Total Factor Productivity Growth, Employment and Openness: A Case Study of Indian Automobile and Textile Industry

Aakanksha Arora, aakanksha.arora20@gmail.com[1]

1) INTRODUCTION

It is often generalized that the performance or productivity or technical efficiency of manufacturing sector has increased remarkably in the last few decades. This study aims at analysing the productivity and efficiency of Indian industries to find out whether they have improved.

The performance of manufacturing sector in India is analysed by examining the new technologies, improvements in technical efficiency and Total Factor Productivity Growth. ***Technological Progress,*** namely, the adoption /availability of new and better technology in an industry makes an industry better equipped and hence it is likely to become more productive and efficient. Technological progress is normally denoted by a shift in the Production Possibility Frontier which is defined as the maximum possible outputs given the level of inputs. ***Technical efficiency,*** on the other hand, refers to how well a firm uses the given know-how or technology and the inputs. It is an indicator of how efficiently the inputs are being used by the firms to produce output. So, Technical Efficiency shows how far a firm is from the Production Possibility Frontier. ***Total Factor Productivity*** is the increase in output not explained by increase in inputs. It can be because of factors like improvements in technology, changes in business environment and managerial skills. It is a sum of technological progress and technical efficiency. For analyzing this difference across industries and within industries over time, 2 industries have been chosen for time period 1997-2012. To get a better picture of the changes in industry, a capital intensive and a labour intensive industry has been chosen. **Automobile, two and three wheeler industry** is highly **"capital intensive"** in nature, so that has been chosen. Secondly, for the **"labour intensive industry", the handmade**

[1] I would like to take this opportunity to thank my guide and my mentor Prof Arup Mitra for his constant guidance and support. This paper would not have been possible without his continuous efforts. He lent a helping hand at every stage of this paper starting from the forming of the idea of the paper to its completion.

fabric sector from textile industry has been selected. The entire analysis has been done at firm level to get a picture of changes in the industry and disparity within the industry too.

Further, impact of Trade openness is checked on the performance of industries. This also has been done by checking the impact of Import / Sales and Export / Sales on Total Factor Productivity and Technical Efficiency. This is to check the validity of argument that with opening up of the economy, the performance of manufacturing sector has improved and whether it has improved for both capital intensive and labour intensive industries. Another point of study is the impact changes in Total Factor productivity, Technical Efficiency and trade openness will have on labour employed in the industry. This is important in light of the argument that improvement in technical efficiency is capital intensive. My purpose here is to analyze whether the employment has increased or decreased with changes in Technical Efficiency or Total Factor productivity.

So, the entire study is to check how the automobile 2 and 3 wheeler industry and handmade fabric textile industry has performed in all the respects discussed above.

The next section explains the methodology followed and the data sources used for analyzing the performance of the automobile and textile industries. Section 3 reviews the analytical the literature on the TFPG of both the industries. Section 4 presents the results of the TFP growth and Technical efficiency of firms. It also contains the results on the impact of trade openness on TFPG/TE of these industries. The relationship between TFPG and labour intensity is also assessed for both these industries. Section5 summarises the results and points out towards the various policy implications. Section 6 is the appendix consisting the tables and graphs. At last, section 7 is the bibliography.

2) 2.1. METHEDOLOGY

To study the trend and status of productivity in the manufacturing sector, 2 very diverse kind of industries are selected for proper representation. One highly capital intensive industry i.e. "automobile industry (2 and 3 wheeler)" and one labour intensive industry i.e. "textile- hand made fabrics" is chosen for the study. Within the industry the listed firms are selected (because of proper availability of data) and subsequently Technical Efficiency (TE) and Total Factor Productivity Growth (TFPG) are estimated for these firms. **10 firms from automobile sector and 14 firms from textile industry are considered for the analysis**.

The methodology followed is that of **"Cornell, Schmidt and Sickles (1990)".** Although there are various techniques but this technique is easiest to compute and understand for the panel data for

firm level analysis and estimate "time varying TFPG and TE for specific firms". The approach followed is basically a "production frontier approach". Usually all the analysis and calculation of TE/TFPG is done on the assumption of Constant Returns to scale and perfect competition. But this methodology does not need any of these assumptions and it takes time series and cross sectional pooled data and uses production function approach to measure TE and TFPG.

CALCULATING THE TECHNICAL EFFICIENCY AND TOTAL FACTOR PRODUCTIVITY:

- The data for sales, capital, raw material, fuel is collected from ACE EQUITY. Then the data for WPI is collected from Office of Economic Advisor.
- Sales haves been used as a proxy for production because data available isfor sales only.
- All the analysis needs to be done in constant prices and for this, all the values have to be deflated using the appropriate index. Here the fuel and power consumed is deflated by WPI of power and fuel. The hand-made fabrics textile sales are deflated by WPI of textiles. The automobile sales are deflated by WPI of automotives. Further the raw materials are deflated by WPI of sales only with the concept of inputs and output having same price level. The capital employed is deflated by WPI of machinery and equipments. With this all the variables are converted in constant prices.
- Labour employed in any firm is calculated using the data on Total employee cost and then dividing it by the average yearly wage level of each industry (taken from ASI). **Since we are using a panel data, the data is divided according to specific units and timeperiod by giving different codes to each units and time periods. For example: Each firm has a distinct unitcode, firm A=1, firm B=2 and so on. And all years are given a distinct timecode like 1997 is given a code 1, 1998 is given code 2 and so on. So, this means every observation has a different combination of unitcode and timecode.**
- **The production function used is generally referred to as KLEM.**
  Production = f (Capital, Labour, Energy, Material)
  Q = f (K, L, E, M)
- **For further assessment all these variables are used in log format Log values of sales are regressed on log values of capital, labour, raw materials, power and fuel and on time code as shown in the equation below**

Log (sales) = a1+ a2 * log (capital) + a3* log (labour) + a4* log (raw materials) +a5 * log (energy) + a6 (timecode) + U

"a6" represents the technological progress. It shows how the technology has changed with time and this is called as TECHNOLOGICAL PROGRESS (where the positive and significant coefficient depicts improvement in technology used) and U is the error term.

Since the dataset being used is a panel data, three methodologies can be followed to find out the coefficients namely Ordinary Least Square method (OLS), Fixed Effect model (FE) and Random Effect model. Lagrange Multiplier Test is used to check whether using OLS method is appropriate. Further Haussmann Test is used to find out whether Fixed effect model or random effect model should be used. These tests in this case point out that Fixed effect method is finest to use.

- So the coefficient that we get using fixed effect model is the "technological progress". It is assumed that the technology used is common across firms.
- After this the technical efficiency is calculated which is captured in the error term (as calculated in above equation).
- For calculating TE, the residuals from 1st equation have to be estimated separately for each firm. Example: The residuals from the above equation have to be estimated as a separate data set for firm A that has a unique unitcode 1. And the same is done for all the firms. So, we have 10 separate residual series for automobile sector and 14 separate residual series is found for textile sector.

  So, a separate residual series is created for all firms.
- The residuals calculated above have 2 components- a **technical efficiency component** and a random component. Now to separate this efficiency component from the error term, the error terms (each residual series separately) are regressed on time and time-square and then the deterministic component is separated.

U= v + w where v is the technical efficiency and w is the random component.

U is the error term from sales equation and then

U = b1 + b2 * (timecode) + b3 * (timecode) ^2 +w

The estimated U from this equation (known as U-hat) is used to measure the technical efficiency (which is the deterministic component) and w is the random term.

- After this the maximum U-hat is found out from the entire panel data set which gives a point on production possibility frontier (PPF). The value of all U's is then subtracted from U maximum. i.e. (U max – U) to find the distance from PPF.

Then the technical efficiency is calculated as TE = exponential ^ (U max – U-hat)

So, with this a separate series of technical efficiency is calculated for each firm over time.
So, we get a time varying TE series for all firms separately which gives not only the average Efficiency level of firms but the TE of firms over time. So it shows that how efficiently the firms are using the available inputs.

- Now the technical progress and Technological Progress is used to calculate the Total Factor Productivity Growth.

TFPG= TECHNOLOGICAL PROGRESS + CHANGE IN TECHNICAL EFFICIENCY

Change in Technical Efficiency = b2 + 2*(b3)*(timecode)
Technological progress = a6
The change of coefficients will show whether the firm is improving and becoming more efficient over time. This is very important as it depicts whether the firm is becoming more efficient over time and is using its input better. If it is positive and increasing, it shows that firm is producing more output with same amount of inputs.

- Using the technological progress and change in Technical efficiency and adding them both , TPF Growth is calculated for all the firms and for all years. The same is done for both textile and automobile industries. The series of TFPG is found for all the firms which are further interpreted to check the trend of productivity over time. So, we get time varying TFP Growth of all the firms apart from the mean TFP level of firms.

ASSESSING THE IMPACT OF TRADE OPENNESS ON TFPG AND TECHNICAL PROGRESS:

To capture the degree of trade openness, import/sales and export/sales ratio are considered as an indicator. Then the effect of import and export is checked on the performance of industries. To do

this TFPG and Technical efficiency separately is regressed on Import / sales and Exports/ Sales while using Age of firm as a control variable. Here the Age of firm is used as a control variable because it may also affect the performance of the industry. So to prevent the impact of age being mixed with the trade indicator it is being used as a control.

Ownership of the firm is also thought to be affecting the performance of the industry significantly. So the ownership of the firms is checked for all these firms but none of them is government owned and all firms are either private limited or public limited companies. So, the ownership is not used as a control variable.

TFPG = c1 + c2 * (Import/Sales) + c3 * (Export/Sales) +Age of the firm

TE = d1 + d2 * (Import/Sales) + d3 * (Export/Sales) + Age of the firm

The coefficients c2 and d2 tell the impact of increase in import/Sales on TFPG and TE respectively. Similarly, c3 and d3 reflect on the increase in Exports/Sales on TFPG and TE respectively. So, the positive and significant signs will show that the trade openness has increased the productivity of the industry. Then this will support the general hypothesis of trade being favourable to firms in terms of increasing their productivity.

FINDING THE EFFECT OF TFPG AND TE CHANGE ON LABOUR EMPLOYED

To check whether the increase in TE/TFP is associated with increase in employment in these firms or not, a regression is done of TFPG or TE on the labour employed in the firm. The relation of change in TFPG/TE is assessed on labour in the firm.

Labour employed= x1+ x2 *(TFPG)

Labour employed= y1+ y2 *(TE)

x1 /y1 tell the impact of 1 unit change in TFPG or TE on labour employed in the firm. The sign of x2 and y2 will tell whether the impact is labour increasing or not.

FINDING THE EFFECT OF IMPORT AND EXPORT CHANGE ON LABOUR EMPLOYED

Export and import by firm would lead to change in the demand of labour by the firm. To check what the impact is, export/ sales and import/sales are regressed on labour employed in a firm.

Labour employed= u1+ u2 * (Import/Sales) + u3 * (Export/Sales)

Where “u2” and “u3” shows the effect of a unit change in Import and Export respectively on the labour employed in the firm.

2.2 DATA SOURCES

- ASI Data from MOSPI: Wage level of labour of textile and automobile industry
- Office of Economic Advisor: WPI Index for fuel and power, WPI index for machinery and raw material, WPI Index for textiles, WPI index for automotives, WPI index for raw materials
- ACE EQUITY: Gross Sales, Capital Employed, Labour employed, Raw Material used, Fuel and Energy used, Imports of firm, Exports of firm
- ANNUAL REPORTS OF FIRMS: Age of firm and Ownership

3) REVIEW OF LITERATURE

3.1 TEXTILE INDUSTRY

Indian textile and clothing industry occupies a unique place in the Indian economy. It contributes about 4% of GDP and 14% of industrial output. It is the second largest employer after agriculture; the industry provides direct employment to 35 million people including substantial segments of weaker sections of society. In 1995-96, the share of cotton and manmade fabric in the textile industry was 60% and 27% respectively. More recently, in 2005-06, the cotton fabric accounted for 46% of total fabric produced while man-made fibres held a share of 41%. [2] With a very low import-intensity of about 1.5% only, it is the largest *net* foreign exchange earner in India, earning almost 35% of foreign exchange.
Major export destinations for India’s textile and apparel products are the US and EU, which togethe r accounted for over 75% of demand. Out of textiles, fabric constitutes a major part. [3]

Man made textiles exports have witnessed a decline of 2.5% in 2005-06. Between 1999-2000 and 2002-03, man-made textiles exports were growing at around 30% per annum. The slowdown began since 2003-04 and has been on the decline since. In mostly all chosen fabric exports to US, India has lost market share during 1995-2000. Except cotton sheeting fabric, India did not grow even in

[2] Textile industry Report- By Dun& Bradstreet India
[3] Export Competitiveness of Indian Textile and Garment Industry, Samar Verma, ICRIER Paper

quantity terms. Indian fabric exports have not revealed to be competitive in the US market now. [4] The main reason attributed to this is the availability of cheap exports from some other countries like Bangladesh. So, it is very important that competitiveness of textile industry should be looked at to maintain the Indian textile position.

3.2 AUTOMOBILE INDUSTRY

Before liberalization, the sector was a highly protected market both from internal and external competition. The market was mainly an oligopoly structure where firms have facing large profit margins and large market share.[5]

The Indian Automotive Industry after de-licensing in July, 1991 has grown at an impressive rate of 17% on an average for last few years. The industry has now attained a turnover of Rs. 1, 65,000 crores (34 billion USD) and an investment of Rs. 50,000 crores. The export in automotive sector has grown on an average CAGR of 30% per year for the last five years and has reached a turnover of 8 billion USD .The export earnings from this sector are 3.5 billion US $ out of which the share of auto component sector 1.8 billion US$ (until 2005-06) . Even with this rapid growth, the Indian Automotive Industry's contribution in global terms is very low. [6] The automotive sector has deep backward (metals- steel, aluminium, copper etc. plastics, paint, glass, electronics, capital equipments, trucking warehousing and logistics) and forward (dealership retails , credit and financing, logistics, advertising, repair and maintenance, petroleum products, gas stations, insurance, service parts) linkages that have been recognized and identified by many agencies (Planning Commission, National Manufacturing Competitiveness Council and Investment Commission). This has potential to increase the manufacturing output in the country.

The passenger car segment has crossed the production figure of 1 million in the year 2005-06. But still India's share is only about 1.6% of world production in the total number of 60 million passenger cars being manufactured in the world (2005). [7] India is emerging as fastest growing passenger car markets and two wheeler manufacturer. It is sometimes argued that Indian Automobile industry has attained competitiveness on the basis of low cost and availability of abundant labour at low wages, favourable exchange rate, low interest rate etc which can only give short run impetus to the industry. The long run factors like R&D, innovation etc. has not been the

[4] Export Competitiveness of Indian Textile and Garment Industry, Samar Verma, ICRIER Paper
[5] Technology Acquisition, De-regulation and Competitiveness: A study of Indian Automobile Industry- K Narayanan September 1997
[6] Report on Working Group on Automotive Industry, Ministry of Heavy Industries and Public Enterprises, Department of Heavy Industries
[7] Report on Working Group on Automotive Industry, Ministry of Heavy Industries and Public Enterprises, Department of Heavy Industries

growth drivers and hence a greater emphasis needs to be put on these factors that can ensure competitiveness in future.

3.3 WHAT IS TOTAL FACTOR PRODUCTIVITY AND WHY IS IT IMPORTANT?

- **Technical efficiency:** It refers to the way in which the inputs are combined to produce output. It tells how good or bad the given technology and inputs are used to generate the output. It gives an idea of how far the firm is from the production frontier which is the most efficient way of utilizing the inputs and shows the maximum attainable output.

- **Technological progress:** It is improved technology available for production in the industry. It can be any kind of advances in knowledge relating to art of production. It can be conceptualized in terms of shifts of production function (Solow1957)

- **Total Factor Productivity Growth:** It explains the increase in output not explained by increase in inputs. It is normally credited to the improvement in knowledge, organizational structure, human resources management, skills attainment, information technology and efficient use of factors of production. Mathematically, it is a sum of changes in Technical Efficiency and Technological Progress.

TFPG is a highly debated topic in all the countries. The importance of TFPG lies in the fact that it tells whether the growth in output has been merely inputs driven or it has been productivity driven. The input–driven growth is achieved through the increase in factors of production which is certainly subjected to diminishing returns and is not sustainable in the long run. Productivity isn't everything, but in long run it is almost everything (Krugman, 1990). It becomes even more important for developing and less developed economies to focus on TFPG to improve the growth of the economy as they have limited income availability. Productivity growth is essential not only to increase output, but also to improve the competitiveness of an industry both in the domestic and international markets.

3.4 TOTAL FACTOR PRODUCTIVITY GROWTH TREND IN INDIAN MANUFACTURING SECTOR

The TFP growth of the manufacturing sector was positive during the first sub period (1992 / 93 - 1997/98), slumped in the next (1998/99 - 2001/02) and rose sharply in the final sub-period (2002/03 -2005/06). In the first sub-period, TFP grew at the rate of 0.7 per cent per annum. This represented a deceleration from the average annual productivity growth of 1.3 per cent registered during 1980/81-1989/90, as reported in Banga and Goldar (2004). It can therefore be argued that productivity

growth in the post reform period of the 1990s was lower than it was during the 1980s. [8] TFP started growing during 2002/03 to 2005/06 period. In the same paper overall for the manufacturing sector, a TFPG of 0.81 is reported. The study by B.N. Goldar states that there has been a slowdown in TFP growth in Indian manufacturing in the post reform period.[9]

But there other studies which have stated that TFPG of manufacturing has improved over the years like study by Bulent Unel [10]and another study done by TSL. Specifically for the case of textile sector, TFPG growth is reported as 0.9 by Bulent Unel. [11] Similarly Ahluwalia (1995) stated that the TFP has been accelerating for the Indian Manufacturing sector since 1980s.

Specifically as well for automobile sector and manmade textile industry, there is varied literature available for the estimates of TE, TFPG for both of these industries. Although the estimates vary across papers, none of them have come across very rosy picture of the performance of the industry. Textile had a TFP Growth of 1.31 % from 1992-93 to 2005-06. Motor vehicles witnessed a TFP Growth of 1.98% in the same time period. [12]

4) RESULTS

4.1 AUTOMOBILE INDUSTRY

After running the regression of capital, labour, fuel, raw material, time on sales the following results is obtained. The coefficients of log (capital), log (labour), log (fuel), log (raw material) on log (sales) show the marginal elasticities of capital, labour, fuel and raw material respectively. Most important is the coefficient of timecode i.e. **-0.016222 which represents the technological progress (technical regress in this case) in the industry.** It is supposed to be common for all the firms across the industry because of the assumption that once the technology is there, it is available to all the firms.

[8] Danish A. Hashim, Ajay Kumar and Arvind Virmani, Impact of major Liberalization on productivity, Department of Economic Affairs, Ministry of Finance

[9] B.N. Goldar, Productivity Trends in Indian Manufacturing in Pre and Post Reform Periods, ICRIER Working Paper no 137

[10] Bulent Unel , Productivity Trends in India's manufacturing sector in last 2 decades, IMF Working Paper, WP/03/22

[11] Bulent Unel , Productivity Trends in India's manufacturing sector in last 2 decades, IMF Working Paper, WP/03/22

[12] Danish A. Hashim, Ajay Kumar and Arvind Virmani , Impact of Major Liberalization on Productivity: The J Curve Hypothesis, October, 2009 , Department of Economic Affairs, Working Paper No 5

Table I: TECHNOLOGICAL PROGRESS FOR AUTOMOBILE INDUSTRY

Log sales	Coefficient	Std. Error	T	P>t
Log capital	0.2443624	0.0861582	2.84	0.005
Log labour	0.1065188	0.0463161	2.3	0.023
Log fuel	0.251821	0.0647877	3.89	0.000
Log raw	0.6132755	0.0376008	16.31	0.000
timecode	-0.016222	0.0066209	-2.45	0.016
constant	0.3602916	0.3311432	1.09	0.279

The negative coefficient here is very important as it shows that there has been no technological progress in the automobile industry. Infact it is a technological regress in the industry. However, the coefficient of time in the above table is not highly statistically significant. Nevertheless it is still very important as this clearly points towards no technological progress in automobile industry and this is in contrast to the general view of high technological progress in this industry.

To separate out the technical efficiency component from this residual term, when these residuals estimated from this equation are regressed on time and time square, residual-hat is calculated. This residual-hat from the second equation is then further used to estimate technical efficiency. From the tables, it is seen the maximum value of the residual is 0.862822 and then all the residuals are subtracted from the maximum value and then further exponential of this difference is taken and the value obtained is Technical Efficiency. It shows how far the firms are technical efficient. This is done within firms and for single firm across time. For convenience it is multiplied with 100 to make comparison about efficiency. The mean, maximum and minimum TE of each firm is shown in the table below.

Table II: TECHNICAL EFFICIENCY FOR AUTOMOBILE FIRMS

Variable	Mean	Std. Dev.	Min	Max
Technical Eff 1	88.74228	11.70805	62.0357	100

Technical Eff 2	36.21184	4.489329	32.12815	43.10085
Technical Eff 3	41.2789	5.214532	30.32654	47.02018
Technical Eff 4	35.72881	4.07434	27.57267	39.32039
Technical Eff 5	29.40527	2.282613	27.40104	35.30522
Technical Eff 6	58.10208	5.174281	53.77287	70.16354
Technical Eff 7	41.86526	3.598112	34.21542	45.10461
Technical Eff8	47.39969	4.725762	37.3427	52.54705
Technical Eff 9	36.15679	1.671845	32.25097	37.74879
Technical Eff 10	8.48746	6.516803	1.592329	14.54493

This shows that the firm is most efficient (on an average 88.74228) with it attaining a maximum value (which is 100) in a particular year. On the other hand, the firm 10 is least efficient with the average of only 8.48. This also points towards the disparity within firms. Apart from this in some years the firms have had efficiency as low as 2%. Not only this, the firms have witnessed change in technical efficiency with some firms having positive change and some negative. **The time varying TE for each firm is attached in the appendix.**

(NOTE: The maximum value is 100. First all the estimated residuals are calculated and then they are subtracted from the max estimated value. So, in this it will be 0 for once when the maximum will be subtracted from itself. Then exponential$^{\wedge 0}$ is 1. Then further for simplification since it is being multiplied by 100. The maximum value of technical efficiency is coming as 100)

Table III: SUMMARY OF TECHNICAL EFFICIENCY IN AUTOMOBILE FIRMS

TECHNICAL EFFICIENCY(AVERAGE)	NO OF FIRMS
>80	1
50-80	1
30-50	6
<30	2

This table shows that there are only 2 firms which are operating above 50% efficiency level out of the 10 sample firms taken. It is only 1 firm that has achieved 80% efficiency level on average over the time period under consideration. This point towards an important observation that this highly capital intensive industry is also not functioning efficiently which is again quite surprising.

After this the change in technological progress is calculated and is added to technical efficiency of the firm and then TFPG is calculated for each firm. It is noted that the TFPG is negative for 7 out of 10 firms. In this as well, there is disparity within firms and for each firm across time with 1 firm having 20% TFPG and another firm having -2% TFPG. But overall the performance of the industry has been very bad in terms of productivity growth.

A point that has not been depicted here is that by analyzing the individual TFPG series for firms it was observed that o**ut of 10 firms, 6 had a decreasing TFPG growth for this time period. For these firms, positive TFP growth turned negative from the positive growth in the initial years. This shows that over time the firms have become rather less productive. The individual firm's time varying TFPG is depicted in the graph attached in the appendix at the last of report.**

Table IV: TFPG OF AUTOMOBILE FIRMS

Variable	Mean	Std. Dev.	Min	Max
TFPG1	-0.00186	0.0595772	-0.09153	0.097458
TFPG2	0.05723	0.0524163	-0.00907	0.123532
TFPG3	-0.00574	0.0603117	-0.10075	0.08927
TFPG4	-0.03797	0.0229258	-0.07399	-0.00351
TFPG5	-0.02632	0.0273483	-0.07047	0.016486
TFPG6	-0.03182	0.0204359	-0.06402	0.000369
TFPG7	0.000704	0.0193609	-0.0298	0.031203
TFPG8	-0.00819	0.0471563	-0.08248	0.066094

TFPG9	-0.02297	0.0170366	-0.04981	0.003863
TFPG10	0.206037	3.979562	-3.77353	4.185598

Table V: SUMMARY OF TOTAL FACTOR PRODUCTIVITY OF AUTOMOBILE FIRMS

TOTAL FACTOR PRODUCTIVITY GROWTH(AVERAGE)	NO OF FIRMS
NEGATIVE	7
POSITIVE	3

This table shows a very important result. The Total Factor Productivity Growth is negative for most of the industries and hence it points towards the fact that the increase in output in this industry is because of more inputs being devoted to production and not increase in efficiency or productivity. One more plausible reason of this can be that cheap availability of imports may have induced them to use more of inputs and hence production increased. This can pose a big challenge to the industry in the long run which for now looks to be doing reasonably well.

As given in other available literature, the reason for fall in TFPG is also given in form of J CURVE hypothesis. This means that after liberalization when new technology and products become available, some of the capital is rendered obsolete. Hence the TFPG may become negative soon after liberalization. The decline is more when the particular industry is not globally competitive and the technological productivity gap with global practices is very large. It has been maximum for the automobile sector and hence TFPG growth is very less, Infact negative for some periods. {Out of 7 industries covered by study including coke, chemicals, machinery etc}[13]

4.2 TEXTILE INDUSTRY

When the regression of raw materials, capital, labour, power on sales is done, it yields the following results. The coefficients of these are 0.6631229, 0.0702505, -0.005987, 0.0864075 respectively which show the partial elasticities of value added with respect to these inputs.

[13] Danish A. Hashim, Ajay Kumar and Arvind Virmani , Impact of Major Liberalization on Productivity: The J Curve Hypothesis, October, 2009 , Department of Economic Affairs, Working Paper No 5

Table VI: TECHNOLOGICAL PROGRESS IN TEXTILE INDUSTRY

Log sales	Coefficient	Std. Error	t	P>t
Log raw	0.6631229	0.0234934	28.23	0.000
Log capital	0.0702505	0.0363093	1.93	0.055
Log labour	-0.005987	0.0207591	-0.29	0.773
Log power	0.0864075	0.0214052	4.04	0.000
Timecode	0.013828	0.003047	4.54	0.000
Constant	1.444923	0.1393691	10.37	0.000

Most important, the table above (Table VI) shows the coefficient of timecode is 0.013828 and this shows the technological progress in the textile industry. It shows that there is a little technological progress in the industry i.e. 1.3% over the period 1997-2012. The variable is also highly statistically significant. Again this is common across all firms of textile industry.

One explanation for this may be the base effect. This means that the textile industry was having very outdated technology and that the technology that they were using was very old. Hence over this time period they may have acquired a little better technology. Hence, there may be a small positive coefficient of the timecode.

After this, the residuals from this model are regressed on time and time square and the estimated portion is separated from random component. Then the maximum estimated value is found out and the estimated residuals from this equation are subtracted from the maximum value. Now the technical efficiency is exponential of this difference value.
(NOTE: The Technical efficiency values are multiplied by 100 for easier understanding)

Table VII: TECHNICAL EFFICIENCY OF TEXTILE FIRMS

Variable	Mean	Std. Dev.	Min	Max
Tech Efficiency 1	54.44691	2.355261	51.89045	59.03759

Tech Efficiency 2	45.6879	0.7421364	44.33577	46.6029
Tech Efficiency 3	40.53307	2.472835	38.28823	46.52125
Tech Efficiency 4	48.54143	3.460934	42.27766	52.89952
Tech Efficiency 5	41.86497	7.508537	29.82262	49.27138
Tech Efficiency 6	60.51499	5.387677	56.06957	71.76771
Tech Efficiency 7	77.27733	5.619071	66.22852	82.94679
Tech Efficiency 8	33.61867	4.57182	24.8109	39.5304
Tech Efficiency 9	87.87882	3.594476	80.96761	91.80105
Tech Efficiency 10	89.47995	6.704616	78.91111	100
Tech Efficiency 11	8.773717	8.92591	0.1642355	17.98554
Tech Efficiency 12	54.35361	3.70908	47.91856	59.26865
Tech Efficiency 13	43.95695	2.315337	39.23447	46.12255
Tech Efficiency 14	56.21108	6.774272	44.65271	63.07861

The above table (Table VII) shows that firm 10 is the most efficient with average efficiency level of 89.4, it also achieves the maximum attained efficiency in the industry in a particular year, which is shown as 100. It is followed by firm 9 having an average technical efficiency of 87.8 and the maximum value being attained as 91. On the other hand firm 11 has an average efficiency of only around 8 with the maximum it has been able to achieve as 17.98. **This shows the disparity within firms where 1 firm has average efficiency of about 90% and another firm has efficiency as low as 9%.** Apart from there are some firms which have witnessed an improvement in TE over the period of study whereas some have had a continuous fall (which is not captured by this table but by separately estimated TE series). **This is very important to note as it shows that some firms (7 out of total 14 firms in consideration) have been becoming more efficient with time whereas there are others which are becoming less efficient. The exact time varying TE series for all the firms is shown in the appendix.**

Table VIII: SUMMARY OF TECHNICAL EFFICIENCY OF TEXTILE INDUSTRY

TECHNICAL EFFICIENCY (AVERAGE)	NO OF FIRMS
>80	2
50-80	5
30-50	6
<30	1

This comparative analysis of Technical Efficiency within firms show that the industry has a whole has only 1 firm that is very poor in efficiency i.e. below 30% whereas there are 7 firms that operating at an efficiency level higher than 50%. There are 6 firms that are operating on efficiency level within 30-50% efficiency level. So, this shows that there at least half firms which are operating very efficiently. After this the technological progress (from table VI) is added to the change in technical efficiency and that is estimated as follows:

Table IX: TFPG OF TEXTILE INDUSTRY

Variable	Mean	Std. Dev.	Min	Max
TFPG1	0.0235218	0.0058989	0.013688	0.0324006
TFPG2	0.0176635	0.0016039	0.015171	0.0201556
TFPG3	0.0050778	0.0230583	-0.03101	0.0411698
TFPG4	0.0237251	0.051203	-0.04214	0.0836024
TFPG5	0.0160925	0.0809166	-0.06037	0.1384269
TFPG6	-0.0034775	0.0358318	-0.05635	0.053388
TFPG7	0.0270857	0.0579868	-0.05761	0.1117809
TFPG8	0.0343456	0.0749794	-0.0686	0.1320747
TFPG9	0.0048588	0.0054041	-0.0036	0.0133176
TFPG10	-0.0019618	0.0012578	-0.00394	0.0000197
TFPG11	-0.8878088	0.1987922	-1.11322	-0.737536
TFPG12	-0.0025238	0.0056374	-0.01128	0.0062356
TFPG13	0.0251059	0.0098405	0.009703	0.0405087
TFPG14	0.0204846	0.0650895	-0.08981	0.0963122

Table IX shows that there are some firms with positive TFPG whereas some with negative TFPG. There is a large variation within positive growth as well with firm 13 having 2.5% TFPG growth and firm 9 having 0.4% TFPG growth. The max value of TFPG attained is 13.8% and min is -

111.32%. But the overall picture can be seen from the table below which shows that 4 firms out of 14 that have a negative Total Factor Productivity Growth in the textile industry, whereas 10 have a positive TFPG on an average. Although again there is a variation within the firm as well across time which is varied for different firms, meaning it can be from positive to negative or negative to positive which is shown in the appendix attached.

Table X: SUMMARY OF TFPG OF TEXTILE INDUSTRY

TOTAL FACTOR PRODUCTIVITY GROWTH (AVERAGE)	NO OF FIRMS
NEGATIVE	4
POSITIVE	10

So, overall it can be seen that the textile industry has been doing little better than the automobile industry in terms of improved productivity, which is quite contrary to the common perception.

Average TFPG growth in textile sector was also reported as positive by Danish (2004). The TFPG estimated by him for the man made textile sector from 1989-97 was 0.56. [14] TFPG estimated by a Ministry of Finance paper is 1.31 from 1992-93 to 2005-06 i.e. after liberalization process began. [15]Infact this sector has experienced high TFPG as compared to other industries just after liberalization started. This is because India was already exporting textile, Infact it had one of the highest share in the category of manufactured exports. But an exception was the man- made fibres. So, one of the plausible reasons is that the technology used was very poor and hence a little improvement in technology shows as a positive TFPG in the analysis.

Another paper that supports the small increase in TE and TFPG in textile sector is one by Arup Mitra and Chandan Sharma, which says that the TFPG has been positive although very small. [16]

4.3. TRADE OPENNESS AND PRODUCTIVITY GROWTH

Rodrik (1995) mentioned that the available empirical evidence on the issue that whether trade openness has lead to productivity increase or not is not conclusive. There are several papers that

[14] Danish A Hashim, Cost and Productivity in Indian Textile Sector: Post MFA implication, ICRIER
[15] Danish A Hashim, Cost and Productivity in Indian Textile Sector: Post MFA implication, ICRIER
[16] Total Factor Productivity and Technical Efficiency of Indian Manufacturing: The Role of Infrastructure and Information & Communication Technology , Arup Mitra and Chandan Sharma

clearly support the hypothesis of trade openness favouring the productivity of the manufacturing sector. Sanjoy Saha in his paper argues that the economy has been experiencing continuous rise in TFP growth since the introduction of external economic reforms. With the help of Granger Causality tests he found out that there is a one way relationship between trade openness and TFP growth for Indian economy. The econometric analysis reveals that trade openness in India has affected TFP growth positively and significantly.[17]

Austria (1998) found that Export-GDP ratio affects TFP positively and significantly in Philippines, while, the import-GDP ratio found to exert a significant negative impact on the TFP. Njikam et al. (2006) found that on one hand trade openness without human capital affects TFP of some Sub-Saharan African countries negatively and significantly and some countries positively and significantly. Gonzalez and Constantin (2009) also found that openness is not a very relevant factor in explaining the role of technological status of the low income countries. On the contrary, openness affects TFP positively and significantly for middle and high income countries. [18]The list does not end here there are so many other studies, some of which have supported whereas others have refuted the stated hypothesis.

With liberalization, firms can choose to adopt strategies that would enable them to shift to a higher growth frontier. This can be because of better imported technology being available and also more R & D expenditure being incurred. The increasing presence of multinationals may have also helped via intra firm technology imports and transfers. All of these efforts are believed to improve the competitiveness and performance of the industry.[19] **Even the theory of Schumpeter says that technology and innovation have a role in stimulating growth.**

Particularly for the case of India, some industries experience very high rates of productivity growth as they are in the process of adopting new technology, and new methods of production at the onset of economic liberalization. At the same time some industries experience sluggish/negative productivity growth as they still use inefficient methods of production.[20] B. N. Goldar and Anita Kumari in their paper also conclude that the TFPG decelerated in the 1990s, a decade of major

[17] Sanjoy Saha, Productivity and Openness in Indian Economy, Journal of Applied Economics and Business Research
[18] Sanjoy Saha, Productivity and Openness in Indian Economy, Journal of Applied Economics and Business Research
[19] Liberalization and the differential conduct and performance of the firms: A study of the Indian Automobile sector, K Narayanan
[20] Economic Liberalization and Productivity Growth: A Disaggregated Analysis of Indian Manufacturing Industries, The 2001 Australasian Meeting of the econometric society

economic reforms in India. [21] But on the other hand, Chand and Sen (2002) found that post-reform trade liberalization in Indian manufacturing raised total factor productivity growth.[22]

4.3.1. THEORITICAL ARGUMENTS IN FAVOUR OF TRADE OPENNESS:

The relationship between trade policy and productivity growth can be identified mainly by 2 mechanisms by which trade policy can affect the performance of industry. The first is the X-efficiency argument that relates the import competition to the effort by the manufacturers. The second argument is that trade can act as a conduit for access to specialized inputs, including capital, for production. [23]

Muendler (2004) in his study has talked about three channels through which trade breeds efficiency. Firstly, trade intensifies competition in the product market which compels the producers to innovate for surviving from which productivity gain is also expected. It is termed as ***'competitive push'***. Secondly, through trade an economy can avail cheap inputs and capital goods from foreign markets which lead to rise in productivity known as ***'foreign input push'***. Thirdly, at the industry or sector level, there is ***'competitive elimination'*** where increased foreign competition forces the least efficient firms to close down while the more efficient ones gain market share, hence raising average productivity.

B Goldar and Anita Kumari, also support all the above stated reasons and apart from this greater access to imported inputs and a more realistic exchange rate associated with a liberalized trade regime would enable industrial firms to compete more effectively in export markets. This would allow them to increase their sales and reap economies of scale with concomitant gains in productivity.[24]

4.3.2. THEORITICAL ARGUMENTS OF WHY TRADE OPENNESS MAY NOT HELP INCREASE TFPG

[21] Bishwanath Goldar and Anita Kumari ,Import Liberalization and Productivity Growth in Indian Manufacturing in 1990s, The Developing Economies, XLI-4 (December 2003): 436–60

[22] Chand, S. and Sen, K.(2002) "Trade Liberalization and Productivity Growth: Evidence from Indian Manufacturing", Review of Development Economics, 6(1), pp. 120-132.

[23] Satish Chand and Kunal Sen, Trade Liberalization and Productivity Growth: Evidence from Indian Manufacturing , Review of Development Economics, 6(1), 120-132, 2002

[24] Bishwanath Goldar and Anita Kumari, Import Liberalization and Productivity Growth in Indian Manufacturing Industries in the 1990s

Although, the proponents of liberalization always argue that opening up the domestic market will improve productivity of the economy diverting resources from less efficient sectors to more efficient ones. But, gain from openness may be different for different countries according to the status of the economy, human capital stock and many other things. Mere inflow of cheap inputs and better technology will not automatically lead to the corresponding increase in productivity. [25] The technology has to be absorbed by the domestic labour force as well, if the domestic labour force does not have the skill to adapt the foreign technology then fruits of trade may not get translated into productivity rise; similarly, it may happen that given availability of other thing different sectors may not gain from the same due to insufficient credit facilities. [26]Therefore, the relationship between the aggregate productivity and trade openness needs to be examined empirically for different countries.

4.3.3 IMPACT OF TRADE OPENNESS ON AUTOMOBILE INDUSTRY PERFORMANCE

{NOTE: THESE ESTIMATES RELATED TO IMPACT OF TRADE OPENNESS HAVE TO INTERPRETED CAREFULLY BECAUSE THE DATA AVAILABLE FOR TRADE WAS VERY LIMITED}

Using import/sales and export/sales as an indicator of trade openness, it is regressed on TFPG and it is found that increase in exports have a positive impact on TFPG although the impact is very small. **It is only 0.08% due to 1% change in export/Sales Ratio** (this is significant only at 5%). But the imports have a negative effect on TFPG growth which is contrary to the expected result (0.4% decline). Increase in imports is expected to get better technology, inputs etc and hence should lead to improvement in TPFG. It may be also the case because of the fact that to compete in international markets, these firms have adopted better technology to keep up with the international standards.

Here age is used as a control variable in this regression. The coefficient of age of the firm is also negative, which means that with increase in age of firm, the TFPG has decreased but the coefficient is highly insignificant. Age of the firm appeared with a negative sign in the study. If the older firms have a larger market share, this may have also contributed to low improvement in technology and efficiency up gradation.[27]

[25] Productivity and Openness in Indian Economy, Sanjoy Saha, Journal of Applied Economics and Business Research
[26] Productivity and Openness in Indian Economy, Sanjoy Saha, Journal of Applied Economics and Business Research
[27] Technology Acquisition, De-regulation and Competitiveness: A study of Indian Automobile Industry- K Narayanan September 1997

One explanation that could have lead to decrease in technological progress is that due to depreciation of exchange rate the cost of imports may have gone up. And hence they could have imported less leading to declining TFPG in the industry.

There are strong complementarities between in house research and the import so that the technology can be adapted well in the industry. The interaction term of both emerged to be the most significant term. Individually both of these did not turn out to be significant. In his study he found "technology imports" had a significant negative impact on the performance of automobile firms. So, one possible reason may be that lack of adequate in house research may have made it difficult to benefit from the improved technology availability as well.

Trade liberalization allows an economy to exploit its comparative advantage; opening up to technology can help an economy benefit from wherever knowledge is produced. However only opening up does not help, it is important that the markets, institutions and political economy of the economy to provide a conducive environment. [28]

Table XI: IMPACT OF TRADE OPENNESS ON TFPG IN AUTOMOBILE INDUSTRY

TFPG_AUTO	Coefficient	Std. Error	T	P>t
import_ ratio	-0.0047699	0.0013295	-3.59	0.001
Export _ratio	0.0008111	0.0004011	2.02	0.049
Age of firm	-0.000156	0.0001276	-1.22	0.227
Constant	-0.0224477	0.0062328	-3.6	0.001

Further, the impact of trade openness is also checked on Technical efficiency i.e. whether it has effected in any way on the way the inputs are being used. But the result has been same here. The import ratio has negatively affected the technical efficiency. The decrease has been 1.9% for 1% increase in import/sale ratio. The coefficient of export/sales is positive and very small i.e. 0.4% but it becomes statistically significant only at 5%. Age of firm also has a negative coefficient but it is again not significant.

[28] Trade Liberalization and Industrial Performance, A disaggregated view of Indian Manufacturing in 1990s- I.J. Ahluwalia

Table XII: IMPACT OF TRADE OPENNESS ON TECHNICAL EFFICIENCY IN AUTOMOBILE INDUSTRY

Technical efficiency	Coefficient	Std. Error	t	P>t
Import _ratio	-0.01937	0.0067456	-2.87	0.006
Export _ratio	0.004199	0.0020351	2.06	0.044
Age of firm	-0.00135	0.0006473	-2.08	0.043
Constant	0.492271	0.0316236	15.57	0.000

Both the tables above show that the imports have not positively affected the productivity/performance of the firms in automobile industry. But exports have a positive relationship with both TFPG and TE, although the impact is very small. This shows that the entire argument of the automobile sector growing after the opening up of economy may not be true in terms of productivity improvement. It may be only that the production is increasing with more and better inputs being used.

4.3.4. IMPACT OF TRADE OPENNESS ON TEXTILE INDUSTRY PERFORMANCE

In case of textile industry, the impact of trade openness has been distinct on technological progress and technical efficiency. For TFPG, the import/sales and export/sales ratio have a positive impact on TFPG but none of the coefficients are significant. Infact the coefficients are significant at 61% and 45% so they hold no value. Even the coefficient of Age is positive but again holds no importance because the coefficient is highly insignificant.

Table XIII: IMPACT OF TRADE OPENNESS ON TFPG IN TEXTILE INDUSTRY

TFPG_TEXTILE	Coefficient	Std. Err.	t	P>t
Import ratio	0.017311	0.0336151	0.51	0.609
Export ratio	0.0168676	0.0218091	0.77	0.444
Age of firm	0.0001794	0.0001111	1.61	0.115
Constant	-0.0194213	0.0105467	-1.84	0.073

To assess the impact on Technical Efficiency, when the import/sales and export/sales are regressed on Technical efficiency, both the coefficients turn out to be negative. But the impact of import

change turns out to be statistically insignificant. The coefficient of export/sales is -0.362 and it is highly significant. Here the age of firm is affecting the technical efficiency positively.

Table XIV: IMPACT OF TRADE OPENNESS ON TECHNICAL EFFICIENCY IN TEXTILE INDUSTRY

Tech efficiency _textile	Coefficient	Std. Err.	T	P>t
Import ratio	-0.0325783	0.0715926	-0.46	0.652
Export ratio	-0.3627892	0.0464486	-7.81	0.000
Age of firm	0.0035321	0.0002366	14.93	0.000
Constant	0.5381204	0.0224621	23.96	0.000

4.4 IS TFPG MORE CAPITAL INTENSIVE?

It is generally believed that the Technological Progress or improvement in TE associated with capital deepening and employing less of labour by the firms. Infact sometime these words are used synonymously. Since technological innovation (that is later imported by developing nations) largely takes place in developed countries **they are made to suit these economies and their factor endowments**. Incidentally these countries are primarily labor scarce and thus the new technology tends to become increasingly **labor saving** (Pack and Todaro, 1969). Import of such technology by the developing countries reduces their employment growth, particularly in the high productivity formal sector. However there is another aspect to this argument as well. There are inter-**linkages between the formal and the informal sectors** may contribute to substantial employment generation in informal sector and hence may not decrease employment at an aggregate level. So, this way it may benefit the economy in terms of more employment.

There is another reason so as to why the labor employment may decrease. If **TFPG means utilizing less of inputs**; means all factors of production then the employment may decrease. It is specifically true for old products and services. Also, the import of some commodities may serve as a **substitute of domestic production of that commodity**. (Chandrasekhar 1992)

Another line of argument is that the production may increase after the improvement and hence the labor employed may also increase along with other factors of production. (Scale effect). Finally, sometime the new technology employed may be labor intensive as well so that the employment

does not decline after adoption of new technology. Besides, the operation of the new technology is not necessarily automated that involves labour displacement.

The empirical literature available on the topic is quite mixed. But the evidence is more against the labor supporting technological or technical improvement. This becomes extremely important particularly in developing economy which has a dual character. Sometimes, the wisdom of developing countries is questioned for applying such labor saving techniques. Of course, this does not mean that capital intensity is bad per se. But a careful balance has to be maintained so as to balance improvement in productivity with absorbing labor of the country. Mureithi (1974)

4.4.1. IMPACT OF TFPG AND TE ON LABOUR EMPLOYED IN AUTOMOBILE INDUSTRY

To find the relationship between employment and TFPG/TE, TFPG is regressed on log (labour employed). It is found that the coefficient is negative meaning increase in TFPG lead to fall in labour being employed in the firm and any improvement in TFPG is not labour intensive. But the coefficient is highly insignificant (even at 90%), so it is not at all reliable.

Table XV: IMPACT OF TFPG ON LABOUR EMPLOYED IN AUTOMOBILE INDUSTRY

Log labour	Coefficient	Std. Error	T	P>t
TFPG_AUTO	-0.1058358	0.299525	-0.35	0.724
constant	7.266604	0.148727	48.86	0.000

When labour employed is regressed on technical efficiency, every unit increase in technical efficiency will lead to 3.09 % decrease in labour employed by a firm on an average. This supports the common view that any improvement in terms of technical efficiency that is happening in the industry is capital intensive and is being achieved by cutting down the labour being employed by the firm. So, the boost in efficiency in the industry has not benefitted the labour in terms of more people being absorbed in the industry.

Table XVI: IMPACT OF TECHNICAL EFFICIENCY ON LABOUR EMPLOYED IN AUTOMOBILE SECTOR

Log labour	Coefficient	Std. Err.	T	P>t
Technical_ efficiency	-3.091002	0.7649136	-4.04	0.000

constant	8.685564	0.377852	22.99	0.000

4.4.2. IMPACT OF TFPG AND TE ON LABOUR EMPLOYED IN TEXTILE INDUSTRY

The coefficient of TFPG when regressed on labour gives a positive coefficient but again the coefficient turns out to be highly insignificant, so it is not highly reliable. Hence, this gives us no idea about how the TFPG has affected the labour employed by the firms.

Table XVII: IMPACT OF TFPG ON LABOUR EMPLOYED IN TEXTILE INDUSTRY

Labour	Coefficient	Std. Error	t	P>t
TFPG_TEXTILE	240.8752	597.1833	0.40	0.687
Constant	789.7761	77.2695	10.22	0.000

The improvement in technical efficiency leads to an increase of 7.48% in labour employed and the coefficient comes out to be highly significant. This shows that the improvement in technical efficiency leads to more number of labour being employed in the firm. This is a positive signal that the technical efficiency improvement is labor supporting. It is specifically important for textile industry, for textile being a labor intensive industry it is a positive signal that the improvement in industry will also be associated with more people being employed by the firms. Hence it can also be held that the labor has become productive.

Table XVIII: IMPACT OF TECHNICAL EFFICIENCY ON LABOUR EMPLOYED IN TEXTILE SECTOR

Log labour	Coefficient	Std. Error	t	P>t
techeff textile	7.48636	0.509	14.7	0.000
Constant	1.2263	0.30486	4.02	0.000

5) SUMMARY AND CONCLUSION

The complete analysis above shows the performance of both the industries- automobile 2 and 3 wheeler industry and handmade fabric of textile industry. The results shown above are quite contrary to the general perception about both of these industries. The textile industry has been performing somewhat better than the automobile industry in terms of productivity improvement both in of positive technological progress and more firms becoming more technically efficient. Although it is true that still the automobile industry is characterised by much better technology and

the efficiency level of firms would be higher than the firms from textile industry. But over this time period of 1997-2012, the textile industry has been improved more than the improvement that has happened in the automobile industry.

Snapshot of Automobile industry:

- Automobile industry has faced a technological regress of 1.6% over these 15 years.
- Only 3 out of 10 firms have positive technical efficiency on an average.
- One firm has attained full efficiency in a year but on the other hand one firm has been operating at about 2% efficiency in a year.
- Only 2 firms operate above 50% efficiency on average, and 3 firms have technical efficiency even below 30%.
- 7 firms have a negative TFPG on an average in these years.
- Out of the 10 terms, 6 firms had faced a decreasing TFPG over these 15 years.

Snapshot of Textile Industry:

- The technical progress in the industry is 1.38%.
- 7 firms out of 10 have technical efficiency on an average of above 50%. And there is only 1 firm that is operating at an efficiency of below 30%.
- 7 firms have faced increase in Technical Efficiency during 1997-2012 and other 7 faced decreasing TE during this time period.
- There are 4 firms that have negative TFPG in these 5 years.

This shows that more number of firms are doing better in textile industry in term of improving productivity. On checking the impact of opening up of the economy on these industries it was seen that:

- In automobile industry, Import / sales had a negative impact on TFPG and TE of the firms. Exports have a positive impact on TFPG (0.08%) and TE (0.4 %) although the impact is extremely small.
- In case of automobile industry, import/sales have no conclusive impact on the productivity of firms (both TFPG and TE). The exports do not have any significant effect on TFPG but exports have a negative impact on Technical Efficiency.

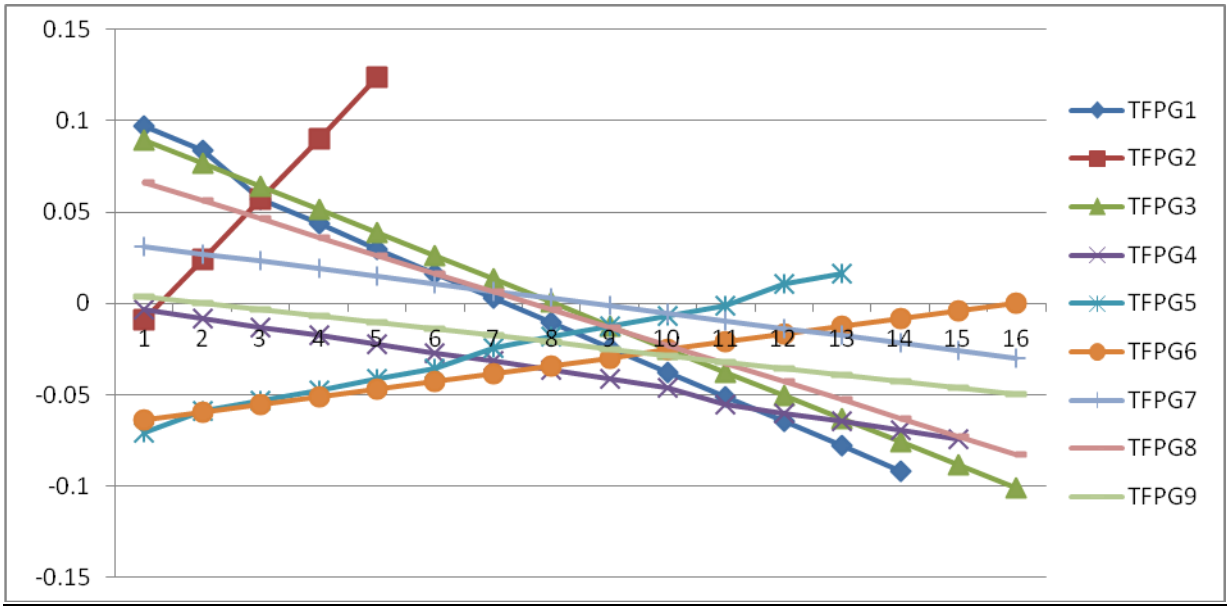
After checking the impact of trade openness the following results are obtained:

- For the automobile industry, TFPG is found to have no conclusive impact on labour employed but the TE is associated with a decrease in labour employed.
- In case of textile industry, again the TFPG is not found to have any significant impact on labour employed in the industry. But the Technical Efficiency is found to increase the labour being employed in the industry.

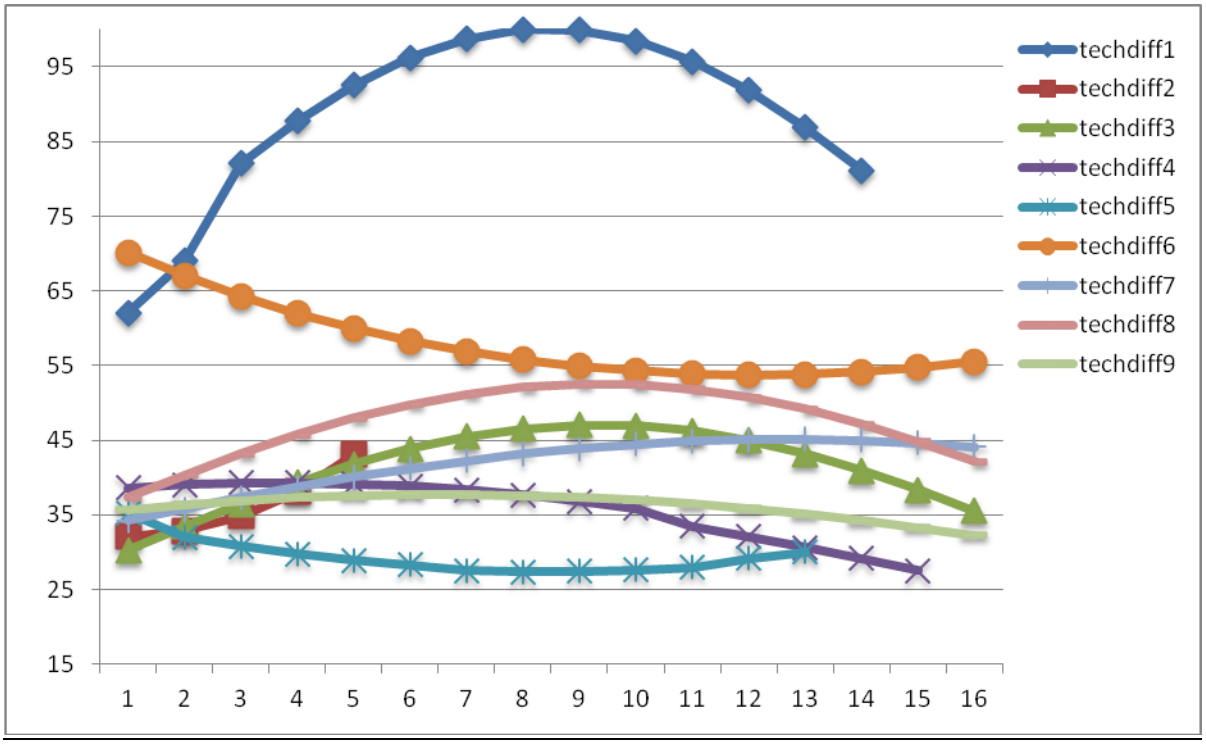
This has very **important implications for policy making**. This presents a grim picture of the manufacturing sector of the country which will have serious consequences for us in future. The general view is that manufacturing sector can be the engine of growth in long run for any country. But this is possible only with the improvements in productivity of the industry, and not mere increase in inputs that will not be sustainable. Not only the industry is lagging behind in terms of emulating better technology, it is not even using the existing technology and resources optimally. The most celebrated sector of the economy that is automobile sector is even not having positive productivity growth in most of the firms. With opening up of the economy, we have access to all kind of updated technology and capital goods, intermediate goods etc. So, all the resources needed to improve the TE and technologies are available. What is needed is an effort to emulate it by the industries. A combination of in-house R&D, improvement in human capital, policies conducive to industries, availability of credit etc is required along with importing technology to have an improvement in productivity of the industries.

6) APPENDIX

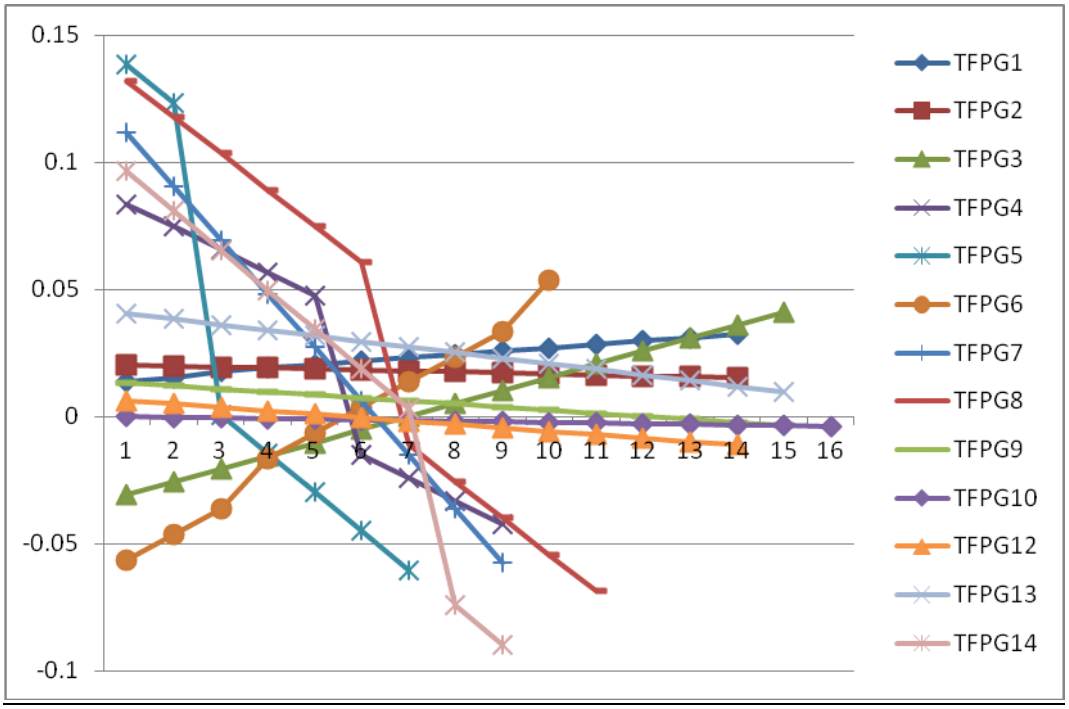
TFPG AUTOMOBILE INDUSTRY



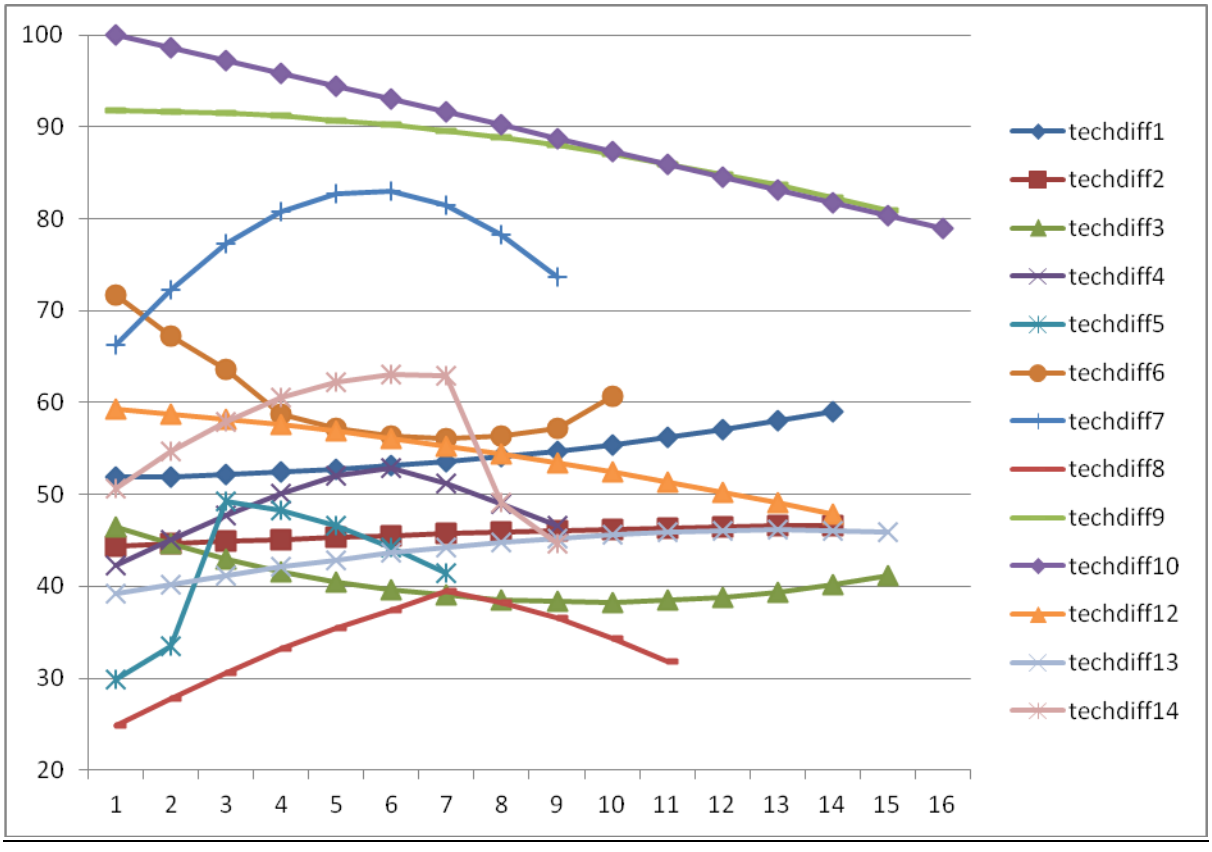
TE AUTOMOBILE INDUSTRY



TFPG TEXTILE INDUSTRY



TE TEXTILE INDUSTRY



BIBLIOGRAPHY

- Samar Verma, Export Competitiveness of Indian Textile and Garment Industry, ICRIER
- Textile Industry Report- Dun and Bradstreet India
- Arup Mitra and Chandan Sharma and Marie-Ange Véganzonèès-Varoudakis, Estimating impact of infrastructure on productivity and efficiency of Indian manufacturing
- Satish Chand and Kunal Sen , Trade liberalization and Productivity Growth: Evidence from Indian Manufacturing
- Deb Kusum Das, "Quantifying Trade Barriers: Has protection declined substantially in Indian Manufacturing?" –ICRIER , Working Paper no 105
- Bishwanath Goldar , Productivity trends in Indian Manufacturing in the Pre and post reform periods- ICRIER
- Bishwanath Goldar and Anita Kumari , Import Liberalization and Productivity Growth in Indian Manufacturing Industries in the 1990s- The Developing Economies, XLI-4 (December 2003): 436–60
- Arup Mitra and Chandan Sharma and Marie-Ange Véganzonèès-Varoudakis, Are reforms productive? Explaining productivity and efficiency in Indian Manufacturing, September 2012, CERDI
- Report of working Group on Automotive Industry, 11th Five Year Plan, Ministry of Heavy Industries and Public Enterprises (August 2006)
- Arup Mitra and Bishwanath Goldar, Productivity increase and Changing Sectoral Composition: Contribution to Economic Growth in India
- Automotive Mission Plan 2006-16, Ministry of Heavy Industries and Public Enterprises
- The Indian Automotive Industry, Evolving Dynamics, KPMG
- Chand, S. And Sen, K.(2002) "Trade Liberalization and Productivity Growth: Evidence from Indian Manufacturing", Review of Development Economics, 6(1), pp. 120-132
- Shallu Sehgal and Suparn Sharma, Total factor productivity of manufacturing sector in India: a regional analysis for the state of Haryana, Economic Journal of Development Issues Vol. 13 & 14 No. 1-2 (2011) Combined Issue
- Ahluwalia, I.J. 1995. "India: Industrial Development Review," The Economist Intelligence Unit and UNIDO.
- Ahluwalia, I.J., (1991), Productivity and Growth in Indian Manufacturing, Oxford University Press, Delhi

- Danish A. Hashim, Ajay Kumar and Arvind Virmani: Impact of major liberalization on Productivity: The J Curve Hypothesis, Working Paper No 5/2009-DEA
- Acemoglu, D. and F. Zilibotti (2001), "Productivity Differences", Quarterly Journal of Economics, vol.116, pp.563-606.
- Cornwell, C. et.al. (1990), Production Frontiers with Cross-Sectional and Time Series Variation in Efficiency Levela, Journal of Econometrics, Vol. 46, No. 1-2, pp. 185-200.
- Chandrasekhar, C.P. (1992) "Investment Behavior, Economies of Scale and Efficiency in an Import Substituting Regime: A Study of Two Industries," in A. Ghosh et.al. (ed.), Indian Industrialization, Structure and Policy Issues, New Delhi, Oxford University Press.
- Goldar, B. N. (1986), Productivity Growth in Indian Industry, Allied Publishers, Delhi.
- Mitra, Arup (2009). Technology Import and Industrial Employment: Evidence from Developing Countries', *Labour*, 23 (4), 697–718.
- Pack, H. and M. Todaro (1969), Technological Transfer, Labour Absorption, and Economic Development, Oxford Economic Papers, vol.21, pp.395-403.
- Solow, R. M. (1957), Technical Change and the Aggregate Production Function, *Review of Economics and Statistics.*