Chapter 4

Analysis of Efficiency of Indian Textile Industry and the factors influencing its behavior

4.1 Introduction

Indian Textile Industry (ITI) has expanded considerably in the last few decades. The industry now a days after meeting the domestic demand is in a position to export significant volume of textile products to various countries, including the two most important markets, USA and EU [Hashim (2005), Verma (2000)]. It has emerged as the major source of low-cost, quality products in the global market. In the global context, ITI ranked second after China [Confederation of Indian Textile Industry (CITI), Annual Report 2016)].

ITI provides one of the bare requirements of life i.e. cloth. Thus textile industries deserves special attention and have been a favourite sector for policy makers in both the developed and developing countries, including India. Thus it is needful to look at the performance of ITI. One way of evaluating the performance of any industry is to calculate technical efficiency and ITI is not an exception.

Also several measures were undertaken by the Government of India over the years for improving industrial efficiency. The economic reform policies embraced by the Government since 1991 became friendly to the more efficient firms. At the same time, global trade in the textile and clothing industry has long been regulated by the Multi-Fibre Agreement (MFA) from 1974 through 1994, which set national quotas for export of textiles from developing countries to developed countries. In 1995, with

World Trade Organization, MFA was replaced by the Agreement on Textile and Clothing (ATC) and expired on 1 January 2005. With the total abolition of the MFA in 2005, competition in ITI has increased many folds. Thus a producing unit has to operate efficiently to face the increased competition. Furthermore, provision of textile goods at an affordable price is a major concern. Thus it is meaningful to measure efficiency of ITI which will be helpful for academics and policy purpose.

Technical Efficiency (TE) represent a situation where it is not possible for a firm to produce (a) a larger output from the given inputs (output-oriented technical efficiency) or (b) the equal output with less of one or more inputs without increasing the amount of other inputs (input-oriented technical efficiency). TE may be of two types such as output-oriented and input-oriented. The present thesis is concerned with estimating the output-oriented TE of Indian textile industry and also attempted to determine the factors which are influencing the variation in TE scores.

The performance of ITI depends largely on its Yarn and fabrics producing sector and these two sectors taken together may serve as a barometer for assessing the performance of ITI as a whole. Thus the present thesis is concerned with the estimation of efficiency scores of these sectors i.e. Yarn and fabrics. Also the performance of Indian Textile industry is not at all uniform across firms as each firm has its own characteristics that persuade the growth and performance of that particular firm. Thus for improving the firms' efficiency which are lagging behind and for framing appropriate policies, one should have knowledge about the TE scores of different firms. Thus there are good reasons to look at the TE scores of ITI viz. yarn and fabrics producing sector using firm level data.

TE can be measured in different ways namely Parametric (Stochastic Frontier Approach) or Non parametric approach (Data Envelopment Analysis).

There are large numbers of empirical studies globally which are related to TE of different manufacturing industries using different methodologies considering different time periods and concluded accordingly. Focusing on the literature regarding estimation of TE of Indian textile industry, mention may be made of studies by De and Ghose (2020), Goyal, Kaur and Aggarwal (2017), Manonmani(2013), Kumaret.al(2012), Bhandari and Ray(2012), Gopalan&Shanmugam (2010), Bhandari and Maiti (2007) among others.

The perusal of the literature on ITI suggests that there are very few studies which are related to efficiency and they mostly used Stochastic frontier approach (SFA) to estimate TE. Thus there is dearth in the study related to estimation of TE of ITI employing the Data Envelopment Analysis (DEA). Also study relating to estimation of efficiency of ITI for different sectors as well as study using firm level data are lacking in the literature. The present thesis tries to fill this gap and estimates Output oriented TE of the yarn and fabrics producing sector by employing DEA approach using firm level data.

Along with the measurement of TE, it is also essential to explain the factors behind the variation in TE.

Given this background, the **objectives** of the present chapter are: **First,** to estimate TE of ITI for all the sample firms over the sample period for the two sectors of ITI namely yarn and Fabrics. **Secondly,** to identify the major determinants of TE for the above mentioned sectors of ITI. The variables considered are Firm Size (FS), Firm Age (FA), Research and Development Intensity (RDI), Advertising Intensity

(ADV), Marketing Intensity (MEI) and Net Export Intensity (NXI) as possible determinants of TE.

The major achievement of the second problem of the present thesis is estimation of Output Oriented Technical Efficiency (OTE) score as well as to determine the factors influencing such Technical Efficiency employing DEA following Banker, Charnes, and Cooper (1984) under variable returns to scale. Along with this the effect of dismantling of Multi-fibre Agreement (MFA) on the yarn and fabrics producing sector are tried to be found out which is another novelty of the present thesis.

Rest of the chapter is as follows:

Section 4.2 discusses the methodology and data source. In subsection 4.2.1 the methodology for Estimation of TE by using DEA and for finding out determinants of TE employing a Simultaneous Panel Approach are discussed. Subsection 4.2.2 discusses data Sources. Section 4.3 present the results of analysis elaborately and Summary and Conclusions are made in Section 4.4.

4.2 Methodology and Data Source

In this section the methodology for Output-oriented technical efficiency estimation by employing DEA and Simultaneous Panel Approach for finding out determinants of TE and the data source have been discussed.

4.2.1 Methodology

The present chapter uses two stage methodologies. In the first stage, the OTE scores are estimated separately for the two sectors i.e. Yarn and Fabric employing DEA. In the next stage, the factors influencing TE are found out.

4.2.1.1 Measurement of Output-oriented Technical Efficiency (OTE)

TE of a firm can be measured either by output-oriented' or 'input-oriented' measure. The present thesis estimates OTE by DEA. In case of OTE, it can be calculated by comparing its actual output with the maximum producible output from its observed inputs i.e. by how much can output quantities be proportionally expanded without altering the input quantities used. In input oriented TE, it can be calculated by comparing its actual input in use with the minimum input that would produce the targeted output level. In order to measure efficiency one has to construct the production possibility set empirically from observed data. In parametric methods, one assumes an explicit specification of production function (in single output case) or a transformation function (in multiple output case) and uses suitable statistical methods to obtain estimates of the parameters from sample data. But in Data envelopment analysis one makes some general assumptions regarding underlying technology but there is no explicit functional form of the production function.

DEA is a Linear Programming Problem which can provide a mean efficiency within a group of organizations. The efficiency of an organization is calculated relative to the group's observed best practice. Fried, Lovell and Schmidt (1994) argued that DEA can provide appropriate role models to serve as possible benchmarks for a program of performance improvement and also the most efficient production facilities. They also concluded that by DEA one can get the optimum scale and optimum size of output if all inputs are to perform according to best practice. So by DEA one can easily identify those inputs which are not efficient and those outputs which are inefficient.

DEA was originally formulated by Charnes, Cooper and Rhodes [CCR (1978)]. The original CCR model was applicable only to technologies characterized by constant returns to scale (CRS) globally. Later Banker, Charnes and Cooper (BCC) (1984) extended the CCR model to accommodate technologies that exhibit variable returns to scale (VRS).

In case of single input and single output both the input oriented and output oriented measures of technical efficiency can be visualized from figure 4.1.

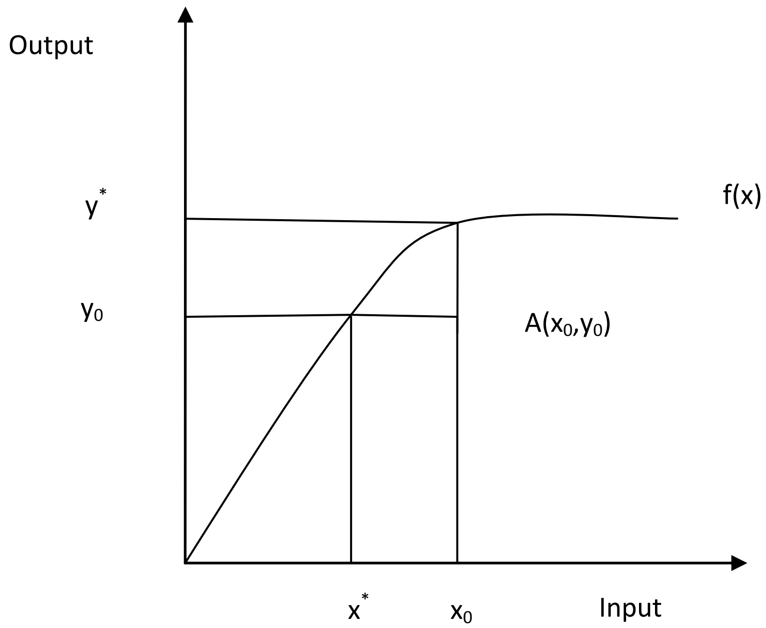

Figure 4.1: The input and output oriented measure of technical efficiency

In figure 4.1 input x is measured along the horizontal axis and output y along vertical axis. Point A (x_0, y_0) represents the actual input-output bundle of firm A.

Now $y^* = f(x_0)$ where y* is the maximum output can be producible from input x_0.The output-oriented measure of TE of firm A is $\frac{y_0}{y^*}$ which is the comparison of actual output with maximum producible output from observed input. The input-oriented TE for firm A is $\frac{x^*}{x_0}$.

The technical efficiency score of a firm takes the value between 0 and 1. A value of 1 indicates that the firm is fully technically efficient.

In the DEA, a benchmark technology is constructed from the observed input-output bundles of the firm in the sample without any assumption regarding the production frontier. The general assumptions about the production technology areas follows:

i) all observed input-output combinations are feasible,

ii) Production possibility set is convex

iii) Inputs and Outputs are freely disposable.

These are the weak assumptions. These assumptions hold for all production technologies represented by quasi-concave and weak monotonic production function

Figure 4.2 illustrate the basic ideas behind DEA and returns to scale. Four data points such as A, B, C and D are used here to describe the efficient frontier and the level of capacity utilization CRS and VRS assumptions. In a simple single output and single input DEA problem, points A, C and D are found to be efficient, while B is inefficient. So unit B can produce more output at point B' on the frontier (which is equal to theoretical maximum) utilizing same level of input at X_1. With CRS, the frontier is defined by point C for all points along the frontier, with all other points falling below the frontier (hence indicating capacity underutilization). With VRS, the frontier is defined by points A, C and D, and only B lies below the frontier i.e. shows capacity underutilization. So capacity output corresponding to VRS is smaller than the capacity output corresponding to CRS.

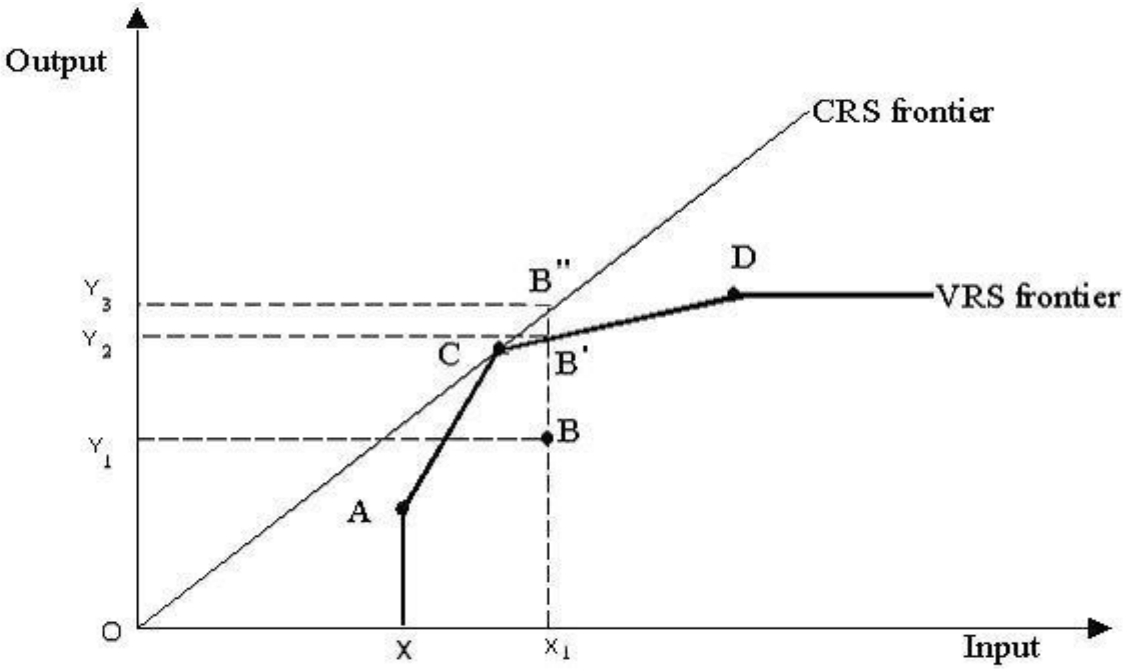

Figure 4.2: The Production Frontier and Returns to scale

Output Oriented TE

It is supposed that there are N firms. Each of them is producing 'q' outputs using 'p' inputs. The firm s uses input bundle $x^s= (x_{1s},x_{2s},\ldots x_{ps})$ and produces the output bundle $y^s=(y_{1s},y_{2s},\ldots y_{qs})$. Technology can either follow CRS or VRS.

The production possibility set corresponding to CRS can be defined as

$$T^{CRS} = \{(x,y): x \geq \sum_{j=1}^{N} \lambda_j x^s; y \leq \sum_{j=1}^{N} \lambda_j y^s;\ \lambda_j \geq 0; (j = 1,2, \ldots\ldots N)\} \qquad \ldots 4.1$$

The specific production possibility set corresponding to VRS can be defined as

$$T^{VRS} = \{(x,y): x \geq \sum_{j=1}^{N} \lambda_j x^s; y \leq \sum_{j=1}^{N} \lambda_j y^s; \sum_{j=1}^{N} \lambda_j = 1;\ \lambda_j \geq 0; (j = 1,2, \ldots..N)\} \quad \ldots 4.2$$

The output oriented measure of TE of firm s under CRS technology requires the solution of the following LP problem

max ϕ

subject to $\sum_{j=1}^{N} \lambda_j y_{rj} \geq \phi y_{rs}$; (r = 1,2,………………q);

$\sum_{j=1}^{N} \lambda_j x_{ij} \leq x_{is}$;(i=1,2,…………........p);

ϕ free $\lambda_j \geq 0$;, (j=1,2,…………….…N) …4.3

Output oriented TE of firm s can be determined by using equation (4.4).

$$TE_0^{cs} = TE_0^{cs}(x^s, y^s) = \frac{1}{\phi^*} \quad \ldots 4.4$$

Where ϕ^* is the solution of equation (4.3) showing the maximum value ofϕ . y* is the maximum output bundle producible from input bundle X^s and is defined as y*=$\phi^* y^s$.

Under VRS, maxϕ , ϕ^* ,can be determined by solving equation (4.3) along with the constraint$\sum_{j=1}^{N} \lambda_j = 1$, taking into account VRS frontier (equation 4. 2). Knowingϕ^*, TE of the firm can be solved using similar methodology corresponding to CRS. That is

max ϕ

subject to $\sum_{j=1}^{N} \lambda_j y_{rj} \geq \phi y_{rs}$; (r = 1,2,………………q);

$\sum_{j=1}^{N} \lambda_j x_{ij} \leq x_{is}$;(i=1,2,…………........p);

$\sum_{j=1}^{N} \lambda_j = 1$ ϕ free $\lambda_j \geq 0$;, (j=1,2,……………..…N) …4.5

Output oriented TE of firm s can be determined by using equation (4.6).

$$TE_0^{cs} = TE_0^{cs}(x^s, y^s) = \frac{1}{\phi^*} \quad \text{…4.6}$$

4.2.1.2 Determinants of Technical Efficiency (TE)

After calculating Technical Efficiency, in the next stage panel regression has been carried out to find out the determinants of OTE of two sectors of the ITI namely Yarn and Fabrics. The variables considered as possible determinants of OTE are Firm Size (FS), Firm Age (FA), Research and Development Intensity (RDI), Advertising Intensity (ADV), Marketing Intensity (MEI) and Net Export Intensity (NXI).

The explanations for the inclusion of the above mentioned variables can be summarized as follows:

Firm Size (FS): It is interesting to test whether Firm Size has any influence in promoting TE of the firm or not. From the theoretical viewpoint the relationship between firm size and its efficiency is not clear (Audrestch, 1999). It can be hypothesized that large size firms will be more efficient because of the presence of threshold limit in production, scale economies, imperfection in capital market (Kumar, 2003). However, beyond a certain limit higher market power may also plague the firm with X-inefficiency (Leibenstein, 1976) which may lead to lower efficiency. Bhandari and Ray (2012),Yasar and Paul (2009), Truett and Truett(2009),Tran, Graften and Kompas (2008), Bhandari and Maiti (2007), Cheng and Lo(2004), Mengistae (1998), Ramaswamy (1994) among others investigated the link between Firm Size and efficiency of the firm. Some of the studies found positive relation between the two while some of the studies postulated a negative relation.

Firm Size is obtained for each firm of each sector as the ratio of a firm's value of output in real terms to value of industry output in real terms.

Firm Age (FA): There exists a debate between firm age and efficiency of the firm in the existing literature due to Bhandari and Maiti (2007, 2012), Berghäll (2006), Walujadi (2004), Lundvall and Battese (2000), Mengistae (1995, 1998), Stinchcombe (1965), Marshall (1920), among others. A positive relationship between firm age and efficiency is possible as older firms become more experienced and display superior performance. The firms have benefits of learning earlier and do not face hazards that the newcomers generally face (Stinchcombe, 1965).Counter argument may be that older firms are unable to adapt changing economic circumstances rapidly which the younger firms can do much more quickly and efficiently (Marshall, 1920). Firm Age is obtained for each firm of each sector by the difference between present year and establishment year of that firm.

Research and Development Intensity (RDI): The role of Research and Development (R&D) may be significant while determining the factors explaining TE of Indian textile industry. R&D on one hand generates new technologies and, on the other hand, it enhances a firm's ability to exploit existing technology. Different studies in the international as well as Indian literature considered Research and Development as the determinants of efficiency at aggregate country level or at sector level or at firm level due to Scannell et al. (2012), Mazumder et al. (2010),Kumbhakar et al. (2009), Yang et al. (2009), Driffled and Kambhampti (2003),Ferrantino (1992) among others. Research and Development expense per unit of output is taken as Research and Development Intensity.

Advertising Intensity (ADV): Advertisement may play a crucial role in explaining technical efficiency. Advertisement helps to introduce a new product in the market easily, increases sales, fights market competition, enhances good-will with consumer and educates the consumers (Shashikanth, Mamatha and Rao(2018), Samad and Sabeerdeen (2016),Mohan (1989)). Linkages between advertising intensity and technical efficiency for the Spanish manufacturing firms and Indian Engineering goods industries respectively are due to Carod and Blasco (2005) and Goldar et al. (2004), whereas Ray (2006) did not find any impact of advertising on TE in the Indian Manufacturing sector. Advertising intensity is measured by the ratio of Advertising expense per unit of sales.

Marketing Intensity (MEI): Marketing intensity may serve as a proxy for product differentiation due to Pal, Chakraborty and Ghose (2018), Ghose and Chakraborti(2013) among others. Kao et al. (2006), Mark and Caves (1988), Leffler (1981) among others got positive relationship between Marketing intensity and technical efficiency. Whereas Sheth and Sisodia (2002) claimed that low efficiency is due to the sliding of marketing effectiveness. Marketing expense per unit of sales is taken as Marketing intensity.

The important aspect of ITI is that Indian textile firms re-engineer the imported items and then re-export the product (De and Ghose, 2020). Thus a related question may arise that whether the efficiency of this industry is affected by trade related variables or not?

Vast amount of literature is available supporting the role of exports in promoting efficiency both at the theoretical as well as empirical level. From theoretical front, there is a common opinion that international trade in general and export in particular improves the efficiency of involved firms (Balassa, 1988). Endogenous growth theory believes that export plays a crucial role by improving efficiency through innovation (Grossman and Helpman, 1991)and technology transfer (Barro and Sala-i-Martin, 1995).In theories, there are different explanations how export expansion improves efficiency: (i) Exporters might learn from knowledge spillovers from international contacts (Clerides et al, 1998; World Bank, 1993), (ii)There are spill-over effects through technology diffusion, from foreign-invested enterprises to domestic firms and from export oriented industries to non-export oriented industries (Huallachain, 1984, Feder, 1983), (iii) A rise in the exports represents an expansion of markets which may lead to efficiency gains for the firms, due to exploitation of economies of scale (Clerides et al, 1998; World Bank, 1993) and (iv) Exports intensify market competition in both the domestic and overseas markets and tend to force firms to be more efficient through rationalization of management and adoption of new technologies (Greenaway and Sapsford, 1994, Chen and Tang, 1990; Balassa, 1988; Kwon, 1986; Greenaway, 1986). Studies by Mok et .al (2010), Walujadi (2004), Sun et .al (1999), Chen and Tang (1987) among others showed that exporting firms have some advantage in efficiency.

Also World Bank Report (1993, 1997) reported that firm’s import of foreign technology has a positive impact on efficiency. Mazumder et al. (2010) and Goldar et al. (2004) reported a positive relationship between technical efficiency and imports in the Indian context.

The above discussion reveals that both exports and imports may affect efficiency. Since both exports and imports affect efficiency, it may be interesting to determine the relative role of exports vis á vis imports in fostering efficiency. The major shortcoming of many of the empirical studies is that they are unable to separate the impact of exports and imports. Some focus on the one and neglect the other.

Some studies in the literature are found to use total trade (i.e. sum of export and import) as measure of openness ((Frank and Romer (1999) and Harision (1996)), assuming that export and import put in equally to the promotion of economic growth and that the import-intensity of export to be zero, which suffers from some drawbacks. There are other studies due to Zhang, Ondrich and Richardson (2003) who used net export (i.e. export minus import) implying distinct export and import effects.

Net Export Intensity (NXI): As both exports and imports may affect efficiency it may be interesting to identify the relative role of exports vis á vis imports in fostering efficiency.

In tune with Zhang, Ondrich and Richardson (2003), the present thesis uses (export minus import) to find the net effect of exports over imports. Thus Net Export Intensity is considered as a possible determinant of efficiency. Net Export Intensity is obtained for each sector by the ratio of Export minus import to sales.

Global trade in the textile and clothing industry has long been governed by the Multi-Fibre Agreement (MFA), which set national quotas for export of textiles from developing countries to developed countries. With the coming of the WTO in 1995, the MFA was replaced by the ATC, under which a 10-year (1995-2004) quota phasing out transitional period was agreed upon, i.e. to phase out the quota restrictions progressively in four stages i.e. in the years 1995-1997 (Phase I), 1998-2001(Phase II), 2002-2004 (Phase III) and in January 1, 2005 (Phase IV). Export quota was removed for Textile and Clothing for the four scheduled groups viz. yarn, fabrics, made-ups and cloth/apparels at 16 %, 17%, 18% and 49% respectively [Verma (2000), Manoj and Muraleedharan (2016)].

Thus one may also be interested in knowing, what happens to the TE of the firms of ITI after the dismantling of MFA?

Policy related Variable: To answer this question, a time dummy, D is introduced taking value 1 from 2005 onwards (i.e. period of dismantling of MFA) and 0 for the years before 2005 (i.e. MFA period).

Problem of Heterogeneity- For determinant analysis panel data estimation method have been used. By using panel data estimation method, variables are obtained which can be taken as significant determinants across all the firms for each sector. Panel data lets us to take into account the information provided by time series, something we cannot do with a single cross section. A panel data set also allows us to regulate for unobserved cross section heterogeneity. Panel regression analysis is done using a seemingly unrelated regression (SUR) framework where each regression was adjusted for contemporaneous correlation (across units) and cross section heteroscedasticity is adopted. Test for better model i.e. whether fixed effect or random effect model is the better one has been checked using Hausman specification test. Fixed effect model turned out to be the better one as suggested by Hausman specification test.

The SUR framework and the problem of adjusting heteroscedasticity using White Cross-Section are explained in **Appendix.**

Problem of Simultaneity- A common problem may be that, a simultaneity may involve between TE and FS, and TE and RDI. Therefore to take care of this problem, simultaneous panel model has been framed with three equations considering TE, FS and RDI as dependent variables for each of the sectors i.e. Yarn and Fabrics.

Proposed model is estimated in a panel set up showing simultaneous relationship among different variables.

While estimating the model for each sector various alternatives of the structural equations are tried out and model with better result are taken.

The models for yarn producing sector and fabrics producing sector are as follows:

For Yarn producing sector, the chosen model of technical efficiency considering TE, FS and RDI as dependent variables and thus separate equations for each of these variables, TE equation (equation 4.7), FS equation (equation 4.8) and RDI equation (equation 4.9) are presented below:

$$TE = f[FS, RDI, FA, NXI, ADV_{(t-1)}, ADV^2_{(t-1)}, D] \quad \text{...4.7}$$

$$FS = f[TE, RDI, FA, ADV, TE^2, RDI^2] \quad \text{…4.8}$$

$$RDI = f[TE, FS, NXI_{(t-1)}, \left(\frac{K}{L}\right), PR, \left(\frac{K}{L}\right)^2, PR^2] \quad \text{…4.9}$$

The specified equation for TE is nonlinear in $ADV_{(t-1)}$. The specified equation for FS is nonlinear in TE and RDI. The specified equation for RDI is nonlinear in $(\frac{K}{L})$ and PR.

The explanations for the inclusion of the above mentioned variables in TE equation have already been justified above.

The relation between FS and the explanatory variables can be justified as follows:

A positive relation between TE and FS may occur because with increase in TE the firm may produce more output, so there can be increase in firm size. RDI may affect FS positively possibly due to firms engaged in R&D can invent superior processes technology or can produce better products employing the same level of input (Aghion and Howitt, 1992; Grossman and Helpman, 1991). Thus firms may produce better and more products thereby increasing firm size. A positive relation may exist between Firm age and Firm Size as well as Advertising intensity and FS. Perhaps firm staying in the market for long period is capable of acquiring perfect market strategy and consumer faith and thus producing more which may lead to firm size increase. Also firms spending more on advertisement are more prone to introduce a new product in the market easily, increases sales, fights market competition which may insist firms to produce more to meet up the extra demand created by advertising, thereby increasing firm size.

The relation between RDI and the explanatory variables can be justified as follows:

TE may affect RDI positively or negatively. A positive relation may prevail between these two may be due to increase in TE, the capability of firms through using its input efficiently may rise and produce more output which can promote Research and development Intensity. Also there can be a possibility of negative relation possibly due to several reasons such as improvement in the ability of the workers, better management decisions, adequate monitoring efforts, etc which may lead to more and more production thereby making firms more reluctant to invest in R&D and so RDI may fall. Positive relationship is expected between Firm size and RDI may be due to the reason that a larger firm can be able to exploit economies of scale which influence firms to increase RDI and further maintain economies of scale. A positive association between NXI in the previous period and RDI may exists possibly due to the fact that with increase in net export in the previous period the firm may generate extra profit from foreign market and increase RDI in the current period. It is hypothesized that higher the degree of mechanization in the production system, higher will be the R&D

expense of the firm. On the other hand, Capital-labour Ratio may affect the R&D expense of the firm negatively due to underutilization of capital. Capital-labour Ratio (K/L) may be obtained for each sector by the ratio of capital to labour. Firm's profits are an important stimulus to, and source of funding for, R&D which in turn may lead to a positive relationship between profit and RDI. Profitability Ratio (PR) is obtained for each sector by the ratio of profit to sales.

For Fabrics producing sector, the chosen model of technical efficiency considering TE, FS and RDI as dependent variables and thus separate equations for each of these variables, TE equation (equation 4.10), FS equation (equation 4.12) and RDI equation (equation 4.12) which are presented below:

$$TE = f[FS, RDI, NXI_{(t-1)}, ADV_{(t-1)}, MEI_{(t-1)}, ADV^2_{(t-1)}, D] \qquad \ldots 4.10$$

$$FS = f[TE, RDI, FA, MEI, NXI, TE^2] \qquad \ldots 4.11$$

$$RDI = f[TE, FS, NXI, PR, \left(\frac{K}{L}\right), TE^2, NXI^2] \qquad \ldots 4.12$$

The specified equation for TE is nonlinear in $ADV_{(t-1)}$. The specified equation for FS is nonlinear in TE. The specified equation for RDI is nonlinear in TE and NXI.

The justifications for the inclusion of the above mentioned variables in TE equation have already been discussed above.

The relation between FS and the explanatory variables can be justified as follows:

Relationship between FS and TE, RDI and FA have been already justified while explaining the FS equation of yarn producing sector. The new variables of FS in fabrics producing sector are MEI and NXI. More marketing activities may indicate strong firm's brand and product image which may lead to higher revenue and in turn enhance output efficiency (Mark and Caves, 1988; Leffler, 1981) which may promote

FS. Net export intensity may affect Firm Size positively. With rise in net export intensity, demand of domestic goods in foreign markets increases which can boost firm size.

The relation between RDI and the explanatory variables have already been discussed while explaining the RDI equation of yarn producing sector. The only new variable of RDI in fabrics producing sector is NXI. A positive association between NXI and RDI may be due to the fact that with increase in net export the firm may make additional profit from foreign market and increase RDI.

Before going to estimation of the model, one need to ensure that these three equations of the two models are identified or not. The identification of the models are tested in the presence of exclusion restriction and the models are overidentified.

Method of estimation- Two step estimation method

Estimation is done first by getting the reduced form of the model. Obtaining the estimated value of the dependent variable from the reduced form and then plugging the estimated value of the dependent variable in the structural form and then applying the method of estimation of panel model.

4.2.2 Data Sources

The present study uses CMIE Prowess data base. Those firms are selected for which all the data of inputs and outputs and the determinants are available throughout the sample period. On the basis of this fact, a sample of 22 firms for Yarn producing sector and 21 firms for Fabrics producing sector have been selected over the period 1991 to 2015.

The study visualises a single-output four-input production technology. Output is measured by the Sum of sales value and change in stock [Deshmukh and Pyne (2013)], Inputs considered are Raw material expenses, power and fuel expenses, salary and wages and capital which is measured by net fixed asset [Ghose and Chakraborti (2013), Bhandari and Ray (2012), Bhandari and Maiti (2007)]. All the data are in Rs. Million being deflated by appropriate wholesale price indices (the base year being 2004-05) to obtain their real values (value of sales and change in stock of the textile firms is deflated by price index of Textile, power & fuel consumption by price index for fuel, power and lubricants, Expenditure on raw materials by price index of material consumed and Expenditure on salary and wages by Consumer price index for industrial worker, expenditure on capital by price index of machinery and equipment).Relevant Price indices are collected from the Index Number of Wholesale Prices in India published by the Office of the Economic Advisor, Ministry of Industry, Government of India, Udyog Bhaban, New Delhi.

4.3 Results of Analysis

4.3.1 Estimated Results of Technical Efficiency

The results of OTE of Yarn producing sector can be found in subsection 4.3.1.1. Whereas in subsection 4.3.1.2 results of OTE of Fabrics producing sector can be found.

4.3.1.1 Results of OTE of Yarn producing sector

In this section, the results of OTE of Yarn producing sector can be found. The distribution of firms on the basis of output oriented mean TE is represented in Table 4.1.

From Table 4.1 it can be said that, 13.63% of the firms under study are fully efficient i.e. they are on the frontier with technical efficiency equal to one for the entire sample period (1991-2015) and the rest of the firms are not fully efficient. Among the inefficient firms, 22.73% firms exhibit mean TE below 0.500 i.e. produces less than

50% of the maximum producible output, percentage of firms showing mean TE in the range (0.500-0.600), (0.600-0.700) and (0.700-0.800) is same and equal to 4.55, 13.63% of firms exhibit mean TE in the range (0.800-0.900) and 36.36% of the firms produces 90 to 99% of the maximum producible output.

It is observed from Table 4.2 that considering all the 22 sample firms of Yarn producing sector together, the mean technical efficiency ranges from 0.165 to 1 i.e. the minimum TE score is 0.165 and the maximum value is 1. The grand mean of TE of the firms (GRM) i.e. the average of mean TE of all the firms over the sample period is 0.766, implying on average the yarn producing sector produces 76.6% of the maximum producible output.36.36%of firms have mean TE below the grand mean and the rest 63.64% of firms is above the grand mean of TE. So the majority of the firms have their mean TE above the GRM.

4.3.1.2 Results of OTE of Fabrics producing sector

In this section, the results of OTE of the firms of Fabrics producing sector can be found. The distribution of firms based on output oriented mean TE is represented in Table 4.3.

From the Table 4.3 it is seen that, out of the 21firms of Fabric sector, only 9.52% firms are fully efficient i.e. they are on the frontier with technical efficiency equal to one for the entire sample period i.e. 1991 to 2015. The rest 90.48% firms under study are not fully efficient i.e. 23.81% firms produce less than 50% of the maximum producible output. 9.52% firms have their mean TE in the range (0.600-0.700) and 19.05% firms are producing 80 to 90% of the maximum producible output. Major percentage of firms i.e. 38.10%produces 90 to 99% of the maximum producible output.

It is observed from Table 4.4 that considering all the 21 sample firms of fabrics producing sector together the mean TE of the firm's ranges from 0.146 to 1. The grand mean of TE of the firms (GRM) i.e. the average of mean TE of all the sample firms over the sample period 1991-2015 is 0.760, implying on average the sector produces 76% of the maximum producible output. The percentage of firms having mean TE below the grand mean is 33.33 and the rest 66.67% of firms are above the grand mean of TE. So the majority of the firms have their mean TE above the GRM.

4.3.2 Results of Determinants of Technical Efficiency

A second stage panel regression has been carried out to explain the OTE of Yarn producing sector and Fabrics producing sector. The variables namely Firm Size (FS), Firm Age (FA), Research and Development Intensity (RDI), Advertising Intensity (ADV), Marketing Intensity (MEI) and Net Export Intensity (NXI) are considered as possible determinants of TE.

It may be mentioned that all the estimated equations in the model for yarn and fabrics are found to be nonlinear. Thus the sign of marginal effects will help to understand the positive or negative relationship for those variables which are nonlinearly related with the dependent variable in each equation. The statistical significance of these variables has been checked by Wald test. Needless to mention, those variables having linear relationship with the dependent variables in the different equations, sign of the corresponding coefficients will matter for finding out whether the concerned variable has a positive or negative relationship with the dependent variable and the statistical significance of the variables are confirmed by the corresponding t ratios.

While estimating the panel model, to test for appropriateness of the assumption of fixed effect vis a vis the random effect model, Hausman's specification test is performed for each of the regression which strongly rejects the assumption of random effect model and supports the assumption of fixed effect model.

The estimated models also reports Adjusted R^2 which represents the overall fit of the model, which is based on the difference between residual sum of squares from the estimated model and the sum of square from a single constant only specification, not from a fixed effect only specification. High value of Adjusted R^2 shows that the fitted models are reasonably good.

The results of determinants of TE for yarn and fabrics producing sector are presented in subsections 4.3.2.1 and 4.3.2.2 respectively which are presented below:

4.3.2.1 Results of determinants of Technical efficiency of Yarn producing sector

In this model, there are three equations namely Technical efficiency, Firm size and RDI.

The results of TE equation are presented in Table 4.5. It can be seen that the only variable Advertising intensity of previous period have nonlinear relationship with TE i.e. inverted U-shaped relationship whereas the other variables such as Firm size, RDI, Firm age and Net export intensity are linearly related with TE. The statistical significance of Advertising intensity of previous period has been checked by performing Wald test which is represented by Table 4.9.

Thus the result suggests that TE increases with increase in ADV_{t-1}, FS, RDI and FA but falls with increase in NXI.

The inverted U-shaped relationship is found between Advertising intensity of previous period and TE. This indicates that with increase in Advertising expense in the previous period, TE may increase but after some threshold level TE may fall. The result perhaps is due to firms spending more on advertisement, are getting help to introduce a new product in the market easily, increases sales, fights market competition, enhances good-will with consumer and educates the consumers but after some threshold point with increase in advertising, technical efficiency decreases may be due customer annoyance considering more advertisement as an indication of fall in quality. The value of marginal effect of Advertising intensity of previous period on TE is found to be positive as is revealed from Table 4.8 which implies that the net effect of Advertising intensity of previous period on TE is positive.

TE is found to be positively related with firm size as large firms may be relatively more efficient than small firms may be due to scale economies, imperfection in capital market and market power (Kumar, 2003). TE is also found to be positively related with Research and development intensity. Research and development basically includes the search for various novel pathways and development of expertise which facilitate faster product development. On one hand, it generates new technologies and, on the other hand, it enhances a firm’s ability to exploit existing technology and thus increases TE. TE also increases with increase in firm age. The reason may be that older firms have benefits of learning earlier and do not face hazards that the newcomers generally face (Stinchcombe, 1965), 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 (Lall and Rodrigo 2001). But there exists a negative relationship between Net export intensity and TE. This may indicate that import can have more favourable impact over export to promote TE. The reasons may be while a firm imports more quality raw material and machineries it also improves its production efficiency. Evidence also suggests that the import of intermediary goods is an important channel through which technological diffusion takes place (Tybout, 2000); this may also affect the efficiency favourably.

The effect of dismantling of MFA has a negative significant effect on Technical Efficiency. The efficiency level of the firms in the post MFA period may fall due to the failure of the firms to match the competitive pressures in terms of price and quantity from different countries and for this unfavorable situation the firms are unable to achieve the economies of scale in production and there may be fall in efficiency.

In **Firm Size Equation** whose results are presented in **Table 4.6,** Technical efficiency and RDI have nonlinear relationship i.e. U-shaped and inverted U-shaped relationship respectively with FS whereas Firm age and Advertising intensity are linearly related as is revealed from Table 4.6. Marginal effect of Technical efficiency and RDI are found to be positive which is revealed from Table 4.10, and the statistical significance of these variables has been checked by performing Wald test which is represented in Table 4.11.

Technical efficiency is found to have a nonlinear i.e. U-shaped relationship with FS. This may be due to the fact that initially with increase in TE, FS may fall possibly due to investment in sophisticated technology and better management but after some threshold level with increase in efficiency, FS increases possibly due to the firms' usage of input efficiently and produce more output, so there can be increase in firm size. The marginal effect of technical efficiency on FS is found to be positive as is revealed from Table 4.10, it implies that the net effect of Technical efficiency on FS is positive.

A nonlinear i.e. inverted U-shaped relationship is found between RDI and FS. The reasons may be that Firms engaged in R&D can invent superior processes technology or can produce better products employing the same level of input (Aghion and Howitt, 1992; Grossman and Helpman, 1991). Thus firms using superior processes technology may produce better and more products thereby increasing firm size but after some point increase in RDI decreases FS, may be due to heavy allocation of resources for R&D can also reduce efficiency if firms fail to get the benefit of R&D (Helpman, 1992) which may reduces FS. The net effect of RDI on FS is positive which is evident from the positive marginal effect.

A positive relationship is found between FA and FS as well as Advertising intensity and FS. The positive relationship between FA and FS may be due to the fact that firm staying in the market for long period, is capable of acquiring perfect market strategy and consumer faith and thus producing more which may lead to increase in firm size. Also firms spending more on advertisement are more prone to introduce a new product in the market easily, increases sales, fights market competition, enhances good-will with consumer and educates the consumers which may insist firms to produce more to meet up the extra demand created by advertising, thus firm size may increase.

For the **Research and Development Intensity equation,** whose results are presented in Table 4.7, it can be concluded that the variables Capital-labour ratio and Profitability ratio have nonlinear relationship with RDI whereas Technical efficiency, Firm size and Net export intensity of previous period are linearly related. Capital-labour ratio has an inverted U shaped relationship with RDI. As the values of marginal effect of Capital-labour ratio and Profitability ratio are found to be positive as is revealed from Table 4.12, it implies that these variables have positive relationship with RDI and the statistical significance of these variables has been checked by performing Wald test which is represented in Table 4.13.

An inverted U-shaped relationship is found between K/L and RDI. Possibly the capital intensive industries have a high potential to generate more profits and ability to generate mass production and high growth and the usage of high technology (Seenaiah and Rath, 2018) thereby raising RDI but after some threshold limit, increase in K/L may decrease RDI may be due to over mechanization and huge investment on machineries thereby reducing RDI. Also the net effect of K/L on RDI is positive which is evident from the positive marginal effect.

Firms' profits are an important stimulus to, and source of funding for, R&D which in turn leads to a stream of health-enhancing new products (Scherer, 2001). So increase in PR may increase RDI may be due to increase in profit, firms have more surplus fund in hand, which stimulates research and development Intensity. This result is similar to the findings of Tyagi, Nauriyal and Gulati (2018).

TE is found to have a negative relationship with RDI. The reason may be that if TE of the firms increases may be by investment for improvement in the ability of the workers, better management, adequate monitoring efforts, etc which may lead to more and more production, then firms may become reluctant to invest in R&D and so RDI may fall. Linear and positive relationship is found between FS and RDI. Possibly a larger firm can be able to exploit economies of scale which influence firms to increase Research and development Intensity.

Net export intensity of previous period is positively related with Research and development Intensity. The reason may be that increase in net export may generate extra profit from foreign market and thereby raising RDI.

4.3.2.2 Determinants of TE of Fabrics producing sector

In this model, there are three equations namely Technical efficiency, Firm size and RDI.

In case of TE equation whose result can be found in Table 4.14, it can be seen that the Advertising intensity of previous period have Inverted U-shaped relationship with TE whereas Firm size, RDI, Net export intensity of previous period and Marketing intensity of previous period are linearly related with TE. As the marginal effect of Advertising intensity of previous period is found to be positive as is revealed from Table 4.17, it implies that this variable has positive relationship with TE and the statistical significance of the variable has been checked by performing Wald test and turned out to be significant which is represented in Table 4.18.

Thus the result suggests that TE increases with increase in ADV_{t-1}, FS, RDI, NXI_{t-1} and MEI_{t-1}.

The relationship between Advertising intensity of previous period and TE is of inverted U-shaped. This indicates that with increase in Advertising expense in the previous period, TE may increase but after some threshold level TE may fall. The result may be due to the reason that firms spending more on advertisement are more prone to introduce a new product in the market easily, increases sales, fights market competition, enhances good-will with consumer and educates the consumers and thus increases efficiency but after some threshold point increase in advertising decreases technical efficiency may be due to loss of consumer good-will with more advertisement. The net effect of Advertising intensity of previous period on TE is positive.

Firm size is positively related with TE as large size firms are more efficient may be due to the scale economies, imperfection in capital market and market power (Kumar, 2003).

Positive relationship is found between RDI and TE. It may be that Research and development generates new technologies and also enhances a firm's ability to exploit existing technology thereby increasing TE.

A positive relationship is found between Net export intensity of previous period and TE. With rise in net export intensity, technical efficiency may rise perhaps due to knowledge spillover from the international contacts and spillovers from technology diffusion.

Positive relationship is found between Marketing intensity and TE. Increase in marketing activities indicates an effort to strengthen the firm's brand and product image which may lead to higher revenue and in turn enhance output efficiency (Mark and Caves, 1988; Leffler, 1981).

The effect of dismantling of MFA has a negative significant effect on technical efficiency. Thus the dismantling of MFA has an unfavorable effect on technical efficiency and demotes technical efficiency of Indian Fabrics producing Sector. This can be due to the failure of these firms to match the competitive pressures in terms of price and quantity from different countries and for this unfavorable situation the firms are unable to achieve the economies of scale in production which may lead to decline in technical efficiency.

In case of **Firm Size Equation** whose results are obtainable in Table 4.15**,** Technical efficiency has nonlinear i.e. Inverted U-shaped relationship with FS whereas RDI, Firm age, Marketing intensity and Net export intensity are linearly related with FS as is revealed from Table 4.15. Marginal effect of TE is found to be positive which is revealed from Table 4.19, i.e. this variable has positive relationship with FS and the statistical significance of technical efficiency has been checked by performing Wald test and turned out to be significant which is represented in Table 4.20.

Technical efficiency is found to have a nonlinear i.e. inverted U-shaped relationship with FS. Perhaps with increase in efficiency the firm uses its input efficiently and produce more output, so there can be increase in firm size but after some threshold level with increase in TE, FS decreases possibly due to the failure of reaping the benefit instantly of huge investment in sophisticated technology and better management there can be a fall in output and hence firm size. The marginal effect of technical efficiency on FS is obtained to be positive.

The relationship between RDI and FS is found as positive. Firms engaged in R&D can invent superior processes technology or can produce better products employing the same level of input (Aghion and Howitt, 1992; Grossman and Helpman, 1991) thereby increasing profit and further production which may increase firm size.

Positive relation is found between FA and FS. It may be possible that staying in the market for longer period, firms are capable of acquiring perfect market strategy, smooth buyer-supplier linkage and consumer faith which may lead to increase in the firm size.

A positive relationship is also found between MEI and FS. More marketing activities indicates an effort to strengthen the firm's brand and product image which may lead to higher revenue (Mark and Caves, 1988; Leffler, 1981) which may promote FS.

Net export intensity affects firm size positively. Increase in Net export may mean demand of domestic goods in foreign markets increases thereby raises production which can boost firm size.

For the **Research and Development Intensity equation,** whose results are represented in Table 4.16, it can be inferred that Technical efficiency and Net export intensity have nonlinear relationship with RDI whereas Firm size, Profitability ratio and Capital-labour ratio are linearly related. The relationship between Technical efficiency and RDI is inverted U-shaped. As the values of marginal effect of Technical efficiency and Net export intensity are found to be positive as is revealed from Table 4.21, it implies that these variables have positive relationship with RDI. The statistical significance of the variable having nonlinear relationship has been checked by performing Wald test and came out as significant which is represented in Table 4.22.

Technical efficiency is found to have a nonlinear i.e. inverted U-shaped relationship with RDI possibly due to increase in TE, the capability of firms through using its input efficiently may rise and produce more output which can promote RDI but after some threshold level with increase in TE, RDI decreases if the rise in TE of the firms are due to improvement in the ability of the workers, better management, adequate monitoring efforts, etc. This may lead to more and more production making firms more reluctant to invest in R&D and so RDI may fall. The marginal effect of technical efficiency on FS is seen to be positive.

The net effect of net export intensity on RDI is positive. Perhaps increase in net export may increase RDI through generating extra profit from foreign market.

Positive relationship is found between FS and RDI. Possibly a larger firm can be able to exploit economies of scale which influence firms to increase Research and development intensity.

Positive relationship is also found between PR and RDI. With increase in PR, firms may have more surplus fund in hand, which may stimulate research and development intensity.

There exists a positive relationship between capital-labour ratio and RDI. It may be possible that the capital intensive industries have a high potential to generate more profits and keep strategies for high growth and usage of high technology (Seenaiah and Rath, 2018) thereby increasing RDI.

4.4 Summary and Conclusion

The present chapter estimates the OTE of Yarn and Fabrics producing sector separately covering the period 1991-2015, using non parametric method of DEA. Side by side it also finds out the determinants of TE for the two sectors.

The major findings of the present study could be listed as follows:

First, majority of the firms of both yarn and fabrics producing sector have their mean TE above the grand mean. The mean TE of all the firms taken together turned out to be 0.77 and 0.76 for Yarn producing sector and Fabrics producing sector respectively implying that on average the Yarn producing sector produces 77% of the maximum producible output and Fabrics producing sector produces 76% of the maximum producible output.

Secondly, comparing the results of determinants of TE in case of both Yarn and Fabrics producing sector reveals that Advertising intensity of previous period is found to have an inverted U-shaped relationship with TE. Firm size and RDI are positively related with TE for both the sectors.

Net export intensity is found to have a linear and negative relationship with TE for Yarn producing sector whereas for Fabrics producing sector, Net export intensity of previous period is linearly and positively related with TE.

The relation between FA and TE is found to be linear and positive for Yarn producing sector. Marketing intensity of previous period is found to have a linear and positive relationship with TE for Fabrics producing sector.

The effect of dismantling of MFA has a negative and significant effect on Technical Efficiency compared to the MFA period for both the sectors.

Finally, Firm size, RDI and Advertising intensity of previous period are the common determinants of TE for both the sectors and these variables may encourage TE for both the sectors.

Thus the analysis reveals that in order to promote technical efficiency, any policy changes that will lead to increase in Firm Size, RDI and Advertising Intensity should be emphasized.

Having done the analysis on Technical efficiency, the very next question arises about the productivity of these sectors. The next chapter thus deals with the productivity analysis.

Table 4.1: Distribution of firms based on Output -Oriented TE scores in Yarn producing Sector

Mean TE scores	Percentage of firms
Below 0.500	22.72
0.500-0.600	4.55
0.600-0.700	4.55
0.700-0.800	4.55
0.800-0.900	13.63
0.900-0.999	36.36
1	13.63

Source: Compiled by the Author.

Table 4.2: Output Oriented Technical Efficiency of Yarn producing sector

Variable	Range of Mean TE	Grand Mean of TE (GRM)	Percentage of Firms below the GRM	Percentage of Firms above the GRM
TE	0.165-1	0.766	36.36	63.64

Source: Compiled by the Author.

Table 4.3: Distribution of firms based on Output -Oriented TE scores in Fabrics producing Sector

Mean TE scores	Percentage of firms
Below 0.500	23.81
0.500-0.600	0
0.600-0.700	9.52
0.700-0.800	0
0.800-0.900	19.05
0.900-0.999	38.10
1	9.52

Source: Compiled by the Author.

Table 4.4: Output Oriented Technical Efficiency of Fabrics producing Sector

Variable	Range of Mean TE	Grand Mean of TE (GRM)	Percentage of Firms below the GRM	Percentage of Firms above the GRM
TE	0.146-1	0.760	33.33	66.67

Source: Compiled by the Author.

Table 4.5: Estimated Results of Simultaneous Equation Model of Yarn producing Sector: The Case of Technical Efficiency Equation

Explanatory Variable	Coefficient	t-Statistic	p-value
C	0.522***	6.527	0
FS	5.090***	26.900	0
RDI	0.231***	26.272	0
FA	0.0002**	2.416	0.016
NXI	-0.002***	-19.108	0
$ADV_{(t-1)}$	0.805***	60.230	0
$ADV_{(t-1)}^2$	-0.658***	-50.352	0
D	-0.042***	-31.098	0
Adjusted R-squared	0.912		
F-statistic	813.805		
Prob (F-statistic)	0		

****** Significant at 1% level, ** Significant at*** **5% level, *Significant at 10% level.**

Table 4.6: Estimated Results of Simultaneous Equation Model of Yarn producing Sector: The Case of Firm Size Equation

Explanatory Variable	Coefficient	t-Statistic	p-value
C	0.040***	12.586	0
TE	-0.195***	-18.650	0
RDI	0.162***	8.060	0
FA	0.0005***	43.539	0
ADV	0.016***	15.106	0
TE^2	0.232***	27.203	0
RDI^2	-0.148***	-33.357	0
Adjusted R-squared	0.871		
F-statistic	618.802		
Prob (F-statistic)	0		

****** Significant at 1% level, ** Significant at*** **5% level, *Significant at 10% level.**

Table 4.7: Estimated Results of Simultaneous Equation Model of Yarn producing Sector: The Case of Research and Development Intensity Equation

Explanatory Variable	Coefficient	t-Statistic	p-value
C	0.376***	29.540	0
TE	-0.566***	-27.073	0
FS	1.338***	13.081	0
$NXI_{(t-1)}$	0.007***	48.945	0
K/L	0.0002***	46.711	0
PR	0.010***	29.974	0
$(K/L)^2$	-3.04E-08***	-7.588	0
PR^2	4.01E-05***	9.198	0
Adjusted R-squared	0.905		
F-statistic	748.135		
Prob (F-statistic)	0		

****** Significant at 1% level, ** Significant at 5% level, *Significant at 10% level.***

Table 4.8: Marginal Effects of the Explanatory Variables from the Simultaneous Equation Model of Yarn producing Sector: The Case of Technical Efficiency Equation

Variable	Marginal Effect
$ADV_{(t-1)}$	0.728

Table 4.9: Wald Statistics of the Simultaneous Equation Model of Yarn producing Sector: The Case of Technical Efficiency Equation

	$ADV_{(t-1)}$
Chi-square	24.462***

****** Significant at 1% level, ** Significant at 5% level, *Significant at 10% level.***

Table 4.10: Marginal Effects of the Explanatory Variables from the Simultaneous Equation Model of Yarn producing Sector: The Case of Firm Size Equation

Variable	Marginal Effect
TE	0.161
RDI	0.156

Table 4.11: Wald Statistics of the Simultaneous Equation Model of Yarn producing Sector: The Case of Firm Size Equation

	TE	RDI
Chi-square	20.433***	4.661*

****** Significant at 1% level, ** Significant at 5% level, *Significant at 10% level.***

Table 4.12: Marginal Effects of the Explanatory Variables from the Simultaneous Equation Model of Yarn producing Sector: The Case of Research and Development Intensity Equation

Variable	Marginal Effect
K/L	0.0002
PR	0.010

Table 4.13: Wald Statistics of the Simultaneous Equation Model of Yarn producing Sector: The Case of Research and Development Intensity Equation

	K/L	**PR**
Chi-square	5.497*	20.574***

****** Significant at 1% level, ** Significant at*** **5% level, *Significant at 10% level.**

Table 4.14: Estimated Results of Simultaneous Equation Model of Fabrics producing Sector: The Case of Efficiency Equation

Explanatory Variable	**Coefficient**	**t-Statistic**	**p-value**
C	0.762***	18.574	0
FS	0.265***	2.684	0.01
RDI	0.762***	7.403	0
$NXI_{(t-1)}$	0.0004***	9.263	0
$ADV_{(t-1)}$	0.077***	9.533	0
$MEI_{(t-1)}$	0.070***	12.982	0
$ADV_{(t-1)}^2$	-0.012***	-8.557	0
D	-0.099***	-59.894	0
Adjusted R-squared	0.895		
F-statistic	639.068		
Prob (F-statistic)	0		

****** Significant at 1% level, ** Significant at*** **5% level, *Significant at 10% level.**

Table 4.15: Estimated Results of Simultaneous Equation Model of Fabrics producing Sector: The Case of Firm Size Equation

Explanatory Variable	Coefficient	t-Statistic	p-value
C	-0.871***	-7.524	0
TE	2.112***	7.075	0
RDI	0.057***	7.331	0
FA	0.002***	42.052	0
MEI	0.031***	40.956	0
NXI	0.0001***	10.787	0
TE^2	-1.266***	-7.518	0
Adjusted R-squared	0.905		
F-statistic	832.965		
Prob (F-statistic)	0		

****** Significant at 1% level, ** Significant at* 5% level, *Significant at 10% level.**

Table 4.16: Estimated Results of Simultaneous Equation Model of Fabrics producing Sector: The Case of Research and Development Intensity Equation

Explanatory Variable	Coefficient	t-Statistic	p-value
C	-0.479***	-41.653	0
TE	1.114***	41.003	0
FS	0.649***	39.282	0
NXI	2.30E-05	4.112	0
PR	8.28E-05***	13.186	0
K/L	0.0002***	83.002	0
TE^2	-0.666***	-4.822	0
NXI^2	4.35E-06***	30.261	0
Adjusted R-squared	0.923		
F-statistic	898.314		
Prob (F-statistic)	0		

****** Significant at 1% level, ** Significant at* 5% level, *Significant at 10% level.**

Table 4.17: Marginal Effects of the Explanatory Variables from the Simultaneous Equation Model of Fabrics producing Sector: The Case of Technical Efficiency Equation

Variable	Marginal Effect
$ADV_{(t-1)}$	0.075

Table 4.18: Wald Statistics of the Simultaneous Equation Model of Fabrics producing Sector: The Case of Technical Efficiency Equation

	$ADV_{(t-1)}$
Chi-square	16.472***

***, ** and *significant at 1%, 5% and 10% level of significance respectively

Table 4.19: Marginal Effects of the Explanatory Variables from the Simultaneous Equation Model of Fabrics producing Sector: The Case of Firm Size Equation

Variable	Marginal Effect
TE	0.171

Table 4.20: Wald Statistics of the Simultaneous Equation Model of Fabrics producing Sector: The Case of Firm Size Equation

	TE
Chi-square	21.377***

***, ** and *significant at 1%, 5% and 10% level of significance respectively

Table 4.21: Marginal Effects of the Explanatory Variables from the Simultaneous Equation Model of Fabrics producing Sector: The Case of Research and Development Intensity Equation

Variable	Marginal Effect
TE	0.094
NXI	0.00004

Table 4.22: Wald Statistics of the Simultaneous Equation Model of Fabrics producing Sector: The Case of Research and Development Intensity Equation

	TE	NXI
Chi-square	30.346***	4.825*

***, ** and *significant at 1%, 5% and 10% level of significance respectively