be determined by estimating the best-practice production frontier and individual industries gives the measure of inefficiency. In view of the growing high production costs productive efficiency and profitability will become increasingly important determinants of the future of Indian industries. In addition to developing and adopting new

production technology, the industries can maintain their economic viability by improving efficiency of existing operation with a given level of technology. In other words the industry's total costs can be reduced and the total output can be increased by making better use of available inputs and technology.

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This study examined the industry level efficiency so as to identify the sources where improvement can be made. The study will provide vital information to help individual industries in using their resources more efficiently and to assist the industries in becoming more competitive and maintaining its long term survival. The determination of frontier technology and knowledge of productive efficiency and its relationship with firm size can provide important insights into future Indian industries. Furthermore, the relationship between efficiency levels and various industry-specific factors can provide useful policy-relevant information. A comparison of industry's frontier or "best practice" function and its average practice function will produce useful information about possible future structural adjustments for the industries.

Methodology

Net Value Added (NVA) was taken as output. Labor input (L) consisted of both workers directly in-

involved in production and persons other than workers like supervisors, technicians, managers, clerks and similar type of employees. The invested capital (K) was taken into account as capital. Wages included remuneration paid to workers. The basic data source of the study was Annual Survey of Industries (ASI) published by Central Statistical Organization (CSO), Government of India covering the period from 1991-92 to 2009-10. All the referred variables were normalized by applying Gross Domestic Product (GDP) deflator. The GDP at current and constant prices were obtained by referring to Economic Survey, published by Government of India, Ministry of Finance and Economic Division, Delhi.

Stochastic Frontier Production Function

The stochastic frontier production function as proposed by Battese and Coelli (1992) is defined as :

$$Y_i = f(X_i, \beta) \varepsilon^{ei}$$

Where Y_i is the output vector for the i^{th} firm, X_i is a vector of inputs, β is a vector of parameter and ε is an error term. In this model, a production frontier defines output as a function of a given set of inputs, together with technical inefficiency effects. Furthermore, this model allows some observations to lie above the production function, which makes the model less vulnerable to the influence of outliers than with deterministic frontier models.

The stochastic frontier is also called composed error model, because it postulates the error term ε_i as two independent error components:

$$\varepsilon_i = v_i + u_i$$

When a symmetric component is normally distributed, $v_i \sim (N, \sigma_v^2)$, represents any stochastic factors that is beyond the firm's control affecting the ability to produce on the frontier such as luck or weather. It can also account for measurement error in Y or minor omitted variables. The asymmetric component, in this case distributed as a half-normal $u_i \sim (N, \sigma_u^2), u_i > 0$ can be interpreted as pure technical inefficiency. This component has also been interpreted as an unobservable or latent variable; usually representing managerial ability.

The parameters of v and u can be estimated by maximizing the following log-likelihood function:

$$\ln(Y \sim \beta, \lambda, \sigma^2) = \frac{N}{2} \ln \left[\frac{2}{\pi} \right] - N \ln \sigma + \sum_{i=1}^N \ln [1 - F(\varepsilon_i \lambda \sigma^{-1})] + \frac{1}{2\sigma^2} \sum_{i=1}^N \varepsilon_i^2$$

Where,

$$\varepsilon_i = Y_i - f(X_i, \beta)$$

$$\sigma^2 = \sigma_u^2 + \sigma_v^2$$

$$\lambda = \sigma_u / \sigma_v$$

F = the standard normal distribution function

N = Number of observations

Given the assumptions on the distribution of v and u, Jondrow et al. (1982) showed that the conditional mean of u given ε is equal to

$$E(u_i | \varepsilon_i) = \frac{\sigma_u \sigma_v}{s} \left[\frac{f(\varepsilon_i / s)}{1 - f(\varepsilon_i / s)} - \frac{\varepsilon_i}{s} \right]$$

Where f and F are the standard normal density and distribution functions evaluated at $\varepsilon_i \lambda / \sigma$. Measures of technical efficiency (TE) for each firm can be calculated

$$TE_i = \exp(-E[u_i | \varepsilon_i]) \text{ so that } 0 \leq TE \leq 1$$

The Cobb- Douglas stochastic frontier production function in logarithm form is as follows:

$$\ln VA_i = \ln \beta_0 + \beta_1 \ln C + \beta_2 \ln L_i + \beta_3 \ln E_i + \varepsilon_i$$

Where VA represents Net value added per year. Independent variables are: C (capital) and L (number of laborers). Parameters β_0 denotes the technical efficiency level and β_1 is elasticities of the various inputs with respect to the output level.

Results

The productive efficiency of the industry was calculated by applying the stochastic frontier production ap-

proach. The results show the summary statistics of the variables, maximum likelihood estimates and technical efficiency for Indian textile industry for

the reference period. As for primary investigation the summary statistics results of the selected variables of the industry are presented in the Table 1.

Table1 Summary Statistics of the Variables

Variable	Mean	Std Deviation	Minimum	Maximum	C.V
Net Value Added (NVA)	3.2454	0.0895	2.50	3.67	2.77
Invested Capital (K)	3.1152	0.0717	2.99	3.40	2.30
Number of workers (L)	3.0393	0.0993	2.97	3.18	3.27

Source: Calculations based on ASI Data

Note: C.V - Co-efficient of variation

Mean values of input variables indicate that the industry's main factors of production were both capital and labor since there were not much differences in their mean values. The magnitude of variability (C.V) also substantiated this point since the coefficients are less for both the inputs.

Table 2 shows the maximum likelihood estimates in the context of its productive efficiency.

Table 2 Maximum Likelihood Estimates of Stochastic Frontier Production Function

Variable	Co-efficient	Std-error	t - ratio
Intercept	-2.2175	1.6384	-0.9658
Ln K	1.4852 ***	0.6383	1.990
LnL	0.3567	1.6094	0.1799
σ^2	0.0006 ***	0.0009	1.8959
Γ	0.9999***	0.00006	1.8003
L	0.0267	0.0496	0.4438
M	0.1118**	0.0459	2.7969

Source : Calculations based on ASI Data

Note: ** - Significant at 5 % level

*** - Significant at 10 % level

labor. The coefficients of σ^2 and λ were statistically significant though their signs differ. It reveals that the estimated levels of output considerably differ from their potential levels due to factors, which are

The estimated levels of output considerably differ from their potential levels due to factors, which are within the control of the industry.

The maximum likelihood estimates for productive efficiency show that in the single output case, parameter of capital input is positive and statistically significant. Hence capital is the main input factor for this industry as its value was higher than

within the control of the industry. The estimated value of λ indicated the absence of efficiency gap that exists between the actual and potential level of performance which is mainly due to technical efficiency of the industry. The statistically not significant co-efficient of μ term indicated

that it followed a normal distribution and positive and statistically significant. Co-efficient of η indicated that efficiency increases in getting production overtime. The summation of the elasticities of factors of production indicated return to scale of 1.8419. The value of return to scale greater than unity suggested that conditions of increasing returns to scale prevail. One percent increase in inputs (labor and capital) resulted in an increase 1.84 percent in output level for the stochastic frontier.

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Table 3 presents the year-wise technical efficiency during the reference period from 1991-92 to 2009 -10 in the industry.

In terms of technical efficiency, the industry recorded an average efficiency of 0.941 (94.1 percent). The table also revealed that the technical efficiency has not shown any decline but showed mixed trend. The average technical inefficiency was observed as 0.020, which was negligible. The magnitude of variability was 4.25 in the growth of technical efficiency of the industry during the reference period. In other words it varied at the rate of 4.25 percent per annum in its growth.

Table-3 Technical Efficiency Scores

S. No	Year	Efficiency Scores
1	1991-92	0.889
2	1992-93	0.910
3	1993-94	0.919
4	1994-95	0.899
5	1995-96	0.965
6	1996-97	0.990
7	1997-98	0.888
8	1998-99	0.879
9	1999-00	0.935
10	2000-01	0.922
11	2001-02	0.893
12	2002-03	0.962
13	2003-04	0.980
14	2004-05	0.999
15	2005-06	0.985
16	2006-07	0.989
17	2007-08	0.939
18	2008-09	0.967
19	2009-10	0.963
20	Mean	0.941
21	Standard deviation	0.040
23	Co-efficient of variation(Standard Deviation / Mean)	4.25
24	Average inefficiency score	0.020

Source: calculations based on ASI data

Conclusion

Based on the results it is recognised that the textile industry in India had performed well in terms of efficiency though the efficiency scores were mixed in nature over the reference period. For future development, productive efficiency and technical change in industries specifically in textile industry have been prominent issues in discussions on the regional diversity of output and employment growth in the industrial sector in developing countries like India. Without improving technology and efficiency, however, the growth performance of the manufacturing sector as of the other sectors of an economy is likely to be limited.

References

- Alias Radam & Ismail Latiff (2000), "Technical Efficiency and Productivity Performance of Malaysian Manufacturing Industries", *The Asian Economic Review*, 42(2): 249-62.
- Adhikary Maniklal & Ritwik Mazumder (2009), "Economic Reforms & Manufacturing Sector Productivity in West Bengal", in *Economic Reforms and Productivity Changes in Selected Indian Industries*, Abhijeet Publication, New Delhi.
- James Jondrow, Knox Lovell, C.A & Ivan S. Mathew (1982) "On the Estimation of Technical Inefficiency in the Stochastic Frontier Production Function Model", *Journal of Economics*, 19:233:38.