Chapter 5

Analysis of Productivity of Indian Textile Industry and identification of its determinants

5.1 Introduction

Any industry for attaining steady growth over the years, can increase cost-competitiveness by encouraging productivity. After liberalisation, Indian Government policies became less friendly to less productive firms. Along with it, the Multi-Fibre Agreement (MFA) which administered global trade in textiles and garments from 1974 through 1994, imposing quotas on the amount developing countries could export to developed countries, totally abolished on 1 January, 2005. Since the expire of MFA in 2005, competition increased many folds. Thus improved performance in productivity of a unit is required for its growth or even for its mere survival. In addition to it, for Indian Textile Industry (ITI), provision of textile goods at an affordable price is a major concern. Naturally, the measurement of productivity changes in ITI is of great interest, both academically and for policy outlook.

Input specific productivities like labor productivity and capital productivity are partial measures of industrial productivity. To have a complete measure, one must have to consider a measure that relates output to all the factor inputs used in production process. Such a measure is known as Total Factor Productivity (TFP) (Tinbergen, 1942). Total Factor Productivity growth (TFPG) measures the amount of increase in total output which is not accounted for increase in total inputs and thus measures shift in output due to shift in the production function over time, holding all inputs are constant (Abramovitz, 1956; Denison, 1962, 1967, 1985; Hayami et al, 1979). Growth in TFP is both a necessary condition as well as sufficient condition for its development. It is a necessary condition because it enables to avoid the trap of Ricardo's law of diminishing returns. It is sufficient condition because it raises production at a reduced unit cost in real terms (For example: Kahlon and Tyagi, 1983; Sidhu and Byarlee, 1992; Kumar and Mruthyunjaya, 1992; Rao, 1994; Kumar and Rosegrant, 1994; Sing, Pal and Moris, 1995; Acharya, 1998 etc.).

TFPG can be measured by (i) Growth Accounting Approach [i.e. by constructing either Solow Index (Solow, 1957), or Kendrick Index (Kendrick, 1956, 1961, 1973) or Translog-Divisia Index (Solow (1957); Jorgenson and Griliches (1967); Christensen, Jorgenson (1969, 1970)]; (ii) Econometric (Parametric/ Semi-Parametric) Approach (by estimating production function or cost function); (iii) Non-parametric Approach (through Data Envelopment Analysis (DEA)).

There are large numbers of empirical studies related to TFPG of different manufacturing industries using different methodologies considering different time periods and concluded accordingly. Focused on the literature regarding estimation of productivity of ITI which is very few in number, mention may be made of studies by Manoj & Muraleedharan (2019), Gambhir and Sharma (2015), Murugeshwari (2011), Sarma and Reddy (2006) among others. Most of the studies used Parametric approach (Stochastic frontier production function (SFPF)) to estimate TFPG and there is dearth in the literature regarding estimation of TFPG of ITI using non parametric method. Also analysis of TFPG using firm level data is lacking in the literature. The present thesis tries to fill the gap and estimates TFPG by using non parametric DEA approach employing firm level data. Along with the measurement of TFPG, it is also essential to explain the factors behind the variation in TFPG.

The textile value chain extends from raw material i.e. fibres to finished products, i.e. clothing and made-ups, with spinning, weaving, knitting and processing coming in between as intermediate processes [Devaraja (2011)]. Spinning process produces yarn and weaving process produces fabrics [Rao (1989), Bedi (2003), Devaraja (2011), IBEF Report (February, 2018)]. There exists inter sectoral disparity in terms of performance and thus productivity in ITI. Productivity of yarn and fabrics taken together serves as a barometer for assessing the productivity performance of the ITI as a whole [Rao (1989)]. Thus two important sectors of ITI namely Yarn and Fabrics have been considered in the present thesis.

At the same time, the performance of ITI is not at all uniform across firms as each firm has its own characteristics that persuade its growth and performance. There is inter firm disparity in terms of productivity as well. Thus firm level analysis may help to understand the performance of ITI much clearly.

TFPG of ITI employing firm level data over the period 1991-2015 is measured by Malmquist Productivity Index (MPI), using non-parametric Data-Envelopment-Analysis, assuming variable returns to scale. Productivity growth embedded itself the extent of technical change (TC), technical efficiency change (TEC) and scale efficiency change (SEC). Thus one may be concerned in knowing about the movement about these three components. As an answer to this, MPI is decomposed into the above three components following the methods suggested by Ray and Desli (1997).

Given this background, the **objectives** of the present chapter are: **First,** to estimate TFPG of all the sample firms over the sample period for the two sectors of ITI namely yarn and Fabrics. **Secondly,** to study the different components of productivity such as TC, TEC and SEC **Finally**, to find out the major determinants of TFPG for the above mentioned sectors of ITI. The possible determinants considered are Firm Size (FS), Firm Age (FA), Research and Development Intensity (RDI), Advertising Intensity (AI), Marketing Intensity (MEI) and Net Export Intensity (NXI).

The major achievement of the third problem of the present thesis is estimation of TFPG values employing Data Envelopment analysis (DEA) following Fare, Grosskopf, Norris and Zhang (FGNZ 1994) as well as to determine the factors influencing such TFPG by using panel regression under simultaneous framework. Side by side, the effect of dismantling of Multi-Fibre Agreement (MFA) on TFPG are tried to be found out.

Rest of the chapter is as follows:

Section 5.2 discusses the methodology and data source. In subsection 5.2.1 the methodology for Estimation of TFPG by DEA and finding out determinants of TFPG employing a Simultaneous Panel Approach are discussed. In subsection 5.2.2 discuss data Sources. Section 5.3 presents the results of analysis elaborately and summary and conclusion are made in Section 5.4.

5.2 Methodology and Data Source

In this section the methodology of TFPG estimation and the data source are discussed. The present chapter uses two stage approaches. At first TFPG is measured for the two sectors i.e. yarn and fabrics separately. TFPG is obtained from MPI. There are two ways to measure the TFPG on the basis of MPI. One is based on a fixed base period and the other is between two adjacent periods. The present thesis used the idea of second method. Then panel regression is run to find out the determinants of productivity growth.

5.2.1 Methodology

In this section, first the methodology for estimating Multi-Factor Productivity Growth using the Data Envelopment Analysis (DEA) is discussed in subsection 5.2.1.1. In the next subsection 5.2.1.2, factors influencing Multi-Factor Productivity Growth are tried to be found out.

5.2.1.1 Estimation and Decomposition of Multi-factor Productivity Growth

MPI introduced by Caves, Christensen and Diewert (1982), is a normative measure that builds a production frontier representing the technology and is measured by the ratio of (output) distance functions and does not need aggregation of inputs (and in the multi-output case output) into quantity index. Fare, Grosskopf, Lindgren and Ross (1992) used mathematical programming to evaluate the distance functions that can be used in empirically measuring MPI. This measure decomposes the Malmquist Index in two components one showing the technical change or shift in the production frontier and the other showing movement towards or away from the frontier. They assumed that the production technology was characterized by global CRS technology. So the scale effect was ruled out here. In a subsequent paper Fare, Grosskopf, Norris and Zhang (FGNZ 1994) followed the decomposition proposed by Fare, Grosskopf and Lovell (1994) and incorporated the returns to scale effect. Ray at al. (1997) has pointed out that there are certain limitations of FGNZ, and provided an alternative decomposition of MPI, which will be used in the present study to estimate the TFPG of the companies. In the 1-output-1 input case, the productivity growth rate is measured by the difference in growth rates of output and input quantities respectively.

When multiple inputs are considered, the rate of Multi-Factor Productivity Growth (MFPG) can be calculated by the difference in output growth rate and that of total input where growth rate of total input can be obtained by the individual inputs' growth rates weighted by the partial output elasticity. In parametric analysis, the specification of some explicit functional form of a production, cost or profit function is needed. In nonparametric analysis, the exact technological relationship is unspecified. The relevant assumptions are — (i) both inputs and output are freely disposable and the production possibility set is convex. (ii) All input-output combinations, actually observed, are by definition feasible. (iii) Variable Returns to Scale prevails.

Consider, for simplicity, a single input – single output industry consists of n firms. Let x_k^t and y_k^t represent the input and output quantities of firm k at time t. The average productivity of this firm at time t is $AP_k^t = \frac{y_k^t}{x_k^t}$ …5.1

Thus, a productivity index for this firm at time t+1, with period t treated as the base, will be

$$\Pi_{k(t+1)} = \frac{AP_k^{t+1}}{AP_k^t} = \frac{y_k^{t+1}/x_k^{t+1}}{y_k^t/x_k^t} \qquad \text{…5.2}$$

Which does not in any way depend on the assumptions about returns to scale. In order to identify the sources of productivity change, however, a bench-mark technology is needed, where returns to scale assumption becomes important.

According to Varian (1984), the free disposal convex hull of observed input-output vectors provides an inner-approximation to the true underlying production possibility set, if the abovementioned assumptions (i) and (ii) hold good.

Consider an industry consisting of four firms: a, b, c and d. Following Figure 5.1, a_0, b_0, c_0 and d_0 show the observed input-output levels of the respective firms in period 0. Similarly, points a_1 through d_1 show their input-output levels in period 1. Firm 'a' uses input ox_0 to produce output a_0x_0 in period 0 and input ox_1 to produce output a_1x_1 in period 1.

Thus, the productivity index for firm 'a' in period 1 is

$$\Pi_{a1} = \frac{a_1x_1/ox_1}{a_0x_0/ox_0} \qquad \ldots 5.3$$

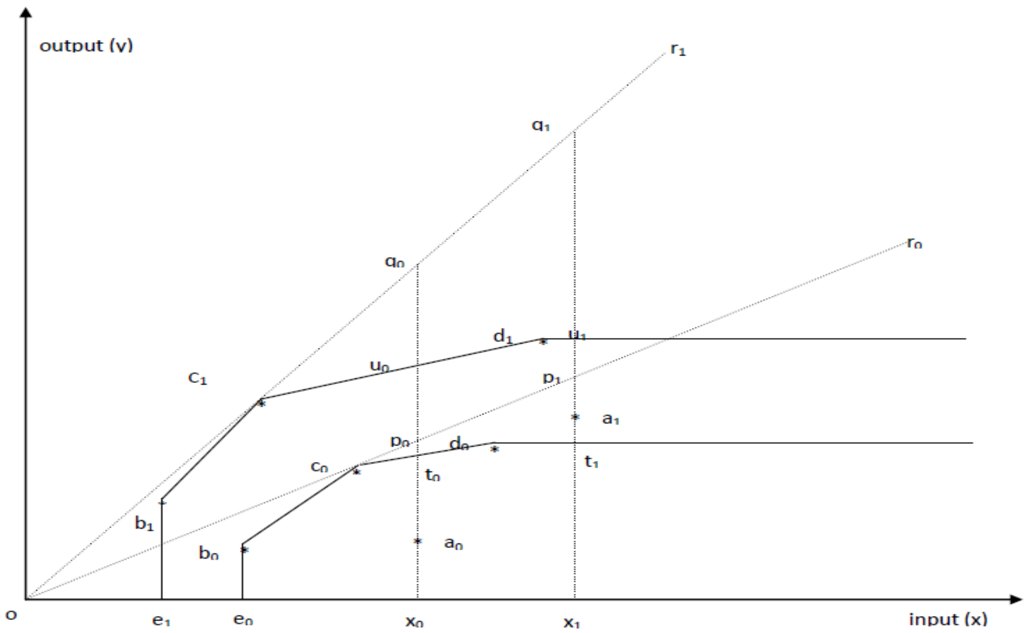

Figure 5.1 Measurement and Decomposition of Productivity Index

By convexity, all the points in the convex hull of the points $a_0, b_{0,} c_0$ and d_0 (i.e., the convex combinations of these points) represent feasible input-output combinations in period 0.

The free disposal convex hull is the set of points bounded by the horizontal axis and the broken line $e_0 b_0 c_0 d_0$-extension. Under Variable Returns to Scale (VRS), all points in this region represent feasible input-output combinations in period 0, although under Constant Returns to Scale (CRS) all radial expansion and (non-negative) contraction of feasible input-output bundles are also feasible, thus the CRS production possibility set in period 0 is the cone formed by the horizontal axis and the ray or_0 through the point c_0 .

The VRS frontier in period 1 is the broken line $e_1 b_1 c_1 d_1$- extension and the CRS frontier is the ray or_1 through the point c_1 . Define the production possibility set as

$$s^t = \{(x, y): y \ can \ be \ produced \ fromX\epsilon period \ t\} \qquad \ldots 5.4$$

The output distance function is

$$D^t(x,y)=\min\theta:(x,\frac{1}{\theta}y)\epsilon S^t \qquad \ldots 5.5$$

In period 0, the maximum producible output from input ox_0 is $t_0 x_0$under the VRS assumption. Thus the distance functions are

$D_V^0(x_0, y_0) = \frac{a_0 x_0}{t_0 x_0}$ and $D_V^0(x_1, y_1) = \frac{a_1 x_1}{t_1 x_1}$, in period 0

In period 0, the maximum producible output from input ox_0 is $p_0 x_0$under the CRS assumption. Thus the distance functions are

$D_c^0(x_0, y_0) = \frac{a_0 x_0}{p_0 x_0}$ and $D_c^0(x_1, y_1) = \frac{a_1 x_1}{p_1 x_1}$, in period 0

The productivity index for firm 'a' is

$$\Pi_{a0} = \frac{a_1 x_1 / o x_1}{a_0 x_0 / o x_0} = \frac{a_1 x_1 / p_1 x_1 \cdot p_1 x_1 / o x_1}{a_0 x_0 / p_0 x_0 \cdot p_0 x_0 / o x_0} = \frac{D_c^0(x_1, y_1)}{D_c^0(x_0, y_0)} \qquad \ldots 5.6$$

Analogously, $\Pi_{a1} = \frac{a_1 x_1 / o x_1}{a_0 x_0 / o x_0} = \frac{D_c^1(x_1, y_1)}{D_c^1(x_0, y_0)}$ …5.7

According to Färe, Grosskopf, Norris and Zhang (FGNZ, 1994) for any reference technology; the distance functions can be calculated. The productivity index is given by the ratio of the CRS distance functions even if the technology was not characterized by CRS. With explicit assumption of VRS, comparing CRS and VRS frontiers in period 0, we get both t_0 and t_1 are points on the production frontier, (both are technically efficient), and the average productivity at t_0 is higher than that of t_1. The point of highest average productivity along the VRS frontier in period 0 is c_0 , whereas along the CRS frontier, that remains constant. The point of highest average productivity along the VRS frontier is called the Most Productive Scale Size (MPSS), according to Banker (1984). At the MPSS, CRS and VRS frontiers coincide. Notably, the average productivity at the MPSS of the VRS frontier (point c_0) is equal to the constant average productivity at any point on the CRS frontier (say, p_0 or p_1). The scale efficiency at any point on the frontier is measured by the ratio of the average productivity at that point to the average productivity at the MPSS.

Thus, $SE^0(x_0, y_0) = \frac{AP(t_0)}{AP(c_0)} = \frac{\frac{t_0 x_0}{a_0 x_0}}{\frac{p_0 x_0}{a_0 x_0}} = \frac{D_c^0(x_0, y_0)}{D_v^0(x_0, y_0)}$ …5.8

Also, $SE^0(x_1,y_1) = \frac{AP(t_1)}{AP(c_0)} = \frac{D_c^0(x_1,y_1)}{D_v^0(x_1,y_1)}$ …5.9

Now equation (5) can be written as

$$\Pi_{a0} = \frac{D_v^0(x_1,y_1).\frac{D_c^0(x_1,y_1)}{D_v^0(x_1,y_1)}}{D_v^0(x_0,y_0).\frac{D_c^0(x_0,y_0)}{D_v^0(x_0,y_0)}} = \frac{D_v^0(x_1,y_1)}{D_v^0(x_0,y_0)} \cdot \frac{SE^0(x_1,y_1)}{SE^0(x_0,y_0)} \quad \text{…5.10}$$

In a perfectly analogous manner, $\Pi_{a1} = \frac{D_v^1(x_1,y_1)}{D_v^1(x_0,y_0)} \cdot \frac{SE^1(x_1,y_1)}{SE^1(x_0,y_0)}$ …5.11

Now, the MPI can be decomposed, as done by Ray et al (1997), in the following manner. The expression is, $\Pi_a = (\Pi_{a0},\Pi_{a1})\frac{1}{2}$

$$= \left[\frac{D_v^0(x_1,y_1)}{D_v^0(x_0,y_0)} \cdot \frac{SE^0(x_1,y_1)}{SE^0(x_0,y_0)} * \frac{D_v^1(x_1,y_1)}{D_v^1(x_0,y_0)} \cdot \frac{SE^1(x_1,y_1)}{SE^1(x_0,y_0)}\right]^{\frac{1}{2}}$$

$$= \left[\frac{D_v^0(x_1,y_1)}{D_v^0(x_0,y_0)} \cdot \frac{D_v^1(x_1,y_1)}{D_v^1(x_0,y_0)}\right]^{\frac{1}{2}} * \left[\frac{SE^0(x_1,y_1)}{SE^0(x_0,y_0)} \cdot \frac{SE^1(x_1,y_1)}{SE^1(x_0,y_0)}\right]^{\frac{1}{2}}$$

$$= \frac{D_v^1(x_1,y_1)}{D_v^0(x_0,y_0)} * \left[\frac{D_v^0(x_0,y_0)}{D_v^1(x_0,y_0)} \cdot \frac{D_v^0(x_1,y_1)}{D_v^1(x_1,y_1)}\right]^{\frac{1}{2}} * \left[\frac{SE^0(x_1,y_1)}{SE^0(x_0,y_0)} \cdot \frac{SE^1(x_1,y_1)}{SE^1(x_0,y_0)}\right]^{\frac{1}{2}} \quad \text{…5.12}$$

$$= peffch * techch * sch$$

Where peffch$= \frac{D_v^1(x_1,y_1)}{D_v^0(x_0,y_0)}$ measures pure TEC,

techch$= \left[\frac{D_v^0(x_0,y_0)}{D_v^1(x_0,y_0)} * \frac{D_v^0(x_1,y_1)}{D_v^1(x_1,y_1)}\right]^{\frac{1}{2}}$ measures technical change, which is the geometric mean of the shift in the production function at x_0 and x_1 .

sch$= \left[\frac{SE^0(x_1,y_1)}{SE^0(x_0,y_0)} * \frac{SE^1(x_1,y_1)}{SE^1(x_0,y_0)}\right]^{\frac{1}{2}}$ measures change in scale efficiency.

FGNZ (1994) showed a similar decomposition. However, as pointed out by Ray et al (1997), there exists some inconsistency in their method of analysis. The technical change factor, according to FGNZ (1994), is the geometric mean of the shift in the pseudo production function and not of actual production function.

The decomposition of MPI into TEC, TC and SEC can be applied in practical sense if the reference technology set is constructed from sample data in the following way —

Let, y_j^t and x_j^t represent the output and input vectors respectively of firm j (j=1,2,3….N) in period t. Following Varian (1984), an inner approximation to the underlying production possibility set in period t will be

$$S^t = \left[(x,y): \sum_{j=1}^{N} \lambda_j x_j^t \leq x; \sum_{j=1}^{N} \lambda_j y_j^t \geq y; \sum \lambda_j \geq 0 (j = 1,2,3 \ldots \ldots, N)\right]$$

It is to be noted here that, by assumption, any observed input-output bundle (x_t^j, y_t^j) is feasible in period t. By the convexity assumption, any input-output pair $(\bar{x}, \bar{y})$ satisfying

$\bar{x} = \sum_{j=1}^{N} \lambda_j x_j^t, \bar{y} = \sum_{j=1}^{N} \lambda_j y_j^t, \sum_{j=1}^{N} \lambda_j = 1, \lambda_j \geq 0, (j = 1,2,3 \ldots \ldots \ldots, N)$ is also feasible, and by the free disposability assumption, any $x \geq \bar{x}$ corresponds $\bar{y}$.

Hence, x can also produce y if $y \geq \bar{y}$.

Therefore, the output oriented distance function under VRS is obtained as

$D_v^t(x_k^i, y_k^i) = \frac{1}{\Phi^*}$ where $\Phi^* = \max \Phi$

subjectto

$$\sum_{j=1}^{N} \lambda_j y_t^j \geq \Phi y_k^t; \sum_{j=1}^{N} \lambda_j x_t^j \leq x_k^t; \quad \sum_{j=1}^{N} \lambda_j = 1; \quad \lambda_j \geq 0, (j = 1,2,3 \ldots\ldots, N)$$

The own-period distance functions can be found for t=k, while $t \neq k$ will define the cross-period distance functions.

The productivity growth rate can be measured easily by the difference in the growth rates of output and input quantities respectively when only one output and one input case is considered. In case of multiple inputs the rate of multi-factor productivity growth (MFPG) is given by the difference in output growth rate and the total input growth rate. In parametric analysis the form of a production, cost or profit function is explicitly specified. But in non-parametric analysis, the exact technological relationship need not be specified. Only few general assumptions about the production technology is made. They are as follows:

All actually observed input-output combinations are feasible. Both inputs and outputs are freely disposable. The production possibility set is convex. In this thesis VRS is assumed to hold throughout the analysis.

5.2.1.2 Determinants of Multi-factor Productivity Growth

After calculating Multi-Factor Productivity Growth, panel regression has been carried out to identify its major determinants corresponding to Yarn and Fabrics producing sector. The variables considered as possible determinants are Firm Size (FS), Firm Age (FA), Research and Development Intensity (RDI), Advertising Intensity (ADV), Marketing Intensity (MEI) and Net Export Intensity (NXI). All the variables have been taken in growth term.

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

Firm Size (FS): It can be argued that higher the Firm Size (FS) less is the competition. FS captures the effect of market structure on TFPG (Ghose and Chakraborti (2013), Bandyopadhyay (2000)). A negative relation between FS and TFPG may occur because as FS falls, competition increases which may lead to cost-consciousness and drive for technological advancement. Others may point out the advantages of big size, secured market and expect a positive association between FS and TFPG. The conclusion from the empirical literature also varies and does not provide a single answer (Kendrick (1973), Katz (1969)). 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): The relationship between firm age and productivity growth is not clear in the literature (Ghose and Chakraborti (2013), Ayyagari et al. (2011), Brouwer et al. (2005), Huergo and Jaumandreu (2004)). A affirmative relationship between firm age and productivity can be found as older firms become more experienced and display superior performance. These firms have benefits of learning previously 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 by the difference between present year and establishment year of the firm.

Research and Development Intensity (RDI): The role of Research and Development (R&D) is relevant while determining the factors explaining productivity of Indian Textile industry. Research and Development basically includes the search for various novel pathways and development of expertise which facilitate faster product development. Thus one may expect a affirmative relationship between productivity of firms and Research and Development Intensity. Research and Development expense per unit of output is taken as Research and Development Intensity.

Empirical literature relating productivity and Research and Development is vast (Moen and Burchardt (2009), Johansson and Lööf (2008), Mate-Garcia and Rodriguez- Fernandez (2008), Goedhuys et al. (2008), Higon (2003), Kwon and Inui (2003), Dietmar (1994), Clark and Griliche (1982) among others). Some studies are available linking the R&D activities and productivity of Indian industry (Pal, Chakraborty and Ghose (2018), Ghose and Chakraborti (2013), Reikard (2011), Sharma (2011), Patibandla and Sanyal (2005), Kathuria (2001), Hasan (2000), Raut (1995) among others).

Advertising Intensity (ADV): The literature review suggests that there are different studies determining the effect of advertising expenditure on productivity. 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 thereby increasing production and hence productivity (Shashikanth, Mamatha and Rao (2018), Samad and Sabeerdeen (2016), Mohan (1989), Ghose and Chakraborti (2013), Luo and Donthu (2005)) among others. Advertising intensity is measured by Advertising expense per unit of sales.

Marketing Intensity (MEI): Some literature is available supporting the role of marketing expense in promoting productivity. Pal, Chakraborty and Ghose

(2018),Ghose and Chakraborti (2013), Donthu et al. (2005),Lukas et al. (2005), Rust et al. (2004), Sheth and Sisodia (2002) among others got positive relationship between Marketing intensity and Productivity. Marketing intensity is measured by Marketing expense per unit of sales.

It should be pointed out that Indian textile firms re-engineer the imported items and then re-export the product (De and Ghose, 2020). Thus one may be interested in knowing whether the productivity of this industry is affected by trade related variables or not.

A vast literature is available supporting the role of exports in promoting productivity both at the theoretical as well as empirical level for different Indian manufacturing Industries. Some empirical study showed that exporting firms have some prior advantage in productivity are due to Pal, Chakraborty and Ghose (2018), Mukim (2011),Loecker (2007), Biesebroeck (2005),Alvarez and Lopez (2005),Bernard and Jensen (1999), Clerides et al.(1998), Roberts and Tybout (1997) among others.

For the textile firms import is also important. Some studies on different industries showed that importing firms have some added advantages on productivity (Pal, Chakraborty and Ghose (2018), Topalova and Khandelwal (2011), Vogel and Wagner (2010), Kasahara and Rodrigue (2008), Amiti and Konings (2007), Halpern et al. (2005), Lawrence and Weinstein (2001), World Bank Report (1993, 1997)).

The above discussion shows that both export and import has an imperative role in determining productivity. So it is essential to find out the relative role of exports vis á vis imports in promoting productivity. A lot of empirical studies have been conducted where focus is given either on export or on import and they are incapable to separate the impact of exports and imports (Arvas and Uyar (2014), Kim et al. (2009) among others). Whereas Zhang, Ondrich and Richardson (2003), while evaluating how cross country differences in export and import openness in 1990 affected the level of real per capita income, used net exports (exports minus imports), which in turn imply distinct exports and imports effects. Their results support the conjecture that income is associated with net trade.

Net Export Intensity (NXI): For finding out the relative role of export viz import on productivity, the present thesis uses (export minus import) to find the net effect of exports over imports in tune with Zhang, Ondrich and Richardson (2003). Net Export Intensity is obtained by the ratio of Export minus import to sales.

Global trade in ITI has long been governed by the 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 Agreement on Textile and Clothing (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)]. Naturally the question arises that: What happens to the TFPG of ITI after the dismantling of MFA?

Policy related Variable: To capture the effect of dismantling of MFA on TFPG, a time dummy, D is introduced taking value 1 from 2005 onwards (i.e. period of dismantling of MFA) and 0 for the rest of the year (i.e. MFA period).

Problem of Heterogeneity- For determinant analysis panel regression have been used. By using panel regression, variables are obtained which can be taken as significant determinants across all the firms for each sector. Panel data permits 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 lets us to control 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.

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

Problem of Simultaneity- A common problem may be that there may exist simultaneity between TFPG and FS as well as TFPG and RDI. Therefore, to take care of this problem, simultaneous panel model has been framed with three equations (equation for TFPG, FS and RDI) for both the sectors.

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.

Models for the Yarn producing sector and Fabrics producing sector are as follows:

For Yarn producing sector, the chosen model considered TFPG, FS and RDI as dependent variables and thus separate equations for each of these variables, TFPG equation (equation 5.13), FS equation (equation 5.14) and RDI equation (equation 5.15) which are presented below:

$$TFPG = f[FS,\ RDI,\ NXI_{(t-1)},\ FA,\ ADV_{(t-1)},\ ADV^2_{(t-1)},\ D] \qquad \ldots 5.13$$

$$FS = f[TFPG, NXI, \left(\frac{K}{L}\right), ADV_{(t-1)}, MEI, ADV^2_{(t-1)}] \qquad \ldots 5.14$$

$$RDI = f[TFPG,\ FS,\ NXI,\ PR,\ FS^2] \qquad \ldots 5.15$$

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

The inclusion of the above explanatory variables in TFPG equation have already been justified.

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

TFPG may have a favourable effect on FS because with increase in TFPG, there is increase in output which may lead to increase in Firm Size. A positive or negative relationship between NXI and FS may occur. Positive relation possibly due to the reason that with increase in net export, demand of domestic goods in foreign markets increases thereby raising production which can boost firm size and negative relation may occur i.e. import may have more favourable impact over export for raising production thereby increasing FS. Capital-labour ratio may have an affirmative relationship with FS as capital intensive industries by using advanced and sophisticated technology into the production process may help to increase production and hence Firm size. Capital-labour Ratio (K/L) may be obtained for each sector by the ratio of capital to labour. Advertisement expense intensity of the previous period may affect FS positively possibly as firms spending more on advertisement are more disposed to introduce a new product in the market easily and increases sales thereby increasing firm size. More marketing activities may indicate strong firm's brand and product image which may lead to higher demand of product which may insist firms to produce more to meet up the extra demand created by marketing, thereby firm size may increase.

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

A positive relation may prevail between TFPG and RDI as with increase in TFPG, the capability of firms increases through usage of its input efficiently and produces more output which may promote RDI. Also there can be a possibility of negative relation between the two possibly due to several reasons which can make firms more productive and they may become more disinclined to invest more in R&D and so RDI may fall. A positive relationship may be found between FS and RDI as a larger firm can be able to exploit economies of scale and produce more which may influence firms to increase RDI. A positive association between NXI and RDI may exist possibly due to with increase in net export, firms may earn extra profit from foreign market which may help in expanding RDI. Firms' profit is an important stimulus to and source of funding for, R&D and there may be 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 considered TFPG, FS and RDI as dependent variables and thus separate equations for each of these variables, TFPG equation (equation 5.16), FS equation (equation 5.17) and RDI equation (equation 5.18) which are presented below:

$$TFPG = f[FS, RDI, NXI_{(t-1)}, FA, ADV_{(t-1)}, MEI_{(t-1)}, ADV^2_{(t-1)}, D] \qquad ...5.16$$

$$FS = f[TFPG, RDI, NXI_{(t-1)}, ADV_{(t-1)}, MEI_{(t-1)}, \left(\frac{K}{L}\right), MEI^2_{(t-1)}] \qquad \ldots 5.17$$

$$RDI = f[TFPG, FS, NXI, PR, FS^2] \qquad \ldots 5.18$$

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

The inclusion of the above explanatory variables in TFPG equation have already been justified.

The relationship between FS and the explanatory variables like TFPG, K/L and ADV of the previous period have been already justified while explaining the FS equation of yarn producing sector. The new variables of FS in fabrics producing sector are RDI, NXI of previous period and MEI of the previous period.RDI may affect FS positively perhaps R&D may increase the production of a firm using sophisticated technology in the production process, which may lead to more production and thereby increasing firm size. Relation between NXI of the previous period and FS may be positive or negative. Positive relation possibly due to increase in Net export of the previous period may mean more demand of domestic goods in foreign markets which may raise production thereby boosting firm size. Also negative relation may occur i.e. import may have more favourable impact over export to increase output and thus to promote FS. More marketing activities in the previous period may indicate strong firm's brand and product image which may lead to higher demand of product and may insist firms to produce more in the next period, thereby increasing FS.

The relation between RDI and all the explanatory variables have already been discussed while explaining the RDI equation of yarn producing sector.

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 is tested in the presence of exclusion restriction and the models are found to be over identified.

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.

5.2.2 Data Source

Same as in the previous chapter.

5.3 Result of Analysis

5.3.1 Estimation of Productivity growth

The present study has considered two sectors of ITI namely yarn and fabric. Each sector is composed of associate firms (goods) and since these associate goods, included in each sector, are of similar type, it can be assumed that such associate goods share same frontier operating under similar kind of technology. The frontiers are generated in the present thesis for both the sectors separately for 1991 to 2015 and the corresponding measure of MPI is obtained for all the firms of the two sectors, using the computer programme DEAP (developed by Tim Coelli). The available firms are then clubbed into the corresponding sectors. For any particular sector, the average of the measured MPI corresponding to their firm level counterpart is considered as a measure of TFPG.

Productivity growth embedded itself the extent of technical change, TEC and SEC. So one may be interested in knowing about the movement about these three components. TC is associated with shift in production frontier; Where TEC is the movement towards the frontier. SEC captures the impact of change in scale of production on TFP.

The details of the estimated results are discussed in the following subsections. The results of MPI and its decomposition in Yarn producing sector can be found in subsection 5.3.1.1. Whereas in subsection 5.3.1.2 results of MPI and its decomposition in Fabrics producing sector can be found.

5.3.1.1 Results of MPI and its Decomposition in Yarn producing Sector

MPI values are obtained for each of the sample firms of Yarn producing Sector over the sample period. Table 5.1 represents the range of Mean MPI or the Annual Averages of the sample firms (all MPI averages are geometric means) and the averages of the Mean MPIs i.e. grand mean (GRM) of all MPIs of the sample firms. Because the productivity index in any one year treats the year immediately proceeding as the base, the difference between the value of the MPI and unity shows the productivity growth rate over the previous year. The sample averages of such annual growth rate are also reported in Table 5.1.

Table 5.1 reveals that the mean MPI of the firms varies over the range 0.939-1.120. The average of the mean MPI or the grand mean (GRM) is 1.014. Among all the sample firms, 59.09% of firms exhibit mean MPI below the grand mean and the rest 40.91% of firms shows mean MPI above the grand mean. So the majority of the firms have their mean MPI below the GRM. The analysis reveals that yarn producing sector shows productivity increase at a rate of 5.4 % per annum.

In Table 5.2, the results relating to technical progress (or regress) based on the decomposition of MPI using Ray et al (1997) approaches presented. It suggests that the major factor behind the overall progress or decline in productivity is the (average) rate of scale efficiency change.

It is apparent from Table 5.2 that the mean technical change (TC) of the firms varies from 0.982 to 1.030. The grand mean (GRM) or average of mean technical change of the firms in the sample period, 1991-2015 is 1.009. The estimated results of mean TEC and mean SEC varies from 0.919 to 1.075 and 0.993 to 1.059 respectively. The GRMs are 0.988 and 1.018 corresponding to TEC and SEC. Table5.3 reports the rate of TC, TEC and SEC in yarn producing sector. Yarn producing sector exhibits technical progress of 7.032% per annum. A positive value of scale efficiency implies that a firm has moved closer to its most productive scale size whereas a negative value implies movement further away from the highest ray average productivity. It must be pointed out that yarn producing sector moves to the most productive scale size since it shows positive value of scale efficiency change i.e. 11.599%. Table 5.3 also reveals that yarn improved in technical efficiency over the years as the value is 8.125%.

Thus for Yarn producing sector, SEC is found to dominate over the other two components such as technical change and technical efficiency change. Therefore SEC is the prime source of productivity increase.

5.3.1.2 Results of MPI and its Decomposition in Fabrics producing sector

MPI values are obtained for each of the sample firms of Fabrics producing Sector over the sample period. Table 5.4 represents the range of Mean MPI or the Annual Averages of the sample firms (all MPI averages are geometric means) and the averages of the Mean MPIs i.e. grand mean (GRM) of all MPIs of the sample firms.

Because the productivity index in any one year treats the year immediately proceeding as the base, the difference between the value of the MPI and unity shows the productivity growth rate over the previous year. The sample averages of such annual growth rate are also reported in Table 5.4.

Table 5.4 reveals that the mean MPI of the firms varies over the range 0.845-1.138. The average of the mean MPI or the grand mean (GRM) is 1.000. Among all the sample firms, 47.62% of firms exhibit mean MPI below the grand mean and the rest 52.38% of firms shows mean MPI above the grand mean. So the majority of the firms have their mean MPI above the GRM. The analysis reveals that fabrics producing sector shows productivity increase at a rate of 7.2 % per annum.

In Table 5.5, the results relating to technical progress (or regress) based on the decomposition of MPI using Ray et al (1997) approaches presented. It suggests that the major factor behind the overall progress or decline in productivity is the (average) rate of scale efficiency change.

It is apparent from Table 5.5 that the mean technical change (TC) of the firms varies from 0.954 to 1.042. The grand mean (GRM) or average of mean technical change of the firms in the sample period, 1991-2015 is 1.002. The estimated results of mean TEC and mean SEC varies from 0.843 to 1.165 and 0.943 to 1.074 respectively. The GRMs are 0.987 and 1.011 corresponding to TEC and SEC. Table5.6 reports the rate of TC, TEC and SEC in fabrics producing sector. Fabrics producing sector exhibits technical progress of 12.947% per annum. A positive value of scale efficiency implies that a firm has moved closer to its most productive scale size whereas a negative value implies movement further away from the highest ray average productivity. It have to be focused that fabrics producing sector moves to the most productive scale size since it shows positive value of scale efficiency change i.e.

18.159%. Table 5.6 also reveals that fabrics producing sector improved in technical efficiency over the years as the value is 17.061%.

Like the yarn producing sector, for Fabrics producing sector also SEC dominates over the technical change and technical efficiency change. Thus SEC is obtained as the prime source of productivity increase.

5.3.2 Factors influencing Productivity Growth

In the second stage, panel regression has been carried out to find out the major determinants of TFPG of Yarn and Fabrics producing sector. 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) of the firms.

It may be mentioned that all the estimated equations in the models for yarn and fabric are 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. 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.

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 report 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 statistical significance of these variables has been checked by Wald test.

The results of determinants of TFPG for yarn and fabrics producing sector are presented in subsections 5.3.2.1 and 5.3.2.2 respectively which are presented below:

5.3.2.1 Determinants of TFPG of Yarn producing sector

In this model, there are three equations namely TFPG, Firm size and Research and Development Intensity. The results of estimation of simultaneous equation model can be visualized from **Table 5.7 to Table 5.15.**

In case of TFPG equation whose result can be found in Table 5.7, it reveals that the variable Advertising intensity of previous period have nonlinear relationship with TFPG. As the value of marginal effect of Advertising intensity of previous period is obtained positive as is revealed from Table 5.10, it implies that the net effect of Advertising intensity of previous period on TFPG is positive. Whereas the other variables namely FS, Research and development intensity, Net export intensity of previous period and Firm age are linearly related with TFPG. The statistical significance of Advertising intensity of previous period has been checked by performing Wald test and turned out to be significant which is represented by Table 5.11.

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

The positive relationship between Advertising intensity of previous period and TFPG possibly may be due firms spending more on advertisement may be more prone to introduce a new product in the market easily, increases sales, fights market competition and thus may increase productivity.

There exists a positive association between FS and TFPG. Large firms may appear to become relatively more productive than small firms. Perhaps the fact that a big firm faces secured market, confronts less market competition, more cost conscious, and may use sophisticated technology in production process which may generate higher TFPG relative to smaller firms.

Net export intensity of previous period is positively associated with TFPG. This indicates that with increase in net export intensity in the previous period, TFPG may increase. The result possibly because of knowledge spillovers from the international contacts and spillovers from technology diffusion with the increase in net export intensity there can be shift in the frontier which may promote TFPG.

A positive relationship is also found between firm age and TFPG which means that TFPG may rise with increase in firm age. The older firms have benefits of learning earlier, possibly have more experience and easier access to finance and smooth buyer-supplier linkage which can help to increase production and may encourage TFPG.

But a negative relationship is found between RDI and TFPG. Research and development expenditure may not enable firms to attain better TFPG rather it reduces

TFPG possibly because of high adaptation cost of the new technology and inability to operate it and reap its potentiality instantaneously (Mitra and Jha, 2015).

The effect of dismantling of MFA has a negative significant effect on TFPG. The falling TFPG levels of the firms after the phasing out of MFA possibly 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 and there may be fall in production which may discourage TFPG.

In case of **Firm Size Equation** whose results are presented in Table 5.8**,** Advertising intensity of previous period has nonlinear relationship with FS whereas TFPG, Net export intensity, Capital-labour ratio and Marketing intensity are linearly related as is revealed from Table 5.8. Marginal effect of Advertising intensity of previous period is positive which is revealed from Table 5.12, and the statistical significance of this variable has been checked by performing Wald test and turned out to be significant which is represented in Table 5.13.

Since the marginal effect is positive, thus net effect of Advertising intensity of previous period on TFPG is positive. Firms spending more on advertisement in the previous period are more inclined to introduce a new product in the market easily; increases sales and fights market competition in the current period thereby increasing production to meet up the extra demand created by advertising. As a result, firm size may increase.

TFPG is found to have a positive association with FS. This indicates that with increase in TFPG, FS may increase. Possibly with increase in TFPG, there is increase in output which may lead to firm size increase.

But there exists a negative association between Net export intensity and FS. This indicates that import have more favourable impact over export to promote FS. The reason may be with more import firms can have access to machineries which may improve its production process thereby increasing its output and thus FS.

Capital-labour ratio, which serves as a degree of mechanization have a favourable effect on FS. The capital intensive industries have an ability to generate mass production and keep strategies for high growth, by using advanced and sophisticated technology into the production process which may help to increase firm size.

MEI is also positively association with FS. More marketing activities indicates an effort to strengthen the firm's brand and product image which may lead to higher demand of product thereby increasing production to meet up the extra demand created by marketing. As a result, firm size may increase.

For the **Research and Development Intensity equation,** whose results are presented in Table 5.9, it can be inferred that the variable Firm size have a nonlinear relationship with RDI whereas TFPG and Net export intensity are linearly related. As the values of marginal effect of Firm size is found to be positive as is revealed from Table 5.14, it implies that Firm size have positive relationship with RDI and the statistical significance of Firm size has been checked by performing Wald test and turned out to be significant which is represented in Table 5.15.

The positive association between Firm size and RDI possibly due to a larger firm can able to exploit economies of scale and produce more which may influence firms to increase Research and development Intensity.

TFPG is found to have a negative association with RDI. In other words, increase in TFPG may decrease R&D expense possibly because with increase in TFPG which implies more production possibly due to simply allocating inputs more appropriately and efficiently (Balk, 2001), effect of economies of scale on change in the scale of operation of a firm or industry firms (Jorgenson and Griliches, 1967) and organizational improvement (Solow, 1957), may become more unwilling to invest further in R&D and so RDI may fall.

Net export intensity is positively related with Research and development Intensity. Perhaps due to increase in net export may generate extra profit from foreign market which may help in expansion of RDI.

5.3.2.2 Determinants of TFPG of Fabrics producing sector

In this model, there are three equations namely TFPG, Firm size and Research and Development Intensity. The results of estimation of simultaneous equation model can be visualized from **Table 5.16 to Table 5.24.**

In case of **TFPG equation** whose result can be found in Table 5.16, it is found that the Advertising intensity of previous period have nonlinear relationship with TFPG and the net effect of Advertising intensity of previous period on TFPG is positive. Whereas Firm size, Research and development intensity, Net export intensity of previous period, Firm age and Marketing intensity of previous period are linearly related with TFPG. Since the marginal effect of Advertising intensity of previous period is positive as is revealed from Table 5.19, it implies that this variable has positive relationship with TFPG 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 5.20.

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

The positive relationship between TFPG and ADV_{t-1}may be due to firms spending more on advertisement are more disposed to present new products in the market easily, increases sales and combats market competition thereby increasing productivity.

The relationship between TFPG and FS is also obtained positive. The reason may be that for a big size firm market is relatively secured, faces less market competition and are able to use sophisticated technology in production process which may generate higher TFPG relative to smaller firms.

There exists a negative association between TFPG and RDI. The reason may be that R&D expenditure may not enable firms to attain better TFPG rather it may reduce TFPG possibly because of the inability to operate new technology and reap its potentiality instantaneously (Mitra and Jha, 2015).

Net export intensity of previous period is found positively related with TFPG. This indicates that with increase in net export in the previous period, TFPG may increase. The result possibly due to with rise in Net export intensity of previous period, knowledge spillover from the international contacts and spillovers from technology diffusion may take place which can promote TFPG in the current period.

A positive relationship is found between firm age and TFPG, which means that TFPG may rise with increase in firm age. The older firms have benefits of learning earlier, may have more experience and also may have easier access to funding compared to new firms which may help to increase TFPG.

There also exists a positive association between TFPG and MEI in the previous period. It may be the reason that a higher allocation of resources for marketing activities may indicate an effort to strengthen the firm's brand and product image which may lead to more production thereby encouraging TFPG.

The effect of dismantling of MFA has a negative significant effect on TFPG. The falling TFPG levels of the firms after the phasing out period compared to the MFA period perhaps due to the failure of the firms to match the competitive pressures of price and quantity from different countries and for this unfavorable situation the firms may be unable to achieve the economies of scale in production and there may be fall in TFPG.

In the **Firm Size Equation** whose results are presented in Table 5.17**,** Marketing intensity of previous period has nonlinear relationship with FS. The marginal effect of MEI in previous period is obtained positive which is revealed from Table 5.21, i.e. MEI in previous period has positive relationship with FS and is statistical significance as revealed from Table 5.22. But TFPG, Research and development intensity, Net export intensity of previous period, Advertising intensity of previous period and Capital-labour ratio are linearly related with FS as is revealed from Table 5.17.

The positive relationship between MEI in previous period with FS may be due to the reason that more marketing activities may help to strengthen the firm's brand and product image which may lead to higher demand of product and firms may produce more thereby increasing firm size.

TFPG is found to have a favorable effect on FS. The reason may be that with increase in TFPG due to frontier shift, there is increase in output which may lead to firm size increase.

Relationship between RDI and Firm size is obtained positive. The reason may be that R&D may increase the production of a firm using sophisticated technology in the production process which may lead to increase in firm size.

There exists a negative association between Net export intensity of previous period and FS. This indicates that import may have more favourable impact over export to promote FS. The reason may be that when a firm imports quality raw material and machineries it may improve its production, which can raise its output level thereby leading to increase in FS.

FS is found to have a positive relation with ADV in previous period which may suggest that more advertisement in previous period helps to introduce a new product in the market easily and increases sales in the current period thereby increasing firm size.

Capital-labour ratio, which serves as a degree of mechanization is positively associated with FS. The reason may be that capital intensive industries have an ability to generate mass production and adopt strategies for high growth employing advanced and sophisticated technology into the production process. This may help to increase Firm size.

For the **Research and Development Intensity equation,** whose results are presented in Table 5.18, it can be inferred that Firm size have nonlinear relationship with RDI. Marginal effect of Firm size is positive as is revealed from Table 5.23, implying that Firm size have positive relationship with RDI and found to be statistically significant which is represented in Table 5.24.Whereas TFPG and Net export intensity are linearly related with RDI.

A positive relationship is found between FS and RDI. Possibly the reason may be that a larger firm can be able to exploit economies of scale thus producing more which may positively influence Research and development Intensity.

TFPG is found to have positive relationship with RDI. Increase in TFPG may increase RDI may be due to increase in productivity firms may be capable to use its input efficiently and produce more output which may promote Research and development Intensity.

Net export intensity is positively related with Research and development Intensity. Perhaps with increase in net exports, firms have the scope of knowledge spillover from the international contacts and technology diffusion which may promote RDI.

5.4 Summary and Conclusion

The present chapter estimates TFPG of Yarn and Fabrics producing sector of ITI covering the period 1991-2015, using the non-parametric method of DEA. Side by side the determinants of TFPG for these two sectors are tried to be found out.

The major findings of the present chapter can be summarized as follows:

First, there is a wide variation in MPI values among the firms in the two sectors. For the yarn producing sector, the majority of the firms have their mean MPI below the grand mean. Thus majority of the firms are performing below average. TFPG as obtained from MPI is 5.4 %.Whereas for the fabrics producing sector, majority of the firms have their MPI above the GRM of MPI. Thus majority of the firms are performing above average. TFPG is calculated and is equal to 7.2 %.

Secondly, all the three components of the productivity index namely TC, TEC and SEC have contributions in determining the firms' productivity for both the yarn and fabrics producing sector.

For both the sectors, SEC is found to dominate over the other two components such as technical change and technical efficiency change.

Thirdly, the results of determinants of TFPG of Yarn and Fabrics producing sector reveals that Advertising intensity of previous period is found to have a nonlinear relationship with TFPG. Firm size, Net export intensity of previous period and Firm age are linearly and positively related with TFPG. RDI is linearly and negatively related with TFPG for both the sectors. Only the variable Marketing intensity of previous period have a linear and positive effect on TFPG of Fabrics producing sector. The effect of dismantling of MFA has a negative and significant effect on TFPG for both the sectors.

Finally, Firm size, Firm age, Net export intensity and Advertising intensity are the common determinants of TFPG and may encourage TFPG for both the sectors.

Thus the analysis reveals that in order to encourage Total factor productivity growth, any policy changes that will lead to increase in Firm size, Net export intensity, Advertising intensity should be emphasized.

Table 5.1: Malmquist Productivity Index and Productivity Growth Rate in Yarn producing Sector (Annual Averages of firms)

Range of Mean MPI	Grand Mean of MPI (GRM)	Percentage of Firms below the GRM	Percentage of Firms above the GRM	Productivity Growth Rate
0.939-1.120	1.014	59.09	40.91	5.4

Source: Compiled by the Author

Table 5.2: Decomposition of Malmquist Productivity Index in Yarn producing Sector

Components	Range of Mean	Grand mean	Remarks
Technical change (TC)	0.982-1.030	1.009	SEC dominates
Technical efficiency change (TEC)	0.919-1.075	0.988	
Scale Efficiency change (SEC)	0.993-1.059	1.018	

Source: Compiled by the Author

Table 5.3: Rate of Technical change, Technical efficiency change and Scale Efficiency change in Yarn producing Sector

Rate of Technical Change	Rate of Technical efficiency change	Rate of Scale Efficiency change
7.032%	8.125%	11.599%

Table 5.4: Malmquist Productivity Index and Productivity Growth Rate in Fabrics producing Sector (Annual Averages of firms)

Range of Mean MPI	Grand Mean of MPI (GRM)	Percentage of Firms below the GRM	Percentage of Firms above the GRM	Productivity Growth Rate
0.845-1.138	1.000	47.62	52.38	7.2

Source: Compiled by the Author

Table 5.5: Decomposition of Malmquist Productivity Index in Fabrics producing Sector

Components	Range of Mean	Grand mean	Remarks
Technical change (TC)	0.954-1.042	1.002	SEC dominates
Technical efficiency change (TEC)	0.843-1.165	0.987	
Scale Efficiency change (SEC)	0.943-1.074	1.011	

Source: Compiled by the Author

Table 5.6: Rate of Technical change, Technical efficiency change and Scale Efficiency change in Fabrics producing Sector

Rate of Technical Change	Rate of Technical efficiency change	Rate of Scale Efficiency change
12.947%	17.061%	18.159%

Table 5.7: Estimated Results of Simultaneous Equation Model of Yarn producing Sector: The Case of TFPG Equation

Variable	Coefficient	t-Statistic	p value
C	-0.614***	-11.236	0
FS	0.014***	10.235	0
RDI	-0.138***	-16.326	0
$NXI_{(t-1)}$	0.011***	35.856	0
FA	0.022***	7.145	0
$ADV_{(t-1)}$	0.030***	16.617	0
$ADV_{(t-1)}^2$	0.0009***	7.564	0
D	-0.012***	-4.404	0
Adjusted R-squared	0.891		
F-statistic	616.409		
Prob(F-statistic)	0		

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

Table 5.8: Estimated Results of Simultaneous Equation Model of Yarn producing Sector: The Case of Firm Size Equation

Variable	Coefficient	t-Statistic	p value
C	-3.210***	-78.694	0
TFPG	2.269***	16.304	0
NXI	-0.225***	-97.799	0
K/L	0.022***	13.798	0
$ADV_{(t-1)}$	0.133***	11.498	0
MEI	0.179***	29.118	0
$ADV_{(t-1)}^2$	0.013***	18.145	0
Adjusted R-squared	0.910		
F-statistic	889.093		
Prob(F-statistic)	0		

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

Table 5.9: Estimated Results of Simultaneous Equation Model of Yarn producing Sector: The Case of Research and Development Intensity Equation

Variable	Coefficient	t-Statistic	p value
C	-2.228***	-9.104	0
TFPG	-5.367***	-27.095	0
FS	2.499***	24.172	0
NXI	0.125***	16.033	0
PR	0.003	0.504	0.615
FS^2	0.435***	38.225	0
Adjusted R-squared	0.871		
F-statistic	712.654		
Prob(F-statistic)	0		

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

Table 5.10: Marginal Effects of the Explanatory Variables from the Simultaneous Equation Model of Yarn producing Sector: The Case of TFPG Equation

Variable	Marginal Effect
$ADV_{(t-1)}$	0.024

Table 5.11: Wald Statistic of the Simultaneous Equation Model of Yarn producing Sector: The Case of TFPG Equation

	$ADV_{(t-1)}$
Chi-square	4.814*

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

Table 5.12: Marginal Effects of the Explanatory Variables from the Simultaneous Equation Model of Yarn producing Sector: The Case of Firm Size Equation

Variable	Marginal Effect
$ADV_{(t-1)}$	0.053

Table 5.13: Wald Statistics of the Simultaneous Equation Model of Yarn producing Sector: The Case of Firm Size Equation

	$ADV_{(t-1)}$
Chi-square	30.378***

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

Table 5.14: 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
FS	0.908

Table 5.15: Wald Statistics of the Simultaneous Equation Model of Yarn producing Sector: The Case of Research and Development Intensity Equation

	FS
Chi-square	7.839**

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

Table 5.16: Estimated Results of Simultaneous Equation Model of Fabrics producing Sector: The Case of TFPG Equation

Variable	**Coefficient**	**t-Statistic**	**p value**
C	-2.947***	-43.445	0
FS	0.161***	26.322	0
RDI	-0.586***	-40.876	0
$NXI_{(t-1)}$	0.017***	18.704	0
FA	0.160***	13.944	0
$ADV_{(t-1)}$	0.033***	71.983	0
$MEI_{(t-1)}$	0.006***	4.152	0
$ADV_{(t-1)}^2$	0.004***	48.104	0
D	-0.041***	-14.297	0
Adjusted R-squared	0.920		
F-statistic	724.063		
Prob(F-statistic)	0		

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

Table 5.17: Estimated Results of Simultaneous Equation Model of Fabrics producing Sector: The Case of Firm Size Equation

Variable	Coefficient	t-Statistic	p value
C	0.978	1.107	0.269
TFPG	1.166***	17.282	0
RDI	0.957***	5.977	0
$NXI_{(t-1)}$	-0.047***	-16.192	0
$ADV_{(t-1)}$	0.025***	6.733	0
$MEI_{(t-1)}$	0.313***	26.462	0
(K/L)	0.184***	11.059	0
$MEI_{(t-1)}^2$	0.042***	20.327	0
Adjusted R-squared	0.879		
F-statistic	523.004		
Prob(F-statistic)	0		

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

Table 5.18: Estimated Results of Simultaneous Equation Model of Fabrics producing Sector: The Case of Research and Development Intensity Equation

Variable	Coefficient	t-Statistic	p value
C	17.823***	12.713	0
TFPG	1.727***	5.248	0
FS	10.131***	15.494	0
NXI	0.196***	18.315	0
PR	0.012	1.528	0.127
FS^2	1.082***	14.274	0
Adjusted R-squared	0.872		
F-statistic	686.338		
Prob(F-statistic)	0		

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

Table 5.19: Marginal Effects of the Explanatory Variables from the Simultaneous Equation Model of Fabrics producing Sector: The Case of TFPG Equation

Variable	Marginal Effect
$ADV_{(t-1)}$	0.017

Table 5.20: Wald Statistics of the Simultaneous Equation Model of Fabrics producing Sector: The Case of TFPG Equation

	$ADV_{(t-1)}$
Chi-square	7.828**

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

Table 5.21: Marginal Effects of the Explanatory Variables from the Simultaneous Equation Model of Fabrics producing Sector: The Case of Firm Size Equation

Variable	Marginal Effect
$MEI_{(t-1)}$	0.185

Table 5.22: Wald Statistics of the Simultaneous Equation Model of Fabrics producing Sector: The Case of Firm Size Equation

	$MEI_{(t-1)}$
Chi-square	9.795***

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

Table 5.23: 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
FS	5.250

Table 5.24: Wald Statistics of the Simultaneous Equation Model of Fabrics producing Sector: The Case of Research and Development Intensity Equation

	FS
Chi-square	26.204***

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