Growth, Efficiency and Productivity of Indian Manufacturing Firms in the Post-Reform Era

SYNOPSIS

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The studies on Indian manufacturing industries suggest that the manufacturing industries are not homogeneous in nature. There is lots of heterogeneity among industries and or firm level both with respect to performances as well as characteristics. The heterogeneity can be visualized from the description about different industries in Section 1.3 of Chapter 1. This necessitates a disaggregated study of the performance analysis. The motivation of the thesis stems from this observation. This thesis basically deals with the performance analysis of growth, efficiency (both input oriented technical efficiency and output oriented technical efficiency) and productivity of Indian manufacturing firms in the post-reform era. Since the characteristics are different among industries and or firms, while studying the performances, the aggregate analysis will not be performed rather the thesis will be based on disaggregated study. The thesis will follow Centre for Monitoring Indian Economy (CMIE) Prowess Database at the company (firm) level for the whole Indian manufacturing sector and will consider the following nine groups of industry: Chemical & chemical products industry (Chemical industry), Food Products, beverages & tobacco industry (Food products industry), Leather & related products industry (Leather industry), Machinery industry, Metal & metal products industry (Metal industry), Non-metallic mineral products industry, Paper & paper products industry (Paper industry), Textile industry and Transport & transport equipment industry (Transport Industry), subject to the availability of data.

While doing the performance analysis, the present study concentrates on mainly three aspects: growth, efficiency (both input oriented technical efficiency and output oriented technical efficiency) and productivity of Indian manufacturing firms in the post-reform era. Growth of the industry is an important indicator of performance. Growth of output is an increase in the production of economic goods compared from one period to the other. Regarding efficiency, there are two alternative concepts: one is allocative efficiency which is the property of an efficient market where all goods and services are optimally distributed among buyers in an economy. The other one is the technical efficiency which is the effectiveness with which a given set of inputs is used to produce an output. The present study uses the concept of technical efficiency and concentrates on both input oriented and output oriented approaches. The input oriented technical efficiency is the ratio of minimum level of input required to produce a given level of output to the actual input used to produce that given level of output. The output oriented technical efficiency shows the ratio of actual

output produced to the maximum level of output that can be produced given the input usage. The third performance indicator that the study uses is the concept of productivity. There are two concepts of productivity. One is the concept of partial productivity of input which can be defined as the relationship between the output and single input used in the production and the other is total factor productivity growth which basically denotes the growth in output which is not accounted by growth in inputs used in the production process. The present study uses the concept of total factor productivity growth.

Thus, the questions arise what are the extents of growth, efficiency (both input oriented technical efficiency and output oriented technical efficiency) and productivity of Indian manufacturing firms in the post-reform era? What are the factors that determine the performances of each of the above indicators of Indian manufacturing firms?

Coming to the determinant analysis, perusal of the literature suggests that there exists a nexus relationship between the Indian manufacturing firms' performances and different strategic variables in the post-reform era. Different strategic variables may be endogenous in nature. For example, Advertising Intensity (ADV), Marketing Intensity (MKT), R&D Intensity (RD) and Net Export Intensity (NX) may not only affect the firms' performance indicators like growth, efficiency (both input oriented technical efficiency (ITE) and output oriented technical efficiency (OTE)) and productivity, but in turn they may get affected by those performance indicators. Thus, there may be inter-connection between these variables. There is dearth in the studies highlighting these simultaneous relationships. The present study fills up this gap and contributes to the literature in this direction. The study separately finds out the determinants of growth, efficiency (both input oriented technical efficiency (ITE) and output oriented technical efficiency (OTE)) and productivity in a simultaneous panel set up. For determinant analysis, a simultaneous panel model as developed by Baltagi (EC2SLS random-effects Instrumental Variable (IV) regression) has been performed for growth of output block (Growth Block) considering the endogenous variables GROUT (Growth of output), ADV, MKT, RD and NX; efficiency block (input oriented approach (ITE Block considering the endogenous variables ITE, ADV, MKT, RD and NX) & output oriented approach (OTE Block considering the endogenous variables OTE, ADV, MKT, RD and NX)) and total factor productivity growth block (TFPG Block) considering the endogenous variables TFPG, ADV, MKT, RD and NX.

Such type of studies is very important for framing appropriate policies to boost up the performance level of Indian manufacturing firms. Due to the existence of heterogeneity, the extent of performances and the factors influencing these performances are not uniform across all the firms and or within the industry. Hence, policy prescription for boosting up each of the performances considered will likely to vary across industry groups.

This study uses Non-parametric approach Data Envelopment Analysis (DEA) for the measurement of technical efficiency and total factor productivity growth. The advantage of DEA is that it does not require the assumption of specific criteria and or production function. Since the existence of heterogeneity among Indian manufacturing industries has been assumed, while constructing the frontier as required by DEA, the frontiers will be constructed separately for each of the assumed nine groups of industries.

The literature on total factor productivity growth (TFPG) suggests that TFPG incorporates technical change (TC), technical efficiency change (TEC) and scale efficiency change (SEC). For sustainable growth, the TC &TEC must have larger contributions towards TFPG. If it is seen that efficiency change is contributing the most towards TFPG, this means that the same level of inputs is being efficiently used, as a result of which the higher amount of output is getting produced which brings about sustainable growth. If TFPG is being contributed by TC through technological improvement, then that will also result in sustainable growth. The current study will also identify what are contributions of TC, TEC & SEC in TFPG of Indian manufacturing firms.

It is also important to measure the extent of efficiency and under- utilisation of different inputs used in the production process and there is lack of studies on this issue and the present study contributes the literature in this direction by measuring input slack for each of the chosen industry groups.

The main research questions of this present study are: In post-reform era, for Indian manufacturing firms:

(1) What are the extents of growth, efficiency (both input oriented technical efficiency and output oriented technical efficiency) and productivity?

(2) What is the extent of under- utilisation of different inputs used in the production process?

(3) Which factor among TC, TEC & SEC is contributing the most towards TFPG?

(4) What are the possible determinants of growth, efficiency (both input oriented technical efficiency and output oriented technical efficiency) and productivity?

(5) Comparative analysis between growth, efficiency (both input oriented technical efficiency and output oriented technical efficiency) and productivity i.e. whether highly growing firms are highly efficient and are highly productive? Whether highly productive firms are highly technically efficient or not?

Data structure and methodology are mentioned in Chapter 3. Data regarding the Input-Output variables and factors determining the growth, efficiency and productivity have been collected from CMIE Prowess Database for the time period March, 1995 – March, 2016. Total No. of Manufacturing Firms incorporated is 820.

The study conceptualizes a 1-output and 5-inputs production technology. The output is the total sales of the firm deflated by the WPI for manufacturing products (base 1993-94 =100). The inputs are: (i) Raw Material inputs (measured in terms of the companies' expenditure on raw materials, stores and spares) deflated by the WPI for manufacturing products (base 1993-94 =100) , (ii) Energy and water Input (measured in terms of the expenditure of the companies for power, fuel and water) deflated by WPI of power & fuel (base 1993-94 =100) , (iii) Labour (measured in terms of wages and salaries of the workers) and nominal wage has been deflated by WPI (base 1993-94 = 100), (iv) Land (measured in terms of rent & lease rent paid) and (v) Capital (measured in terms of value of the net fixed assets) deflated by WPI of machinery (base: 1993-94 =100).

Growth is measured as done in standard literature. Productivity and Efficiency are measured by using Non-parametric Data Envelopment Analysis (DEA).

For determinant analysis, a simultaneous panel model as developed by Baltagi (EC2SLS random-effects Instrumental Variable (IV) regression) has been performed for growth block, productivity block, efficiency block (both input oriented approach & output oriented approach) consisting of the following determinants: ADV, MKT, RD, NX and different firms' characteristics like Diversification Index (DIVIND) (It is the reciprocal of Herfindahl Index or Concentration Index), Age of the firms (The present study has divided the sample companies into two groups: Agedum = 1, if Mean Age of the firm < Grand Mean Age and

Agedum = 0, Otherwise) and Size of the firms (The present study divides the sample basis on investment into three groups, on the basis of Investment in plant & machinery or equipment according to MSME Classification: Smalldum = 1, if mean investment < 5 Cr. rupee and Smalldum = 0, otherwise. Mediumdum = 1, if mean investment < 10 Cr. rupees and Mediumdum = 0, otherwise. Largedum = 1, if mean investment > 10 Cr. rupees and Largedum= 0, otherwise. In order to avoid dummy variable trap, Mediumdum has been dropped).

The sole effect of different strategic variables, the effect of the square term and the joint effect of different strategic variables, the effects of the lag value (one year lag) of strategic variables (the effects of different strategic variables in the previous period) and effect of different firm's characteristics on firm's performances have been considered.

The strategic variables like ADV, MKT, RD, NX can be determined by firm's performances, firm's characteristics and other economic and strategic variables. NX can also be influenced by real effective exchange rate (REER) (Base: 1993-94 = 100). This factor has been taken from the publication of RBI (Handbook of Statistics on Indian Economy).

Since the simultaneous equation model in a panel setup is being done, for purpose of estimation two stage procedures have been used.

In the first stage we have started with structural equation model and then obtained reduced form of the model. We have then obtained estimated values of reduced form parameters from the panel model and hence the estimated values of the endogenous variables.

In the second stage we have used these estimated values of the endogenous variables into the structural equation of the panel model to arrive at the final estimate of the parameters from the panel set up.

The growth analysis is carried out in Chapter 4. The result of this chapter reports that the sample manufacturing firms are experiencing 13.95% of growth of output during the study period. The highest 36.19% growth has been experienced by non-metallic mineral products industry and the lowest 6.89% of growth has been experienced by the food products industry.

About 39% of sample Indian manufacturing firms are working above the mean growth rate of output. The highest 56% of sample firms are working above the mean growth rate of output

in transport industry and the lowest 14% of sample firms are working above the mean growth rate of output in non-metallic mineral products industry.

The highest 50.17% of Indian sample firms are experiencing the growth of (0-10) %. The maximum percentage of sample firms included in all the nine industry groups is having growth of output lying in between the range (0-10) %. About 11.45% of sample firms are experiencing negative growth. The highest 35.71% of sample firms included in the paper industry are having negative growth rate of output. More than 100% growth is being experienced by only 0.79% firms. The highest 7.14% of sample firms included in the non-metallic mineral products industry is having growth rate of output more than 100%.

The determinant analysis of growth of output for the sample firms included under the considered nine industry groups suggests that ADV has positive marginal effect on GROUT in leather, machinery, metal, non-metallic mineral products and paper industries in the current period. Increase in ADV increases growth of output (GROUT) in these industries in the current period. But, ADV has U-relationship with GROUT with negative marginal effects in chemical, food products, textile and transport industries in the current period. For the current sample, mean value of ADV is lesser than the critical value of ADV beyond which its positive marginal effect will be felt. The positive effect of ADV on GROUT in these industries can be achieved beyond the critical level of ADV. When the mean level of ADV will exceed that critical level of ADV, its positive effect on GROUT will be realised in those industries. These industries are not doing enough ADV, as a result they have failed to experience the positive effect of ADV on GROUT. Thus, it is suggested that those industries should increase spending more on ADV in the current period to get its positive marginal effect on GROUT.

ADV of the previous period (one year lag has been considered) has positive effect on GROUT in chemical, food products, machinery, non-metallic mineral products, paper, textile and transport industries. Increase in ADV in the previous period increases GROUT in the current period.

MKT has positive marginal effect on GROUT in food products, leather, non-metallic mineral products and textile industries in the current period. Increase in MKT increases GROUT in these industries in the current period. But MKT has U-relationship with GROUT with negative marginal effect in chemical, machinery, metal, paper and transport industries in the current period. The mean value of MKT is lesser than the critical level of MKT beyond

which its positive effect can be felt. The positive effect of MKT on GROUT in these industries can be achieved beyond the critical level of MKT. When the mean level of MKT will cross that critical level of MKT, its positive effect on GROUT will be realised in those industries. These industries are not doing adequate MKT, as a result they have not felt the positive effect of MKT on GROUT yet. Further increase in MKT by these industries in the current period is recommended to obtain its positive marginal effect on GROUT.

MKT of the previous period has positive effect on GROUT in chemical, food products, leather, machinery, metal, non-metallic mineral products, paper and textile industries. Increase in MKT in the previous period increases GROUT in these industries in the current period.

RD of the current period has positive marginal effect on GROUT in chemical, food products, leather and paper industries. Increase in RD increases GROUT in these industries in the current period. But, RD has U-relationship with GROUT with negative marginal effect in machinery, metal, non-metallic mineral products, textile and transport industries in the current period. The mean value of RD is lesser than the critical level of RD beyond which its positive effect can be felt. The positive effect of RD on GROUT in these industries can be achieved beyond the critical level of RD. When the mean level of RD will be higher than the critical level of RD, its positive effect on GROUT will be realised in those industries. These industries are not doing adequate RD, as a result they have not felt the positive effect of RD on GROUT yet. Thus, further increase in spending on RD is suggested to achieve its positive marginal effect on GROUT by these industries.

RD of the previous period has positive marginal effect on GROUT in food products, machinery, metal, non-metallic mineral products, paper, textile and transport industries. Increase in RD in the previous period increases GROUT in the current period in these industries.

NX of the current period has positive marginal effect on GROUT in chemical, machinery, metal, paper, textile and transport industries. In these industries, the exports dominate over the imports, as an effect these industries are experiencing positive marginal effect of NX on GROUT.

NX of the current period has negative marginal effect on GROUT in food products, leather, non-metallic mineral product industries. As the imports dominate over the exports, the

negative marginal effect of NX on GROUT has been obtained by these industries. This result suggests that these industries are highly dependent on the imported inputs.

NX of the previous period has positive effect on GROUT in the food products, machinery and non-metallic mineral products industries. The increase in NX in the previous period increases GROUT in the current period.

There exists a joint interaction term of NX and RD having positive marginal effect on GROUT in the chemical, food products, non-metallic mineral products and paper industries. Through RD, the product quality gets enhanced in these industries, as a result NX increases which in turn leads to the rise in GROUT in these industries. In these industries, the effect of RD on GROUT depends on NX and vice-versa.

There exists another composite effect of RD and ADV on GROUT in leather and machinery industries. This joint interaction term of RD and ADV has positive effect on GROUT. Through RD, new advertising strategies will be invented, as a result of which GROUT will increase. In these industries, the effect of RD on GROUT depends on ADV and vice-versa.

There is another joint interaction term of ADV and MKT having positive impact on GROUT in non-metallic mineral products, paper and textile industries. The joint spending on ADV and MKT will lead to achieve higher level of GROUT in these industries. In these industries, the effect of MKT on GROUT depends on ADV and vice-versa.

Agedum has direct positive effect on GROUT in chemical industry, meaning that the younger firms are having higher level of GROUT than the older firms. Agedum has indirect positive effect on GROUT through ADV in food products, machinery and textile industries, implying that the younger firms are having higher level of ADV than the older firms in these industries; As ADV is a significant determinant of GROUT, the sufficient increase in ADV increases GROUT in these industries. Agedum has indirect positive effect on GROUT through RD in machinery, paper and textile industries, implying that the younger firms are having higher level of RD in these industries. As RD is the significant determinant of GROUT, the significant rise in RD increases GROUT in these industries.

Agedum has negative indirect effect on GROUT through RD and ADV in leather industry, through RD in metal industry and through ADV in transport industry. The older firms are having higher levels of RD and ADV in leather industry, RD in metal industry and ADV in transport industry than the younger firms. RD and ADV in leather industry, RD in metal

industry and ADV in transport industry are the significant determinants of GROUT. Thus higher levels of RD and ADV in leather industry, RD in metal industry and ADV in transport industry increase GROUT in these industries.

DIVIND has direct positive effect on GROUT in leather industry. As the market share gets diversified in this industry, its GROUT of the sample firms in leather industry will go up. DIVIND has indirect positive effect on GROUT through NX in the metal industry, indicating that as the market share gets diversified, NX of the firms, which is the significant determinant of GROUT in metal industry, increases; as a result GROUT will be affected by DIVIND via NX.

DIVIND has a negative indirect effect on GROUT through NX in chemical industry, through ADV in machinery industry and through ADV and RD in transport industries. As the market share gets concentrated in the hands of few large sized firms, NX in chemical industry, ADV in machinery industry and ADV and RD in transport industries increase. These are the significant determinant of GROUT in the said industries. As a result, the GROUT of firms in these industries will be affected.

Largedum has direct positive effect on GROUT in chemical industry. The larger sized firms are higher level of GROUT than the smaller sized firms in this industry. Largedum has indirect positive effect on GROUT through ADV and RD in food products and machinery industries. Larger sized firms are having higher levels of ADV and RD which are the significant determinants of GROUT in these industries; as a result their GROUT increases. Smalldum has negative indirect effect on GROUT through MKT in food products industry. This means that as the food products firms become larger sized, their MKT increases. MKT is the significant determinant of GROUT in food products industry, the significant rise in MKT increases GROUT of the firms.

Largedum has negative indirect effect on GROUT through ADV in leather industry and through RD in metal industry. Smaller sized firms are having higher levels of ADV in leather industry and RD in metal industry. ADV in leather industry and RD in metal industry are the significant determinants of GROUT. As a result, their GROUT increases. Smalldum has positive indirect effect on GROUT through NX in leather industry. In leather industry, smaller sized firms are having higher level of NX; as a result GROUT will be affected.

REER has negative indirect effect on GROUT through NX in food products, machinery and metal industries. An increase in nation's REER is an indication that its exports are becoming costlier and its imports are becoming cheaper. It is losing its trade competitiveness; as a result NX falls. Thus, a fall in REER will have its positive effect on NX, which will in turn influence the GROUT in the current period.

The marginal effect of GROUT on ADV, MKT, RD and NX are positive in chemical, food products, leather, metal, non-metallic mineral products and textile industries in the current period. Increase in GROUT increases ADV, MKT, RD and NX in the current period which will further accentuate increase in GROUT in these industries.

In machinery industry, the marginal effect of GROUT on ADV and NX is positive, implying that increase in GROUT increases ADV and NX in the current period which will further accentuate increase in GROUT in this industry. But, GROUT has U-relationship with MKT and RD with negative marginal effect in the current period. As the mean level of GROUT is lesser the critical level of GROUT beyond which the positive effect of GROUT on MKT and RD will be achieved, the machinery industry has witnessed negative marginal effect of GROUT on MKT and RD. It is suggested to increase further growth in output which may boost up MKT and RD and in turn will further increase GROUT.

Similarly in paper industry, GROUT has positive marginal effect on ADV and RD, meaning that increase in GROUT increases ADV and RD in the current period which will further accentuate increase in GROUT in this industry. But, GROUT has U-relationship with MKT and NX with negative marginal effect. As the mean level of GROUT is lesser than the critical level of GROUT beyond which its positive marginal effect will be felt, its positive effect on MKT and NX has not been achieved by the paper industry yet. Further increase in GROUT in the current period is needed to get its positive marginal effect on MKT and NX in this industry which may further influence GROUT.

In transport industry, GROUT has positive marginal effect on MKT and RD, meaning that increase in GROUT increases MKT and RD in the current period which will further accentuate increase in GROUT in this industry. But, GROUT has U-relationship with ADV and NX with negative marginal effect. As the mean level of GROUT is lesser than the critical level of GROUT beyond which its positive marginal effect will be felt, its positive effect on ADV and NX has not been achieved by transport industry yet. Further increase in GROUT in

the current period is needed to get its positive marginal effect on ADV and NX in this industry which may further influence GROUT.

Both the approaches of input oriented technical efficiency and output oriented technical efficiency are discussed in Chapter 5. The main findings of this chapter are the following: The grand mean input oriented technical efficiency (all industries taken together) is 0.884 for the sample firms. This indicates that the scarce resources have been inefficiently used during the study period. If the inputs are efficiently used, then the same level of output could be produced by reducing 11.6% of inputs. However, the result varies across industry groups. For the present sample, the mean input oriented technical efficiency is the highest (0.940) in leather industries and the lowest (0.825) in food products industry.

About 30% of the total sample firms were producing efficiently on an average. This means that their input efficiency score is equal to 1 and others are producing below the production frontier. The highest 64% of sample firms in leather industry are input-efficient whereas lowest 12% of sample firms under chemical industry are input-efficient.

The estimated result of **mean input slack** shows that the same amount of output can be produced by reducing raw materials input by 29.420%, energy & water input by 23.820%, labour by 26.486%, land by 3.941% and capital by 139.457% for the sample manufacturing firms all industries taken together on an average. Thus, the above empirical result is an instance of inefficient utilization of scarce resources by the Indian manufacturing firms in the study period. Among all the inputs used in the production process, capital is being most inefficiently utilized by all the considered nine industry groups. Among all these industry groups, chemical industry is utilizing capital, energy & water input and land most inefficiently. Non-metallic mineral products industry is employing raw materials input most inefficiently. Transport industry is using labour most inefficiently.

The estimated results of input oriented technical efficiency (year-wise analysis) suggest that the mean input oriented technical efficiency of the sample manufacturing firms is fluctuating over the study period. It is the highest (0.919) in the year 2000 and lowest (0.845) in 1995. The mean input oriented technical efficiency score was not one for any of the years. The mean input oriented technical efficiency has been increased from 0.845 in 1995 to 0.868 in 2016.

For the sample firms included in chemical industry, mean ITE has been increased from 0.744 to 0.783 during the study period (1995-2016). The mean ITE is the highest (0.910) in 2000 and the lowest (0.737) in 2015.

For the sample firms included in food products industry, mean ITE has been increased from 0.794 to 0.795 during the study period (1995-2016). The mean ITE is the highest (0.877) in 1997 and the lowest (0.792) in 2002.

For the sample firms included in leather industry, mean ITE has been increased from 0.886 to 0.945 during the study period (1995-2016). The mean ITE is the highest (0.979) in 2012 and the lowest (0.886) in 1995 & in 2006.

For the sample firms included in machinery industry, mean ITE has been decreased from 0.895 to 0.854 during the study period (1995-2016). The mean ITE is the highest (0.936) in 1998 and the lowest (0.854) in 2016.

For the sample firms included in metal industry, mean ITE has been increased from 0.73 to 0.896 during the study period (1995-2016). The mean ITE is the highest (0.936) in 1999 and the lowest (0.73) in 1995.

For the sample firms included in non-metallic mineral products industry, mean ITE has been decreased from 0.94 to 0.888 during the study period (1995-2016). The mean ITE is the highest (0.981) in 2002 and the lowest (0.731) in 2006.

For the sample firms included in paper industry, mean ITE has been decreased from 0.931 to 0.918 during the study period (1995-2016). The mean ITE is the highest (0.954) in 1996 and the lowest (0.840) in 2004.

For the sample firms included in textile industry, mean ITE has been increased from 0.756 to 0.795 during the study period (1995-2016). The mean ITE is the highest (0.92) in 2000 and the lowest (0.756) in 1995.

For the sample firms included in transport industry, mean ITE has been increased from 0.933 to 0.939 during the study period (1995-2016). The mean ITE is the highest (0.957) in 2009 and the lowest (0.879) in 2015.

The determinant analysis of input oriented technical efficiency for the sample firms of the considered nine industry groups suggests that ADV in the current period has positive

marginal effect on ITE in chemical, leather, machinery, metal, non-metallic mineral products, paper, textile and transport industries. Increase in ADV increases ITE in these industries in the current period. But ADV has U-relationship with ITE with negative marginal effect in food products industry as the mean level of ADV is lesser than the critical level of ADV beyond which its positive effect can be felt. Initially increase in ADV being the sunk cost will not initiate ITE but the positive effect of ADV on ITE can be obtained beyond the critical level of ADV in food products industry. As the food products industry is not doing enough ADV, as a result it has not achieved the positive effect of ADV on ITE yet. Further increase in ADV is recommended to obtain its positive marginal effect on ITE by the food products industry.

ADV of the previous period has positive effect on ITE in the current period in the machinery industry. Increase in ADV in the previous period increases ITE in the current period in this industry.

The marginal effect of MKT on ITE is positive in chemical, food products, leather, machinery, metal, non-metallic mineral products, paper, textile and transport industries in the current period. Increase in MKT increases ITE in the current period in all these industries.

MKT of the previous period has positive effect on ITE in chemical, leather, non-metallic mineral products industries. Increase in MKT in the previous period increases ITE in the current period in these industries.

RD in the current period has positive marginal effect on ITE in chemical, food products, leather, machinery, metal, non-metallic mineral products, paper and transport industries. Increase in RD increases ITE in the current period in these industries. But RD has U-relationship with ITE with negative marginal effect in textile industries as mean level of RD is lesser than the critical level of RD beyond which its positive effect can be felt. Initially increase in RD will not initiate ITE in the textile industry. Textile industry should have sufficient spending on RD so that the mean level of RD will exceed the critical level of RD; as a result the positive effect of RD on ITE will be achieved. For the present sample firms in textile industry, mean level of RD is lesser than critical level of RD, as a result the negative marginal effect of RD on ITE has been obtained. Further increase in RD is recommended to get its positive marginal effect on ITE by the textile industry.

RD of the previous period has positive effect on ITE in chemical and transport industries. Increase in RD in the previous period will bring about rise in ITE in the current period in these industries.

NX in the current period has positive marginal effect on ITE in chemical, food products, machinery, metal, non-metallic mineral products, paper, textile and transport industries. In these industries, the effect of exports dominates over the effect of imports; as a result the positive marginal effect of NX has been obtained. Only in the leather industry, the relative strength of imports is higher than that of exports; as an effect this industry has experienced negative marginal effect of NX on ITE. This industry is very much dependent on imported inputs to increase its input efficiency.

The marginal effect of NX of the previous period has positive effect on ITE in textile industry. The increase in NX in the previous period increases ITE in the current period.

There exists a joint interaction term of NX and RD having positive marginal effect on ITE in food products, leather, machinery, paper and textile industries. Through RD, the product quality will get enhanced, as a result NX will be increased which in turn increases ITE in these industries. The effect of RD on ITE depends on NX and vice-versa.

There is another joint interaction term of RD and MKT having positive marginal effect on ITE in food product industry. Through RD, new marketing strategy will be invented, which will increase ITE in this industry. The effect of RD on ITE depends on MKT and vice-versa.

There is the existence of another joint interaction term of ADV and MKT having positive effect on ITE in machinery, metal, paper, textile and transport industries. Joint increase in ADV and MKT increases ITE in these industries. The effect of MKT on ITE in these industries depends on ADV and vice-versa.

Agedum has positive direct effect on ITE in paper and textile industries. In these industries, the younger firms are more input efficient than the older firms. Agedum has positive indirect effect on ITE through MKT in chemical industry, through ADV and MKT in food products industry, through ADV and RD in machinery industry. The younger firms are having higher levels of MKT in chemical industry, ADV and MKT in food products industry, ADV and RD in machinery industry than the older firms. MKT in chemical industry, ADV and MKT in food products industry and ADV and RD in machinery industry are the significant

determinants of ITE. As a result the younger firms have become more input efficient in these industries.

Agedum has negative direct effect on ITE leather and non-metallic mineral products industries. In these industries, the older firms are more input efficient than the younger firms. Agedum has negative indirect effect on ITE through MKT in transport industry. In this industry, the older firms are having higher level of MKT than the younger firms and MKT is the significant determinant of ITE; as a result the older firms are more input-efficient for having higher level of MKT.

DIVIND has positive direct effect on ITE in leather, metal and paper industries. As the market share gets diversified, ITE of the firms in these industries increases. DIVIND has positive indirect effect on ITE through ADV and RD in textile industry. In this industry, the market share gets diversified, ADV and RD of the firms, which are the significant determinant of ITE, increase; as a result their ITE increases.

DIVIND has negative direct effect on ITE in chemical, machinery, non-metallic mineral products and transport industries. As the market gets concentrated in the hands of few large firms, ITE of the firms increases in these industries. DIVIND has negative indirect effect on ITE through ADV and MKT in food products industry. In this industry, the market share gets concentrated, ADV and MKT of the firms which are the significant determinant of ITE increase; as a result their ITE increases.

Largedum has positive indirect effect on ITE through ADV in chemical and machinery industries, through RD and ADV in food products industry. The larger sized firms are having higher levels of ADV in chemical and machinery industries and RD and ADV in food products industry than the smaller firms. ADV in chemical and machinery industries, RD and ADV in food products industry are the significant determinants of ITE; as a result the larger sized firms have become more input efficient.

Smalldum has negative direct effect on ITE in machinery industry. This result also suggests that the larger sized firms are more input efficient in this industry. Smalldum has negative indirect effect on ITE through MKT in food products industry, meaning that as the firm size becomes larger, MKT which is the significant determinant of ITE increases; as a result ITE increases.

Largedum has negative direct effect on ITE in textile industry. Smalldum has positive direct effect on ITE on leather industry. In these industries, the smaller sized firms are more input efficient than the larger sized firms. Smalldum has indirect positive effect on ITE through ADV in paper industry. In this industry, the smaller sized firms are having higher level of ADV being the significant determinant of ITE, as a result they are more input efficient.

REER has negative indirect effect on ITE through NX in food products, machinery and non-metallic mineral products industries. An increase in nation's REER is an indication that its exports are becoming costlier and its imports are becoming cheaper. It is losing its trade competitiveness; as a result NX falls. When REER will fall, NX of the firms in these industries increases; as a result their input efficiency increases.

Marginal effect of ITE on ADV, MKT, RD and NX is positive in chemical industry. Increase in ITE increases ADV, MKT, RD and NX in the current period in chemical industry which will further boost up ITE.

In the food products industry, the marginal effect of ITE on ADV, MKT and NX is positive. Increase in ITE increases ADV, MKT and NX of the sample firms which will further accentuate the increase in ITE. But ITE has U-relationship with RD with negative marginal effect. As the mean level of ITE is lesser than the critical level of ITE beyond which its positive effect can be felt, the negative marginal effect of ITE on RD has been obtained. The positive effect of ITE on RD can be felt beyond the critical level of ITE. Further increase in ITE is required to get its positive marginal effect on RD in the food products industry which will again boost up ITE.

In the leather industry, the marginal effect of ITE on ADV, RD and NX is positive. Increase in ITE increases ADV, RD and NX of the sample firms which will further accentuate the increase in ITE. But ITE has U-relationship with MKT with negative marginal effect. As the mean level of ITE is lesser than the critical level of ITE beyond which its positive effect can be felt, the negative marginal effect of ITE on MKT has been obtained. The positive effect of ITE on MKT can be felt beyond the critical level of ITE. Further increase in ITE is required to get its positive effect on MKT in the leather industry which will again boost up ITE.

In machinery, paper and textile industries, the marginal effect of ITE on ADV, MKT and RD is positive. Increase in ITE increases ADV, MKT and RD of the sample firms in these industries which will further accentuate the increase in ITE. But ITE has U-relationship with

NX with negative marginal effect. As the mean level of ITE is lesser than the critical level of ITE beyond which its positive effect can be felt, the negative marginal effect of ITE on NX has been obtained. The positive effect of ITE on NX can be felt beyond the critical level of ITE. Further increase in ITE is required to get its positive effect on NX in these industries which will again influence ITE.

In metal, non-metallic mineral products and transport industries, the marginal effect of ITE on MKT, RD and NX is positive in the current period. Increase in ITE increases MKT, RD and NX of the sample firms in these industries which will further accentuate the increase in ITE. But ITE has U-relationship with ADV with negative marginal effect. As the mean level of ITE is lesser than the critical level of ITE beyond which its positive effect can be felt, the negative marginal effect of ITE on ADV has been obtained. The positive effect of ITE on ADV can be felt beyond the critical level of ITE. Further increase in ITE is required to get its positive effect on ADV in these industries which will again boost up ITE.

The estimated results of output oriented technical efficiency (all industries taken together) of the present sample suggest that the output oriented technical efficiency is 0.897 for the sample manufacturing firms on an average. This indicates that the scarce resources have been inefficiently used during the study period. If the inputs are efficiently used, then the additional 10.3% output can be produced by utilizing the same level of inputs. However, the result varies across industries. The mean output oriented technical efficiency is the highest (0.954) for the sample firms in leather industries and the lowest (0.835) for the sample firms in chemical industries.

About 31% of sample manufacturing firms are output efficient on an average. They are having the efficiency score of one. The highest 64% of sample firms of leather industries are output-efficient whereas the lowest 14% of sample firms in chemical industry are output-efficient.

The estimated results of output oriented technical efficiency (year-wise analysis) of the present sample suggest that the mean output oriented technical efficiency was highest (i.e. 0.924) in 2000 and lowest (i.e. 0.852) in 1995 for the sample manufacturing firms. The mean output oriented technical efficiency score was not one for any of the years. The mean output oriented technical efficiency has been increased from 0.852 in 1995 to 0.874 in 2016.

For the sample firms included in chemical industry, mean OTE has been decreased from 0.764 to 0.719 during the study period (1995-2016). The mean OTE is the highest (0.924) in 2013 and the lowest (0.719) in 2016.

For the sample firms included in food products industry, mean OTE has been increased from 0.828 to 0.832 during the study period (1995-2016). The mean OTE is the highest (0.901) in 1997 and the lowest (0.828) in 1995.

For the sample firms included in leather industry, mean OTE has been increased from 0.886 to 0.959 during the study period (1995-2016). The mean OTE is the highest (0.999) in 2004 and the lowest (0.886) in 1995.

For the sample firms included in machinery industry, mean OTE has been decreased from 0.917 to 0.886 during the study period (1995-2016). The mean OTE is the highest (0.941) in 2000 and the lowest (0.846) in 2014.

For the sample firms included in metal industry, mean OTE has been increased from 0.709 to 0.932 during the study period (1995-2016). The mean OTE is the highest (0.947) in 1999 & in 2006 and the lowest (0.709) in 1995.

For the sample firms included in non-metallic mineral products industry, mean OTE has been decreased from 0.951 to 0.896 during the study period (1995-2016). The mean OTE is the highest (0.973) in 2002 and the lowest (0.716) in 2006.

For the sample firms included in paper industry, mean OTE has been decreased from 0.928 to 0.907 during the study period (1995-2016). The mean OTE is the highest (0.948) in 1996 and the lowest (0.871) in 2000.

For the sample firms included in textile industry, mean OTE has been increased from 0.746 to 0.783 during the study period (1995-2016). The mean OTE is the highest (0.919) in 2000 and the lowest (0.746) in 1995.

For the sample firms included in transport industry, mean OTE has been increased from 0.938 to 0.950 during the study period (1995-2016). The mean OTE is the highest (0.962) in 2009 and the lowest (0.885) in 2014.

The determinant analysis of output oriented technical efficiency of the sample firms under nine industry groups suggests that ADV in the current period has positive marginal effect on

OTE in chemical, food products, machinery, metal, non-metallic mineral products, paper, textile and transport industries in the current period. Increase in ADV increases OTE of these industries. But ADV has U-relationship with OTE with negative marginal effect in leather industry as the mean level of ADV is lesser than the critical level of ADV beyond which its positive effect can be felt. Increase in ADV being the sunk cost will not initially result in the rise in OTE but its positive effect on OTE can be felt by the leather industry when the mean level of ADV of this industry will exceed the critical level of ADV beyond which its positive effect on OTE can be achieved. As the mean level of ADV is lesser than the critical level of ADV, the positive marginal effect of ADV on OTE has not been obtained by the leather industry yet. Further increase in ADV is recommended to get its positive marginal effect on OTE by the leather industry.

ADV of the previous period has positive effect on OTE in non-metallic mineral product and transport industries. Increase in ADV in the previous period increases OTE of the current period in these industries.

MKT in the current period has positive marginal effect on OTE in chemical, food products, leather, metal, non-metallic mineral products, paper and transport industries. The rise MKT in these industries will increase OTE in the current period. MKT has U-relationship with OTE with negative marginal effect in machinery and textile industries as the mean level of MKT is lesser than the critical level of MKT beyond which its positive effect can be felt. Initially the increase in MKT increases the cost of production in these industries, as a result OTE falls. But when the critical level of MKT is reached, its positive effect on OTE will be experienced by both machinery and textile industries. As these industries are not doing adequate MKT, their mean level of MKT is still lesser than the critical level of MKT; for that they have not received the positive effect of MKT on OTE yet. Further increase in MKT is suggested to get its positive marginal effect on OTE by these industries.

MKT of the previous period has positive effect on OTE in machinery industry. The increase in MKT in the previous period will surely lead to the rise in OTE in the current period in this industry.

The marginal effect of RD on OTE is positive in chemical, food products, leather, machinery, metal, non-metallic mineral products, paper and textile industries in the current period. Increase in RD increases OTE in the current period in these industries. RD has U-relationship with OTE with negative marginal effect in transport industry as the mean level of RD is

lesser than the critical level of RD beyond which its positive effect can be felt. The transport industry is not doing sufficient RD to experience the positive of RD on OTE. Further increase in RD is needed to get its positive marginal effect on OTE.

RD of the previous period has positive effect on OTE in chemical and transport industries. The rise in RD in the previous period increases the OTE in the current period.

NX of the current period has positive marginal effect on OTE in chemical, food products, machinery, metal, non-metallic mineral products, paper, textile and transport industries. In these industries, the effect of exports dominates over the effect of imports; as a result NX has positive marginal effect on OTE in these industries.

NX of the current period has negative marginal effect on OTE in leather and paper industries. The industries are experiencing greater relative strength of imports over exports, as a result they are facing negative marginal effect of NX on OTE. These industries are dependent more on the imported inputs for increasing their output efficiency.

NX of the previous period has positive effect on OTE in chemical, leather and paper industries. Increase in NX in the previous period increases OTE in the current period.

There exists a joint interaction term of RD of the current period and NX of the previous period which has positive effect on OTE in the chemical and leather industries. By participating in the international trade in the previous period, these industries adopt foreign technologies; as a result RD of the current period increases which in turn increases OTE. Thus the effect of RD on OTE in the current period in these industries depends highly upon NX in the previous period.

There is another joint interaction term of ADV and MKT which is having positive effect on OTE in food products industry. OTE of food products industry being the consumer good producing industry increases with the simultaneous rise in ADV and MKT in the current period. The effect of ADV on OTE depends on MKT and vice-versa.

There is the existence of another joint interaction term of NX and RD. It also has positive effect on OTE in food products, paper and textile industries. Through RD, the product quality gets enhanced; as a result there will be an increase in NX which will lead to the rise in OTE in these industries in the current period. In these industries, the effect of RD on OTE depends on NX and vice-versa.

The machinery and paper industries also get a positive composite effect of RD and ADV on OTE. Through RD, new advertising strategies will be invented; as a result OTE rises. In these industries, the effect of RD on OTE depends on ADV and vice-versa.

The paper industry also gets another positive composite effect of RD and MKT on OTE. Through RD, new marketing strategies will be invented; as a result OTE rises. In this industry, the effect of RD on OTE depends on MKT and vice-versa.

Agedum has direct positive effect on OTE in chemical and textile industries. In these industries, the younger firms are more output efficient than the older firms.

Agedum has negative direct effect on OTE in metal industry. In this industry, the older firms are more output efficient than the younger firms. Agedum has negative indirect effect on OTE through ADV, RD and NX in the leather industry. In this industry, the older firms are having higher levels of ADV, RD and NX than the younger firms. ADV, RD and NX are the significant determinants of OTE in this industry as a result OTE of the sample firms in this industry will be affected.

DIVIND has direct positive effect on OTE in leather, paper and textile industries. As the market share gets diversified, OTE of firms increases in these industries. DIVIND has positive indirect effect on OTE through ADV and NX in metal industry. As the market share gets diversified in this industry, ADV and NX of the firms increases, as a result their output efficiency of the firms will be affected.

DIVIND has negative direct effect on OTE in chemical, machinery, non-metallic mineral products and transport industries. . In these industries, OTE of the firms increases as the market gets concentrated in the hands of few large firms. DIVIND has negative indirect effect on OTE through ADV, MKT and RD in the food products industry. In this industry, as the market gets concentrated, ADV, MKT and RD of the sample firms, which are significant determinants of OTE, increase; as a result their output efficiency increases.

Largedum has positive indirect effect on OTE through RD in chemical industry and through ADV in machinery industry, meaning that the larger sized firms are having higher levels RD in chemical industry and ADV in machinery industry than the smaller sized firms. RD in chemical industry and ADV in machinery industry are the significant determinants of OTE; so their output efficiency increases.

Largedum has negative direct effect on OTE in textile industry, implying that the smaller sized firms are more output efficient than the larger sized firms in this industry. Largedum has negative indirect effect on OTE through ADV in leather industry. In this industry, smaller sized firms are having higher level of ADV which is significant determinant of OTE; as a result their output efficiency increases.

Smalldum has positive indirect effect on OTE through RD in leather industry and through ADV in paper industry. The smaller firms are having higher levels of RD in leather industry and ADV in paper industry than the larger firms. RD in leather industry and ADV in paper industry are the significant determinants of OTE; as a result they have become more output efficient than the larger firms.

Smalldum has negative indirect effect on OTE through ADV and MKT in food products industry. The larger firms are higher levels of ADV and MKT (which are significant determinants of OTE) than the smaller firms in this industry. As a result they have become more output efficient.

REER has indirect negative effect on OTE through NX in food products, machinery, non-metallic mineral products industries. An increase in nation's REER is an indication that its exports are becoming costlier and its imports are becoming cheaper. It is losing its trade competitiveness; as a result NX falls. When REER falls, NX of the firms increases; as a result, their OTE increases.

OTE has positive marginal effect on ADV, MKT, RD and NX in the current period in food products, leather, non-metallic mineral products and textile industries. Increase in OTE increases ADV, MKT, RD and NX in the current period in these industries which will further boost up OTE.

In chemical industry, OTE has positive effect on ADV, MKT and NX. Increase in OTE increases ADV, MKT and NX which will further boost up OTE. But OTE has U-relationship with RD with negative marginal effect as the mean level of OTE is lesser than the critical level of OTE beyond which its positive effect can be felt. The positive effect of OTE on RD will be achieved by the chemical industry when the mean level of OTE will exceed the critical level of OTE beyond which the positive effect of OTE on RD will be felt. As mean level of OTE is lesser than the critical level of OTE, its positive marginal effect on RD has

not been felt yet. Further increase in OTE is recommended to derive its positive marginal effect on RD which will accentuate the further increase in OTE.

In machinery industry, OTE has positive marginal effect on MKT and NX. Increase in OTE increases MKT and NX which will further boost up OTE. But OTE has U-relationship with ADV and RD with negative marginal effect as the mean level of OTE is lesser than the critical level of OTE beyond which its positive effect can be achieved. The positive effect of OTE on ADV and RD will be achieved by the machinery industry when the mean level of OTE will exceed the critical level of OTE. As mean level of OTE is lesser than the critical level of OTE, its positive marginal effect on ADV and RD has not been felt yet. Further increase in OTE is recommended to derive its positive marginal effect on ADV and RD which will accentuate the further increase in OTE.

In metal industry, OTE has positive marginal effect on MKT, RD and NX. Increase in OTE increases MKT, RD and NX which will further boost up OTE. But OTE has U-relationship with ADV with negative marginal effect as the mean level of OTE is lesser than the critical level of OTE beyond which its positive effect can be achieved. The positive effect of OTE on ADV will be achieved by the metal industry when the mean level of OTE will exceed the critical level of OTE. As mean level of OTE is lesser than the critical level of OTE, its positive marginal effect on ADV has not been felt yet. Further increase in OTE is recommended to derive its positive marginal effect on ADV which will accentuate the further increase in OTE.

In paper industry, OTE has positive marginal effect on ADV and MKT. Increase in OTE increases ADV and MKT which will further boost up OTE. It has U-relationship with RD and NX with negative marginal effect as the mean level of OTE is lesser than the critical level of OTE beyond which its positive effect can be achieved. The positive effect of OTE on RD and NX will be achieved by the paper industry when the mean level of OTE will exceed the critical level of OTE beyond which the positive effect of OTE on RD and NX will be felt. As mean level of OTE is lesser than the critical level of OTE, its positive marginal effect on RD and NX has not been felt yet. Further increase in OTE is recommended to derive its positive marginal effect on RD and NX which will accentuate the further increase in OTE.

In transport industry, the marginal effect of OTE on ADV, RD and NX are positive. Increase in OTE increases ADV, RD and NX which will further boost up OTE. But OTE has U-relationship with MKT with negative marginal effect as the mean level of OTE is lesser than

the critical level of OTE beyond which its positive effect can be achieved. The positive effect of OTE on MKT will be achieved by the transport industry when the mean level of OTE will exceed the critical level of OTE beyond which the positive effect of OTE on MKT will be felt. As mean level of OTE is lesser than the critical level of OTE, its positive marginal effect on MKT has not been felt yet. Further increase in OTE is recommended to derive its positive marginal effect on MKT which will accentuate the further increase in OTE.

The issue regarding total factor productivity growth is analysed in Chapter 6. The estimated result of productivity suggests that the total factor productivity growth is the highest (0.992) in 2004-05 and 2014-15 and the lowest (0.902) in the year 2002-03 for the sample firms of chosen industry groups. Over the study period, the total factor productivity growth falls from 0.997 in 1995-96 to 0.962 in 2015-16 for the present sample. On an average, mean TFPG is 0.958 for the sample firms, indicating that TFPG has declined by 4.2% over the study period.

The efficiency change is the highest (1.159) in the year 1995-96 and is the lowest (0.935) in the year 2002-03 for the sample Indian manufacturing firms. In the study period, the efficiency change falls from 1.159 in 1995-96 to 0.985 in 2015-16 for the present sample. On an average, the mean efficiency change is 1.000 for the sample firms, meaning that efficiency change remains more or less the same over the study period.

The technical change is the highest (1.051) in the year 2006-07 and is the lowest (0.881) in 1995-96 for the present sample. Over the study period, the technical change rises from 0.88 in 1995-96 to 0.993 in the 2015-16 for the present sample. On an average, the mean technical change is 0.967 for the present sample, implying that technical change has declined by 3.3% over the study period.

The scale change is the highest (1.101) in 1995-96 and is the lowest (0.976) in 2000-01 for the sample firms. Over the study period, the scale change falls from 1.101 in 1995-96 to 0.995 in 2015-16 for the present sample. On an average, the mean scale change is 1.004, meaning that the scale change has increased by 0.4% over the study period.

On an average, mean TFPG is 0.958 for the sample firms, indicating that TFPG has declined by 4.2% over the study period. The rigidity in efficiency change and the fall in technical change outweigh the rise in scale change, as a result TFPG has decreased over the study period.

About 80% of sample firms are having the average Malmquist Productivity Index (MPI) ranging between 0.900 -1.000. Only 11% of sample firms are having the average MPI lying above 1.000. Remaining 9% of the sample firms are having the average MPI below 0.900. The highest 18% of sample leather firms are having MPI more than one and the lowest 6% of food products firms are having MPI more than one.

Around 54% of sample firms are having the average efficiency change ranging between 0.900 to 1.000. Only 40% of sample firms are having the average efficiency changes lying above 1.000. Remaining 6% of the sample firms are having the average efficiency change below 0.900. The highest 73% of sample metal firms are having average efficiency change more than one and the lowest 9% of sample leather firms are having average efficiency change more than one.

About 94% of sample firms are having the average technical change ranging between 0.900 to 1.000. Only 5% of sample firms are having the average technical changes lying above 1.000. Remaining 1% of the sample firms are having the average technical changes below 0.900. The highest 15% of sample machinery firms are having average technical change more than one and the lowest 0% of sample food products and transport firms are having average technical change more than one.

About 65% of sample firms are having the average scale change ranging between 0.900 to 1.000. Only 33% of sample firms are having the average scale changes lying above 1.000. Remaining 2% of the sample firms are having the average scale changes below 0.900. The highest 77% of sample metal firms are having average scale change more than one and the lowest 7% of sample transport firms are having average scale change more than one.

The estimated result regarding Malmquist Index Summary of Annual Means at disaggregated level suggests that the efficiency change has been increased only for paper industry from 1.028 to 1.197 during the study period from 1995-96 to 2015-16.

During the study period, technical change has been increased only for food product industry from 0.903 to 1.031, leather industry from 0.910 to 1.035, machinery industry from 0.941 to 1.175, metal industry from 0.571 to 0.794, textile industry from 0.710 to 1.033 and transport industry from 0.942 to 0.962.

In the study period, scale change has been increased only for paper industry from 1.020 to 1.070 and transport industry from 1.009 to 1.019.

TFPG has been increased in the study period only for paper industry from 1.067 to 1.143 and textile industry from 0.973 to 1.143.

The industry wise analysis of Malmquist Index Summary of Annual Means (all the years taken together) suggests that the mean efficiency change is the highest (1.017) for metal industry and the lowest (0.973) for food products industry. The mean technical change is the highest (0.979) for machinery industry and the lowest (0.940) for metal industry. The mean scale change is the highest (1.017) for metal industry and the lowest (0.995) for non-metallic mineral product industry. The mean TFPG is the highest (0.967) for leather industry and the lowest (0.938) for food product industry.

The growth rate of efficiency change is the largest contributor of total factor productivity change for all the industries except leather industry. On an average, growth rate of efficiency change, technical change, scale change and total factor productivity change are 118.05%, 5.24%, 10.63% and 125.24% respectively for the current sample over the study period. This result suggests that efficiency change is contributing the most towards TFPG which brings about sustainable growth. For the present sample, mean growth rate of efficiency change is the highest (271.98%) in paper industry and the lowest (5.4%) in leather industry. Mean growth rate of technical change is the highest (8.16%) in non-metallic mineral products industry and the lowest (2.49%) in food products industry. Mean growth rate of scale change is the highest (43.79%) in paper industry and the lowest (2.95%) in food products industry. Mean growth rate of TFPG is the highest (287.53%) in paper industry and the lowest (29.89%) in chemical industry.

The determinant analysis of TFPG for the sample firms of the considered nine industry groups suggests that ADV has positive marginal effect on TFPG in machinery, non-metallic mineral products and paper industries in the current period. Increase in ADV increases TFPG in these industries in the current period. But ADV has U-relationship with TFPG with negative marginal effect in chemical, food products, leather, metal, textile and transports industries as their mean level of ADV is lesser than the critical level of ADV beyond which its positive effect can be obtained. Initially increase in ADV being the one of the sunk costs will not initiate TFPG in these industries but the positive effect of ADV on TFPG can be achieved beyond the critical level of ADV in these industries. As these industries are not doing adequate ADV, as an effect they have not received the positive effect of ADV on

TFPG yet. Thus, further increase in ADV is suggested to get its positive effect on TFPG in these industries.

ADV of the previous period has positive effect on TFPG in chemical, food products, leather, machinery and transport industries. Increase in ADV in the previous period increases TFPG in the current period in these industries.

The marginal effect of MKT on TFPG is positive in food products, leather, machinery, metal, non-metallic mineral products, paper and textile industries in the current period. The increase in MKT in the current period increases TFPG in these industries. But, MKT of the current period has U-relationship with TFPG with negative marginal effect in chemical and transport industries as their mean level of MKT is lesser than the critical level of MKT beyond which its positive effect can be obtained. Initially increase in MKT being the one of the sunk costs will not initiate TFPG in these industries but the positive effect of MKT on TFPG can be achieved beyond the critical level of MKT in these industries. As these industries are not doing adequate MKT, as a result, they have not received the positive effect of MKT on TFPG yet. Further increase in MKT is recommended to get its positive effect on TFPG by these industries.

MKT of the previous period has positive effect on TFPG in chemical, leather, machinery, metal and non-metallic mineral products industries. Increase in MKT in the previous period increases TFPG in these industries in the current period.

RD has positive marginal effect on TFPG in chemical, food products, leather, machinery, paper and textile industries in the current period. Increase in RD increases TFPG in these said industries in the current period. But RD has U-relationship with TFPG with negative marginal effect in metal, non-metallic mineral products and transport industries as their mean level of RD is still lesser than the critical level of RD beyond which its positive effect can be felt. Initially increases in RD will not initiate TFPG in these industries but the positive effect of RD on TFPG can be achieved only when the mean level of RD would exceed the critical level of RD beyond which the positive effect of RD on TFPG can be achieved in these industries. As these industries are not doing adequate RD, as a result, they have not received the positive effect of RD on TFPG yet. Further increase in RD is needed to get its positive effect on TFPG by these industries.

The marginal effect of RD of the previous period on TFPG is positive in the food products, machinery, metal, non-metallic mineral products and transport industries. Increase in RD in the previous period increases TFPG of the current period in these industries.

NX of the current period has positive marginal effect on TFPG in chemical, machinery, metal, paper, textile and transport industries. The effect of exports dominates over the effects of the imports in these industries; as a result the positive marginal effect of NX on TFPG can be achieved in these industries.

NX of the current period has negative marginal effect on TFPG in food products, leather and non-metallic mineral products industries. The effect of imports dominates over the exports in the industries; as a result the negative marginal effect of NX on TFPG can be achieved in these industries. This result means that these industries are highly dependent on the imported inputs.

The marginal effect of NX of the previous period on TFPG is positive in food product, leather, machinery and non-metallic mineral products industries. Increase in NX in the previous period increases TFPG in these industries in the current period.

There exists a joint interaction term of NX and RD, having positive effect on TFPG in chemical and non-metallic mineral products industries. Through RD, the product quality will get enhanced, as a result NX increases which will result in the rise TFPG in these industries. In these industries, the effect of RD on TFPG depends on NX and vice-versa.

There exists another joint interaction term of ADV and MKT having positive marginal effect on TFPG in machinery, non-metallic mineral products, paper and textile industries. Joint increase in ADV and MKT brings about a rise in TFPG in these industries. The effect of MKT depends on ADV in these industries.

There is the existence of another joint interaction of RD and MKT, having positive effect on TFPG in paper industry. Through RD, new marketing strategy will be invented; as a result TFPG will increase in paper industry. The effect of RD on TFPG depends on MKT in this industry.

Agedum has direct positive effect on TFPG in chemical and paper industries. In these industries, the younger firms are more productive than the older firms. Agedum has indirect positive effect on TFPG through ADV in food product industry, through RD in machinery

industry and through ADV and RD in textile industry. The younger firms are having higher levels of ADV in food product industry, RD in machinery industry and ADV and RD in textile industry than the older firms. ADV in food product industry, RD in machinery industry and ADV and RD in textile industry are the significant determinants of TFPG. As a result, TFPG of the younger firms for having higher levels of ADV in food product industry, RD in machinery industry and ADV and RD in textile industry industries are significantly higher than that of the older firms.

Agedum has negative direct effect on TFPG in metal industry. In this industry, the older firms are more productive than the younger firms. Agedum has negative indirect effect on TFPG through ADV in leather industry. The older firms are having ADV in leather industry than the younger firms, which in turn increases TFPG as ADV is the significant determinant of TFPG in leather industry.

DIVIND has positive direct effect on TFPG in leather, metal and textile industries. As the market share gets diversified, TFPG increases in these industries.

DIVIND has negative direct effect on TFPG in chemical industry. As the market share gets concentrated in the hands of few large firms, TFPG of this industry increases. DIVIND has negative indirect effect on TFPG through ADV, MKT, RD and NX in food product industry and only through ADV in machinery and transport industries. When the market share gets concentrated in the hands of few large firms, the ADV, MKT, RD and NX in food product industry and ADV in machinery and transport industries increase which in turn affect TFPG as ADV, MKT, RD and NX in food product industry and ADV in machinery and transport industries are the significant determinants of TFPG.

Largedum has positive direct effect on TFPG in machinery industry. The larger sized firms are more productive than the smaller sized firms in this industry. Largedum has positive indirect effect on TFPG through RD in chemical industry and through RD and ADV in food products industry, meaning that the larger sized firms are having higher levels of RD in chemical industry and RD and ADV in food products industry than smaller sized firms; as a result they are having higher level of TFPG as RD in chemical industry and RD and ADV in food products industry are the significant determinants of TFPG.

Smalldum has positive direct effect on TFPG in metal industry, implying that the smaller sized firms are more productive than the larger sized firms.

REER has negative indirect effect on TFPG through NX in food products and machinery industries. An increase in nation's REER is an indication that its exports are becoming costlier and its imports are becoming cheaper. It is losing its trade competitiveness; as a result NX falls. Thus, the fall in REER will bring about a rise NX in these industries which will in turn influence TFPG.

The marginal effect of TFPG on ADV, MKT, RD and NX is positive in the current period in chemical, food products, machinery, paper and transport industries. Increase in TFPG increases ADV, MKT, RD and NX in these industries which will further boost up TFPG.

In leather industry, the marginal effect of TFPG on MKT and RD is positive, implying that increase in TFPG increases MKT and RD which will further boost up TFPG in the current period. But TFPG has U-relationship with ADV and NX with negative marginal effect as the mean level of TFPG is lesser than critical level of TFPG beyond which its positive effect can be obtained. Initially increase in TFPG will not initiate ADV and NX but the positive effect of TFPG on ADV and NX can be obtained beyond the critical level of TFPG. As the mean level of TFPG is lesser than the critical level of TFPG, the positive effect of TFPG on ADV and NX has not been felt yet. Further increase in TFPG is recommended to get the positive effect on TFPG on ADV and NX in these industries which will further boost up TFPG.

Similarly, in metal, non-metallic mineral products and textile industries, TFPG has positive marginal effect on ADV, RD and NX, implying that increase in TFPG increases ADV, RD and NX which will further boost up TFPG in the current period. But, TFPG has U-relationship with MKT with negative marginal effect as the mean level of TFPG is lesser than critical level of TFPG beyond which its positive effect can be obtained. Initially increase in TFPG will not initiate MKT but the positive effect of TFPG on MKT can be obtained beyond the critical level of TFPG. As the mean level of TFPG is lesser than the critical level of TFPG, its positive effect on MKT has not been felt yet. Further increase in TFPG is needed to realise its positive effect on MKT in these industries which will further boost up TFPG.

The empirical results of this Chapter 7 suggest that high growth implies high productivity but does not necessarily imply efficiency for the sample Indian manufacturing firms.

On an average 36% of the sample firms are working above mean TFPG, mean input oriented technical efficiency and mean output oriented technical efficiency. The highest 43% of sample firms in leather and paper industries are operating above mean TFPG, mean input

oriented technical efficiency and mean output oriented technical efficiency whereas the lowest i.e. only 30% of sample firms in chemical industry are operating above mean TFPG, mean input oriented technical efficiency and mean output oriented technical efficiency.

About 38.60% of highly productive sample firms are having high ITE as well as high OTE on an average. For the present sample, high productivity will indicate high efficiency (both ITE & OTE). For chemical, food products, leather, machinery, non-metallic mineral products and textile industries, the most of the highly productive sample firms are having high ITE as well as high OTE.

By analysing the description of different industry groups as obtained in Section 1.3 of Chapter 1, it can be seen that only Indian chemical firms are doing RD in the true sense. The other manufacturing industries are reporting RD in accounting sense but they are not doing real RD. But the determinant analysis of this thesis shows that increase in RD enhances growth, productivity and efficiency (both input oriented and output oriented TE) in all the nine industry groups. These results imply that in order to promote growth, productivity and efficiency (both input oriented and output oriented TE) RD of all the industry groups should be enhanced, since RD has a positive impact on growth, productivity and efficiency (both input oriented and output oriented TE). For promotion of RD, one may suggest the following: The reduction of RD cost is very important. Tax incentives to key sectors have played a central role in RD. Since RD activity is mainly dependent on imported inputs, facilitated imports will also boost up the RD activity which in turn will improve growth, productivity and efficiency (both input oriented and output oriented TE) of the firms. Through international trade, the foreign technologies flow within the domestic country, as a result further rounds of RD will be enhanced and growth, productivity and efficiency (both input oriented and output oriented TE) will increase. But since import of the goods is not a permanent solution for the sustained growth of the firms and hence of industries, at the same time indigenous measures of development should be generated to develop RD skill of the firms, so that in the long run one can minimize the import requirements for RD activity. The fiscal incentives and support measures presently available include exemption of import duties on key RD expenditure, customs duty exemption on capital equipment, spares, accessories and consumables imported for Research and Development by approved institutions, weighted tax deduction for sponsored research and on in-house Research and Development expenditure, custom duty exemption on imports for RD projects supported by Government, an excise duty waiver on indigenous items purchased by approved institution for Research

and Development. These measures should be carried out and strengthened. The Government should promote RD activities and at the same time Government should facilitate import activities of the firms which basically foster RD. The firms on their part have to invest more on RD and at the same time they have to carry on their export activity, keeping in mind that RD and export activity have joint positive interaction effect on growth, productivity and efficiency (both input oriented and output oriented TE) in different Indian manufacturing industries. At the same time the firm should try to improve the quality of export. This in turn suggests greater role of RD because sustained increase in RD will in turn help to improve the quality of the product.

The discussions of the thesis suggest that advertisement and marketing activities have favorable effects on growth, productivity and efficiency (both input oriented and output oriented TE). Thus it is recommended that the firms should carry on their advertisement and marketing activities. Simultaneous increase in ADV and MKT also brings about increase in growth, productivity and efficiency (both input oriented and output oriented TE) in different industries. Through RD, new advertising and marketing strategies will be invented that will also result in the enhancement of growth, productivity and efficiency (both input oriented and output oriented TE) in different manufacturing industries.

The determinant analysis also suggests that growth, productivity and efficiency (both input oriented and output oriented TE) enhance advertising, marketing, RD and net export activities in all the industries. Therefore, advertising, marketing, RD and net export activities must be boosted up to enhance growth, productivity and efficiency (both input oriented and output oriented TE) of the Indian manufacturing firms which in turn will further have positive impact on advertising, marketing, RD and net export activities which will again accentuate the firms' performances.

The younger firms are performing better than the older firms in chemical, food products, machinery, textile and paper industries. Thus the younger firms should be given incentives in these industries as they are having adequate flexibility to quickly adjust with the changing economic circumstances and work efficiently. On the other hand, older firms display superior performance in leather, metal, non-metallic mineral products and transport industries as they are more experienced and have the benefit of learning earlier. Thus, the older firms should be given encouragement in the last mentioned industries.

As the larger sized firms enjoy economies of scale, they are showing better performance in chemical, food products and machinery industries. So they should be given incentive by the Govt. for rendering much better performance. On the other hand, smaller sized firms are having better performance in leather, metal, textile and paper industries. So, the smaller sized industries should be given incentive in the last mentioned industries.

As the market share gets diversified among all the firms in leather, metal, paper and textile industries; the firms' performance will be better. For the well diversification of market shares in these industries, the government action is needed. On the other hand, as the market share gets concentrated, the firms' performance will be better in chemical, machinery, transport, non-metallic mineral products and food products industries. Thus, they should be given encouragement by the Govt.

The most striking result of this thesis is that one cannot recommend a single policy for boosting up of growth, efficiency and productivity for all the industry groups. Given the heterogeneity, the policies needed for boosting up the performance indicators vary among different industry groups and also among the indicators themselves.

The one limitation of the thesis may be that while explaining total factor productivity growth and efficiency, the Non-parametric DEA has been used. However, the literature supports that the alternative method of estimation is Parametric Stochastic Frontier Production Function approach to explain total factor productivity growth and efficiency. Thus, the additional agenda of research may be to carry out the whole analysis of the thesis using Parametric Stochastic Frontier Production Function approach to verify the robustness of the result. This is agenda of our future research.