Chapter 2

An Overview of the Existing Literature

2.1 Introduction

Globalization influenced several developing countries to change their industrial policies and exposing the domestic firms to global competition. The switch from a protectionist system to global competition forced different industries to change their method and take measures needed for long term endurance and growth and Indian Textile industry (ITI) is not an exception.

Several important policies have been taken for ITI in different periods. During the initial period of 1990s, delicensing of ITI was done. Then a Technology Upgradation Fund Scheme was launched in 1999 and The Government of India announced the National Textile Policy (NTP) in 2000. Global trade in ITI has long been administered by the Multi-Fibre Agreement (MFA), which fixed national quotas for the export of textiles. But from January 1, 2005 ITI was opened to free competition at international level. As a result, competition increases significantly, the scope of employment has increased and the industry started using various cost-saving operational measures to turn out more competitive, more efficient and more productive**.**

The rest of the chapter is structured as below: Section 2.2 presents the survey of literature. Section 2.2.1 discusses studies on employment of manufacturing industries, studies relating to employment in the international context as well as in the Indian Context are presented in 2.2.1.1 and 2.2.1.2 respectively. Section 2.2.2

discusses the literature relating to testing for Structural Break using Unit Root Hypothesis. The Alternative Theories of Unit Root Hypothesis and the empirical studies on Trend Analysis using modern time series technique are discussed in 2.2.2.1 and 2.2.2.2 respectively. Section 2.2.3 discusses studies on Technical efficiency (TE) of Manufacturing Industries. Econometric theoretical literature on TE is presented in 2.2.3.1. Empirical literature on TE for Manufacturing Industries is discussed in 2.2.3.2. Studies relating to TE in the international context as well as in Indian Context are presented in section 2.2.3.2.1 and 2.2.3.2.2 respectively. Section 2.2.4 discusses Studies on Total Factor Productivity Growth (TFPG) of Manufacturing Industries. Section 2.2.4.1 discusses econometric theoretical literature on TFPG. Empirical literature relating to TFPG of Manufacturing Industries is presented in 2.2.4.2. Studies relating to TFPG in international context as well as in Indian Context are presented in Sections 2.2.4.2.1 and 2.2.4.2.2 respectively. Different studies on Indian Textile industry are discussed separately in the section 2.2.5. Studies on employment, efficiency and productivity of Indian Textile industry are discussed in section 2.2.5.1. Other studies on Indian Textile Industry are discussed in section 2.2.5.2. The connection of the present thesis with the existing literature is presented in Section 2.3.

2.2 Survey of Literature

In the existing literature there are several studies on different aspects of manufacturing industries in various parts of the world. Researchers have given endeavour to determine the performance of manufacturing industries considering different time periods, employing different methodologies and concluded accordingly. However, since the area of interest of the present thesis is limited to the analysis of growth of employment, efficiency and productivity and particularly of Indian textile industry, to keep discussion within limit, studies on employment, technical efficiency and total factor productivity growth of different manufacturing industries are discussed in this section. The studies on employment, efficiency and productivity and also other studies relating to ITI are deliberated in detail in a separate subsection.

2.2.1 Studies on employment of Manufacturing Industries

The present thesis attempts to analyse the growth of employment and particularly of Indian textile industry. The econometric theoretical literature on growth rests on both traditional methodology of curve fitting as well as modern advanced time series econometric techniques.

2.2.1.1 Empirical Literature on employment of Manufacturing Industries

Over the years there are various studies that are concerned with the employment of different manufacturing industries in the different parts of the world under different time periods, employing different methodologies.

2.2.1.1.1 Studies relating to employment in International Context

There are several studies that examined employment of different manufacturing industries in the different parts of world (other than India). Some important studies are done by O'Farrell (1985), Haynes and Machunda (1987), Dunne and Roberts (1991), Akbari, Riazuddin and Choudhry (1993), Lever (1996), Lett and Banister (2009), Kollmeyer (2009), Banister and Cook (2011), Barker (2011), Blasio and Menon (2011), Huang, Pang and Tang (2014), Pierce and Schott (2016), Hernandez (2018), Fort, Pierce and Schott (2018), Houseman (2018), Moazzem and Reza (2018) among others.

O'Farrell (1985) presented evidence regarding manufacturing employment change and plant size in Ireland during 1973 to 1981. This paper concluded that size influenced more upon net employment change than ownership and smaller and younger plants are more upwardly mobile.

Haynes and Machunda (1987) analyzed employment change in Indiana during the period 1950-1980. They found that the reversal of the previous metro non-metro pattern of the employment growth in Indiana, occurring during the 1970s, was caused by the shift of manufacturing from metropolitan areas to nonmetropolitan areas.

Dunne and Roberts (1991) used longitudinal data of individual U.S. manufacturing firms from 1963 to 1982 in their study. The results of this empirical paper concluded that, of the employment opportunities in advancement in the U.S. manufacturing sector in 1982, 30 percent were at least 19 years old and 59.6 percent would have a completed length of at least 20 years. They also concluded that high rates of turnover in employment scopes coexist with a huge number of long-duration employment opportunities.

Akbari, Riazuddin and Choudhry (1993) analysed the employment growth in the manufacturing sectors of Punjab and Sindh province during 1980 to 1987. They argued that during this period average daily employment in Pakistani manufacturing sector rose by 16.42 %, Punjab and Sindh province experienced significantly different employment growth rate and employment growth in Sindh province was quicker than the average national employment growth while growth of employment in Punjab was slower.

Lever (1996) examined the firm size effect on determination of employment employing panel data of 67 three -digit Dutch manufacturing industries for the period 1974 to 1986. This empirical paper revealed that employment adjustment takes place faster in small firms, real wage elasticity at constant output and elasticity of factor substitution more or less same for both types of firms and number of working hours has less impact on employment in small firms than in large firms.

Lett and Banister (2009) investigated the employment growth of Chinese manufacturing sector from 2000 to 2006 and the impact of compensation costs on employment growth. They noted that both employment and the compensation costs in manufacturing sector increased rapidly throughout the period; employment increased more than 10 % during those 4 years, while compensation costs increased more than 40 %.

Kollmeyer (2009) investigated the reasons of deindustrialization and effect of productivity growth and globalization on employment growth with panel data of 18 OECD countries covering the data over 1970 to 2003. The panel data estimation under two-way fixed effects regression model revealed that rising consumer affluence, faster productivity growth and expanding trade linkages between North and South of the global economy are three main influencing factors. The result of this paper showed that three factors makes significant contribution to the deindustrialization and global trade exert both indirect and direct effects on patterns of employment.

Banister and Cook (2011) investigated the employment growth of Chinese manufacturing sector through 2008 and impact of compensation costs on employment growth.

Barker (2011) examined the Manufacturing employment trends of the 2007–09 recession and observed that during recession manufacturing industry lost 2 million jobs i.e. 17 % of its workforce, and industry employment fell to its lowest level since March 1941.

Blasio and Menon (2011) concluded that the local impact of growth in employment for tradable sectors is zero due to three candidates, namely lack of variability for wages, excess regulation for the nontradables and additional obstacles to labour mobility.

Huang, Pang and Tang (2014) examined the effect on employment due to exchange rate in Canada. They concluded that appreciation of the Canadian dollar has significant effects on employment in manufacturing industries such effects are mostly connected with the export-weighted exchange rate and when the commodity prices increased by 15.77 %, manufacturing employment decreased by 0.8 %, around 0.08 % of aggregate employment.

Pierce and Schott (2016) investigated the reasons of sharp drop in employment of US manufacturing after 2000 and argued that greater employment loss is due to shifts toward less labor-intensive production, US trade policy change and greater entry by US importers and foreign owned Chinese exporter.

Hernandez (2018) examined the situation of labour employment in manufacturing sector of United States during 1980 to 2017 diving into two sub periods (1980-2000 and 2000-2017). He argued that 2 million jobs were lost between 1980 and 2000 and 5.5 in the second period and these losses affect the employment rates of prime age workers may be due to rising trade with China.

Fort, Pierce and Schott (2018) investigated different perspective of United States manufacturing employment from Second World War. They concluded that manufacturing employment of US declined over the time and this exhibit three notable trend; These are manufacturing employment has deviated from non-manufacturing employment, United States manufacturing employment fell just 12 % over the years 1979-2000, and then dropped by 25 % from 2000-2012, and despite the relative similarity and ensuing sharp decline in US manufacturing employment.

Houseman (2018) investigated the reasons of historically incomparable decline in the employment in 2000s of U.S. manufacturing. This paper pointed out that trade meaningfully contributed to fall down of the manufacturing employment in 2000s, and found little evidence of causal link to mechanization.

Moazzem and Reza (2018) focused on the effect of Bangladesh manufacturing sector on the generation of productive employment, supported by the trade policies toward industrialization and manufacturing employment growth for the period 2013 to 2017. They observed that while wages of this sector grew to some extent, there was negative employment growth and employment growth rate in manufacturing sector decreased over time (-1.84%).

2.2.1.1.2 Studies relating to employment in Indian Context

There are plenty of studies on employment of manufacturing industries in India. Some of the important studies are due to Goldar (1987), Seth and Seth (1991), Nagaraj (1994), Bhalotra (1998), Goldar (2000), Nagaraj (2000), D.N (2004), Nagaraj (2004), Das (2007), Panda and Ryou (2007), Kannan and Raveendran (2009), Goldar (2011), Mehrotra et. al. (2014), Jain (2015), Das and Sengupta (2015), Mehta (2016), Das et al. (2017), Mehrotra and Parida (2019), Rodgers (2020) among others.

Goldar (1987) computed employment growth in Indian industry during the period 1951-1980 collecting the data from Annual Survey of Industries (ASI). This empirical paper concluded that for the sub-periods 1951-60 and 1960-70 employment growth rate is less than half of the output growth but during 1970-80 both are almost equal.

Seth and Seth (1991) investigated the labour absorption in Indian manufacturing sector for the period 1960 to 1984 and estimate employment function. They noted that Output in manufacturing sector as a whole has grown at 6.4 % per annum while employment has grown at 3.% per annum over 1960 to 1984 and the value of gross employment output elasticity (Eg) as 0.543.

Nagaraj (1994) investigated employment growth and wage rate trend in Indian manufacturing industries over 1973-74 to 1988-89 collecting data from ASI and concluded a decreasing trend of employment growth rate took place not at aggregate level and also for the most 2 digit industry and reportedly sharp rise in the wage rate in the 80s in registered manufacturing. This study provided evidence to suggest that the wage rate and earnings per man day did not increase excessively as has been argued, this growth mainly due to the increase in number of man days per worker.

Bhalotra (1998) estimated employment growth of Indian organized manufacturing industry and concluded that employment growth in the organized manufacturing came to a halt even as output accelerated during 1980s, value added in organized manufacturing grew at 5% per annum during 1965-79, while employment grew at 3.5 % per annum where as the growth rate of value added increased to 6.3 %

per annum, while employment growth rate declined to -0.3 % per annum for the period of 1979-87.

Goldar (2000) analysed ASI data during 1980-81 to 1997-98 to estimate the employment growth of two-digit Indian manufacturing industry and examined the econometric relationship between employment growth and real wages, man days per employee and growth rates of output. This article concluded that employment growth rate was still during 1980s, but grew in 1990s for the change in size structure in favor of small scale and medium scale industries and slowdown in growth in real wages. He also noted that no statistically valid relationship between growth in employment and wages across industries, coefficients of output growth and real wages have the correct sign and are statistically significant; coefficient of growth rate in man days has the correct sign, but statistically insignificant.

Nagaraj (2000) investigated the employment growth situation in organized manufacturing industries and reexamine (Goldar, 2000) the relationship between employment growth and output growth, real wage rate and man days during 1991 to 1997. This article concluded that registered manufacturing employment grew annually at about 3 % during this period which is contrary to the jobless growth during 1980s and found a positive statistically significant relation with both employments in one case and with wages in the other.

D.N. (2004) discussed about the low employment growth of manufacturing industry in India due to curious feature of India's experience with globalisation in the 1990s. He noticed that due to globalisation India in exports of medium and even relatively high-technology products like pharmaceuticals, automobiles and automobile parts, and software where as south-east Asia and Chin was concentrated in such labour-intensive sector in the first phase of export. He suggested that to increase growth of employment, India should focus on low technology, labour-intensive exports.

Nagaraj (2004) estimated employment growth of Indian organised manufacturing sectors using ASI data covering the period from 1995-96 to 2000-01 and concluded that about 15 % of workforce lost their jobs between these periods perhaps due to setting up National Renewal Fund to finance mainly economizing of workers in the public sector enterprises, growing unavoidable domestic and external competition and introduction of information technology.

Das (2007) explored the role manufacturing output growth on overall economic growth and on employment growth in India manufacturing industries in the pre and post-liberalisation phases of the country and test Kaldor's hypotheses with Indian data. This paper shaded new light on differences in regional patterns of growth in India over the period 1970-71 to 2002-03 collected from National Accounts Statistics (NAS), the Central Statistical Organisation and published by the EPW Research Foundation, 2003. He mainly focused on West Bengal and Gujarat, experiencing different types of growth. This paper concluded that manufacturing growth as of overall economic growth has increased after the mid-1980s, such as explosion of information technology; telecom and entertainment have also registered impressive growth, Indian manufacturing industries did not play any noteworthy part as the engine of growth during past three decades and simple regression results give a strong statistical relationship between employment and output growth and no causality between them at the national level and Gujarat.

Panda and Ryou (2007) estimated employment growth of manufacturing industries in India during pre and post reform period covering the data from 1980-81 to 1997-98. They argued that rise in the employment is the effect of growth of the real gross value added; employment intensity of the real gross value added dropped over time and contributed negatively to employment growth. This paper also noted that structure of the aggregate manufacturing shifted in indulgence of less employment intensive industries (due to insufficient economic incentives and infrastructural constraints) which contributed negatively to employment growth.

Kannan and Raveendran (2009) examined long terms growth performance of organised manufacturing sector separating the period into pre and post-reform years, employment performance, change in income distribution between capital and labour using the ASI data from 1981-82 to 2004-05 at the 3-digit level of industrial classification. They concluded that for two separate periods growth was unable to create job opportunities (jobless growth) due to the combine effect of two trend i.e one group by employment creating and other groups by employment displacing; and over the period there has been hastening capital intensification at expense of creating employment

Goldar (2011) analysed ASI data during 2003-04 to 2008-09 to estimate employment growth rate of Indian organised manufacturing industries. He noted that employment has increased in recent years at very rapid rate of 7.5 % per annum amongst 2003-2004 and 2008-2009 not for the labour intensive industries or labour intensive enterprises, this is for to the private limited companies because growth of employment has been relatively quicker among private limited companies (14% per annum), whereas the employment growth rates in proprietorships, partnerships and public limited companies were 7.7 percent, 5.3 percent and 6.1 percent per annum respectively.

Mehrotra et. al. (2014) investigated trends in employment of India from 1993-94 to 2011-12 based on NSSO unit level data. They found that structural transformation absolutely go down in agricultural employment and mount in non-agricultural employment, a fall in demand for manufacturing exports and increasing capital intensity decline manufacturing employment during the period 2004-05 to 2009-10. This paper also estimates 17 million jobs per year need to be created in non-agriculture during 2012 to 2017 and makes policy prescription to increase nonagricultural employment in India.

Jain (2015) analysed ASI data considering the period 1990-91 to 2009-10 at 3-digita and 4-digit level data to estimate the output growth and employment growth of Indian organised manufacturing industries and find out the relationship between employment growth and output growth, wage rate and employment growth of the previous period. This article noted that manufacturing industries performed well for output during this period but was not able to increase employment growth and found a positive relation between employment growth and output growth, employment growth of the previous period.

Das and Sengupta (2015) examined the regional variation (across major states in India) in output, productivity growth and employment of registered manufacturing industries collecting the data from ASI during 1998-2010. They concluded that growth of output increases productivity growth rate rapidly but not employment growth. They also noted that workers are most affected than worker and western part is leading whereas eastern part lagging behind.

Mehta (2016) investigated the effect of innovation on the employment growth using the data during 2000–2001 to 2013–2014 for Indian pharmaceuticals, textiles, ferrous metals and transport industries and found the positive impact of 'Product innovation' on employment.

Das et al. (2017) examined the relationship between wage rate and labour productivity and its impact on employment for all 2 digit manufacturing industry collecting the data from ASI during 1998-2013. This study concluded that differential effects on wage and employment through labour productivity growth across different industry groups and higher wage-productivity gap enhance employment growth.

Mehrotra and Parida (2019) investigated the employment growth scenario of non-agricultural sector in India during 2005-2018. They found a falling trend of total employment and growing educated youth unemployment and lack of the quality non-farm jobs though share of formal and regular employment augmented marginally due to private sectors and real wages not increased in both rural and urban areas.

Rodgers (2020) reviewed knowledge transformation and thinking regarding the employment and labour issues in India over the last fifty years and examines six issues like the mode of production; employment deficits; labour institutions and the labour market; wages; quality of work; poverty and inequality and concluded that India need to develop new approach to address employment problems adequately.

2.2.2 Testing for Structural Break using Unit Root Hypothesis

If we go through the existing literature, we find several studies where researchers have empirically made the Unit Root hypothesis and Structural Break analysis employing any of the existing methodologies (by curve-fitting technique or traditional trend analysis technique) and concluded accordingly. With concrete empirical supports, some researchers have developed alternative theories of Unit Root hypothesis. The following sub-sections consist of some important studies on macroeconomic time series related to analysis of trend / true nature using Unit Root test procedure.

2.2.2.1 Alternative Theories of Unit Root Hypothesis

Conventionally it is viewed that macroeconomic time series only have a temporary effect due to random shock and in the long run the movement of the series remains unaffected since the macroeconomic series generally follows Trend Stationary Process and one can reject the presence of Unit Root in the series. To test Unit Root hypothesis some alternative approaches are developed. Some important works are done by Samuelson (1973), Gould and Nelson (1974), Hall (1978), Blanchard and Summers (1986), Nelson and Plosser (1982), Stulz and Wasserfallen (1985), Wasserfallen (1986), Clark (1987), Champbell and Mankiw (1987, 1988), Shapiro and Watson (1988), Cochrane (1988), Christiano and Eichenbaum (1989), Perron (1989), Zivot and Andrews (1992), Perron and Vogelsang (1992), Christiano (1992), Perron (1997), Vogelsang and Perron (1998).

Samuelson (1973) did Unit Root tests on stock prices, Gould and Nelson (1974) tests Unit Root hypothesis on velocity of money, Hall (1978) and Blanchard and Summers (1986) on consumption series and on employment respectively. They apply different methods of conventional testing procedure and instigate a sequence of theoretical research with steady implications of presence of the Unit Root.

The conventional view claimed presence of deterministic trend in major macroeconomic series, which **Nelson and Plosser (1982)** challenged boldly. They used statistical techniques (due to **Dickey and Fuller (1979, 1981)**) in their seminal study and argued that current shocks have an everlasting consequence in long run on most macroeconomic series and financial time series. Later the Dickey-Fuller test is modified due to **Said and Dickey (1985)** and noted that the series follows autoregressive moving average process.

Stulz and Wasserfallen (1985) and **Wasserfallen (1986)** apply methodology like Nelson and Plosser, to other economic series and endorse the conclusion of stochastic trend in respective considered economic time series.

Clark (1987), Champbell and Mankiw (1987, 1988), Shapiro and Watson (1988), Cochrane (1988) and Christiano and Eichenbaum (1989) test Unit Root hypothesis on different macroeconomic time series and concluded that current shocks are a combination of permanent and temporary shocks and the response of a series in the long run due to random shock is dependent on the relative size or importance of permanent and temporary shocks.

Perron (1989) performed the Unit Root test taking different macroeconomic time series to assess the reliability of the hypothesis of Unit Root conditional on a known break point. Comparing the experiential results with asymptotic critical values he argued that most economic time series do not have the Unit Root and the fluctuations are transitory in nature except crash of 1929 and the Oil Price Shock of 1973 have had a enduring effect on various macroeconomic variables.

Many studies developed criticizing Perron's method which assumed exogenous break in the time series. Along with Zivot and Andrews (1992), other important studies are by Perron and Vogelsang (1992), Christiano (1992), Perron (1997), Vogelsang and Perron (1998) adopting Perron's methodology (1989) for each possible break date i.e., the breaks are endogenous in nature.

Zivot and Andrews (1992) argue against the exogeneity assumption concerning the Great Depression (1929) and the Oil Crisis (1973) and transform the whole testing procedure into an unconditional Unit Root test considering the break points as endogenous. They can't reject the existence of Unit Root at 5% level for four series (which series are rejected by Perron) out of the ten Nelson and Plosser series comparing the empirical findings with their own-constructed asymptotic critical values.

Christiano (1992) tests Unit Root hypothesis on post-war quarterly real GNP series employing bootstrap methods and unable to reject Unit Root.

Different statistical tools are developed due to Phillips and Durlauf (1986), Engle and Granger (1987), Stock and Watson (1988) suitable for more general models such as the multivariate systems with integrated variables and co-integration framework. Other literature related to determination of estimated structural breaks and requisite asymptotic distribution are presented by Rappoport and Reichlin (1989), Rappoport (1990) and Banerjee, Dolado and Galbraith (1990).

2.2.2.2 Empirical Studies on Trend Analysis using modern time series technique

Some studies are applied the modern time series technique of trend analysis on different economic series and concluded accordingly. The empirical studies are done by Sun and Wang (1996), Kanjilal and Ghosh (2002), Strazicich and List (2003), Sen (2003) and Aldy (2006) among others.

Sun and Wang (1996) used 129-year historical data of global CO_2 emissions to test the stationarity employing Augmented Dickey-Fuller (ADF, 1979) Unit Root test.

Kanjilal and Ghosh (2002) argued that CO_2 emissions are non-stationary for India Industrial sector.

Strazicich and List (2003) concluded that per capita CO_2 emissions are converging in 21 industrialized countries employing the hypothesis of Environmental Kuznets Curve (EKC) and the concepts of convergence.

Sen (2003) investigated the power properties of SupWald test or maximum F statistic proposed by Murray (1998) and Murray and Zivot (1998) and concluded that the power of maximal F statistic is less erratic and can be greater than mixed model minimum t statistics. He also concludes that the hypothesis of Unit Root can be rejected for all Nelson Plosser series except consumer prices, GNP deflator, interest rate and velocity.

Aldy (2006) used Unit Root test of Dickey Fuller-Generalized Least Square as well as reported that countries' per capita CO_2 emissions are converging.

The perusal of literature regarding the analysis of structural break using Unit Root hypothesis reveals that not much attempt have been done to study, with empirical application, the behavior of industries all over the world. In fact, empirical studies using structural break analysis and Unit Root hypothesis in the ITI context is very limited.

2.2.3 Studies on Technical efficiency (TE) of Manufacturing Industries

The performance of a firm is based on economic efficiency which has two components namely technical and allocative. The technical component refers to the capability to minimize waste of input (i.e. input oriented technical efficiency) by producing as much output or by using as little input as required by technology and output production (i.e. output oriented technical efficiency). Change in input usage due to change in input prices resulting from cost minimization is taken into account by the allocative efficiency. Since the present thesis is limited to technical efficiency (TE) analysis, therefore, to keep the survey within limit, studies relating to TE will be discussed.

2.2.3.1 Econometric Theoretical Literature on Technical Efficiency

2.2.3.1.1 Parametric Approach: Stochastic Frontier Production Function Approach

Solow (1957), associated the production growth with neutral technical change and input growth under the assumption of Constant Return to Scale (CRS). After that many studies focused on efficiency change component, among which, the study by Nishimizu and Page (1982) is the first to introduce efficiency change as a source of productivity change.

A frontier definition of Technical efficiency is provided by Koopmans (1951) corresponding to which Debrew (1951) and Farrell (1957) propose two measures of TE viz. the input-oriented and the output-oriented. The present thesis focuses on the output-oriented measure of Farrell (1957), which consists in comparing the observed output with maximum potential output obtainable from the given inputs. A number of works follow Farrell's work. Aigner and Chu (1968), Afriat (1972), Richmond (1974) using both the linear and quadratic programming techniques estimated production frontiers. Though, this variety of literature is developed around the idea of deterministic production frontier, where the inefficiency is considered as the only source of random disturbance in production process. The random shocks lying outside the control of production units are totally overlooked in these models. To fill this gap Meeusen and Van den Broeck (1977) and Aigner, Lovell and Schmidt (1977) published two papers. After these, the paper by Battese and Corra (1977) is published shortly.

Aigner, Lovell and Schmidt (1977) is one of the contributory papers with which the discussion on Stochastic Frontier Analysis (SFA) originated. They used the empirical example of US primary metal industry of 28 states for 1957-58 to define the composite error term as the sum of symmetric, normal, statistical noise and non-negative one-sided error component that captures the effects of technical inefficiency.

Pitt and Lee (1981) used the data on 50 firms of Indonesian weaving industry for the years 1972, 1973 and 1975 to estimate technical inefficiency employing extend cross sectional maximum likelihood estimation techniques to panel data

Jondrow et al. (1982) formulated a technique of separating the error term of the stochastic frontier production (SFP) model into a normal error term and a non-negative inefficiency term. They estimate two models- one with Technical efficiency error term following a half-normal distribution and other with efficiency term following exponential distribution.

Battese and Coelli (1988) estimated stochastic frontier production (SFP) function under the assumption of non-negative and time-invariant technical inefficiencies, having truncated normal distribution using data on dairy firms in Australia for 1978-81.

Cornwell, Schmidt and Sickles (1990) used panel data on US airlines from the first quarter of 1970 to the fourth quarter of 1981 to incorporate a flexible function of time in the production function instead of making strong distributional assumptions for technical inefficiencies or random error term.

Kumbhakar (1990) considered increasing, decreasing and time-invariant behavior of TE, specifies a model for TE estimation incorporating the assumption of cost minimization and input specific allocative inefficiency.

Huang and Liu (1994), anticipated a model of stochastic frontier regression. They combined truncated regression and stochastic frontier regression to estimate production frontier with non-neutral shifting of average production function.

Battese and Coelli (1995) used 10 years panel data on paddy farmers from an Indian village to define a SFPF in which non-negative technical inefficiency effects are assumed to be a function of time and firm-specific variables using a single-stage approach and found that inefficiency effects are dependent on time of observation and the farmer-specific variables and.

Kalirajan (1997) suggested a simple method to measure the economic efficiency of firms through returns to scale, using firm-level data from South India, when there is no data on price.

Kumbhakar and Lovell (2000) are concerned with the development of a modified econometric approach (Stochastic Frontier Analysis) to the estimation of productive efficiency.

Wang and Schmidt (2002) added to the theoretical aspect of technical efficiency analysis by contrasting one-step estimation method with two-step estimation method of estimation of technical efficiency. When the inputs and firm-specific variables are correlated as well as independent to each other then they found very significant bias in the first step. On the other hand the one-step estimators, based on a correctly-specified model, are found to be asymptotically optimal. They showed the severity of the two-step procedure's bias with extensive Monte-Carlo experiment and suggested the use of single-step procedure.

2.2.3.1.2 Non-Parametric Approach: Data Envelopment Analysis (DEA)

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 Data envelopment analysis one can get the optimum scale and optimum size of output if all inputs are to perform according to best practice. So by Data envelopment analysis one can easily identify those inputs which are not efficient and those outputs which are inefficient.

In order to measure efficiency one has to empirically create the production possibility set empirically from the 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 the underlying technology but there is no explicit functional form of the production function. Introduced by Charnes, Cooper, and Rhodes (CCR) (1978) and afterward generalized by Banker, Charnes, and Cooper (BCC) (1984), DEA allows to empirically create the production possibility set from the observed data.

In case of single input and single output both the input oriented and output oriented measures of technical efficiency can be visualized from figure -2.1.

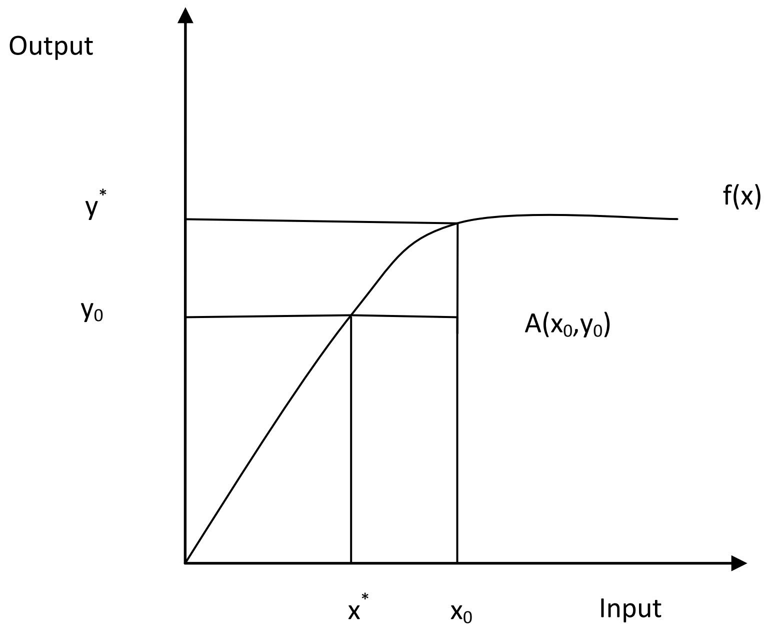

Figure 2.1: The input and output oriented measure of technical efficiency

In figure -2.1 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 TE of firm A = $\frac{y_0}{y^*}$ which involves comparing actual output with maximum producible output from observed input. Now for same output bundle y_0, the input amount can be lowered proportionately until the frontier is reached. So, y_0 can be produced from input x*. Thus the input-oriented TE for firm A = $\frac{x^*}{x_0}$.

The TE value 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 are as 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

Output Oriented Measure:

In case of output oriented technical efficiency of a firm which can be figured through comparison of actual output with the maximum producible output from its given inputs i.e. by how much can output be proportionally increased without changing the input quantities used.

Following Banker, Charnes, and Cooper (BCC) 1984, the output oriented radial TE of a firm with an observed input-output bundle (x^0, y^0) under the variable returns to scale (VRS) assumption is obtained as:

$$\zeta_y\,(x^0, y^0) = \frac{1}{\Phi^*}$$

Where Φ^* = max $\mathbf{\Phi}$

Subject to $\sum_1^N \lambda_j y^j \geq y^0$;

$\sum_1^N \lambda_j x^j \leq x^0$;

$\sum_1^N \lambda_j = 1$ Where $\lambda_j \geq 0$;(j=1,2,…N)

When Constant return to scale (CRS) is assumed the restriction $\sum_1^N \lambda_j = 1$ is deleted from equation.

Input Oriented Measure:

The input-oriented technical efficiency (IOTE) of any firm t under CRS requires the solution of the following Linear programming problem:

min θ

Subject to $\sum_{j=1}^{N} \lambda_j y_{rj} \geq y_{rt;}$ (r=1,2……..g)

$\sum_{j=1}^{N} \lambda_j x_{ij} \leq \theta x_{it};$ (i =1,2………h)

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

The input-oriented TE of firm t under CRS is

$$TE_{IN}^{ct} = TE_{IN}^{ct}(x^t, y^t) = \theta^* \in T^{CRS}$$

Where $\theta^* = \min \theta : (\theta x^t, y^t) \in T^{CRS}$

Thus knowing θ^* by solving equation (5) IOTE of firm t can be determined by using equation (6)

The IOTE of any firm t under VRS can be determined by solving problem (5) along with the constraint $\sum_{j=1}^{N} \lambda_j = 1$, taking into account the VRS frontier.

2.2.3.2 Empirical Literature on Technical Efficiency (TE) of Manufacturing Industries

There are literatures on TE using parametric as well as nonparametric approach for India and abroad. Studies Relating to International Context and Studies Relating to Indian Context are presented in this section.

2.2.3.2.1 Studies relating to Technical Efficiency (TE) in the International Context

There is a vast literature that examined the performances related to TE of different manufacturing industries across the world. Mention should be made of the names like Carlsson (1972), Eckard (1990), Caves and Barton (1990), Holmstrom (1995), Wing and Yiu (1995), Jaforullah (1996), Jarofullah and Devlin (1996), Ibrahim (1997), Taymaz and Saatci (1997), Burki and Terrell (1998), Kong et. al. (1999), Sun et. al. (1999), Marcos et. al. (2000), Mini & Rodriguez (2000), Diffield and Mundy (2001), Alvarez and Crespi (2001), Haris (2001), Kim and Lee (2002), Samad and Patwary

(2003), Baccouche and Kouki (2003), Domazlicky and Weber (2003), Mouelhi and Goaïed (2003), Haouas et al (2003), Uğur (2004), Coto et al. (2004), Hossain and Karunaratne (2004), Faria et al(2005), Oczkowski and Sharma (2005), Tan (2006), Baten et al. (2006), Mahmood, Ghani and Din (2006), Destefanis and Sena (2007), Mitra and Sato (2007), Radam et al (2008), Tran et al. (2008), Diaz and Sanchez (2008), Faruq and Yi (2010), Karadağ (2010), Mok, Yeung, Han and Li (2010), Bhattacharyya (2012), Essmui, Berma, Shahadan and Ramlee (2013), Gamtessa (2014), Findik and Tansel (2015), Tingum and Ofeh (2017), Abdullah, Ismail, Sulaiman, and Talib (2017), Lin et al. (2018), Ming and Barnabé (2018) among others.

Carlsson (1972) measured efficiency of 26 Swedish manufacturing industries and analyzed in terms of macroeconomic variables. The results revealed that tariff affected efficiency adversely and firm concentration ratio affected efficiency favourably.

Eckard (1990) mainly focused on to measure the correlation between concentration and efficiency of US manufacturing industries considering large firm as well as small firm. The paper focused on cost improvements as measure of efficiency. This paper also examined the role of relative large vs small firms' labor productivity growth, and used factor in changing industrial concentration as a proxy of relative unit labor cost growth. The results of this paper exhibited that there was a positive association between concentration changes and relative labor productivity growth advantages of large firm vs small firm.

Caves and Barton (1990) measured TE of 350 US manufacturing industries using SFP function. They also tried to elucidate the variation in TE among industries.

The study shown that flexible employment arrangements and import competition boosted up the TE score but corporate diversification acted the other way.

Holmström (1995) studied the relationships between employment and investment efficiency of Canada, Finland, Japan, South Korea, the UK and the USA manufacturing industries. This paper also explained efficiency as value added relative to both investment in the machinery and equipment and the costs of employment.

Wing and Yiu (1995) studied the relationship between technical efficiency and firm size of Shanghai's manufacturing enterprises from 1989 to 1992 and showed that largest size (thousand workers or above) group generally have the maximum TE and the lowest TE is for group of enterprises having 100 to 249.9 workers while the TE very high for the group of the smallest enterprises with 0-99 workers. They concluded that technical efficiency computed from net industrial product has upward bias compared with that computed from gross industrial product.

Jaforullah (1996) assessed TE of Bangladesh manufacturing industries using Cobb-Douglas form of SFP function and noted that for 19 four-digit manufacturing industries efficiency varies from 29.2% to 86.8% and have significant scope for increasing TE.

Jarofullah and Devlin (1996) estimated firm level TE of 264 dairy industries in New Zealand for the period 1991-92. Translog and Cobb-Douglas specifications were considered. They showed that under half-normal translog frontier model, technical efficiency varies from 76% to 95%.

Ibrahim (1997) measured the efficiency of Malaysian manufacturing industries considering panel estimation method of SFPF. The study showed that on an average the industries have achieved 70% technical efficiency, except Iron & Steel, Leather; Paper and Food industries.

Taymaz and Saatci (1997) measured the efficiency of Turkish motor vehicles, cement, and textile industries using panel estimation method of SFPF for the years 1987-92 introducing time dependent variables in the production function. They identified sector-specific factors which influence TE.

Burki and Terrell (1998) measured the TE and scale efficiency Applying Tobit regressions for 153 small manufacturing firms from nine industries in Pakistan. The paper showed that the new firms with at least primary education and engaging in production were more efficient.

Kong et al. (1999) estimated TE of chemicals, building material, machinery and textile industries in China during 1990-94. They used the SFP function approach developed by Battese and Coelli (1995). They noted that industries' TE has reduced significantly resulting in negative TFPG for particularly chemical and textile industries and minor TFP change for machinery industry.

Sun et al (1999) found that trade openness have a positive outcome on TE of twenty eight manufacturing industries across twenty nine provinces of China. They used DEA for measuring technical efficiency.

Marcos et al. (2000) estimated TE of 855 Spanish manufacturing firms for 15 sectors for the period 1990 to 1994. They used the panel data approach (following Schmidt & Sickles, 1984). The results revealed that heterogeneity in the firm's efficiency. The result also showed that the predominance of CRS and the great rate of technical progress.

Mini & Rodriguez (2000) used SFPF to investigate the relationship between size and TE in the Philippines textile industry and showed that TE increases with size, thus weakening the case for SME targeted policies. They also noted that both exports and the government interferences are positively related with TE although the link between the government support and the TE is somewhat weaker.

Diffield and Mundy (2001) examined how far foreign manufacturing investment with the spatial agglomeration in UK industries affects TE. Stochastic production frontier has been used to exmine.

Alvarez and Crespi (2001) using data of plant survey and nonparametric deterministic frontier methodology of manufacturing firms of Chile, explored the factors which can enlighten the observed differences in TE. They notice that TE is positively related with modernization of physical capital, experience of workers and innovation in the products whereas other variables such as owner's education and participation in the public programs, outward orientation do not affect TE of the firms.

Haris (2001) estimated TE of more than 200 four-digit UK manufacturing industries, for the period 1974 to 1995, using SFP function approach. They noted that manufacturing plants in the Northern Ireland on an average functioned at lower levels of TE compared to their equivalents in the other regions of UK. However Northern Ireland had fewer plants with highest levels of TE within most industries.

Kim and Lee (2002) investigated the relationship between technical efficiency and public capital using panel data from US state manufacturing industries during 1969 to 1986, applying SFP model. The results presented that TE varied much both between states and years and this variation was explained by variation in public sector capital significantly.

Samad and Patwary (2003) estimated TE in the textile industry of Bangladesh using panel data on translog SFPF from 1985-93. The maximum likelihood estimation method suggested that overall average technical efficiency is 0.80%.

Baccouche and Kouki (2003) estimated technical inefficiency of commonly used one-sided distribution of the inefficiency error term. The empirical analysis was done on Tunisian manufacturing firms using panel data analysis covering the period 1983 to 1993. They noted that formal test leads to rejection of the zero mean restriction embodied in the half-normal distribution. The degree of TE was much sensitive to the assumption related to the distribution of inefficiency error term.

Domazlicky and Weber (2003) estimated efficiency and productivity growth at the 3-digit SIC level for six chemical industries considering the period 1988-93 and decomposed TFPG into a product of efficiency change and technical change. The study concludes that annual growth rate of productivity is in between 2.4% and 6.9%. The productivity growth rate is accounted for toxic chemical release and there is no indication of environmental protection measures reduces growth of productivity.

Mouelhi and Goaïed (2003) measured TE of Tunisian textile, clothing and leather (TCL) industries using dynamic translog production frontier. This paper also provided an outlook on efficiency and productivity that should be helpful to a developing economy which will face substantial competitive pressure along with the gradual economic liberalization process.

Haouas et al (2003) estimated labor-use efficiency of Tunisian manufacturing covering the period 1971-96. The empirical results showed that employment demands responded maximum to output, followed by variations in capital stock and minimum by wages in long run and labor-use efficiency showed variations among the manufacturing industries over time.

Uğur (2004) estimated technical efficiency following SFPF approach of Battese and Coelli (1995) using firm level panel data from 1991-99 for optical equipment and electrical industries of Irish manufacturing sector. The paper observed that labor quality and investment intensity are two vital determinants of TE in all the subsectors of both the industries. Only the manufacturing industry of Television and Radio Receivers showed significant relationship between technical inefficiency and export intensity.

Coto et al. (2004) compared the Technical efficiencies of 19 international airline industries worldwide over a period of 8 years, from 1992 to 2000, after liberalization of air transport. They measured TE using panel data on SFP function followed the methodology of Battese and Coelli (1995). They argued that the Asian air industries were technically most efficient industries with a growing market base and able to face the challenges of globalization.

Hossain and Karunaratne (2004) investigated the effects of the trade liberalization on TE of Bangladesh manufacturing sector by estimating combined stochastic frontier inefficiency model using panel data considering the period 1978 to 1994. The results of this paper showed that overall TE of manufacturing sector and TE's of majority of individual industries had increased over time and showed that trade liberalization reducing the overall technical inefficiency.

Faria et al (2005) examined whether flexible production technologies (FPTs), contributed to increase in firms TE for the Portuguese manufacturing industry. To obtain the individual TEs, they used the parametric stochastic frontier approach.

Oczkowski and Sharma (2005) measured efficiency at firm level in Nepalese context using translog SFPF and maximum likelihood econometric method. They found that large firms are much efficient compared to smaller firm and higher capital intensity leads to inefficiency. They do not found any linkage between efficiency improvement and export intensity but observed that higher protection results in inefficiency.

Tan (2006), measured technical efficiency change in Singapore manufacturing industries using the Malmquist index of Data envelopment analysis(DEA) from 1975-98 and showed that there have been improvements in technical efficiency(TE) over the sample period for overall manufacturing industry.

Baten et al. (2006) estimated Technical efficiency scores of selected Bangladeshi manufacturing industries using panel data following the methodology of Battese and Coelli (1992). They found that the average technical efficiency score of four industry groups as 40.22 %, when the inefficiency terms followed normal distribution and the TE score was 55.57% under half-normal distribution.

Mahmood, Ghani and Din (2006) estimated the efficiency of large scale manufacturing industry of Pakistan using the SFP for 1995-96 and 2000-01 on 101 5-digit level industries data and showed that there has some enhancement in efficiency of large scale manufacturing industry. They found mixed results at the disaggregated level, whereas a maximum industrial groups have benefited in terms of technical efficiency, some industries have shown decline in their efficiency level, for example, glass and glass products, non-metallic mineral products, transport equipment, and other manufacturing.

Destefanis and Sena (2007) measured technical efficiency (TE) using DEA. They analyzed the association between corporate governance system and TE for nine Italian manufacturing firms.

Mitra and Sato (2007) estimated region-specific technical efficiency for two-digit industry groups in Japan, using stochastic frontier production function. The results reveal that TE had a positive relationship with the external scale variables in majority of the industry groups.

Radam et al (2008) estimated the TE of 7360 small & medium Malaysian Enterprises for the year 2004 using SFPF. The empirical results exhibited that only 3.06% firms were technically efficient and the technical efficiency varied from 0.30% to 97.10%. The study also suggested that technical efficiency could be improved by promoting economies of scale and developing technical skills of labour.

Tran et al. (2008) inspected efficiency performance using Vietnam’s non-state small and medium scale firm level data for 1996-2001.

Diaz and Sanchez (2008) estimated degree of technical inefficiency using SFP function of small and medium Spanish manufacturing firms from 1995 to 2001,. They used an unbalanced panel. They concluded that large firms are more efficient.

Faruq and Yi (2010) estimated the technical efficiency using the DEA technique, of six manufacturing industries of Ghana throughout the period 1991 to 2002. The study concluded that firm characteristics such as age, size, the mix of labor and capital used during the production process, and foreign ownership had positive effects on firm efficiency.

Karadağ (2010) employed DEA for calculating efficiency scores employing the panel data of 25 regions in Turkey. This paper investigated the impact of the public capital formation on private manufacturing industries efficiency. The study shown that public capital had positive impact on efficiency of the private manufacturing industries at the regional level.

Mok, Yeung, Han and Li (2010) estimated TE of 287 large clothing manufacturing firms in southern China employing DEA. They argued that there is U-shaped relationship between the export ratio and TE.

Bhattacharyya (2012) constructed a dynamic SFP function using panel data set considering 9 years on the private manufacturing in Egypt, to measure the speed of adjustment of output and to compare the TE estimates from this dynamic model to those from a static model. The study found that the speed of adjustment is significantly lower than unity but the static model underestimates TE by 4.5 percentage points on average.

Essmui, Berma, Shahadan and Ramlee (2013) estimated firm level TE and performance of 207 manufacturing firms in Libya using SFPF. The estimated result revealed that TE ranging from 37.77 % to 95.27 % with the average of 71.27 % and only 17.87 % firms was considered as technically efficient.

Gamtessa (2014) applied panel SFP methodology on the Canadian KLEMS data set taking the period 2001–2007 to estimate TE and technical change (TC) in manufacturing sector. The result of this paper showed that significant declines in the

TE during last ten years and observed slowdown in TFPG during recent past is partly due to declining TE whereas annual growth rate of TC is 1.5-1.6%.

Findik and Tansel (2015) measured TE of software intensive manufacturing firms in Turkey for the period 2003-2007 using SFP approach and define the factors of TE. The result showed that the effect of software investment on TE is larger incase of high technology firms such as electricity, machinery and chemicals as compared to that of the low technology firms such as paper, food, textiles, and unclassified manufacturing. They also contended that Research & Development expenditure is more important than the software investment to increase TE.

Tingum and Ofeh (2017) measured TE and find out the determinants of TE in Cameroon manufacturing firms using frontier model employing RPED data of 319 manufacturing firms from different manufacturing industries namely Metals and Machinery, Wood & furniture, Food Processing ,Textile & Garments, and Electronics. The results of this paper showed that the TE is 0.498, 0.653, 0.724, 0.555 and 0.631 for Metals and Machinery, Wood & furniture, Food Processing, Textile & Garments, and Electronics respectively and the overall TE for all the manufacturing is 0.619. The result also revealed that firm size, firm age, corruption, tax rate and foreign ownership played a vital role in explaining TE.

Abdullah, Ismail, Sulaiman, and Talib (2017) estimated TE and find out the causes of technical inefficiency for 130 Malaysian transport manufacturing firms in 2010 employing stochastic frontier analysis. The results showed that the average level of TE was moderate and concluded that employees wage rate, cost of information and communication technology are the important causes of technical inefficiency.

Lin et al. (2018) analyzed the change of technological innovation efficiency using innovation input and output data of twelve listed tourist equipment manufacturing firms of china during 2011–2017 employing DEA. To build a Tobit model they used MPI and its components as dependent variable and government ownership, cooperation with international corporations and academics as independent variables. They noted that these firms displayed a slight decline of technological innovation efficiency due to decline of technical level and TE and suggest that the firms need to increase input of innovation and enhance management level.

Ming and Barnabé (2018) estimated TE and technology advancements using the tailored four types of firm ownership firm-level database of 30 manufacturing sectors of China employing nonparametric method. They argued that ownership is significant in explaining TE and technology gap. They also noted that foreign firms and private firms show high TE and technology advancements where as state-owned firms need some improvement.

2.2.3.2.2 Studies Relating to Technical Efficiency (TE) in the Indian Context

Several studies looked at the performance related to TE of different manufacturing industries in India. Mention should be made of the names like Bhavani (1991), Neogi and Ghosh (1994), Lall and Rodrigo (2001), Driffield and Kambhampati (2003), Golder et al. (2004), Nikaido (2004), Mukherjee and Ray (2004), Mukherjee and Ray (2005), Karunaratne (2007), Ray (2009), Bhaumik and Kumbhakar (2010), Sahu (2015), Abdulla and Ahmad (2017), Kathuria (2019), Pant and Mondal (2020) among others.

Bhavani (1991) estimated the technical efficiency for four four-digit Metal small-scale industrial units in 1973 by fitting deterministic translog production frontier. They observe on an average, a very high TE score across industry groups.

Neogi and Ghosh (1994) used panel data of industries from 1974-87 to examine the inter-temporal movement of TE and concluded that technical efficiencies are falling over time.

Lall and Rodrigo (2001) observed wide variation in technical efficiency scores among four industrial sectors of India during 1994. They considered location, scale, extent of the infrastructure investment etc. as determinants of technical efficiency.

Driffield and Kambhampati (2003) examined the impact of liberalization in 1991 on firm-level efficiency of six Indian manufacturing sectors by evaluating the factors of firm level efficiency and conclude that increase in overall efficiency in the post- liberalization period in five sectors but imports do not improve efficiency.

Golder et al. (2004) fitted a translog SFPF to estimate technical efficiency scores of each firm using firm level panel data of engineering industry from 1990 to 1999 from CMIE Prowess data base and showed that the mean TE of foreign firms is higher compared to domestically owned firms. The export intensity, degree of vertical integration and import intensity were considered as determinants of variation in technical efficiency.

Nikaido (2004) estimated technical efficiency using a SFP considering second all-India census data of small scale industries in 1987–88 for all the two-digit industry groups and the results suggest that average level of TE was high in each industry and little variation in technical efficiencies across industry groups.

Mukherjee and Ray (2004) used ASI data covering the period 1986 to 1999 to investigate the technical efficiency ranking of individual states after economic reform. Their empirical study revealed that no major change in TE ranking among states and reported no convergence in the distribution of technical efficiency scores across states due to the effect of state specific factors like local infrastructure and political environment.

Mukherjee and Ray (2005) studied efficiency dynamics of 'typical' firms in different states during pre and post liberalization period using DEA and utilized super efficiency model to rank them in terms of their performance. They analyzed state level data of Indian manufacturing sector taking the period 1986- 87 to 1999-00. Their empirical study revealed that neither major change in efficiency ranking among states after reform period nor convergence in the distribution of efficiency scores.

Karunaratne (2007) employed maximum likelihood techniques to estimate TE scores for Indian manufacturing industries employing combined stochastic production frontier inefficiency model. He used a panel data set of 8 manufacturing industries covering the period 1969 to 1995. The results of this paper suggest that TE and cutback of the effective rate of assistance and capital deepening and technology proxies are negatively correlated. He also noted that technology transfer and the trade liberalisation had no considerable impact on decline of TE.

Ray (2009) estimated the state wise levels of cost efficiency of Indian manufacturing using ASI data covering the period 2004-05. He found that majority of the states were cost efficient, however on average, Indian firms were too small. This paper also suggested that consolidation of firms would lower average cost and enhance efficiency.

Bhaumik and Kumbhakar (2010) estimated technical efficiency using plant level data during 1989–1990 and 2000–2001 and analyzed the effect of change in TE on change in gross value added (GVA). The empirical result showed that median TE declined and explains very small amount of change in gross value added.

Sahu (2015) used firm level panel data considering the period of 2001-02 to 2010-11 to estimate firm level TE of Indian manufacturing sector separately for foreign and domestic firms employing Stochastic Frontier Approach (SFA) of Cobb-Douglas type. The results of the paper indicates that mean TE of the foreign firms in the entire manufacturing sector is greater than domestic firms, at sectoral level mean TE of electronics industry, machinery industry, chemical industry, and transport industry was greater for the foreign firms whereas mean TE of textile industry, food & beverage, and basic metal was greater for domestic firms.

Abdulla and Ahmad (2017) estimated TE and its determinants of Uttar Pradesh sugar mills using the data of 115 sugar mills for the year 2011-12 employing Stochastic Frontier Approach (SFA). They argued that public limited mills is most efficient than individual proprietors mills and public corporation is least efficient. This paper also concluded that state and central government owned and private owned sugar mills are found to be more efficient, mills operation yeas has positive effect on TE, location has no effect on TE and efficiency level can be changed by changing the scale.

Kathuria (2019) used the production data of pulp and paper industry during 1951 to 2016 for testing the structural break and estimate TE using 160 paper manufacturing firms' data for 2011-2012 employing SFA. The empirical results showed that structural break in the production trend occurring in 1999 due to the delicensing in July 1997, firms TE is 0.74 with half of the firms having TE higher than 0.76 and TE influenced by its age, ownership, size and location.

Pant and Mondal (2020) investigated the impact of FDI on TE of Indian manufacturing firms during 1994–2001 and 2002–10 employing SFA. They noted that domestic firms achieve TE from foreign skill spillovers and backward linkages in the first period but it has adverse effect in the second period. This study also concluded that technology gains take place through development expenditure, internal research, purchase of capital goods and imported raw materials.

2.2.4 Studies on Total Factor Productivity Growth (TFPG) of Manufacturing Industries

TFPG measures the amount of increase in total output which is not accounted for increase in total inputs and thus measures change in output due to change in the production function over time, keeping all inputs are constant (Abramovitz, 1956; Denison, 1962, 1967, 1985; Hayami et al, 1979). Input specific productivities like capital productivity and labor 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). Since the present thesis is concerned with TFPG, to keep the discussion within limit, studies on TFPG will be discussed only.

A vast literature exists around the globe dealing with the estimation of TFPG of manufacturing industries for India as well as other countries considering different time periods and using different methodologies.

2.2.4.1 Econometric Theoretical Literature on Total Factor Productivity Growth

TFPG can be determined 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) Approach (by estimating production function or cost function); (iii) Non-parametric Approach (through Data Envelopment Analysis (DEA)).

In order to get an idea concerning the extent of TFPG the following diagram is considered:

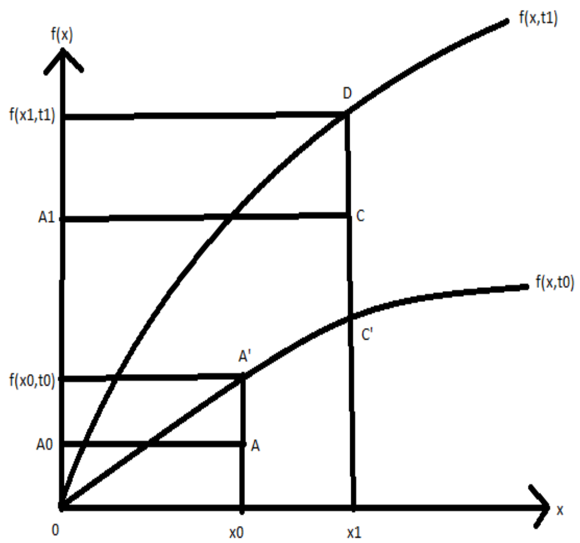

Figure 2.2: Diagram explaining Total Factor Productivity Growth

Where t is time period; $t_1 > t_0$ and x is single input and f(x) is single output, $y_0 = f(x, t_0)$ and $y_0 = f(x, t_1)$ are the production functions at time period 0 and 1 respectively.

Production Function: y = f(x), shows the maximum output y obtainable from a given input x. If $(y^/, x^/)$ be the observed plan of the firm then the plan is TE if $y^/ = f(x^/)$ and technically inefficient if $y^/ < f(x^/)$.

Measure of TE = $\{y^/ / f(x^/)\}$; $0<TE<1$

In the above diagram, $AA^/$ = inefficiency because with x_0 amount of input, maximum $f(x_0, t_0)$ amount of output can be produced by using the frontier but the entire input is not efficiently used that is why in reality only A_0 amount of output has been produced which is lesser than $f(x_0, t_0)$.

$$\text{Inefficiency} = \frac{\text{Actual output}}{\text{Maximum producible output}} = \frac{A0}{f(x0)}$$

Similarly, with x_1 amount of input, maximum $f(x_1, t_1)$ amount of output can be produced by using the frontier but the entire input is not efficiently used that is why in reality only A_1 amount of output has been produced which is lesser than $f(x_1, t_1)$.

$$\text{Inefficiency} = \frac{\text{Actual output}}{\text{Maximum producible output}} = \frac{A1}{f(x1)}$$

Movement from A to C = Movement from A to $A^/$ (Efficiency Change) + Movement from $A^/$ to $C^/$ (Scale Efficiency Change) + Movement from $C^/$ to D - Movement from D to C (Efficiency Change)

Where Technical Change, $CC^/$ = (Movement from $C^/$ to D – Movement from D to C)

TFP change is the totality of rate of technological progress and changes in TE.

2.2.4.1.1 Measurement of TFPG using Growth Accounting Approach

TFP may be defined as the ratio of output to a weighted combination of inputs. Several TFP indexes are different from one another for their weighting scheme involved.

A. Solow Index

B. Kendrick index

C. Divisia Index – Translog Index

A. Measurement of TFPG using Solow Index

This index is based on Cobb-Douglas production function. Under the assumption of CRS, autonomous Hicks-neutral technological progress and payment to factors according to marginal product, the following equation is obtained

$$\frac{\dot{A}}{A} = \frac{\dot{Y}}{Y} - [(1-\beta)\frac{\dot{L}}{L} + \beta\frac{\dot{K}}{K}]$$

Where Y is output, L is labour, K iscapital and β is the income share of capital. Dot stands for time derivative.

The discrete form of the above equation

$$\frac{\Delta A}{A} = \frac{\Delta Y}{Y} - [(1-\beta)\frac{\Delta L}{L} + \beta\frac{\Delta K}{K}]$$

$\frac{\Delta A}{A}$ is basically the extent of TFPG.

B. Measurement of TFPG using Kendrick Index

It is assumed that there is one homogeneous output (Y) and there are two factors of production: capital (K) and labour (L) and factor rewards of capital and labour is r_0 and w_0 respectively in the base year. So the Kendrick index for year t is

$A_t = \{Y_t / (w_0L_t + r_0K_t)\}$

Under the assumptions of CRS, perfect competition and payment to factors according to their marginal product, the total earnings of capital and labour in the base year is exactly equal output of that year; so A_0 is equal to unity by definition.

For any $t \neq t_0$, A_t will differ from unity. The extent of TFPG is measured by the departure of A_t from unity.

C. Measurement of TFPG using Divisia Index – Translog Index

Consider an aggregate production function with two factors of production Y = F (K, L, T)

Where aggregate output (Y), aggregate capital (K), aggregate labour(L) and time (T).

The share of the factors will be $V_K = (rK / pY)$ & $V_L = (wL / pY)$

$\Delta \log Y = V_K (\Delta \log K) + V_L (\Delta \log L) + V_T$

Where $\Delta \log Y = \log Y(T) - \log Y(T\text{-}1)$

$\Delta \log K = \log K(T) - \log K(T\text{-}1)$

$\Delta \log L = \log L(T) - \log L(T\text{-}1)$

and $V_K = (1/2) [V_K(T) + V_K(T\text{-}1)]$ & $V_L = (1/2) [V_L(T) + V_L(T\text{-}1)]$

This expression for V_T is termed the average translog quantity index of technological change.

2.2.4.1.2 Measurement of TFPG using Parametric Approach i.e. by estimating production function or cost function

A. Estimation of TFPG using Production Function

B. Estimation of TFPG using Cost Function

A. Estimation of TFPG using Production Function

Since TFPG measures the shift of production function over time, in order to estimate TFPG using production function, we basically start with the assumption of any particular form of production function and add time as an argument in that function.

The responsiveness of the production function (Y) with respect to time $\frac{\partial y}{\partial t}$ gives us the extent of TFPG. The researchers can assume different types of production function like Cobb- Douglas, CES, Translog etc.

B. Estimation of TFPG using Cost Function

Cost Function is given by: $C = C(P_K, P_L, T)$

where P_K = Per unit price of capital, P_L = Per unit price of labour and T = time

If the coefficient of T is negative and statistically significance, then we have technical progress.

$$\text{TFPG} = \frac{\partial \log C}{\partial T}$$

Negative of the coefficient $\frac{\partial \log C}{\partial T}$ gives us the extent of TFPG. To get positive TFPG, cost function should fall over time.

2.2.4.1.3 Non parametric approach of Data Envelopment Analysis (DEA)

The nonparametric approach of TFPG measure differs from the other approaches in the sense that it does not require any explicit specification of production technology nor does it require any econometric estimation. Only a few assumptions about the production technology are needed. No assumption regarding market structure adds more flexibility to the analysis. This approach uses mathematical programming to measure TFPG based on actual input-output observations. A benchmark technology is constructed based on sample observations and this benchmark technology is then used to decompose the changes in productivity into its components like technical efficiency change, technical change, and scale efficiency change. The most widely used measure of TFPG is followed by constructing Malmquist Productivity Index (MPI). MPI scales output levels up or down radially with respect to the benchmark technology. Commonly the measurement of TFPG using MPI is done through DEA. DEA is a 'data-oriented' approach for evaluating the performance of multiple decision making units (DMUs).

In DEA, without explicitly specifying a production function, the maximum producible output is constructed using the sample observations and based on a few assumptions like feasibility, convexity of the production possibility set, free disposability of inputs and outputs and also of CRS or VRS. In DEA, the efficiency frontier envelops all the data.

In the formulation of DEA by Charnes, Cooper and Rhodes (CCR) (1978, 1981), the data on market prices are not available. Shadow prices are chosen with the help of linear programming problem for maximizing the average productivity. Distance functions can be derived by suitably defining a non-negative scale factor. Productivity indices can be obtained from the distance functions. However, later extension of DEA allow for reformulation of the original problem to take into consideration the market price.

CCR (1978, 1981) induced the method of DEA to address the problem of efficiency measurement for DMUs with multiple inputs and outputs in the absence of market prices. However, the CCR-DEA model measures TE of a firm under the assumption of CRS.

Then, **Banker, Charnes and Cooper (BCC) (1984)** extended the CCR model by incorporating technologies exhibiting VRS.

Caves, Christensen and Diewert (1982) showed that in case of translog production function, Törnqvist output and indexes are equal to mean of two MPIs. They introduce MPI as the ratio of output distance functions without any aggregation of inputs.

Färe, Grosskopf, Lindgren and Roos (1992) applied mathematical programming to evaluate the distance functions that can be employed in empirically measuring MPIs. They also decompose the measured MPI into technical change and 'catching up' showing movements towards (or away from) the frontier, assuming CRS and any scale effect, by definition, is ruled out.

Färe, Grosskopf, Norris and Zhang (FGNZ) (1994) analyzed the productivity growth in 17 OECD countries considering the years 1979-88 following an extended decomposition proposed by Färe, Grosskopf, and Lovell (1994) to further single out the returns to scale effect. The use of CRS and VRS by FGNZ within the same decomposition of MPI is later criticized by Ray and Desli (1997).

Schimmelpfennig and Thirtle (1994) used the data on agriculture for UK, 10 EC countries and USA to investigate whether any causal relationship between TFP and a few explanatory variables applying Granger Causality tests and Cointegration tests and found a long-run relationship between the TFP and spending on research.

Ray and Desli (1997) term the use CRS and VRS by FGNZ (1994) within same decomposition of Malmquist Productivity Index as not being consistent. They proposed an alternative decomposition of Malmquist Productivity Index by using VRS frontier as the benchmark and reached at the conclusion different from that of FGNZ.

Färe, Grifell-Tatjé, Grosskopf and Lovell (1997) provided a further decomposition of technical change index into an index of magnitude of technical change, output-bias index and input-bias index.

2.2.4.2 Empirical Literature on TFPG of Manufacturing Industries

There are various studies on TFPG considering parametric and nonparametric approach in different manufacturing industries in both the international as well as in the Indian Context.

2.2.4.2.1 Studies relating to TFPG in the International Context

The worth-mentioning studies on TFPG in different manufacturing industries world-wide (other than India) are due to Krueger and Tuncer (1982), Siggel (1992), McGuckin et al. (1992), Klenow (1996), Singha and Trieu(1996), Kumbhakar and Heshmati(1996), Leung (1997), Kumbhakar et al. (1999), Sahin et al. (1999), Weber and Domazlicky (1999), Mahadevan and Kalirajan (1999), Bermen (2000), Kubhakar et al. (2000), Hanel (2000),Kim (2000), Andersson (2001),Kim and Han (2001), Färe, Grosskopf and Margaritis (2001) , Lee and Tang (2001), Chun and Nadiri (2002), Mahadevan (2002), Liu (2002), Kruger (2003), Kwon (2003), Kim and Park (2003), Kubhakar (2003), Hwang (2003), Mahadevan (2003), Kruger (2003), Park (2004),Sun (2004), Sun and Kalirajan (2005) ,Kim and Park (2006), Margono and Sharma (2006) , Ikhsan (2007), ,Jajri (2007), Sun (2007), Oh et al. (2008), Fernandes (2008), Vial (2008), Raheman, Afza, Qayyum, and Bodla (2008) , Economidou and Murshid (2008), Kim and Shafi'I (2009), Hamit-Haggar (2009), Majeed, Ahmed and Sabihuddin Butt (2010), Oh (2011),Banda and Verdugo (2011), Bosma et al. (2011), Abegaz and Basu (2011), Liao, Liu and Wang (2012), Kilicaslan and Erdogan (2012),Kim, Park and Park (2012), Oh, Heshmati and Loof (2012), Javorcik and Li (2013), Sterlacchini and Venturini (2013), Medda and Piga (2014), Ulku and Pamukcu (2015), Harris and Moffat (2015), Sari, Khalifah and Suyanto (2016), O'Donnell, Fini and Triantis (2017), Harris and Li (2019), Mattsson, Månsson and Greene (2020) among others.

Krueger and Tuncer (1982) measured the rate of TFPG for public and private enterprises in each industry separately of Turkeys manufacturing industries considering the period 1963 to 1976. They noted that rate of TFPG for both sectors were almost same.

Siggel (1992) estimated productivity growth of Kenya's manufacturing sector and focused on methods to found out the weakness of the data through sensitivity analysis. He used a modified version of neoclassical growth accounting approach and broken down labor productivity growth into two components.

McGuckin et al. (1992) estimated TFPG of 39 Chinese industries covering the period 1980-85. They segregate the contributions of materials, capital, labor and TE to output growth using gross output and value added models. The results showed that Chinese industries experienced sharp increases in TFPG in the period 1984-85 as compared to the 1980-84. They also showed that private enterprises have greater TFPG than state enterprises. The empirical results showed that profits, proportion of total employees and Labor bonuses had greater influence on TFPG.

Klenow (1996) showed that productivity growth and Research and development intensity differ significantly across United States manufacturing industries due to industry differences in market size, technological opportunity, and appropriability of innovations. He noted that R&D intensive industries do not deserve a higher R&D tax credit. The result also shows that there are different predictions for the cross-industry correlation between R&D intensity and research productivity.

Singha and Trieu (1996) estimated TFPG for South Korea, Japan and reassessed productivity growth experience of Taiwan and Korea as compared to Latin American countries and Japan. They noted that Taiwan and Korea's experience was not simply explained by Krugmans (1994) factor accumulation, and TFPG in these countries are dissimilar to Latin America.

Kumbhakar and Heshmati (1996) estimated TFPG and technical change for Swedish manufacturing industries using time trend and general index model covering the period 1964 to 1989. They showed that general index model was better than time trend model in examining the pattern of TFPG and technical change.

Leung (1997) measured TFPG employing translog production function from data at industry level for Singapore. The empirical results showed that TFPG was around 2-3%. The result also revealed that export orientation, foreign ownership and remuneration per employee had remarkable effect on TFPG.

Kumbhakar et al. (1999) measured TFPG and technical change of Swedish cement industry using parametric models and decomposed TFPG into different components.

Sahin et al. (1999) measured TFPG of Bangladesh food processing industries and decomposed the productivity changes into technical progress and changes in the productive capacity realization. They noted that though there is technological progress in some food processing industries but the overall performance is low due to low rate of capacity realization.

Weber and Domazlicky (1999) estimated TFPG in US manufacturing industries during 1977 to 1989 using non-parametric linear-programming method. The empirical results indicate that technological progress exhibits a labor-using partiality during 1977 to 1983 and capital-using bias from 1983 to 1989.

Mahadevan and Kalirajan (1999) mainly focused on the limitations of an article on TFPG of Singapore's manufacturing industries by Leung (1997) and suggested SFPF approach as an alternative method to estimate TFPG.

Bermen (2000) estimated factor-bias within the industries and the countries using nineteen country panels of manufacturing data over the period 1980s. He showed that the technological change is intensely inclined against the less skilled workers using production functions and TFP functions.

Kubhakar et al. (2000) estimated TFPG using several dual parametric models considering firm-level panel data from the Japanese chemical industry covering the period 1968 to 1987 and showed that the results are robust in the sense that the traditional time trend model and the general index model are included, after generalizing them, to accommodate firm-specific technical change and technological bias.

Hanel (2000) examined the relationship amongst TFPG and Research and Development expenditures of Canadian manufacturing industry and considered FDI as key channel of transmission of new technology. The empirical result proposed a positive relationship and the three proxies associated positively and significantly with TFPG.

Kim (2000) used panel data of thirty-six Korean manufacturing industries considering the period 1966-1988 to examine the dynamic effect of the trade liberalization on scale efficiency and productivity, market competition. The empirical result showed a constructive effect of liberalization on productivity, scale efficiency and market competition.

Andersson (2001) studied the effect of trade openness on TFPG of Swedish Manufacturing for the period 1980 to 1995 and explore the effect of openness on TFP from different aspects namely spillovers, and the indirect competition effects. The empirical results showed a favourable impact on TFPG due to high degree of openness.

Kim and Han (2001) applied SFPF model to decompose TFPG into technical efficiency changes, technical progress, and allocative efficiency change, and scale effects using Korean manufacturing industries data considering the period 1980-1994 and the result showed that technical progress dominates.

Färe, Grosskopf and Margaritis (2001) measured TFP of Australian and New Zealand manufacturing sectors from 1986-96 using MPI to measure TFPG and decompose it. The empirical result indicates that Australian manufacturing exhibits greater of individual factor productivity while TFPG is higher in New Zealand manufacturing and TFPG in New Zealand is driven by technical change rather than efficiency change.

Lee and Tang (2001) estimated multifactor productivity gap between U.S and Canadian manufacturing firms and investigated its causal factors. The empirical result indicate that the multifactor productivity performance of Canadian firms relative to U.S. manufacturing deteriorated from 1985-88 to 1989-92 and partially improved in 1993-95 and multifactor productivity gap stood at 18 % in the 1993-95.

Chun and Nadiri (2002) used a joint production model of output quantity and quality to estimate TFPG of the US computer industry from 1987-79 to 1999-2000 and decomposed into the scale economies and contributions of process and product innovations. The empirical results showed that 30% of TFPG is due to product innovation.

Mahadevan (2002) estimated the growth potential of Malaysian manufacturing sector using SFPF and decomposed into input growth and TFPG and further TFPG was decomposed. He used panel data comprising of twenty eight manufacturing industries from 1981 to 1996. The results showed that growth was highly dependent on input growth which was positively related to skilled labor.

Liu (2002) investigated the effect on productivity growth due to Foreign direct investment (FDI) of Chinese manufacturing industries using the data of 29 manufacturing industries from 1993-98 in the Shenzhen Special Economic Zone. He found that FDI has a significantly large spillover effects and raises level, productivity growth and the domestic sectors are main beneficiaries.

Kruger (2003) estimated TFP of 87 countries covering the period 1960 to 1990 applying the Malmquist Index. The results for growth rates and relative labour productivity levels are reported.

Kwon (2003) used Korean manufacturing data over the period 1987 to 1996 to estimate the consequence of R&D on TFP. The result revealed that rate of return to own Research and Development was slightly higher than developed countries. However the effect on productivity growth due to R&D spillovers in Korea was lower than developed countries.

Kim and Park (2003) used industry-level data of Korean manufacturing over the period 1976-96 to observe the effect on productivity due to R&D spillovers and trade patterns. The empirical results revealed that the function of domestic and foreign

R&D capital stocks was vital in the productivity growth and foreign R&D capital had more effect in improving the TFP of Korean manufacturing.

Kumbhakar (2003) decomposed TFPG employing panel data into specific input components and measured input specific productivity growth of U.S. manufacturing industries considering the period 1959 to 1992. This paper also tested alternative neutrality hypotheses in technical change specification.

Hwang (2003) used Taiwanese manufacturing industries' firm-level data to examine the significance of international market efficiency of trade and international scale economies. He measured scale economies and TFP to find the relationships among scale economies, exports, and productivity and the result suggested that export intensity of a firm was positively related with its productivity.

Mahadevan (2003) provided concise outline and critique of TFPG measuring techniques, highlighting the debate adjoining the accounting identity for TFPG and evaluates the usefulness of TFPG and finally suggested some direction for future work on TFPG.

Kruger (2003) estimated TFP using nonparametric methods and compare with TFP values by frontier production function using the data of US manufacturing industries for the years 1958-96. This empirical paper concludes that diligence relative to the frontier production function plays an extensive role in sectoral productivity development.

Park (2004) studied international and inter-sectoral R&D spillover effects on TFPG of the manufacturing sectors and non-manufacturing sectors from pooled time-series data set of 14 OECD countries and 3 East Asian countries—Korea, Singapore and Taiwan. The results recommended that foreign manufacturing Research and development had strong effect on domestic productivity growths of both the sectors. Whereas domestic manufacturing Research and development had great inter-sectoral R&D spillover effect on domestic nonmanufacturing productivity growth.

Sun (2004) measured TFP of Taiwan's manufacturing sector throughout the time 1981 to 1999. This paper concluded that the TFP level simply improved by 0.2% a year, steaming from 0.4% technological progress and 0.2% decline in technical efficiency.

Sun and Kalirajan (2005) estimated TFPG of Korean high-tech and low-tech manufacturing industries data from 1970 to 1997 and investigate the key source of growth. This empirical paper resolved that technological progress was the most important contributor to TFPG for both industries.

Kim and Park (2006) estimated productivity of Korean manufacturing industries and find out the foremost source of productivity gain. This empirical paper noted that productivity gains mainly from efficiency improvement than technical progress. The result presented that R&D played a vital role in fostering efficiency and technical progress in Korean manufacturing sector and domestic research and development has more effect on technical progress, while foreign research and development has played a relatively stronger role in fostering efficiency.

Ikhsan (2007) inspected the pattern of TFPG and TEC for Indonesian manufacturing from 1988 to 2000 employing stochastic frontier production then decomposed TFPG into technical efficiency change, technical progress, and scale efficiency change.

Jajri (2007) estimated TFPG in Malaysia considering the period from 1971 to 2004 using DEA approach.

Sun (2007) estimated TFPG of twenty-five manufacturing industries of Singapore from 1970 to 1997 using varying coefficients frontier model and decomposed TFPG. He found that average a -0.8% TFPG per annum with slight improvement in the 1990s, technological progress was responsible for the undesirable TFPG and growth mainly comes from factor accumulation.

Oh et al. (2008) estimated TFPG of manufacturing industries of Korea for 1991 to 2003 employing parametric as well as non-parametric approach separately and divided the period into pre and post Asian Financial Crisis. They compared results of both approach and suggested a number of firm-specific characteristics such as location of firm, size and sector capture systematic heterogeneity.

Fernandes (2008) measured TFP in Bangladesh and correlates with firm size, firm age, global integration and managerial quality. This paper found that firm age and TFP showed an inverted U-shaped relationship while negatively correlated; global integration and managerial quality are positively correlated with firm total factor productivity.

Vial (2008) estimated TFPG of large and long lived companies and several small and medium enterprises manufacturing using plant-level panel data from 1975 to 1995 of Indonesian manufacturing sector and decomposed TFPG into market reallocation among incumbents, intra-plant TFP growth and the plant turnover effect.

Raheman, Afza, Qayyum, and Bodla (2008) measured TFPG of important Pakistani manufacturing industries using panel data from 1998 to 2007 employing

DEA approach and decomposed TFPG. Malmquist productivity index was used to calculate and decompose productivity growth. Result revealed that TE improved productivity growth while technological change has a negative effect and the overall productivity growth only increased by 0.9 %.

Economidou and Murshid (2008) used a panel dataset of 9 manufacturing industries through 12 OECD countries covering the period 1978 to 1997 to analyze the result of trade on productivity growth. The empirical result showed that increased revelation to trade exerts a favourable influence on productivity growth.

Kim and Shafi'I (2009) estimated TFPG of Malaysian manufacturing industries employing stochastic frontier approach using the data taking the period 2000 to 2004 and decomposed TFPG into technical efficiency change, technical progress, scale efficiency change and allocative efficiency change. The result revealed that technical progress enhances productivity growth while technical efficiency deters productivity. Allocative efficiency and Scale efficiency have a significant effect on TFP.

Hamit-Haggar (2009) estimated TFPG of Canadian manufacturing industry employing stochastic frontier approach using the data taking the time 1990 to 2005 and decomposed TFPG into technical efficiency change, technical progress, scale efficiency change and allocative efficiency change. The result revealed that technical progress enhances productivity growth while technical efficiency deters productivity. The result also submits that investment in information and communications technology, trade openness and R&D expenditure had a positive impact on productivity growth.

Majeed, Ahmed and Sabihuddin Butt (2010) measured TFPG using growth accounting technique in large scale manufacturing sector of Pakistan throughout the period 1971 to 2007 and examined the relationship between trade liberalization and TFPG using Auto Regresive Distributed Lag model. The result shown that coefficients of openness are negative but statistically significant and abolition of government intervention and limitations has characterized all policy stances, though only liberalization is not adequate to produce considerable effect.

Oh (2011) used Malmquist productivity growth index to estimate productivity growth of Korean manufacturing industry taking the period from 1993 to 2003 and decomposed productivity growth. The second stage regression analysis indicated that R&D activity, export activities, innovativeness and a competitive market condition promotes the rate of productivity growth.

Banda and Verdugo (2011) measured multifactor productivity of Mexican manufacturing sector for 14 ample groups and find out some determinants of the productivity growth. This empirical paper found a positive association between technology adoption and market concentration. They also found that human capital and technology adoption promote productivity, while market concentration demotes productivity.

Bosma et al. (2011) scrutinized the effect of firms' entry and exit on competitiveness of 40 regions in Netherlands, as measured by TFPG which was conducted over the period 1988–2002. Result showed that firm entry was related to productivity growth in services, but not in manufacturing. The efficiency of existing firms may be increased by high degrees of creative devastation.

Abegaz and Basu (2011) investigated the influence of trade liberalization on TFPG for six emerging economies. The empirical results showed positive influence of liberalization on productivity growth and TFPG was insensitive to tariff reduction.

Liao, Liu and Wang (2012) used the data of China's manufacturing firms' more than 10 thousand local and foreign-invested firms considering the period from 1998 to 2001 employing stochastic frontier framework to explore the diffusion and diffusion of technological knowledge. The empirical paper showed that a positive inter industry productivity spillovers from research and development and foreign presence but indication of intra industry productivity spillovers from FDI to Chinese manufacturing firms is not as much robust.

Kilicaslan and Erdogan (2012) investigated the relationship between exporting behavior and productivity of Turkish manufacturing firms. The result exposed that exporting did not foster productivity.

Kim, Park and Park (2012) measured TFPG of Malaysian manufacturing sector employing SFP model considering the data of seven manufacturing industries during 2000 to 2004 and decomposed TFPG into technical progress and TEC for different plant size groups. The empirical results also indicates that plant size groups rather found confirmation of considerable technical progress and TE has aggravated across all industries.

Oh, Heshmati and Loof (2012) estimated technical change and TFPG of a large panel of Swedish manufacturing and service firms from the period 1992 to 2000 using parametric production function approach. Empirical results showed that growth rate improved initially started in large exporting firms, after economic crisis at the beginning of the 1990s, spilled over in manufacturing and services firms irrespective of size and technology intensity.

Javorcik and Li (2013) investigated the impact of expansion of global retail chains on TFP in the Romanian supplying manufacturing industries using a panel data. The empirical results suggested that a 2.4-2.6% boost in TFP due to 10% increase in the foreign chains' outlets and opening of the retail sector to foreign direct investment may promote productivity growth.

Sterlacchini and Venturini (2013) estimated long-run elasticity of TFP with respect to research and development capital employing dynamic panel using the data for 12 manufacturing industries of five developed countries covering the period 1980 to 2002. The highest elasticity of TFP is found for US, followed by Germany and intermediary values are realized by Spain and France while R&D impact is lowest in Italy.

Medda and Piga (2014) investigated the effect of R&D activity and technological spillovers on TFP dynamics for Italian manufacturing firms. They concluded that firm’s involvement in R&D activities accounts for significant productivity gains and firms also benefit from spillovers originating.

Ulku and Pamukcu (2015) used firm level data of Turkeys manufacturing from 2003-2007 to study the influence of Research and development intensity and various channels of knowledge diffusion on productivity. They found that technology licensing and foreign ownership share in firms increases firms’ productivity, they also concluded that increase in R&D intensity raises productivity only in firms with a threshold of technological capability.

Harris and Moffat (2015) tried to find out the determinants of TFP using a British firm-level dataset and concluded that multi-plant economies of scale and competition, foreign ownership, internal and external knowledge, R&D and age of plant affect TFP.

Sari, Khalifah and Suyanto (2016) estimated productivity employing time-varying SFA on firm level panel data of manufacturing industry of Indonesia and inspected the effect of FDI spillover effects on firms' productivity performances. They concluded that foreign firms attain much productivity but less efficient than the domestic firms, degrees of foreign ownership have a depressing effect on firms' productivity but positively related to firms' efficiency and forward spillovers have constructive impact on productivity and backward spillovers have positive impact on efficiency.

O'Donnell, Fini and Triantis (2017) discussed about the measuring problem and analysing productivity change of Virginian industry and measured productivity change and also find out the relationship between productivity and efficiency

Harris and Li (2019) estimated TFP of 26 china manufacturing industries taking the period from 1998 to 2007 and examined the impact of government assistance on it. This empirical results showed that firms receiving assistance at the rates of 1 to 10%, 10 to 19%, 20 to 49% and 50+% experienced on average 4.5, 9.4, 9.2 and −3% gains in TFP respectively i.e assisted firms contributed comparatively more to TFP growth than non-assisted firms.

Mattsson, Månsson and Greene (2020) investigated TFP change and its components for the Swedish manufacturing industry using stochastic frontier analysis

(SFA) for the period from 1997 to 2013 and compared with the TFP of private service sector during the years 1997–2013. They concluded that TFP change is lower in between 2007–2013, compared to the years of 1997–2007 due to lower technological progress.

2.2.4.2.2 Studies Relating to TFPG in the Indian Context

Studies on analysis of TFPG in the Indian manufacturing industries considering different time periods and using different methodologies are found in Hasim and Dadi (1973), Banerjee (1975), Goldar (1985), Dabir-Alai(1987),Deolalikar and Roller (1989), Ahluwalia (1991), Dholakia and Dholakia (1994), Balakrishnan and Pushpangadan (1994), Rao (1996), Kumbhakar and Bhattacharyya (1996), Ray (1997), Pradhan and Barik (1998), Gangopadhyay and Wadhva (1998), Mitra (1999), Hulten and Srinivasan (1999), Bandyopadhyay (2000), Srivastava (2000), Trivedi et al. (2000), Mitra (2000), Chand and Sen (2002), Ray (2002), Kathuria (2002), Hasan (2002), Goldar and Kumari (2003), Chattopadhyay (2004), Parameswaran and Prameswaran (2004), Trivedi (2004), Milner, Vencappa and Wright (2007), Madheswaran et al. (2007), Mitra and Ural (2008), Manjappa & Maheshá (2008), Soo (2008), Parameswaran (2009), Kathuria, Natarajan and Sen (2010), Kato (2009), Gupta (2010), Nataraj (2011), Raj (2011), Sharma and Mishra (2011), Haidar (2012), Harrison, Martin and Nataraj (2012), Ghose and Roy Biswas (2012), Pradeep and Chen (2012), Ray and Pal (2012), Ghose and Chakraborty (2012), Ghosh (2013), Roy, Das and Pal (2016), Verma and Kaur (2017), Pal ,Chakraborty and Ghose (2018), Roy (2019) among others.

Hasim and Dadi (1973) using Solow index calculated TFPG of manufacturing industries of India for the period 1946-47 to 1964-6. Their result showed 2.82% TFP growth rate per annum respectively.

Banerjee (1975) estimated TFP of manufacturing industry using Solow Index in India during 1946-47 to 1964-65. The estimated result showed 1.6% growth of TFP per annum.

Goldar (1986) using multiple regression framework studied pattern of growth of TFP of manufacturing industries in India at two-digit level to explain the variation in TFP. The study tried to assess the influence of industrial concentration and import substitution on TFP growth.

Dabir-Alai (1987) using Solow and Kendrick estimation equation estimated TFPG of large scale Indian manufacturing industries covering the period during 1973-74 to 1978-79. Capital intensity and capital and labor productivity were main determinant of movement in TFPG over this period. Demand for products of these industries was also significant determinant of productive efficiency.

Deolalikar and Roller (1989) examined the impact of patent on TFPG using firm-level panel data for the period 1975-79. The study revealed that patenting played a significant role in TFPG.

Ahluwalia (1991) analyzed TFPG manufacturing industries in India for the period 1965-66 to 1985-86 using pooled cross section and time series data on the above said industry. The data was collected from Annual Survey of Industries (ASI). Using Single Deflation Method (SDVA) and translog production function he estimated growth of TFP. The result reveled a significant increase to 3.4% per annum during 1980-81 to 1985-86 compared to -0.3% per annum during 1965-66 to 1979-80.

Dholakia and Dholakia (1994) examined the impact of patenting on TFP growth employing panel data of farm-level. The result reveled a significant influence of patenting on TFPG.

Balakrishnan and Pushpangadan (1994) estimated TFPG for the period 1970-71 to 1988-89 using the Double Deflated Value Added (DDVA) method criticizing that SDVA method did not give the correct result.

Rao (1996) used three methods to estimate TFPG in Indian manufacturing industries considering the period 1973-74 to 1992-93. The methods were SDVA, DDVA and Gross Output Function (GOF). According to the method of SDVA growth of TFP was -0.2% per annum from 1973-74 to 1979-80 and it increased to 2.1% per annum from 1981-82 to 1992-93. According to the method DDVA it increased at 4.6% from 1973-74 to 1980-81 per annum and according to GOF method it as 5.5% per annum from 1973-74 to 1980-81 and -2.2% from 1981-82 to 1992-93 per annum.

Kumbhakar and Bhattacharyya (1996) measured the TFP growth of publicly-owned passenger-bus companies for period 1983-87 in India. To measure TFP they used translog variable cost function. The TFP was decomposed into economies of scale and technical change. The result depicted that the main source of TFP growth was economies of scale.

Ray (1997) calculated the TFP growth of aggregate manufacturing for union territories and individual states of India for the period 1970-86. He used Data envelopment approach. The result reveled decline in productivity for maximum states.

Pradhan and Barik (1998) estimated TFP growth of manufacturing industries in India using Gross Output Function method. According to the result growth of TFP was 3.06% per annum during 1972-73 to 1981-82 and it was -1.23% per annum from 1982-83 to 1992-93 and the growth of TFP was falling during 1980s.

Gangopadhyay and Wadhva (1998) using ASI data estimated TFP growth at two-digit manufacturing industries and also for aggregate Indian manufacturing. The result showed 1.17% per annum growth of TFP from 1974-75 to 1980-81 and 5.44% per annum during 1981-82 to1985-86.

Mitra (1999) using DDVA method estimated TFP growth and TE for 17 two digit industries for 17 major states during 1976-77 to 1992-93. The result showed that growth of TFP was 5.57% per annum during 1985-86 to 1992-93 and it was .76% per annum during 1976-77 to 1984-85.

Hulten and Srinivasan (1999) calculated the rate of growth of TFP of manufacturing industries in India for the period 1973-1992. The result presented that TFP, rather than capital growth, had a significant role for the sustainable growth of output.

Bandyopadhyay (2000) provided an explanation for inter-temporal changes in growth of TFP in Indian industrial sector during 1973-74 using multiple regression model and considering capital- labor ratio, export intensity, import substitution, skill composition and industrial concentration as explanatory variable. The result suggested that relative factor abundance (according to HOS model) was the main determinant for productivity growth and gain from trade. It was also found that TFP was positively related with import substitution and output growth.

Srivastava (2000) analysed TFP and TE of India manufacturing industries using the data of 3000 companies during 1980-81 to 1996-97. Growth accounting approach and production function approach was employed for estimating TFP growth and frontier production function was used to estimate efficiency. The result showed decline in TFP growth in manufacturing sector in the 1990s.

Trivedi et al. (2000) calculated TFP growth of Indian manufacturing industries from 1980-81 to 1997-98. Three methods were used for estimating TFP growth viz DDVA, SDVA and GOF. According to DDVA method TFP growth rate was 3.7% per annum from 1990-91 to 1997-98 and was 7.63% per annum during 1980-81 to 1990-91. According to SDVA method TFP growth was reported to be 3.60% per annum from 1980-81 to 1990-91 and it was 1.97% per annum from 1990-91 to 1997-98. On the basis of GOF method the declining trend of TFP was same as DDVA and SDVA.

Mitra (2000) analyzed TFP growth for 17 two digit industries of major 15 states. Panel data was used for analysis. The result found suggested that the TFP growth was responsive to urban population and industrial spread for 11 industries out of 17.

Chand and Sen (2002) tested the influence of trade liberalization on rate of TFP growth for India manufacturing industries both theoretically and empirically. Their result showed that liberalization had the positive impact on TFP growth. They also supported the new theory of growth which suggests greater favorable effect on TFP growth than final goods due to liberalization of the intermediate good.

Ray (2002) using the non parametric approach analyzed the affect of reform in manufacturing industries in India. The result shows that productivity growth was higher in post reform period than that of pre reform period.

Kathuria (2002) using panel data and SFPF analysed the impact of liberalization on productivity of local firms for 3-digit manufacturing industries from 1989-90 to 1996-97. The result suggested that the productivity of industries specially owned by foreign firms and scientific non FDI increased.

Hasan (2002) found significant effect of imported technology, specifically disembodied technology, on productivity. He also found that new domestic capital affected productivity positively.

Goldar and Kumari (2003) performed an analysis to explain the slowdown of Indian manufacturing industries through 1990s.Their study revealed that lowering of protection had positive impact on productivity growth. But agricultural slowdown in 1990 and gestation lag in new investment project had adverse impact on productivity growth in this industry. Another reason of slowdown was underutilization of capacity of industry.

Chattopadhyay (2004) examined the TFP growth of manufacturing industries for West Bengal and for India separately for last three decades. He also examined the TFP growth for some selected two digit industry of west Bengal all together declining though it was increasing for India.TFP was falling for six major industry group which was playing the dominant role in 1960s except jute industry.

Parameswaran and Prameswaran (2004) using scholastic frontier production function examined the two component of TFP of manufacturing sector i.e.

technical change and technical efficiency. The result showed that all the industries experienced notable improvement in technical changes during post-reform period though the TE were not only lower but it was declining during this period.

Trivedi (2004) studied the inter -state differences in the productivity of organized manufacturing sector in India for ten major states considering the period 1980-81 to 2000-01. The result displayed that West Bengal and Bihar are diverging from the national level and for Bihar though productivity growth was high but it was jobless growth. Rajsthan and Madhyapradesh was good performer from a wider perspective.

Milner, Vencappa and Wright (2007) examined the productivity performances for Indian manufacturing industries in the light of changes of policies advocated by Balasubramanyam. Their result strongly supported the result of Balasubramanyam. But they were not sure about what would have happened if there had been different or no policies.

Madheswaran et al. (2007) using SFPF examined the TFP growth in Indian manufacturing industries from 1979-80 to 1997-98. The focus of the study was mainly on the trend of TE change and technological progress. The result found that the TFP growth was mainly for the technological progress. The result also showed that TFP increased during 1997-98 compared to 1980-81. The suggested efficiency oriented plan to overcome the fiscal and financial constraint.

Mitra and Ural (2008) using Cobb-Douglas production function found out the factors of productivity of manufacturing industries at two digit levels for Indian states during 1988-2000.The result found suggested that the flexibility of labor and trade liberalization significantly improved productivity of manufacturing industry.

Manjappa & Maheshá (2008) using time series data considering the period 1994 to 2004 measured TFPG and its components. They classified the industries into labor intensive and capital intensive (five in each segment). MPI was used to calculate the growth of productivity.

Soo (2008) employing panel data of 18 Indian industries tried to investigate the relationship among technology, factor endowment and industrial structure. He also tried to see the impact of liberalization on Indian economy. The study found a significant evidence of structural breaks among the above mentioned factors. After liberalization factor endowment played the significant role.

Parameswaran (2009) used firm level panel data to study the result of trade facilitated R&D spillovers on productivity in the manufacturing industries of India. The study also studied the inter sectoral variation in productivity and importance of investment in R&D. The result presented that the R&D spillover has a significant pore in increasing the productivity and this effect is significant in case of technology intensive sector.

Kathuria, Natarajan and Sen (2010) using national sample survey unit level data examined the productivity growth of unorganized manufacturing industries during 1994-95 to 2005-06. TFP and labor productivity were measured by estimating Cobb-Douglas production function by the method of Levinson and Petrin. The result showed fluctuations in labor productivity for the first period viz. 1995-2001 when the sector was experiencing 7% growth per annum. They showed that the capital intensity was the key driver of labor productivity and capital intensity played the significant role in driving the sector.

Kato (2009) examined the effect of product market competition on the rate of growth of factor productivity in the Indian manufacturing industries in 1991.The result showed that firms with the small market share experienced the higher productivity.

Gupta (2010) tried to find out the reasons of low productivity growth in pre reform period compared to the post reform period in Indian manufacturing industries and to see the impact of liberalization on productivity. The empirical result shown that sub optimal material per worker and underutilization of materials in comparison to labor were the main reasons of low productivity.

Nataraj (2011) showed the impact of unilateral reduction in the tariff of final goods and noted that the reduction in tariffs increased the productivity of informal and small firms which account 80% of manufacturing employment. The result also revealed that this reduction in tariff did not increase the productivity of formal sector.

Raj (2011) using nonparametric methods, DEA and Malmquist index analyzed the performance of productivity of Indian unorganized sector for the period 1978-79 to 2000-2001. The result showed the decline in TFP during the reform period mainly due to the progress in technology. In the mid 1990s productivity increased.

Sharma and Mishra (2011) studied the interrelation among exporting and productivity performance of sample Indian manufacturing firms during 1994 to 2006 and argued that entering in the export market not improving productivity performance and the decision to exit from this market have a negative effect on it. They also noted the existence of a high export sunk cost possibly due to lesser information about foreign markets.

Haidar (2012) examined the association between firm's productivity and export market participation of Indian manufacturing firms during 1991–2004 and showed that more productive firms become exporters but do not display that entry into export markets improve productivity. He also analyzed the clarification of self selection hypothesis for TFP differences.

Harrison, Martin and Nataraj (2012) explained the impact of market share allocation on productivity in the organized manufacturing sector. The result displayed that market share allocation had a significant influence in the growth of productivity. According to their study the improvement in productivity of manufacturing industry occurred through learning and this was linked with the reform.

Ghose and Roy Biswas (2012) using DEA examined the intra-industrial variation in TFP of manufacturing industry in India. The study revealed a considerable difference in the productivity among industry. They also added that technological progress is the key source of productivity. Lowering tariff and relative adjustment of real effective exchange rate also contributed positively in the increase of productivity.

Pradeep and Chen (2012) used DEA to analyze efficiency change, technical progress and productivity of small manufacturing firms in Coimbatore. The result calculated showed that technical progress and productivity were higher in pre reform period than post reform period. Technical efficiency was higher in post reform period.

Ray and Pal (2012) using partial factor productivity and Malmquist total factor productivity tried to see the productivity performance of glass industry considering the period from 1979-80 to 2003-04. They tried to relate total factor productivity with capacity utilization. The empirical result showed that the partial factor productivity increased in case of material though it declined in case of labor capital productivity. Output growth was input driven rather than productivity driven.

Ghose and Chakraborty (2012) measured TFP growth by estimating a production function for Pharmaceutical Industry for 1973-74 to 2003-04. Translog form gave the better fit and it was confirmed by Wald-coefficient test. Their result also found the variation in the growth of total factor productivity.

Ghosh (2013) examined the association between TFP and economic reform using data on 3digit industry. The result showed that there was not so significant increase in productivity in post reform period that that of pre reform period. The result also suggest at the farm level productivity is explained by interest channel, labor market variables and financial accelerator. And in the macroeconomic level in was mainly explained by trade policy, foreign direct investment.

Roy, Das and Pal (2016) used stochastic frontier production approach to examine the sources of TFPG of the 2 -digit manufacturing industries in West Bengal considering the period during 1981-82 to 2010-11, divided into pre and post reform period. They concluded that technological progress has been the prime driving force of productivity growth**.**

Verma and Kaur (2017) analysed the performance of Punjab's manufacturing sector using the data of twelve two-digit industrial groups (Paper and paper products, non-metallic mineral products, cotton, wool, silk and jute products, Wood and wood products, leather and leather products, chemical and chemical products) during 1980–81 to 2007–08 dividing into pre and post-reform period. The empirical results concluded that average TFP of manufacturing sector was 1.6 % per annum during last 28 years; Technical efficiency change contributed more to TFPG and Panel data results revealed that labour skills, output, good emoluments to employees and size of factory have a positive significant effect on TFP.

Pal, Chakraborty and Ghose (2018) used data at firm level from 2000-2013 to estimate TFPG of Indian Pharmaceutical Industry and performed its decomposition employing DEA and examined whether productivity of the industry has improved after 2005 i.e. after TRIPS. This empirical paper concluded that during 2006 to 2013, scale efficiency for the first period whereas better utilization of factors of production for the second period may drive the firms to a higher TFPG. The second stage panel regression analysis suggested that Marketing expenditure, R&D expenditure, Capital-Labour ratio, import intensity, export intensity and Market size, have positive and significant influence on TFPG.

Roy (2019) decomposed output and TFPG of the whole Indian manufacturing industries of fifteen major states and all-India during 1981–1982 to 2010–2011 using stochastic frontier model. He decomposed Output growth into input growth effect and TFPG. He noted that technological progress is main contributor to TFPG and input growth is the key contributor to the output growth and technological progress (TP) is major contributor to TFPG.

Since the present thesis is confined to Indian Textile industry (ITI), the studies relating to ITI is summarized in a separate section. The present thesis is concerned with employment, efficiency and productivity of ITI, so studies on these issues are presented in this section. Apart from the studies on employment, efficiency and productivity, there also some other studies dealing with Textile industry which are useful to have some idea regarding this industry.

2.2.5 Studies on Indian Textile Industry (ITI)

There are some studies in the literature that analyzed employment, efficiency and productivity and also studies under different perspectives of Indian Textile Industry considering different time points using different methodologies.

2.2.5.1 Studies Relating to Employment, Efficiency and Productivity of Indian Textile Industry

There are some studies in the literature that analyzed employment, efficiency and productivity of Indian Textile Industry considering different time points using different methodologies.

2.2.5.1.1 Studies on employment of Indian Textile Industry

Studies that discussed employment of ITI considering different dimensions are due to Narayanan (2003), Oberoi (2012), Arora (2015), Ahlawat and Renu (2018) among others.

Narayanan (2003) discussed about the employment growth rate of ITI and found out the determinants of employment for 32 sectors of the ITI from 1973 to 1999 using dynamic panel data model. This empirical paper noticed a negative growth rate of employment and the panel data model shows a favourable effect of capital, output stock, past employment and a negative effect of previous period wage on employment.

Oberoi (2012) analysed structural change of ITI considering both spinning and weaving sector, impact of technology and the reasons for the unsatisfactory performance of the ITI on the employment front. She argued that changes in structure of the ITI and technology use since 1990s have unfavourably affected the employment level.

Arora (2015) estimated subsector level (spinning, weaving and finishing of textiles and manufacture of other textiles) employment-export elasticity for the period 1988-2013 and predict the employment till the year 2020. The empirical result suggests that subsector manufacture of other textiles (139) have really high employment generation potential in comparison to subsector spinning, weaving and finishing of textiles (131).

Ahlawat and Renu (2018) analysed growth and composition of employees engaged in ITI, measured growth and relation between employments, wages, man-days employed, net value added (NVA) and influence of labour productivity in wage determination for spinning, weaving and finishing of textiles sector and manufacture of other textiles sector covering the period 2008-09 to 2013-14. The empirical results concluded huge gender disparity in employment, increasing trend in overall employment of textile industry for both sectors, spinning, weaving and finishing of textiles sector is growing faster than manufacture of other textiles sector, employment in textile has a positive and significant association with the real wage rates and labour productivity is a significant factor of wage rate of textile employees.

2.2.5.1.2 Studies on Efficiency in Indian Textile Industry

There are some studies on TE of ITI due to Kambhampati (2003), Bhandari & Maiti (2007), Gopalan & Shanmugam (2010), Das (2011), Bhandari & Ray (2012), Kumar et. al (2012), Manonmani (2013), Verma, Kumavat & Biswas (2015), Goyal, Kaur & Aggarwal (2017), De and Ghose (2020) among others.

Kambhampati (2003) analysed the impact of reforms on Indian cotton textile industries efficiency and concludes that dispersion in efficiency levels has reduced since the reforms. He found that reforms influenced exports and imports, market shares, and capital–labour ratios positively and also the location of the firm within a state and its proximity to a major urban centre to increase efficiency.

Bhandari & Maiti (2007) estimated technical efficiency of Indian textile firms using Translog SFPF taking the firm-level cross sectional data of ASI for each of the five selected years (1985–86, 1990–91, 1996–97, 1998–99, 1999–00 and 2001–02). They found that average technical efficiency varies between 68 percent to 84 percent and individual firms technical efficiency varies with firm specific characteristics such as age and size. They also argued that private sector firms are relatively more efficient.

Gopalan & Shanmugam (2010) investigated the effect of the complete phasing out of MFA in 2005 on the efficiency of Indian textiles firms. They estimated overall and input specific efficiency scores from 1993-94 to 2005-06 employing Stochastic Coefficients Frontier Approach. They concluded that the average efficiency declined over the time, overall TE is 53.63, labour efficiency is 69.99, raw material efficiency is 99.90, energy efficiency is 22.88 and capital efficiency is 82.41.

This paper also concluded that phasing out of MFA has a negative effect on efficiency.

Das (2011) estimated efficiency and productivity of jute industry in India employing nonparametric approach using ASI data considering the period 1974-75 to 2004-05. He concludes that in 2004, the mean technical efficiency was 0.62 where as mean scale efficiency was 0.77. The mean technical and mean scale efficiencies deteriorated during 1981-91 but the mean efficiency level increased during 1991-2004. The mean scale efficiency values of the industry also deteriorated in the 1980s, but it improved thereafter.

Bhandari & Ray (2012) estimated the levels of technical efficiency (TE) employing DEA in the Indian textiles industry at firm level. They used a meta-frontier production function to examine whether the technology varies across locations, ownership types and organizational patterns and determine how proprietary, organizational characteristics of a firm and location affect its performance. They concluded that West Bengal performed at higher average levels of TE, Private sector firms were more efficient and technologically superior than public sector and TE tends to increase with firm size.

Kumar et. al (2012) estimated TE and scale efficiency of 50 firms of Indian Weaving (Fabrics) Industry employing DEA using data collected from CMIE Prowess database for the year 2009. This empirical paper showed that overall mean technical efficiency of fabrics manufacturer is 0.78; mean pure technical efficiency is 0.86 where as overall average scale efficiency is 0.91.

Manonmani (2013) estimated technical efficiency of ITI using SFPF approach considering the ASI data from 1991-92 to 2009-10. Maximum likelihood estimation for productive efficiency showed that capital was the main input factor and summation of the elasticities of factors of production is 1.8419. This empirical paper also concluded that average technical efficiency of this industry is 0.941.

Verma, Kumavat & Biswas (2015) estimated technical efficiency of 10 Indian textile mills for the period 2012 and 2013. The data is obtained from CMIE data base. This empirical paper concluded that average technical efficiency score was increased from 0.90 to 0.96 and percentage of efficient firm increased from 50% to 70%.

Goyal, Kaur & Aggarwal (2017) measured overall technical, pure technical and scale efficiencies of ITI applying DEA on 101 firm level data of 2014-15 collected from CMIE. The empirical paper showed that overall technical efficiency is 0.83 and 25.74 % firms is fully efficient where as average pure TE is 0.88 and 42.58 percent firms are pure technically efficient and mean scale efficiency is 0.94.

De and Ghose (2020) estimated TE of Indian textile firms using DEA for the period of 1995-2016 and find out the determinants of TE. They noted that TE improves after the withdrawal of multi-fiber-trade-agreement and firm size, R&D intensity, net export intensity, marketing intensity and advertising intensity are the major determinants of TE.

2.2.5.1.3 Studies on Productivity in Indian Textile Industry

Some studies on productivity in ITI are done by Rao (1989), Subramanian (1992), Bedi (2003), Mariappan & Chidambaram (2003), Hashim (2004), Hashim

(2005), Das (2014), Sarma and Reddy (2006), Joshi & Singh (2010), Pal & Chakraborty (2011), Murugeshwari (2011), Ghambir and Sharma (2015), Manoj & Muraleedharan (2019) among others.

Rao (1989) investigated the effect of technology on productivity of ITI and its relations and is strictly based on yarn (spinning) and fabrics (weaving) production of ITI and measured productivity and scope of employment. He concluded that increase of 20-25% in productivity can be brought by using the available technology in the best way; rationalisation of labour by giving 80% workload to all itself would result in about 20% reduction in labour and also the industrial relations climate of the past needs to be improved substantially by Worker education, Systematic training needed, need to be linked with workload and wages should be linked with productivity.

Subramanian (1992) estimated partial and TFPG of capital and labour of cotton textile industry in Tamilnadu and also studied the nature of return to scale and estimated elasticity of substitution among these two factors and technical progress for the period 1975-76 to 1985-86. The results recommended that labour productivity increased by 2.4%, capital productivity declined, capital substitution dominated, both measure of productivity showed decline trend. TFP indices shows a decline in TFP due to workers' strike, severe power cut, and increasing cost of raw cotton, electricity and labor.

Bedi (2003) studied the productivity and technological change in spinning sector collecting the data from office of the Textile Commissioner, GOI for each of the six selected years (1983, 1988-89,1992-93, 1994-95,1995-96,1996-97). This paper used count-composition wise analysis to find out the impact of technological change on productivity. He concluded that excess spindles used over time due to the technological gap shows the changes in productivity of working spindles.

Mariappan & Chidambaram (2003) investigated the productivity (material productivity, machine productivity and labour productivity) performance of spinning and weaving industry of the National Textile Corporation in Tamil Nadu and Pondicherry for the period 1986-87 to 1996-97. This paper compared productivity of corporation with SITRA norms to understand its position in industry. They observed that number of spindles more or less same over the period but looms unit fall drastically from 2070 to 406 only but the capacity utilization is increased for loom unit. Machine productivity is less than standard productivity for these two sectors, material productivity is more or less same for the periods and labour productivity index increased over the time.

Hashim (2004) used a panel data consisting of 16 states in cotton yarn, and 13 each in garments and man-made from 1989-90 to 1997-98 collected from ASI to measure productivity of these three industries and find out the determinants of productivity. This paper also measured the cost function collecting the data of the variables from various publications of CMIE, NCAER (2000), Monthly Index Numbers of Wholesale Prices, RBI Bulletin, National Accounts Statistics, Chandhok (1990), and Input-Output table. This empirical paper includes the competition in the post MFA scenario and concluded that Poor productivity performance; in general while technological inefficiency and retrogression contribute to poor productivity performance in cotton yarn sector, diseconomies of scale affect the productivity performance in garments and man-made sectors.

Hashim (2005) argued that dismantling of Multi-Fibre Agreement (MFA) increased competition in the Indian textile and garment industries due to increase in unit cost which is contingent upon factor prices and productivity level. This paper estimated total factor productivity (TFP), relate with unit cost and analysed the main determinants of productivity for the cotton yarn and garment industries for selected states employing panel data analysis considering the period from 1989 to 1997. This empirical paper suggested that large-scale production, cheaper raw materials, disbursement of credit, promotion of better capacity utilization, flexible labour laws and greater accessibility of electricity helped the cotton yarn and garment industries become more cost-effective.

Das (2014) measured efficiency, productivity and capacity utilization of Indian jute industry applying Data envelopment analysis on firm level data at 5-digit disaggregation collected from ASI during the period 1981, 1991 and 2004 as available. The result shown that mean technical efficiency was highest in 2004-05 where as mean scale efficiency was highest in 1981-82 in all India case and TFPG was highest in 2004-05.

Sarma and Reddy (2006) investigated the productivity trends of India textile industry during pre and post-liberalization period using Divisia total factor productivity index methodology. Results displays that for maximum states the TFPG rates are relatively lesser in the post-liberalization period and TFPG rates are negative in post-reforms period. This paper also concluded that the relative degree of concentration is a significant factor of productivity for all the states.

Joshi & Singh (2010) analyzed the TFP in the Indian garment manufacturing firms during 2002-2007 to identify the sources of TFP and also suggested measures for the firms to enhance their productivity. It was found that Indian garment industry has realized an average TFPG rate of 1.7 % per annum. The large and medium scale firms were seen to be more productive compared to small firms. The study endorsed productivity growth mainly due to technical efficiency change.

Pal & Chakraborty (2011) estimated productivity employing translog index on time series data on some of the key structural variables like number of factories, number of workers, fixed capital, gross fixed capital formation value of output, and net value added for jute sector considering the period of 1991-92 to 2004-05 collected from various reports of ASI. The empirical analysis reveals that capital intensity, labour productivity and TFP increased during the globalization era, but the falling trend of capital productivity with a low growth of capital-output ratio signifies the general descent of the quality of investment and its improper utilization over time and lower ratio of value added to output also indicates cost ineffective technology used by the industry.

Murugeshwari (2011) investigated the effect of the policy shift on TFP in the ITI. The result reveals that the industry has shown TFP improvement and technological progress in pre-liberalization era which tells that competition has condensed the technological progress of this industry and the productivity performance.

Ghambir and Sharma (2015) investigated the sources of productivity growth employing output-oriented Malmquist productivity index for large and small scale manufacturing firms of ITI using firm-level panel data of 160 firms taking the period from 2007-2008 to 2012-2013. The result shows that technological change and scale efficiency change are the main sources of productivity growth and large firms exhibited better productivity.

Manoj & Muraleedharan (2019) examined the influence of trade liberalisation on productivity of ITI during the period 1989-90 to 2011-12 collected from ASI. The empirical results revealed that labour productivity and capital intensity increased in the post MFA period whereas capital productivity decreased during the second period.

2.2.5.2 Other Studies on Indian Textile Industry

The survey of literature reveals that there are several studies, other than employment, efficiency and productivity that analysed Indian Textile Industry (ITI) under different perspectives considering different time points using different methodologies. Some worth mentioning names are Verma (2000), Bhavani & Tendulkar (2001), Verma (2002), Fenske & Bharadwaj (2010), Devaraja (2011), Gera (2012), Tandon & Reddy (2013), Bagchi & Das (2014), Banik & Shil (2014), Manoj (2014), Dikshit, Basak & Vagrecha (2015), Senthikumar & Sengottaiyan (2015), Dikshit, Basa & Vagrecha (2015), Yoganandan & Vetriselvan (2016), Bag, Kumar & Pal (2016), Manoj & Muraleedharan (2016), Chaudhary, Parvej & Anjum (2016), Kumar (2017), Kalita & Bhuyan (2018), Dixit and Lal (2019), Kim (2019) among others.

Verma (2000) studied on the restructuring of the ITI including the sectors like apparels, yarn, Fabric and made-ups and also studied with respect to the global context. He conclude that synergy would not only generate unique stakeholders' architecture, which could be a sustainable basis for competitive advantage, but also force technological up gradation in the textile producing firms, and a better appreciation of the role of state-of-the-art information technology in enterprise resource planning (ERP).

Bhavani & Tendulkar (2001) examined the export performance of Garment and Apparel producing units in Delhi and identified the determinants of firm level export employing Probit and Tobit model on the data of 310 Manufacture of Textile Garments including Wearing Apparel for the year 1987-88 collected from the office of the Development Commissioner, Small Scale Industries. This empirical paper concluded that marginal impact of scale and share of sales expenses on the probability of exporting in an estimated Probit model drops severely when moving from proprietorship to partnership to limited companies and scale, share of sales expenses, share of wages and technical efficiency has been found to have an increasing marginal impact on export performance.

Verma (2002) analyzed competitive performance of Indian textile exports in Unites States and European Union markets. It was found that except made-ups, Indian textile export to the Unites States had no future. The market share of other products (Fabrics) was declining over time. In case of European Union, India's performance was good in synthetic products (yarn and made-ups) in textiles, among garments: suits, coats, jackets and skirts were leaders. The products whose exports to European Union had been constrained by quotas (MFA) and hence were likely to gain from quota dismantling in 2005 were cotton bleached fabric and woven bed linen.

Fenske & Bharadwaj (2010) investigated the effect of partition, migration on jute cultivation in India collection the data from Censuses of India from 1931 and 1951 and 1931 Agricultural Census and the World Bank Agricultural and Climate data set using instrumental variables (IV) strategy. They concluded that migrants played a most important role in India’s jute cultivation, migrants completely explain post-Partition jute cultivation and migrants increased jute yields.

Devaraja (2011) studied the effect of liberalization on Indian textile and garments industry and discuss Buyer-driven value chains and producer-driven value chains of the textile industry. This paper specially studied the spinning, weaving, knitting, Processing and Garmenting.

Gera (2012) discussed about the significance of Indian textile export and its future in the world market collecting the data from DGCI&S, Kolkata for the period from 1990-91 to 2011-12. The result showed that there is an increasing trend of export from India.

Tandon & Reddy (2013) observed that Textiles industry and its labour relations are experiencing profound changes. The textile industry is undergoing changes whereby the management, workers and all stakeholders need be ready to competition for sustainability.

Bagchi & Das (2014) inquired into short-run efficiency, with factory level data collecting from ASI and Office of the Jute Commissioner, Government of India for the period from 2000 to 2010. This empirical paper concluded that structural change took place in favour of capital; skilled unskilled employment growth and in wage differentials. They tried to figure out the ways in which technical helped the revival or growth of this industry.

Banik & Shil (2014) analyzed trend and pattern of diversified Indian jute products in global market and assess the performance of National Jute Board, India for distribution and promotion of diversified Indian jute products using the secondary data collected from National Jute Board and Indian Jute Mills Association, Kolkata over the period from 2000-01 to 2012-13. They concluded that diversified jute products have a highly demanded export market and to retain its position research programme should be undertaken by govt. organizations like IJMA, IJIRA etc.

Manoj (2014) investigated the export performance of ITI in post-MFA regime collected data from reports of WTO, Ministry of Textiles and DGCIS, Kolkata for the year 1992 to 2012 and divided the data in tow sub periods as pre MFA period (1992-2004) and post-MFA period (2005-2012). This paper concluded that Indian textile export increased in post-MFA period. This paper also investigated the increase in export amount in different type of textile products.

Dikshit, Basak & Vagrecha (2015) investigated the impact of abolition of MFA on export of yarn, fabric, garments and whole textiles and clothing during the period 2001-02 to 2011-12 collected from Handbook of Statistics on Textile Industry, Official Indian Textiles Statistics, Office of the Textile Commissioner Government of India and concluded that the export of textile intermediates (i.e. yarn and fabric) and textiles and clothing improved considerably after the dismantling of MFA.

Senthikumar & Sengottaiyan (2015) used the data of 20 firms collected from CMIE database for the year 1997 to 2011 to estimate growth and development of ITI and trends and patterns of efficiency of Working capital utilization. The empirical paper concluded that overall utilization index is poor during 1999, 2003, 2004, 2005, 2009; overall performance index is poor during 2001, 2003, 2009 and overall efficiency index is poor during the years 1999, 2003, 2004, 2005 and 2009.

Yoganandan & Vetriselvan (2016) studied the growth of Textile Industry and they observed that the ITI was dominated by cotton fibre but the recent trends highlight the changes happening in this sector. i.e, the man-made fibre has been on a rising trend. They also investigated the production performance of Yarn and Fabrics collecting the data from Annual Report, Ministry of Textile for the period 2010-11 to 2014-15 and noticed an increasing trend of production.

Bag, Kumar & Pal (2016) investigated the scope and status of Indian Jute industry with other countries. They argued that sacking goods production share is 75% of the total goods production and B twill bags share is 85% of the total sacking bag production in India. They also concluded that there exists a rising trend of imports of jute goods and bags, hessian cloth are the major exporting items of jute goods.

Manoj & Muraleedharan (2016) found that the removal of MFA has provided opportunities and challenges to India's exports of textile sector. The results are based on CMIE data base and divided the data into MFA period (1992-2004) and post-MFA period (2005-2012). This study concluded that export of readymade garments, cotton textiles and manmade textiles increased in the post MFA period.

Chaudhary, Parvej & Anjum (2016) used secondary data covering the period from FY 2010-11 to 2015-16 to estimate productivity of Bombay Dyeing & Mfg. Co. Ltd. This empirical paper concluded that Dyeing & Mfg. Co. Ltd faced a low productivity situation due to inaccessibility of resources, excessive time expended to acquire and use resources, most of the mills are working with old and obsolete machinery and poor management practices.

Kumar (2017) discussed about the growth of Indian jute industry in the universal market as well as highlighting the overall scenario of jute industry in recent years. This paper based on secondary data and information collected from Jute Technology Mission, Ministry of Textiles, Govt. of India.

Kalita & Bhuyan (2018) analyzed the marketing practice of Assam jute farmers and identified the factors which influenced the choice of channel selection in the process of marketing raw Jute using both primary and secondary data.

Dixit and Lal (2019) investigated how textile industry is contributing in inclusive development using textile industry is contributing in inclusive development and concluded that this sector contributes in inclusiveness and employment generation but has no social responsibility due to its unorganized structure.

Kim (2019) investigated export competitiveness of Indian textiles and clothing (T&C) sector in USA during 1991 to 2017 using Comparative Advantage by Countries (CAC), Revealed Comparative Advantage (RCA) and Market Comparative Advantage (MCA) and concluded that India had a comparative advantage.

2.3 Connection of the Present Study with the Existing Literature

The perusal of the literature on ITI suggests that not much attempt has been made on the issue of growth of employment, technical efficiency and TFPG in different sectors of ITI viz. yarn and fabrics using firm level data employing modern econometric approach. So, the analysis of ITI at sectoral level considering firm level data is very much essential both from the academic point of view as well as policy perspective.

ITI consists of different firms; each firm has its own special characteristics that persuade the growth and performance of textile industry in several counts. Also the production in different firms varies. Hence the growth and performance of textile industry in different firms do not always move in the same track. There is inter firm disparity in terms of employment, efficiency and productivity as well. Thus firm level analysis may help to understand the performance of ITI much clearly.

Thus it will be interesting to extend the literature by addressing the following important issues in the context of ITI using firm level data:

(i) Analysis of the growth of employment of Yarn producing sector and Fabrics producing sector of ITI using modern time series approach. Such an analysis will be meaningful and helpful for identifying the sector for which the growth performance is unsatisfactory and thus proper measure can be taken for promoting growth for those backward sector. Also there is a lack in the literature highlighting this area and methodology.

(ii) Analysis of technical efficiency of Yarn producing sector and Fabrics producing sector of ITI using DEA considering firm level data. This area needs to be motivated because for sustained long run growth, an industry has to run with higher technical efficiency. There is enormous scope to add in the literature considering this matter.

(iii) Estimation and analysis of TFPG of Yarn producing sector and Fabrics producing sector of ITI by applying nonparametric DEA method. For attaining steady growth over the years or for its mere endurance, improved performance in productivity of a production unit is required. 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 as well as for policy outlook.

These are the significant issues that seek for consideration in the context of Indian Textile Industry. The contributions to the literature regarding each of these problems are discussed elaborately in the specific chapter dealing with the problems.