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

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By

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Certified that the Thesis entitled

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

submitted by me for the award of the Degree of Doctor of Philosophy in Arts at Jadavpur University is based upon my work carried out under the Supervision of Dr. Arpita Ghose, Professor, Dept. of Economics, Jadavpur University and that neither this thesis nor any part of it has been submitted before for any degree or diploma anywhere / elsewhere.

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I **SANCHITA De** registered on July 7, 2014 do hereby declare that this thesis entitled **Growth, Efficiency and Productivity of Indian Manufacturing Firms in the Post-Reform Era** contains literature survey and original research work done by the undersigned candidate as part of Doctoral studies.

All information in this thesis have been obtained and presented in accordance with existing academic rules and conduct. I declare that, as required by these rules and conduct, I have fully cited and referred all materials and results that are not original to this work.

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Sanchita De

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Abbreviations

ADV	-	Advertising Intensity
ADVlag	-	Advertising Intensity of the last year (one year lag)
Agedum	-	Age dummy
ASI	-	Annual Survey of Industries
BCC	-	Banker, Charnes and Cooper
CAGR	-	Compound Annual Growth Rate
CMIE	-	Centre for Monitoring Indian Economy
CR	-	Concentration Ratio
CRR	-	Charnes, Cooper and Rhodes
CRS	-	Constant Returns to Scale
CSO	-	Central Statistical Organisation
CV	-	Coefficient of Variation
DEA	-	Data Envelopment Analysis
DIVIND	-	Diversification Index
ESG	-	Environmental, Social and Governance
FY	-	Financial Year
FGNZ	-	Fare, Grosskopf, Norris and Zhang
GDP	-	Gross Domestic Product
G.O.I.	-	Government of India
GROUT	-	Growth of Output
GVA	-	Gross Value Added
GRM	-	Grand Mean
HHI	-	Herfindahl-Hirschman Index
INAE	-	Indian National Academy of Engineering
ITE	-	Input Oriented Technical Efficiency
Largedum	-	Large firm dummy
LP	-	Linear Programming
Mediumdum	-	Medium firm dummy
MKT	-	Marketing Intensity
MKTlag	-	Marketing Intensity of the last year (one year lag)
MPI	-	Malmquist Productivity Index
MPM	-	Marketing Performance Measurement

MPSS	-	Most Productive Scale Size
MSM	-	Micro, Small & Medium Enterprise
NAS	-	National Accounts Statistics
NNP	-	Net National Product
NX	-	Net Export Intensity
NXlag	-	Net Export Intensity of the last year (one year lag)
OTE	-	Output Oriented Technical Efficiency
R&D	-	Research & Development
RD	-	R&D Intensity
RDlag	-	R&D Intensity of the last year (one year lag)
REER	-	Real Effective Exchange Rate
SC	-	Scale Change
SD	-	Standard Deviation
SEC	-	Scale Efficiency Change
SME	-	Small and Micro Enterprise
SWOT	-	Strengths-Weaknesses-Opportunities-Threats
TC	-	Technological Change/ Technical Change
TE	-	Technical Efficiency
TEC	-	Technical Efficiency Change
TFP	-	Total Factor Productivity
TFPG	-	Total Factor Productivity Growth
2SLS	-	Two Stage Least Square
VRS	-	Variable Returns to Scale
WPI	-	Wholesale Price Index

Chapter 1

Introduction and Relevance of the Present Study

1.1 Introduction

The development of the manufacturing sector in proper channel is helpful in strengthening the base of the economies which have been facing recession in its output and employment growth, thus reducing the magnitudes of demand. Further, given the growing importance of the service sector in the global economy, and the fact that there is an established inter-sectoral linkage between service and the manufacturing sector, the service sector growth is contingent on manufacturing sector's growth. The role of increasing the productivity and efficiency of manufacturing sector in absorbing economic shocks is well established (Kendrick (1956); Solow (1957), Denison (1967), Jorgenson and Grilliches (1967) etc.).

There is a conceptual distinction between technological change (TC) and total factor productivity growth (TFPG). TC is advances in knowledge and its application to the art of production (invention, innovation and diffusion). TFPG is defined as growth in output which is not accounted by growth in inputs; it includes TC, technical-efficiency change (TEC) and scale-change (SC). SC is actually input-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. TFPG driven by TC and TEC normally arises due to the improvement in knowledge, organizational structure, human resources management, skills attainment, information technology and efficient use of factors of production, which are much more desirable for sustainable growth. Long-run development is benefited, if TFPG is driven by sources other than SC, i.e. TC and TEC.

1.2 Relevance of the present study

The 1991 economic reforms in India exposed the domestic firms to international competition. The Government of India removed all sorts of trade restriction and took a liberalized policy. The impacts of trade liberalization on the productivity and efficiency of domestic manufacturing firm are a matter of considerable debate. According to traditional infant industry arguments, the abolition of protection results in the bankruptcy of large number of domestic firms. On the other hand, many argue that the trade liberalization makes the domestic firms much more efficient and competitive to face the foreign competition by improving their performances. Numerous regulations enforced through rigid bureaucratic control created a 'permit-licence Raj' in the pre-Reform decades that effectively inhibited productivity growth and technical efficiency in Indian manufacturing. Policies like reservation of a large number of items for production by firms in the small scale sector, high customs tariffs distorting resource allocation and inhibiting the ability of Indian firms to compete in the global markets, restrictions on capacity expansion restraining firms from attaining efficient size, frictions faced in establishing and closing down of firms in response to normal competitive market dynamics, and other distortions created by domestic trade taxes and excise duties discouraged efficiency and hindered productivity growth. The earlier regulatory regime ended by the introduction of various reforms and gradual liberalization of both domestic and international trade. Also there is recognition of the urgency on the part of the Indian industries to become efficient so as to tolerate successfully the pressure of foreign competition. Over the years, several financial measures such as rationalization of excise duties, liberalization of tax laws and rates, reduction in interest rates and so on, alongside physical measures meant to remove infrastructural constraints in the power, transport and telecommunications sectors have been taken by the government of India to help domestic industries to achieve higher efficiency. The argument for pursuing liberalisation policies is to foster growth, productivity and efficiency of Indian manufacturing industry.

Thus, the question can be asked what the performance position of Indian manufacturing industry is during this post-reform era. This is the main motivation behind doing this study.

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?

Such type of studies is very important for framing appropriate policies to boost up the performance level of Indian manufacturing firms. However, the extent of performances and the factors influencing these performances are not uniform across all the firms and or within the industry. There is a lot of heterogeneity. The extent of the heterogeneity can be visualized from the description about different industries in Section 1.3. This necessitates a disaggregated analysis. Further, the perusal of the literature on the factors influencing the growth, efficiency (both input oriented technical efficiency and output oriented technical efficiency) and productivity (as summarized in Chapter 2 of the thesis) suggests that the factors influencing the determinants of the above performance are not independent and purely exogenous. They affect the performance indicators and in turn also get affected by the performance indicator itself. Thus the determinant analysis should be carried out in a simultaneous equation frame. However, there is dearth of studies in this respect. The present study contributes the literature in this direction.

The motivation and the objectives of this study stems from these above observations. The present study is carried out at disaggregated firm level for each of the chosen industries and the factors determining the performance indicators are analysed in a simultaneous equation frame.

The present study has considered the following nine Indian manufacturing industry groups: chemical industry, food products industry, leather industry, machinery industry, metal industry, non-metallic mineral products industry, paper industry, textile industry and transport industry. All the industry groups under Indian manufacturing sector have been initially incorporated but subject to the availability of data, the above mentioned nine industry groups have finally been selected for the current study.

1.3 Description of different Indian manufacturing industries

The characteristics of different Indian manufacturing industries are as follows:

1.3.a Chemical Industry

Chemical sector is one of India's oldest industries. It has significant contribution towards the economic growth of the country. According to the department of chemicals and petrochemicals, the chemical industry of India is estimated to be worth about 3% of GDP. The total investment in the Indian chemical industries is approximately US$60 billion. The total employment generated in Indian chemical industry is about 1 million. Indian chemical industry is the 12th largest in the world and 3rd largest in Asia in terms of the volume. This industry produces more than 80000 products and supplies to almost all sectors of the economy. The products related to petrochemicals, fertilizers, paints, varnishes, glass, perfumes, toiletries, pharmaceuticals etc. are produced by Indian chemical industry. The exports of chemicals from India have raised significantly. It is about 14% of total exports. Indian chemical sector is exporting its various products to both developed and developing nations. The INAE study (2011) views R&D as the most probable growth engine for Indian chemical industry. R&D expenditure is about Rs. 7860 Crores (2008-09). The Indian chemical exports and imports stood at US$ 20.5 billion and US$ 12.5 billion respectively in 2008-09 with a positive trade balance. Indian chemical industry was a net importer in early 1990s. It has now become a net exporter due to reduction in its imports and significant increase in its exports in drugs/pharma and biotech sectors and higher share of high tech product manufacture. Indis's share of global exports is around 5% in 2006 which is the highest among developing countries except China. Indian share of global pharmaceutical import is less than 1% in 2006 mainly due to higher level of self-reliance of Indian pharmaceutical sector. The sub-division of Indian chemical sector is the following: 1) Basic chemical sector, 2) Knowledge intensive chemical sector, 3) Specialty chemical sector.

The basic chemical sector is dominating the Indian chemical industry as its cumulative investment is 57%, production capacity is 85% and turnover is 47%. This sector is contributing to 77% of Indian chemical imports with a negative trade balance mainly due to organic chemical and fertilizer sectors. Its share is around 13% in terms of R&D spending. According to the KPMG study (2010), the Indian basic chemical sector has a Herfindahl Index (HFI) of less than 0.3 indicating a high degree of fragmentation and internal competition.

Indian companies in knowledge intensive chemical sector have imposed comparatively higher importance to R&D as a mean to get product leadership. Leading industries in this segment are making R&D investments to the extent of 5%-15% of their sales. This segment is the fastest growing segment of Indian chemical sector. The main elements of this segment are drugs/pharma, agro-chemical and bio-technology. According to INAE study (2011), the maximum number of medium and large scale units of Indian chemical sector exists in knowledge intensive chemical sector. The INAE study shows that Indian knowledge intensive chemical sector is having 34% turnover, 54% exports in Indian chemical sector as a whole. This sector has made R&D expenditure of Rs. 6579 Crores during 2008-09. About 84% of chemical sector R&D spending has been spent by the firms in knowledge intensive chemical sector with drugs/pharma accounting for about 60% of expenditure.

Speciality chemical sector provide required solutions to meet the customer specific needs. The important constituents of Indian speciality chemical sector are dyes, household & personal care products, auxiliary chemicals, processed food, paints/coatings, additive and sealants. This sector registered a positive trade balance around Rs. 12000 Crores in 2008-09. The R&D expenditure spent by this sector is about 4% of the entire Indian chemical industry. The KPMG study (2010) identified poor access to common R&D facilities for speciality chemical sector as its growth obstruction factors. Its contribution is 30% to the cumulative investments of the chemical sector during 1991-2008. It is having 15%-20% share in production, turnover and exports of chemical sector during 2008-09 which are quite remarkable. The speciality chemical sector has registered growth rates higher than the overall Indian chemical industry. But its R&D intensity has remained constant during last 10 years. The Indian speciality chemical industry is largely driven by strong domestic demand with export determined growth. The speciality and knowledge intensive chemical sector need R&D for product improvement.

1.3.b Food Industry

The significance of processed food items in the consumption basket has been increasing internationally over the years. With higher level of income, urbanization, demographic changes, improvement in transportation and change in consumer views regarding quality, food consumption patterns have altered over the years (Regmi and Gehlhar, 2001; Wilkinson & Rocha, 2008). Advertisement via social media has also led to increase in the demand-driven food processing industry growth in India (Regmi and Gehlhar, 2005).

Food processing is the conversion of raw ingredient into food or of food into other forms. Food processing typically takes clean, harvested crops or butchered animal products and processes these items to produce food products. The final production of agriculture, animal husbandry and fishing is processed into food and drink for human or animal consumption by the food industry. The food processing industry is a growing manufacturing sector in India. It is a source of strengthening the rural regions. The Indian food products industry has witnessed the rise in demand for the population growth and the increase in per head consumption of processed food. Food processing industries are utilizing the foodgrains and other agricultural products optimally. It is known that the production of agriculture goods is continuously falling in Indian economy and the rural workers involved in the agriculture are shifting to the other regions. Rural people are migrating due to disguished unemployment and other problem related to primaryactivities. In this situation, the food processing industries are the motivation to the agricultural workers for increasing their production because the main raw materials of the food processing industries are obtained from the agricultural sector. Food processing industry benefits both the farmers as well as processors.

The post-liberalisation period has been observed the adoption of different policy measures on food industries. Food processing industry has been assigned as one of the potential sectors to be appropriate for exports. For promoting export in the food industries, G.O.I. has taken different measures to set up free trade zone and export processing zone. India which is an agriculture based country has a capacity to become the manufacturing hub for agro-food processing industry, mainly in view of the ‘Make in India’ program adopted by the G.O.I. For the increase in purchasing power of the people, rise in number of women labourer, urban migration and the change in social dynamics etc., the growth of the agro-food processing industry in India is very much expected (Pingali & Khwaja, 2004).

China being the leader in food production in the world, India has the potential of becoming the largest food producer in future. Currently, India is the 2nd largest producer of food in the world. The Indian food industry is on the 5th position in accordance with production, consumption and export. The Indian food industry is far from developed even though it is large in size. According to RBI Bulletin March 2020, India is a chief producer of different agricultural/food items in the world but only less than 10% of the produced items are processed. This industry is contributing about 7% to GDP of India and providing direct employment to about 13 million people according to Food Processing Sector in India, 2012.

The food processing sector comprises six major segments: Fruits and vegetables, Milk and milk products, Meat and poultry, Marine products, Grain processing, Consumer food including packaged food, aerated soft drinks, packaged drinking water and alcoholic beverages.

Within the food processing industry, contribution of the registered sector is 11.1% (NAS, 2013). In FY11, India had 35838 registered food processing units with total capital investment of approx. US$ 52.1 billion. The overall technology level of the Indian food manufacturing is quite low. Small and micro enterprises pre-dominantly use medium technology. The cause behind the technological backwardness is the lack of finance. Within the formal sector, the large scale enterprises contribute much more to gross value added, which is about 51.21% (ASI 1999-00 and 2009-10). Operating on a large scale would bring in economies of scale. It will thus help to resuce the per unit cost of the entrepreneur. Indian food processing industry is mainly dominated by small and medium sized firms which do little R&D.

The contribution of food processing industry in manufacturing (FY12) is 9%. India's food processing industry registers for 32% share of the total food market. The food processing industry in India is mainly domestic oriented. Its exports accounts for only 12% of its total production. It is a net foreign currency earner having a positive trade balance in recent time. The share of India's food processing sector in exports of processed food in world trade is about 1.5% (Bhuyan, 2010). Food product export is increasing but in 2014-15 the export earning decreases as compared to 2014 due to low production in the primary sector. India mainly exports crustaceans and fish frozen in the world market and its leading trade partners are USA, Japan, Spain, China and UK. In recent year, the export of fish fillets and pieces, fresh, chilled and frozen and fish cured or smoked is having a growth of more than 30% p.a.

(Productivity and Competitiveness of Indian manufacturing: Food Processing Sector, (ESG), NPG). Some sub-sector specific policies are being adopted recently, the exports of fruits and vegetable and marine fish products are freely allowed. The manufacture of dairy products is contributing very small to total exports. Coffee and tea essences and concentrates, mixed sauce and seasonings and ice-creams showed high export growth and wine and beverages exports grew considerably.

1.3.c Leather Industry

Leather industry in India is one of the important sectors for its contribution to generate the employment. It is one of the solitary sectors which is having the benefit of the both value addition and export potential. Leather industry is contributeing a significant amount to total manufacturing output and exports from India. Total output of leather sector increased from Rs. 27233 Crores in 2004-05 to Rs. 47940 Crores in 2009-10 (National Accounts Statistics, 2011). The study by Italian Trade Commission (2010) finds that nearly 60%-65% of the leather production is in the small/micro sector. 21% of world cattle and buffalo and 11% of world goat and sheep population are housed in India. India is the second largest producer of footwear and leather garments and third largest producer of saddler and harness items. Indian leather sector is generating the employment of 2.5 million people, mostly from the weaker sections with 30% women predominance. Indian leather industry is one of the top eight foreign currency earners worth over Rs. 10000 Crores p.a.. It registers for 3% of the global leather-related trade of Rs. 387200 Crores. An approximate 15% of total consumption of influential global brands in footwear, garments, leather goods & accessories in UK & USA and 10% of global supply are outsourced from India. The Indian leather industry consists of both organized and unorganized sectors. The organized manufacturing sector broadly comprises of tanning and dressing of leather manufacture of luggage, handbags saddler, harness and footwear. India’s leather and leather product exports have been flouring at 6.80% p.a. during FY1991-92 to FY 2007-08. Major export target markets are UK, USA, Germany, Italy and Hong Kong. With an annual turnover of over US$ 12 billion, the export of leather and leather products increased manifold over the past decades and touched US$ 6.5 billion during 2014-15, recording CAGR of about 13.10%.

According to Report of Working Group on leather & leather products (12^{th} Five Year Plan Period (2012-17), Department of Industrial Policy & Promotion (G.O.I., Ministry of

Commerce & Industry), the post-liberalisation era has generated significant opportunities for the Indian leather industry. The leather industry has transformed from being a mere exporter of raw materials in the sixties to being a producer of value added finished products in the nineties. India has a 2.6% share in the global leather trade. As per RBI, Development Research Group Study No.37, the growth of total factor productivity in the organized leather sector raised from 0.78% p.a. during 1980-81 to 1990-91 (pre-reform period) to 1.18% p.a. during 1991-92 to 2003-04 (post-reform period). The growth of TFPG in leather sector during 1980-81 to 2003-04 at 1.17% p.a. was significantly higher than TFPG of 0.92% p.a. in the total manufacturing sector.

Indian leather industry has faced many difficulties and bans since 1990s (Gupta, Gupta, Dhamija & Bag, 2018). This is because of its undoubting contribution towards environmental degradation (Sankar, 2006). Roy (2012) has explained three stages for leather processing to produce the final leather product. First, the hides and skins of animals (sheep, goat etc.) are used which are available domestically for production purpose. This stage is called as pre-tanning stage. Second, the collected hides and skins are transformed into leather which discharges immense pollution. This stage generates the maximum pollution in leather industry. In the third stage, all labour intensive and highly value added activitites take place. It is known as post-tanning stage. These three processing stages are connected to key commercial components of the leather value chain such as the marketing of intermediate inputs, components and end products, trade and consumption. The various inputs to the chain without which the chain cannot operate competitively are qualified labour, design and art centers, component production, access to chemicals, technical and administrative support institutions, research and development, training and a set of adequate policies. Different segments of Indian leather sector are following: Tanning sector, Footwear, Leather garments and Leather goods & accessories sector including saddlery & harness. Now, in this twenty-first century, G.O.I. likes to project India as manufacturing hub with ‘Make in India’ as a brand. The focus should be on increase in productivity without comprising the products’ quality while keeping in mind the SWOT analysis of Indian leather industry (Italian Trade Commission, 2010). The strengths of Indian leather industry are: Leather uniqueness, human resource abundance, easy raw material accessibility, fine quality leather skins and international development agencies. The weaknesses of Indian leather industry are: Traditional productivity technology, pollution hurdle, insufficient enterprising development opportunities, inadequate database and widely dispersed set ups. The opportunities of Indian leather industry are: Government incentive schemes, Indian leather demand, advances in modern chemical engineering, affluent synthetic support material and development in technology and electro-polymer science. The threats of Indian leather industry are: Irregular supply of raw materials, pollution and synthesis challenges, high pricing of leather and its products, increasing competition from international markets and reliance on western markets. There is a requirement to develop new ‘Mega Leather Clusters’ in the states where there is a major presence of the leather industry and also in states that offer very good potential for development of the leather industry (Guidelines Leather Scheme 21, March 2012). The concept of Mega Leather Cluster seeks to address the constraints of large infrastructure with integrated production chains in the country. The leather industry must create a scientific infrastructure based on information and technology. This infrastructure must be based on knowledge and make the basis for R&D studies. Leather industry firms are caonstantly affected by the social, cultural, technological, political and legal changes around them. The leather industry must keep up with the changes around it so that it can survive and compete against its competitors (Yamamoto, Sekeroglu and Bayramoglu 2011). Only carrying out product oriented efforts will not be enough for survival of companies. There is a need to improve the marketing activities which must be achieved with minimum cost.

1.3.d Machinery Industry

Indian machinery industry has strategic significance in the nation. It forms the backbone of the manufacturing activity. This industry has a multiplier effect on the overall growth of the economy and assists development of a wide range of user industries by supplying major inputs necessary for manufacturing. Machinery and equipment mainly consists of general machinery such as engines, turbines, pumps, compressors, taps, valves, bearings, gears, ovens, furnaces, lifting and handling equipment and special purpose machinery such as agricultural machinery, machine tools, metalluring machinery, mining/quarrying/ construction machinery, textile/leather machinery and food processing machinery. Classification of Indian Machinery Sector (Source: MOSPI): (1) Non-electrical: (a) General Purpose: Bearings, Valves, Pumps, Compressors, Gears, Boilers and Turbines, Engines etc., (b) Specific Purpose: Machine Tools, Industrial Machinery, Construction and Mining Equipment and (2) Electrical.

India's position in global production of machinery and equipment has fallen from 8^{th} in 2010 to 10^{th} in 2014. In the segment of electrical equipment, India has registered for nearly 2.9% of global production. Both in 2010 and 2014, Brazil and India were the top two producers for machinery and equipment among all the developing industrial economies,. However, India's share in the total for developing industrial countries has reduced from 19.1% in 2010 to 16.1% in 2014. Among developing and emerging industrial economies, India remained the largest producer of electrical equipment in 2014, though its share has fallen from 16.9% in 2010 to 15.8% in 2014 (International Yearbook of Industrial Statistics 2016). India was the 20^{th} largest importer of machinery in 2014, with a share of 1.5% in global imports. The share in global exports was also low at 0.7%. India was not among the top five exporters in any of the categories of machinery. India featured as the fifth largest importer of textile machinery in 2014. India is a net importer of machinery, with exports in 2015-16 amounting to US$ 19.4 billion and imports aggregating US$ 34.0 billion. The CAGR for exports during FY12 –FY16 remained robust at 3.8%. The segments of machine tools, miscellaneous machinery and textile machinery of Indian manufacturing sector have registered a y-o-y growth in exports of 4.1%, 7.6% and 1.5% resp. On The imports of machinery have reduced from US$ 39.3 billion in FY12 to US$ 34 billion in FY16. Process plant machinery imports have registered the highest y-o-y growth during FY16 of 10.2%. This was the largest category of imports by India. During the period FY11-FY16, imports by India in the categories of construction machinery, electrical equipment and parts and process plant machinery recorded negative CAGR of -10.6%, -11.7% & -2.9% resp. Consequently, total imports recorded a CAGR of -3.6% during this period. These intersecting trends have reduced the overall trade deficit in the sector, although it still remains sizeable as US$ 14.6 billion.

Indian machinery industry has many opportunities both in domestic and export markets. While the demand for capital goods in the country is a consistently increasing, the domestic machinery manufacturers have not been able to keep up with the pace of demand. This is manjor challenge. Thus there is an increasing dependence on imports. The availability of low cost equipment from China and other countries has led to the increased imports of process equipment machinery by India.

The USA was the largest market for India's exports of machinery in 2015-16, with a share of 16% in total exports. The other top export destinations for machinery exports of India were UAE, Germany and UK (shares of 5% each) during the year. The USA was the top most export destination in the segments of electrical equipment and parts (13.3%), process plant machinery (16.4%), hand tools (19.8%), machine tools (11.2%) and miscellaneous machinery (28.1%). For construction machinery export, UAE was the largest market for India's export during 2015-16, with a share of 8.9%. Asian countries are feature among India's major export destinations. For instance, under construction machinery, UAE, Singapore and Soudi Arabia were among the top five export destinations for India in 2015-16, with shares of 8.9%, 5.8% & 4.9% resp. Bangladesh, Vietnam and Indonesia were the top export destinations for India in the category of textile machinery, with shares of 12.2%, 8.5% & 7% resp. China was the largest import source for India among all categories of machinery. Germany (12.5%), USA (12%) and Japan (8.4%) are the other major import sources.

The National Capital Goods Policy of 2016 has been predicted to unlock the potential of the machinery sector and establish India as a global manufacturing powerhouse. The policy targets to increase the production of capital goods and to raise the generation of direct and indirect employment and to increase export orientation of capital goods production. It also aims to raise the share of domestic production in India's demand for capital goods. The key issues addressed in this policy are the following: the availability of finance, raw material, innovation and technology, productivity, quality and environment friendly manufacturing practices, promotion of exports and creation domestic demand.

In the manufacturing sector, the most of operational units are Micro, Small and Medium Enterprises (MSMEs). Low scale of operation and low technology orientation of MSMEs is a major limitation for growth in the machinery sector. Though this industry invests in product development, there is no sufficient investment in technology development through R&D due to two reasons: lack of R&D support institutions to perform R&D and the high expenditure of R&D mainly in modern technology machine tools. Textile machinery industry is dependent on borrowed technology. There has been inadequate in-house R&D. There is slow rate of absorption of new technology and significantly small investment in R&D by domestic producers of electrical equipment. The prime purchasers of electrical equipment industry are the utilities in generation, transmission and distribution of power. Recently, most of these utilities are either owned by the central government or different state governments. The buying nature of the government does not motivate R&D. Metallurgical machinery sector is also suffering from lack of R&D.

1.3.e Metal Industry

The progress of human society is the manifestation of invention of metals. Metals are playing a significant function in the growth of country. Since metal products are the crucial inputs to different sectors of any country, the development of metal industry is necessary for the overall development of the world economy. Basic metal can add on the prosperity of all sectors in the county like India. Locating at the beginning line of the most value chains, this sector is a major supplier of essential materials and products and a global generator of trade, employment and economic development (World Economic Forum 2015). Basic metals sector is remaining to be a key sector in India as it meets the needs of all the sectors ranging from agriculture to space technology. The development of sectors like agriculture, transportation, communication and infrastructure are completely dependent on the growth of basic metal industry. The low labour wage rate, the abundance of quality worker and the mature production base are the advantages of India as a producer and further exporter of basic metals and products. The share of basic metal industry in aggregate gross value added (GVA) in India stands first during 2008-12. The basic metal industry had the second largest share (10.19%) in gross value added of Indian industrial sector in 2012-13. The basic metal industry generates employment about 8% of total number of persons engaged in the Indian industrial sector (Annual Survey of Industries, 2008-09 to 2012-13).

The India basic metal industry is categorized into two main segments: (1) the iron-based metal industries and (2) the non-iron-based metal industries. The iron-based segment includes the production of the different kinds of steel such as carbon steel, ferrochrome steel and stainless steel. The non-iron-based category includes the production of copper, tin, brass, lead, zinc, aluminum and manganese. The main functions of the basic metals industry in India are as follows: the mining of ores, refining of the ore, casting, alloying, sheet and rolling into foils.

India basic metals industry witnessed big changes in the nineties during post-liberalisation era. With the new sources of investments, the infrastructure relating to the industries was changed. More efficient and technologically advanced methods were applied which led to the improvement in the production processes that in turn raised the production of the industry along with the improvement in the quality of the products. Some of the popular methods used for the production of basic metals are open hearth, oxygen furnaces, blast furnaces etc.

The steel industry in India has experienced a rapid increase in production over the past few years. This has resulted in India to become the fourth largest producer of crude steel after China, Japan and USA and the largest producer of sponge iron in the world. The steel sector in India registers for about 2% of GDP of India. It holds 6% share in the India's industrial production. The Indian steel sector was the first core sector to be completely freed from licensing regime. Since 1991, the sector has witnessed consistent reforms including elimination of pricing and distribution controls. Crude steel production in India amounted to 81.54 million tonnes in 2013-14, registering a growth of 4% as compared to the previous year. The production for sale of total finished steel (alloy and non-alloy) in the country stood at 85.05 million tonnes in 2013-14 as compared to 14.23 million tonnes in 1991-92. In the case of direct reduced iron, India is one of the largest producers in the world. From a mere 1.31 million tones of production in 1991-92, India's Direct Reduced Iron (DRI) production reached 14.97 million tonnes in 2013-14 after touching a high of 25.08 million tonnes in 2010-11.

In terms of value, the export of iron and steel was US$ 13.3 billion in the year 2008-09 in India. India's export of iron & steel during 2003-04 was hugely concentrated in China. India's export of articles of iron & steel remained concentrated within USA and UAE, both during 2003-04 and 2014-15, with their cumulative shares being 34.7% in 2003-04 and 31.7% in 2014-15. India is very dependent on imported coking coal. Nearly 60%-65% of the domestic coking coal needs are satisfied through imports due to the unavailability of appropriate qualities within the country. Post-liberalisation export of iron & steel recorded a quantum jump in India. During 2013-14, India's iron & steel exports were around 7 million tones. In India, imports of carbon steel touched 5.4 million tonnes in 2013-14. In 2007-08, India became a net importer of iron & steel for the first time in the post-liberalisation era.

The investment on R&D by the large steel companies in India varies from one company to another in the range of 0.07% - 0.58% of their sales turnover. Secondary steel sector is having inadequate capacity for performing R&D. Thus, Ministry of steel is pursuing different R&D projects for the benefit of the secondary units.

1.3.f Non-metallic mineral products industry

Non-metallic minerals are either organic in origin such as fossil fuels, derived from the buried animal and plant life such as coal and petroleum or inorganic in origin such as mica, limestone and graphite, etc. Mica is the important one among the non-metallic minerals produced in India. The other minerals extracted for local consumption are limestone, dolomite and phosphate.

India is presently producing a total of 47 non-metallic minerals. These are buy-and-large characterized as low value and high volume minerals and are basic inputs for a number of industries like fertilizers, glass & ceramics, refractory, asbestos-cement and chemical products. In India, this sector is mainly consisting of small mines owned by private firms.

The resource base of non-metallic minerals in India is adequate except for Rock Phosphate, Magnesite and Ball Clay, for which the estimates are showing decreasing stocks. The non-metallic mineral products category comprises of cement, glass, gems and jewelry, refractories, ceramic tiles, abrasive, granite and other non-metallic products industries. The industries falling in this sector are mainly export-based and are contributing about 3-4% of total GDP of India. All these above industries have seen manifold growth during the post liberalization phase. The exports of the industries experienced nearly 200% growth after 2002. One of the important industries of the group is the cement industry. Cement industry of India is the second largest producer of cement in the world. It is contributing about 1.3% of total GDP. The industry has been experiencing prosperity for the last few years due to the growth in real estate business, increasing investment in the infrastructure and overall development of the Indian economy.

1.3.g Paper Industry

Paper products are used in education, health care, food, trade, communication and packaging. The population of India has been growing at a significant speed which has resulted in the increase in the paper consumption as each individual utilizes paper and other related products. Paper industry in India is growing in a rapid rate with the rise in demand increment and opportunity creation and attraction to the international players. The paper industry in India can be categorized into three groups according to the raw material consumed by it: wood based paper industry, waste paper based paper industry and agro based paper industry.

In India, the soft wood is the main raw material employed for producing paper mainly newsprint and high quality printing papers. With increase in population size and improvement in educational sector, the demand for paper has been continuously increased.

As soft woods grow in temperate climate, India is in shortage of supply of soft woods. Under this situation, the bamboo has become the main raw materials for the manufacture of paper in India as it grows at a very rapid speed after cutting.

The Indian paper industry produces 10.11 million tonnes paper p.a., just 1.6% of total world production of paper and paperboard. The mills employ a variety of raw materials like wood, bamboo, recycled fibre, bagasse, wheat straw, rice husk etc. Nearly 35% are dependent on chemical pulp, 44% on recycled fibre and 21% on agro-residues. The estimated turnover of the industry is US$ 5.95 billion. Acoording to the industry estimates, the production of paper has increased at a CAGR of 8.4% while the consumption of paper has raised at a CAGR of 9% in 2012-13. India is the fastest growing market for paper globally. The industry employs 0.37 million people directly and 1.37 million indirectly. This industry is a diversified and specialized industry that produces various types of papers which are having different usages like watermark, filter paper, drawing sheet etc. Other products including paper bags, paper diaries, paper photo frames, greeting cards, handmade paper boxes, paper albums etc. are produced and exported worldwide. Today India exports nearly Rs. 400 Crores worth products p.a. to the developed nations. It has created sustainable livelihood in rural areas and has helped generating especially for women to earn their livelihood. The capacity of Indian paper industry has been raised to 75000 tonnes a year. The total newsprint production has now reached over 400000 tonnes. Indian paper industry is an industry consisting of more than 157 paper producing units all over India. These 157 operational units produce handmade paper worth Rs. 21 Crores.

The strengths of Indian paper industry are the following: it has large and growing domestic paper market and updated research institute. It has well developed printing industry and local market knowledge. The weaknesses of Indian paper industry are the following: thereis shortage of fibre mainly virgin wood fibre. The industry structure is small and fragmented. Ther is unavailability of skilled workers. There are environmental problems created by most of the small pulp mills and also some big mills. There is lack of infrastructure and transportation. The cost of raw material including wood, non-wood and waste paper is very high. The energy costs are also high. The cost of financing is significantly higher. This industry emphasizes less on R&D. The opportunities of Indian paper industry are the following: there are domestic market potential, forest plantation potential and export potential. There are integration of combined wood and agro-based paper-making. Govt. is undertaking different literacy programs. The demand for printing / writing papers is constantly increasing and the labour costs are sufficiently low. The threats of Indian paper industry are the following: The mills are unprepared for world competition both on price and quality. There is reduction in capacity due to environmental pressures. There is decline in capacity as some of the segments of mills are not able to compete at national and international levels with respect to quality and cost of products. There is delay in forest plantations and deficit of wood fibres which are weakening the competitiveness of domestic industry due to shortage of basic inputs.

1.3.h Textile Industry

The textile industry is one of the leading industries of the Indian economy. This is the largest in the world for its huge raw materials and textiles producing base. It is one of the major sectors of India for its contribution to production, generation of job and foreign currency earnings. After agricultural sector, the textile industry is the second largest employment giver in India. Presently, it is contributing around 14% to total India's industrial production, 4% to the GDP, and 17% to the country's export earnings. It generates direct employment for over 35 million people (Ministry of Textiles Annual Report 2012-13). The basic strength of Indian textile industry is its strong production base with wide range of fibers. These are natural fibers such as cotton, jute, silk and wool and synthetic/man-made fibers like polyester, viscose, nylon and acrylic. There is close inter-connection between the textile industry and agricultural sector as its main raw materials such as cotton come from primary sector. India has low share in the global textiles trade (3%). But, it is having huge contribution towards India's export basket. The exports of textiles from India register for about one third of India's total exports. The Indian textile industry maintains its prominent presence in the world textile economy for its significant contribution to world textile capacity and production of textile fibres/yarns. This industry contributes about 20 percent to the world spindle age of 166.36 mn. spindles and 3 percent to the world rotor age of 7.81 mn.. this industry has the second highest spindle age in the world after China. With almost 5.7 mn. looms (including handlooms), this industry is also having the highest loomage (including handlooms) in the world. If we exclude handlooms, this industry has the contribution of 42 percent to the world loomage. In the world textile economy, Indian textile industry is the largest producer of jute, second largest producer of silk, third largest producer of cotton and cellulosic fibre/yarn and fifth largest producer of synthetic fibre/yarn. It is also the third largest producer of cotton yarn. India's textile industries' share in world trade is 3.11 percent. Textile products comprising of handicrafts, jute and coir account for about 20% of total exports from India. Indian textile industry is the largest net foreign currency earner. India exports varieties of textile products like cotton yarn and fabrics, man-made fibre yarn and fabrics, wool and silk fabrics, made-ups and apparel. The readymade garments account for about 42% of total exports of textile items. The major export destinations are the EU, US, Canada, Japan, the UAE and Switzerland. Cotton textiles are occupying more than two-thirds of exports of all fibres, yarns and fabrics.

For textile industry, India's investment in R&D is much lower. Spending on R&D in India is 0.9% of its GDP. In these circumstances, the further improvement in textile industry will be possible only if more funds will be invested on R&D. The Indian textile industry is also having lesses access to the modern and advanced technology.

1.3.i Transport Industry

The transport industry of India is very large fulfilling to the requirements of 1.1 billion people. In 2007, this industry has contributed about 5.5 percent to GDP of India. The road transportation is having its largest contribution towards the total production of India's transport industry. For economic growth, the connectivity between the urban and rural areas is very much necessary. In this regard, India's transport industry is playing a vital role. Since 1990s, Indian economy has has been facing an increase in the demand for transport infrastructure. However, the sector has not been able to keep pace with rising demand. Thus major improvements in the sector are needed to support the economic growth of the country.

The roads are the central means of transportation in India. They carry near about 85 percent of passenger traffic of the nation. The density of India's highway network stands at 0.66 km of roads per square kilometer of land. However, most of the roads in India are narrow and congested with very bad surface quality. The roads in rural regions are the backbone of villages in India. But, 33 percent of villages in India do not have access to all-weather roads.

Indian Railways is one of the largest railways under the single management. The railways play a leading role in carrying passengers and cargo across India's vast territory. In 2009, it carried some 19.8 million passengers and 2.4 million tonnes of freight a day. It is one of the world's largest employers.

India is having 13 major and 199 minor and intermediate ports along with its more than 7500 km long coastline. India's seaborne foreign trade being 95% by volume and 67% by value, the ports are playing significant role in improving foreign trade in a growing country. These ports serve the country's growing foreign trade in petroleum products, iron ore, and coal, as well as the increasing movement of containers.

India has 128 airports, including 15 international airports. Indian airports handled 142 million passengers in 2010-11 and 1.6 million tonnes of cargo in year 2009-10. The CAGR for the domestic passenger and freight growth over the last decade has been 14.2% and 7.8% respectively.

India is experiencing rapid urbanization. Thee population of nearly 340 million are living in urban areas. The number of million plus cities is presently at 42. The urban economy is estimated for roughly 60% of the GDP. The share of public transport in cities with population sizes over 4 million has decreased from 69% in 1994 to 38% in 2007.

1.4 The Structure of the Present Study

The Structure of the present study is as follows:

- Chapter 1: Introduction and Relevance of the Present Study
- Chapter 2: An Overview of the Existing Literature and Linkage with the Present Study
- Chapter 3: Data Structure and Methodology
- Chapter 4: Growth Performance of Indian Manufacturing Firms
- Chapter 5: Analysis of Efficiency
- Chapter 6: Analysis of Productivity
- Chapter 7: Comparative Analysis between Growth, Efficiency and Productivity of Indian Manufacturing Firms in the Post-Reform Era
- Chapter 8: Summary & Conclusion
- References

Chapter 2

An Overview of the Existing Literature and Linkage with the Present Study

2.1 Survey of Literature

Over the years there are plenty of studies that examine performances of manufacturing industries in India. Some of the important studies are done by Banerjee (1974), Bagchi (1975), Desai (1981), Patnaik (1981), Rangarajan (1982), Ahluwalia (1985), Goldar and Seth (1989), Nagaraj (1989), Albin (1990), Sen Gupta (1993), Upendranath et al. (1994), Burange (1999), Unni et al. (2001), Das (2004). Quite a long ego, the study by Banerjee (1974) tries to identify the main sources of growth of five selected Indian industries such as, Cotton Textiles, Jute Textiles, Sugar, Paper and Bicycle. Using time series and cross-section data for each of the industry, the Cobb-Douglas production function is estimated to measure elasticities of output with respect to various inputs, returns to scale and technical progress, which provide the basis for drawing inferences regarding the nature of the growth of industries. An elderly study by Bagchi (1975), examining some characteristics of industrial growth in India, reports the lack of industrialization in the modern periods of nineteenth and middle of the twentieth century, despite the growth of large-scale industries in India since 1850. The study suggests a dynamic process of industrialization by increasing the ratio of industrial output to total national output and the ratio of the workers employed in secondary sector to the total workforce searching for proper employment. Desai (1981) views that petty-bourgeois haute-proletarian, with little education and less property, inherit the power from the British in India. The members of this class assemble the employment markets and require proliferations of the public enterprises and the small enterprises. With high capital-output ratios, there is a situation, which is incapable of expansion, as the petty-proletarians have a minimum work ethic and absorb the entire meagre surplus through wanting and extracting jobs. When the system grinds to a halt, where government investment can just maintain the industrial base but cannot expand industrial employment, the petty-proletarians rise in revolt against a system that employs them but fails to exploit them. Desai (1981) argues against the fashionable themes about the political-economic crisis in the system with reference to facts and figures commonly quoted. Patnaik (1981) tries to provide an explanatory hypothesis together with some empirical support for the phenomenon of industrial stagnation in particular and economic stagnation in general, which has bothered the Indian economy since the mid-sixties. He argues that the cause of stagnation does not lie in shortage of savings. The real problem lies in inadequate control over the process of use of savings. Domestic savings, as a per cent of Net National Product (NNP) at current prices increase and in 1976–77, it exceeds the level of aggregate net investment (that included accretions to inventories also). The argument of constraint productive investment, due to domestic savings, becomes difficult to sustain. Although the savings performance is not much satisfactory, but the constraints on investment expansion, even at low level, lie elsewhere. Under the fact that since independence, India's performance in industrial sector is certainly impressive, Rangarajan (1982) examines the striking fact of deceleration of industrial growth rate and sizeable underutilization of capacities. He points out that in the early years of plan formulation; the biggest constraint in growth process was the low savings ratio. But over the years, the country has been able to raise the savings-investment ratios. The rise in incremental capital-output ratio has nullified the output increase that would have come from the rise in the share of investment to income. Ahluwalia (1985) carries out a detailed empirical analysis of industrial deceleration since mid-sixties. The results reveal that the deceleration is confined largely to basic and capital goods industries and that significant deceleration in growth occurs only among industries (two-digit level), which has grown at an annual rate of 5% or more during 1959–65. Some factors are indicated as responsible for this deceleration such as, slow down in public investment and resulting inadequate infrastructure investment, poor management of the infrastructure sector, slow growth in agricultural incomes and the resulting slow growth in demand for industrial product etc. The study does not find any empirical support for the hypothesis that deceleration is due to deterioration in income distribution and for the hypothesis of wage goods constraint shifting industrial growth. Goldar and Seth (1989) tested the trends in industrial output in 12 major states during the period 1960–61 to 1985–86 with the objective for finding out the reasons of industrial deceleration faced after the mid-sixties at all-India level. Kinked exponential model is used to estimate growth rates for the sub-periods. The results report that the deceleration in industrial growth after the mid-sixties and the recovery after the mid-seventies, observed for the aggregate industrial sector (at economy level), can be traced mainly to inter-temporal variations in the rate of industrial growth experienced by Bihar, West Bengal, Orissa, Rajasthan and Uttar Pradesh. An attempt is made to explain the observed inter-state variations in the extent of deceleration. A positive rank-correlation (across states) between agricultural growth rate and the extent of industrial deceleration is found. A positive rank correlation between the extent of deceleration and the index of regional intensity of public sector investment is also found, which implies in general, the states, which gain relatively more from public sector investment during the 1950s and 1960s, experience greater deceleration in industrial growth after the mid-sixties. This may be resulted to slow down in public investment in that period. Nagaraj (1989), using National Accounts Statistics, describes trends in growth of gross value added in the manufacturing sector of India. The results come out to be noteworthy in the context of the doubts expressed on the validity of the revised index of industrial production (1980–81 as base year) and the continuing debate on the persistence of a 'relative stagnation' or 'deceleration' since the mid-sixties. Albin (1990) inspects the role of structural and regional factors in determining the observed trend and pattern of the industrial growth experience of Kerala. His contention is that regional factors (such as, public investment, land prices, availability of entrepreneurs, wage rates, labor dispute etc.) had not been so adverse, the structural factors should have increased the rate of industrial growth in Kerala above all-India rate. Sen Gupta (1993) reviews the growth process in Indian manufacturing in the 1980s with an attempt to explore the broad inter-linkages between growth and the various elements, such as, demand, productivity, employment, structural change and the balance of commodity trade. Upendranath et al. (1994), considering the state of Karnataka, analyze the growth and structure of the disaggregated manufacturing sector at district and industry levels. The empirical results point out to a growing capitalization of the industrial sector as a whole and stagnant employment growth in the employment-augmenting industries. Burange (1999) examines growth and structural changes in manufacturing industries of Maharashtra (occupied very significant position in the manufacturing sector in India) and reports significant changes in the industrial composition, wherein capital and intermediate goods industries are becoming leading. During 1979–80 to 1994–95, Maharashtra realizes a high growth rate in fixed capital which results in reduction in the employment. The increasing capital intensity, low growth rates of output and value added, lead to unsatisfactory performance on the industrial front. In post–reform period, there is a sigh of revival in the manufacturing sector. Unni et al. (2001), considering pre– and post–reform periods, analyze the trends in growth and efficiency in the utilization of resources in Indian manufacturing industries. The study shows that both the organized and unorganized sectors in Gujarat (one of the most industrially developed states) are doing better in terms of growth of value added than all India average. Its efficiency is also higher than all-India average after the reforms were introduced. Nagaraj (2003) studies that since 1980–81 Indian manufacturing sectors' output grows at 7% per year and continues as a trend up to 1990.

After peaking in 1995–96, growth decelerates in all over India. Although the second oil-price shock is successfully handled by increasing state-wise domestic oil production and import substitution in fertilizers in a short time, the agricultural supply shock perhaps affects the manufacturing sectors. Das (2004), focusing on the period of 1980–2000 and four sub-periods to reflect the shifts in trade-policy regimes, examines the productivity performance of Indian manufacturing. The empirical results support the fact of not much change in total factor productivity growth, following liberalization of the regime which was initiated in the early 1990s.

Some studies are available regarding the efficiency analysis for different industries. Driffield and Kambhampati (2003) showed that the overall efficiency in the post-reform period increased in five out of their considered six manufacturing sectors. The analysis of Mazumdar and Rajeev (2009) indicated that increased export earnings did not necessarily lead to higher efficiency of Indian Pharmaceutical firms. Bhandari and Maiti (2012) presented a direct association between the size of the firm and technical efficiency of Indian leather firms. Kumar and Arora (2012) showed a steep fall in the level of technical efficiency in post-reform period as compared to the post reform period. They have also shown that the availability of skilled labour and profitability are the significant determinants of technical efficiency of Indian sugar industry. Saravanakumar and Kim (2012) revealed that the reform improved the efficiency and technological progress of heavy industries but failed to improve efficiency in light industries. Sinha (1993) showed that there was positive and significant impact of foreign equity participation on technical efficiency. Pattnayak and Thangavelu (2004) observed total factor productivity improvements in Indian manufacturing industries which in-a-way improved their economic efficiency. Bhaumik and Kumbhakar (2010) presented that there was a rise in productivity of factor inputs during 1990s but the growth in value-added was majorly determined by the growth in the use of factor inputs. The change in technical efficiency explained a very small percentage of the change in gross value added. Parameswaran (2004) estimated technical change and technical efficiency change using a stochastic frontier production function for Indian capital goods industries during 1990s. This study showed that these industries experienced a significant improvement in the rate of technological progress but decline in level of technical efficiency during the post reform period. Mazumdar, Rajeev and Ray (2012) used non- parametric approach of DEA to examine the sources of heterogeneity in the efficiency of Indian pharmaceutical firms for the period 1991-2005. They found that these firms could make efficient use of their inputs but output efficiency was declining during this period. Their analysis showed that difference in firm size and presence of economies of scale in production are the sources of firms' heterogeneity. Bhandari and Ray (2011) used data from Annual Survey of Industries (ASI) for a number of years 1985–86, 1990–91, 1996–97, 1998–99, 1999–00, 2001–02 to measure the technical efficiency in the Indian textile industry at firm level. Their analysis suggested that the size of the firm would have a direct effect on technical efficiency, implying the small firms must get consolidated to build large entities which might enhance efficiency. The limitation of Bhandari and Ray is that they did not consider the role of Advertising, marketing, R&D, import, export on the level of technical efficiency. However, these variables affect the technical efficiency of the firm as suggested by the literature around the globe.

Some studies are available regarding the productivity analysis for different industries. The study of Sidu (2007) has showed that the Indian industry recorded a high growth in total factor productivity (TFP) during 1973-2003 and also during the post liberalization period. The analysis of Sarnia & Reddy (2006) revealed that the TFP growth rate of all India textile industry is relatively lower in post- liberalization period than in pre- liberalization period through divisia total factor productivity index methodology. They showed that the relative degree concentration (output/number of factories) is positive and a significant contributor of productivity in 14 major states of India. Golder and Veeramani (2004) found that a market friendly investment climate is an essential determinant of high level of TFPG in the registered manufacturing sector across the major states of India. Das (2004) examined the productivity performance of Indian manufacturing for the period 1980-2000 using ASI data. The selected methodology was growth accounting and the econometric estimation of production functions. His result indicated that TFP growth was 0.08 percent per annum for 75 three digit industries. Golder (2004) made a comparative study on Indian manufacturing industries in the pre and post reform period. Using ASI data, he concluded that the growth rate of TFP of Indian manufacturing declined after 1991 reforms. Bheda, Narag and Singla (2003) evaluated the productivity level achieved by Indian apparel industry. They recommended that India would need to have efficient manufacturing operations to retain its competitiveness in the apparel industry at global level. Sharma and Upadhyay (2003) attempted to estimate the different components of the total factor productivity in Indian fertilizer industry by fitting Translog cost function over a period from 1973-74 to 1997-98. The analysis reveals that the industry has exhibited decreasing returns to scale over the study period but technical progress has occured at a rising rate. The result also showed that energy and material are the substitutes of capital while these inputs are complements to each other. Singh and Agarwal (2006) examined the TFPG and its components (technical efficiency change and technological change) in the sugar industry of UP. The TFPG is estimated using SBM-DEA based Malmquist productivity index (MPI) on the panel data of 36 sugar mills for the period 1996-97 to 2002-03. The study showed that the average TFPG increased at a medium rate of 1/6 percent per annum during the period. The decomposition of TFPG disclosed that the TFPG was mainly contributed by technical change. The study observed that the mills with larger plant size had higher TFPG than the smaller sized plants. Further relatively higher TFPG obtained during the later part of the study period implying that the policy induced factors like de-licensing and partial decontrol of sugar sector had some direct effect on the TFPG. Goel (2003) focused on the productivity impact of the provision of infrastructure on the registered manufacturing sector with cost as the function of the prices of the variable inputs including capital, labour and intermediate input, level of outputs and infrastructure stocks in India. The time series data were used for the period of 1965 – 1999 and a variable cost function model was used for this purpose. Datta (2002) analyzed the productivity trend in the Indian cotton mill during 1966-67 to 1990-91. He found that TFPG exhibited an annual trend rate of growth at about 3.00 percent during 1966-67 to 1990-91. Goldar and Kumari (2002) stated that in the post reform period, there had been a notable decrease in the growth of TFP in Indian manufacturing industries. The explanation for the fall in the growth rate of productivity might lie partially in gestation lags in investment projects and in a slowdown in agricultural growth in the 1990's. Singh (2000) computed the TFPG for 10 industries in the manufacturing sector of India for the period 1973-74 to 1993-94. This study used Solow's unexplained residual as the measure of TFPG. The result suggested that the TFPG improved in all the sample industries except the basic metal industries which wtinessed a declining trend in TFPG over the study period. The food industry observed the highest TFPG, chased by the transport equipment, non-metallic products, electrical machinery, non-electrical machinery, the wool and silk textiles and chemical and jute textiles. Kumar (1999) tried to estimate the growth of productivity in Indian leather industry for the period of 1974-75 to 1992-93 using the Kendrick, Solow and Divisia indices for estimating the total factor productivity growth. The main findings of the study implied the TFPG in tanning sector was rising insignificantly (except the Solow index) and the TFPG in footwear sector was found to decline significantly in all the three indices. Rao (1996) estimated TFPG in the Indian manufacturing industries for the period of 1973-74 to 1992-93. The study stated that the trend rate of growth of TFPG was around 2.00 percent for the entire period. Chandrasekar and Sridharan (1993) estimated productivity trends for the Indian cotton textile industry for the period 1973- 1986. Total and partial factor productivity indices were used to analyse the operational efficiency. For estimating TFPG, Kendrick index was employed. The estimates of TFPG accounted for 2.1 percent growth in output per annum during the study period. The study concluded that TFPG index was influenced by efficient utilisation of capital. Subramanian (1992) analyzed the partial and total productivity growth of capital and labour in cotton textile industry in Tamilnadu for the period 1975- 76 to 1985-86. He used the Kendrick and Solow indices of TFPG. This paper revealed a significant decline in the total factor productivity. The Kendrick's TFPG declined at an average rate of 10.25 percent while Solow indices indicated a constant annual average decline of 14.89 percent. Ahluwalia (1990) stated that productivity was the crucial source of growth in an economy characterized by severe resources constraints. The performance of Indian industry over the first three decades of planning was very poor with respect to productivity that was why the sixth five year plan which was launched in 1980-81 placing major importance on improving the productivity of the Indian industry. A survey conducted by Central Statistical organization (CSO) (1981) estimated Kendrick index of TFPG for the Indian manufacturing industry for the period 1970-77. The results pointed out the annual rate of TFPG for the basic industries, the capital goods industries, the intermediate goods industries and the consumer good industries were 1.28 percent, 4.49 percent, 1.72 percent and -2.28 percent respectively. The TFPG of the Indian manufacturing taken together showed a low growth rate at around 1.21 percent per annum on an average. Kaur and Kiran (2008) analysed the trends in output and inputs as well as partial productivity and total factor productivity of Indian manufacturing for the period 1980-2003. The comparative analysis of pre-liberalisation period and post-liberalisation period depicted a slower growth of the Indian manufacturing sector in the post-reform era for aggregative as well as sectoral level. Sharma (2012) suggested that RD Intensity had a positive significant impact on total factor productivity in Indian pharmaceutical industry in the post reform period using growth accounting and production function.

Regarding the role of exports an enormous amount of literature is available. There is a common opinion that world trade in general and export in particular enhances economic growth. It also improves the efficiency and / or productivity of the involved firms (Balassa, 1988). The economic policies under export-led growth strategy have been widely supported on the argument that the exposure to world market through export helps in raising the efficiency of exporters. Similarly, advocates of endogenous growth theory consider that the export plays an important role by improving efficiency through innovation (Grossman and Helpman, 1991) and transfer of technology (Barro and Sala-i-Martin, 1995). One key factor in favor of the export-led hypothesis is the impact of economic openness on the efficiency with which resources are employed in the country. In theories, there are four explanations of how export expansion improves the efficiency and/or productivity of industry; as a result, it tends to promote economic growth. (i) The expansion of export leads to economies of scale. An increase in exports will represent an expansion of markets. The world demand determines higher capacity utilization. It allows the utilization of economies of scale which facilitates the expanding of the scale of production and the achievement of economies of scale. Outward orientation may result in efficiency gains for firms, due to the exploitation of economies of scale (Clerides et al, 1998; World Bank, 1993).(ii) The *exporters may learn from their presence in the world markets associated with knowledge spillovers from international connections* (Clerides et al, 1998; World Bank, 1993). International connection with buyers is likely to improve knowledge and technology spillovers, like access to technical expertise which include new designs of product and new methods of production. (iii) *Exports intensify market competition in both overseas and domestic markets, and tend to force enterprises to be more efficient through the rationalization of management and the adoption of new technologies* (Balassa, 1988; Kwon, 1986; Greenaway, 1986; Chen and Tang, 1990; Greenaway and Sapsford, 1994). (iv)*There are spill-over effects, for instance, the technology diffusion, from foreign-invested enterprises to domestic firms, and from export-oriented industries to non-export-oriented industries* (Feder, 1982; Huallachain**,** 1984). The empirical evidence representing that the firms which will become exporters will enjoy some prior advantage is very rich and unambiguous. Some of this kind of studies are the studies by Chen and Tang (1987), Sun et al. (1999), Walujadi (2004), Mok et al. (2010). However, the studies vary with respect to the impact of export on productivity of the firms.

At the same time the researchers also justified the role of imports in explaining productivity. Import is essential to carry out R&D activity and for inputs to be used in the production process. World Bank Report (1993, 1997) mentioned about the firm's import for foreign technology which is having positive effect on its efficiency and/or productivity. Such activities enable firms to increase their internal production capabilities. The abolition of quantitative restrictions on imported goods and reducing of customs duties in the post liberalization era in India have improved the access to the imported capital goods and raw materials to enter into the domestic economy. Imports of materials embodying latest technologies should foster the productivity and or efficiency of the firms. A direct relationship between technical efficiency and imports is reported by Goldar et al. (2004) and Mazumder et al. (2012) in the context of India.

Advertising is used as the mean to reduce effectiveness of price competition by creating product differentiation among firms in the consumer goods industry. Syverson (2004) points out the effect of product substitutability in an industry on the disparity of productivity level. When the consumers can easily switch between the producers, relatively more inefficient (high-cost) producers cannot be able to operate profitably. Thus high-substitutability industries would exhibit less productivity dispersion; as a result they would have higher average efficiency and/or productivity levels. Syverson (2003) represented this mechanism in a simple industry equilibrium model and tested it empirically employing producer-level data from 443 U.S. manufacturing industries. He also tested for the impact of higher advertising intensity on substitutability. Advertising expenditure can also influence output oriented efficiency of the industry. Goldar et al. (2004) and Carod and Blasco (2004) showed the connection between advertising intensity and technical efficiency for the Indian Engineering goods industries and Spanish manufacturing industries respectively. Ray (2006) did not find any effect of product differentiation on technical efficiency in the Indian manufacturing sector.

Marketing Expenditure as a ratio to total sales will also serve as a proxy for product differentiation. Sheth and Sisodia (1998) proved that low productivity or efficiency ocuurs for the fall in marketing effectiveness. Their study suggests some changes which are needed at the corporate level. The most elementary point is that the corporations should treat marketing as an investment rather than an expense. Kao et al. (2006) evaluates technical efficiency and allocative efficiency in marketing and obtains the positive relation between return and marketing expenditure, which can be defined as a kind of investment. The return can take the form of increased sales or customers or some forms of infrastructure which makes acquiring these items easier.

The Herfindahl Index is known as the Herfindahl-Hirschman Index (HHI) which measures the market concentration of an industry's firms in order to determine whether the industry is competitive or nearing monopoly. The Herfindal Index or Concentration Index is calculated as follows:$H = \Sigma s_i^2$, where s_i is the market share of the i^{th} firm in the market and N is the number of firms.

The Herfindahl index ranges from a low of 0, indicating perfect competition, to a higher of 10,000, indicating perfect monopoly. Greater values mean higher level of concentration, less competition and majority of market control held by individual firms. At the low end, a 0 Herfindahl index means perfect competition or at the very least monopolistic competition i.e. extremely competitive. The number of firms is so large that sum of the square of the market shares is 0. At the high end, a 1 Herfindahl index means monopoly. This value is only achieved if one firm has a market share of 100%. The diversification index is reciprocal of HHI. The impact of diversification on productivity, which in turn impacts performance of a firm, was pioneered by Lichtenburg (1992) who pointed out that if diversification is beneficial (detrimental) to the firm, it should result in higher (lower) productivity for diversified firms. By using the US Census Bureau's data on manufacturing plant-wise data, Lichtenburg observed that diversification affects the productivity of the firms negatively. Schoar (2002) used a similar but larger data set from the US Census Bureau's Longitudinal Research Database and got a positive correlation between diversification and performance of the firm.

The age of the company can also act as an important determinant explaining the output oriented efficiency of the firm. The relationship is not clear in the literature. There is counter arguments regarding relation between age and efficiency. On argument is that older firms have superior performance since they are more experienced. Thus, they will have the advantages of learning earlier and will not face the difficulties which the newcomers usually face (Stinchcombe, 1965). On the other hand the counter argument is that older firms are prone to inertia and they lack the enough flexibility to adapt quickly to the changing economic circumstances which the younger firms can do more efficiently and rapidly (Marshall 1920). The relationship between technical efficiency and the age of the firm can be seen in Mengistae (1995), Lundvall and Battese (2000), Walujadi (2004), Berghäll (2006), Bhandari and Maiti (2007, 2012). But the relationships are not uniform across these studies. Studying the effect of age on technical efficiency of Kenyan manufacturing firms in the food, wood, textile and metal sectors, Lundvall and Battese (2000) found the effect of age is less systematic, but is insignificant in all sectors, except textiles. Walujadi (2004) found the inverse but insignificant relationship between age and technical efficiency of the firms. Bhandari and Maity (2007) got a significant inverse relationship between the age of the firms and technical efficiency, whereas in Bhandari and Maity (2012) no such clear relationship can be found. The role of firm's age comes out to be insignificant for explaining technical change and efficiency in Berghall (2006). Mengistae (1995) postulated that there are age-size effects in the firm level efficiency whereby older firm are efficient given size and bigger firms are efficient given age. Further, direction of causation is not from firm age or size to efficiency but the other way round. It is not the case that some firms are more efficient than other because they are bigger or older but the firms are bigger or longer lived than others because they are efficient.

The growth, productivity and efficiency differ due to the difference in relative size. A larger sized firm may have an easier access to cheaper and superior quality inputs which helps to enhance its productivity. It is easier for such firms to get the advantages of large scale production i.e. the economies of scale that widen scope of production by making its operation more effective, allowing it to perform better compared to the smaller firms (Penrose, 1959).

2.2 Gap in the existing literature and contribution of the present study

While considering the effects of different explanatory variables, the authors considered those variables as exogenous. However, it may be possible that there may exist the problem of endogeneity among the relationship. For example, RD (R&D Intensity), ADV (Advertersing Intensity), MKT (Marketing Intensity), NX (Net Export Intensity) may not only affect the performance indicators like growth, productivity and efficiency, but in turn they can get affected by those performance indicators. Thus, there may be two way relationships between these variables. There may be 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, productivity and efficiency in a simultaneous panel set up.

The studies on Indian manufacturing industries (Bhandari and Maiti, 2012; Mazumdar and Rajeev, 2009; Parameswaran, 2004) suggest that the manufacturing industries are not homogeneous in nature. There are lots of heterogeneity among industries and or firm level both with respect to performances as well as characteristics. Since the characteristics are different among industries and or firms while studying the performance of growth, efficiency and productivity, we shall not carry out the aggregate analysis rather we shall consider the following nine industry groups based on (Centre For Monitoring Indian Economy) CMIE

Prowess Database: Chemical & chemical products industry, Food Products, beverages & tobacco industry, Leather & related products industry, Machinery industry, Metal & metal products industry, Non-metallic mineral products industry, Paper & paper products industry, Textile industry and Transport & transport equipment industry, subject to availability of data.

Next coming to the concept of efficiency, there are two alternative concepts. One is allocative efficiency which is a property of an efficient market where all goods and services are optimally distributed among buyers in an economy and other one is technical efficiency which is the effectiveness with which a given set of inputs is used to produce an output. The present study measures technical efficiency. Technical efficiency can be measured either input-oriented (the optimal combination of inputs to achieve a given level of output) or output-oriented approach (the optimal output that can be produced by a given set of inputs).

Coming to the productivity aspect, it is found that there are two concepts of productivity. One is the concept of Partial Productivity of any input which can be defined as the relationship between the output and single input which is used in the production and another one is total factor productivity growth (TFPG) which basically denotes the changes in output which is not accounted by the growth of inputs used in the production process. This present study uses the concept of total factor productivity growth (TFPG).

The literature on the measurement of efficiency and productivity suggests that they can be measured either by Parametric Stochastic Frontier Production Function approach or Non-parametric approach (DEA). This study uses DEA. The advantage of DEA is that it does not require the assumption of specific criteria and or production function. Since we assume the existence of heterogeneity among Indian manufacturing industries, while constructing the frontier as required by DEA analysis, we shall construct the frontiers separately for each of the assumed group 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 TFPG is mainly being contributed by SEC that never imply sustainable growth because it is quite natural that higher level of input employment will produce higher volume of output. But, 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. The TC & TEC take place due to the changes in different strategic variables like ADV, MKT, RD, NX and the present study highlights the nexus relationship between these variables.

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.

2.3 Research Questions

In post-reform era, for Indian Manufacturing firms (1) What are the extents of growth, efficiency (both input oriented and output oriented technical efficiencies) 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 and output oriented technical efficiencies) and productivity? (5) Comparative analysis between growth, efficiency (both input oriented and output oriented technical efficiencies) and productivity i.e. whether highly growing firms are highly efficient and are highly productive? Whether highly productive firms are more technically efficient or not?

Chapter 3

Data Structure and Methodology

3.1 Data

Data regarding the Input-Output variables and factors determining the growth, productivity and efficiency have been collected from **Centre for Monitoring Indian Economy (CMIE) Prowess Database for the time period March, 1995 – March, 2016. Total No. of Manufacturing Firms incorporated is 820.**

Table 3.1 Composition of Manufacturing Firms (Sample details)

Manufacturing Firms	**No. of Firms**	**Percentage (%)**
Chemicals & chemical products (Chemical Industry)	223	27.20
Food Products, beverages & tobacco (Food Product Industry)	34	4.15
Leather & related products (Leather Industry)	11	1.34
Machinery Industry	150	18.29
Metal & metal products (Metal Industry)	114	13.90
Non- metallic mineral products	46	5.62
Paper &paper products (Paper Industry)	25	3.05
Textile Industry	125	15.24
Transport & Transport equipment (Transport Industry)	92	11.22
Total	820	100

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).

Data regarding different determinants of growth, productivity and efficiency has also been collected from CMIE Prowess Database.

3.2 Methodology

Growth is measured as done in standard literature. Productivity and efficiency are measured by using **DEA**.

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), efficiency block (input oriented approach & output oriented approach) and **total factor productivity growth block (TFPG Block)** consisting of the following determinants:

(i) **Advertising Intensity (ADV)**: It is a mean to lower the effectiveness of price competition by creating the product differentiation among the firms in the manufacturing sector (Goldar et al. (2004) and Carod and Blasco (2004). Advertising intensity is defined as the ratio of advertisement expenditure to sales of the firm.

(ii) **Marketing Intensity (MKT)**: It is also a proxy of product differentiation (Sheth and Sisodia (2002). Marketing intensity is defined as the ratio of marketing expenditure to sales of the firm.

(iii) **R&D Intensity (RD)**: When the individual firms invest in R&D for private knowledge that enhances the efficiency and productivity of the firm (Grossman and Helpman, 1990a, Grossman and Helpman, 1990b, Romer, 1986). RD intensity is calculated as the ratio of R&D expenditure to sales of the firm.

(iv) **Net Export Intensity (NX)**: Export expansion leads to economies of scale. International demand will allow the exploitation economies of scale which will tend to facilitate the expansion of the scale of production (Grossman and Helpman, 1991; Clerides et al, 1998; World Bank, 1993). Export intensity is defined as exports of goods & services by sales in real terms. Import is essential to carry out R&D activity and for inputs to be used in the production process (Goldar et al. (2004) and Mazumder et al. (2010). Import intensity is defined as the ratio of imports to sales of the firms. To examine the relative role of exports against imports, net export has been incorporated as an explanatory variable. Net export intensity is measured as the difference between export intensity and import intensity.

(v) **Diversification Index (DIVIND)**: DIVIND of a particular industry groups captures the effect of market structure on growth, productivity and efficiency of the firms. DIVIND is the reciprocal of concentration ratio. The Herfindal Index or Concentration Index is calculated as follows: $H = \Sigma s_i^2$;where s_i is the market share of the i^{th} firm in the market and N is the number of firms.

An inverse relation between CR (Concentration Ratio**)** and TFPG is expected by some researchers because the competition may lead to cost-consciousness and bring about the technological advancement. Others may point out the advantages of large size, secured market and expect a positive or direct association between CR and TFPG. The conclusion from the empirical literature also varies and does not provide us a single answer [(Katz, 1969); (Kendrick, 1973)].

(vi) **Age**: There are counter arguments regarding the effect of age on firm's performances. One argument is that older firms are having the superior performances since they are more experienced. So, they are having the advantagess of learning earlier; as a result they are not experiencing the hazards which the newcomers usually face (Stinchcombe, 1965). On the other hand, the counter argument is that older firms do lack the enough flexibility to adopt quickly to the changing economic conditions which the younger firms can adopt more rapidly and efficiently (Marshall, 1920).

(vii) **Size**: The growth, productivity and efficiency differ due to difference in relative size. A larger sized firm may have an easier access to the cheaper and better quality inputs which helps to increase its productivity. It is easier for such firms to make use of economies of scale by enlarging the scope of production and by making its operation more effective, allowing it to perform better compared to the smaller firms (Penrose,1959).

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). A rise in nation's REER implies that its exports have become more expensive and its imports have become cheaper. As a result, it is losing its trade competitiveness. Thus, NX falls. Therefore, a fall in REER increases NX.

Since we are doing with simultaneous equation model in a panel setup, for purpose of estimation we have used two stage procedures.

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.

Chapter 4

Growth Performance of Indian Manufacturing Firms

4.1 Introduction

Growth of output is an increase in the production of economic goods compared from one period to another. It can be measured in nominal or real terms. The present study measures growth in real terms.

The question can be raised whether the Indian manufacturing firms under nine industry groups are experiencing growth over the study period? What are the different determinants of growth in all those nine industries? What are the determinants of different strategic variables like ADV, MKT, RD and NX in the nine industry groups under consideration?

The perusal of the literature relating to studies on growth as discussed in Chapter 2 suggests that there is dearth in studies dealing with the measurement of growth and finds its determinants in a simultaneous panel framework for Indian manufacturing firms under nine industry groups. The present chapter adds the literature to this direction.

The present chapter measures growth as done in the standard literature for the nine industry groups under consideration. This chapter also tries to find out the determinants of growth in a simultaneous panel set up as developed by Baltagi (EC2SLS random-effects IV regression) for all those nine industry groups. It intends to find out joint dependence between growth of output (GROUT) and other strategic variables like ADV, MKT, RD, NX. While determining growth, the present study formulates and estimates a simultaneous panel equation model comprising of the following endogenous variables like growth, ADV, MKT, RD, NX.

The chapter unfolds as follows. Section 4.2 reports methodology and data source. The result of the estimation of growth is presented in Section 4.3. Section 4.4 finds out the determinants of growth in a simultaneous panel equation model comprising of the following endogenous variables like growth, ADV, MKT, RD, NX for the nine industry groups. Finally Section 4.5 concludes the study.

4.2 Methodology and Data Source

4.2.1 Methodology

The chapter uses two stage methodologies. In the first stage, the chapter measures growth as done in this standard literature. In the second stage, the estimated growth is used to determine the determinants of growth in a simultaneous panel equation model comprising of the following endogenous variables like growth, ADV, MKT, RD, NX.

4.2.2 Data Source

Data regarding the Input-Output variables and factors determining the growth have been collected from CMIE Prowess Database for the time period March, 1995 – March, 2016. After estimating growth, this chapter tries explain the variation of growth in term of other economic and strategic variables like R&D, Marketing, advertisement, net export, diversification index, size and age of the companies. The data for all these are also collected from CMIE Prowess data. Growth, ADV, MKT, RD and NX are assumed to be jointly determined in a simultaneous equation frame. ADV, MKT, RD and NX affect the growth of the firms and in turn get reciprocally affected by growth. In order to explain net export behavior I have used real effective exchange rate, the data of which are collected from Reserve Bank of India.

4.3 Estimated Results of Growth performance of the firms

Table 4.1 Extent of Growth of Output of Indian Manufacturing Firms

Industry	Mean Growth Rate of Output (%)
Chemical	10.41
Food Products	6.89
Leather	8.49
Machinery	10.57
Metal	23.83
Non-metallic mineral products	36.19
Paper	13.08
Textile	8.48
Transport	7.58
Grand Mean	13.95

Source: Author's Calculation

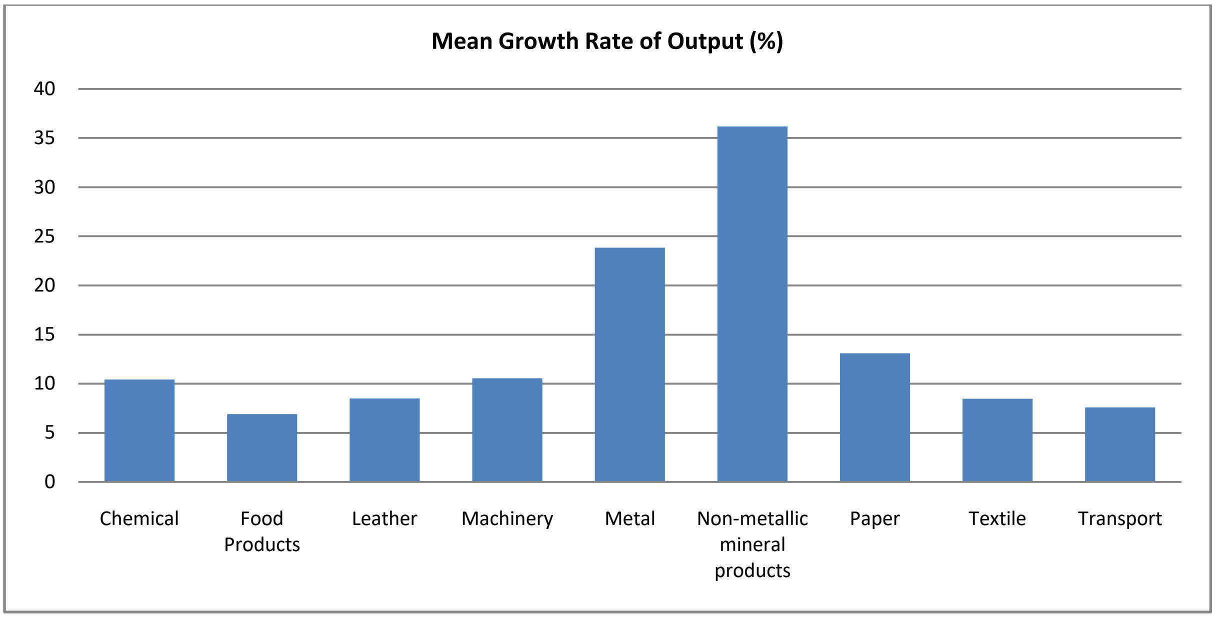

Figure 4.1. Growth of Output of Indian Manufacturing Firms

Table 4.1 and Figure 4.1. suggest that the sample manufacturing firms are experiencing 13.95% of growth 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.

Table 4.2 Percentage of firms working above the Mean Growth Rate of Output for all industry groups

Industry	Percentage of firms working above the Mean Growth Rate of Output (%)
Chemical	39
Food Products	50
Leather	55
Machinery	35
Metal	40
Non-metallic mineral products	14
Paper	29
Textile	31
Transport	56
Grand Mean	39

Source: Author's Calculation

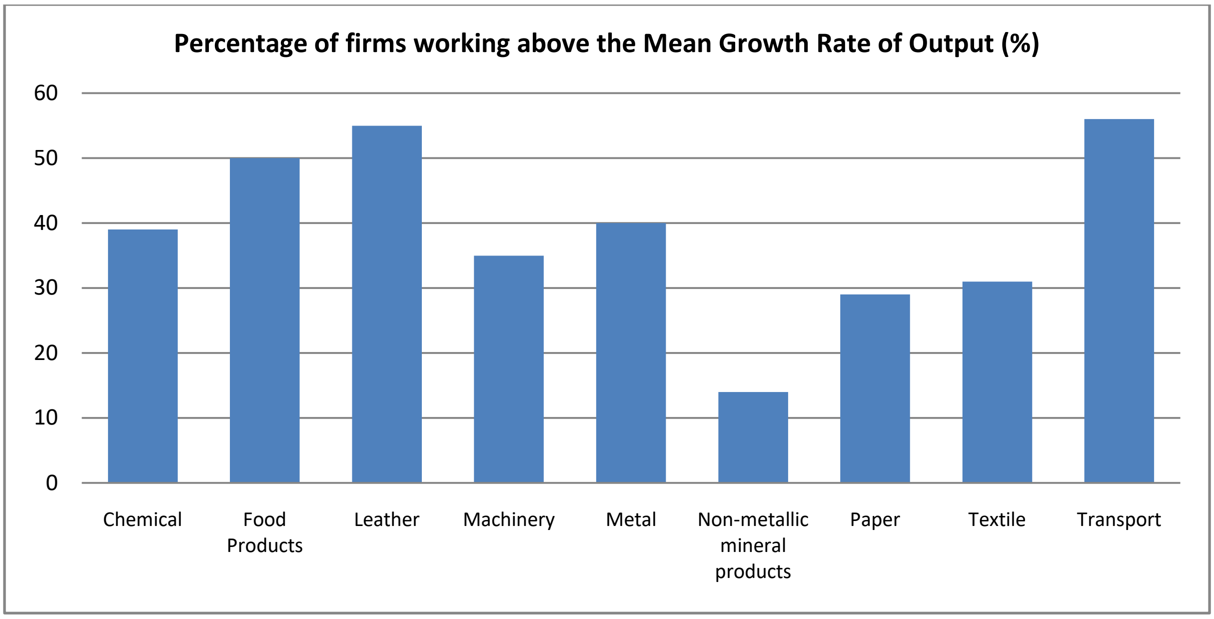

Figure 4.2. Percentage of firms working above the Mean Growth Rate of Output for all industry groups

Table 4.2 and Figure 4.2. show that 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.

Table 4.3 Range of average rate of growth of output for all industry groups

Growth Rate of Output of firms	Chemical	Food Products	Leather	Machinery	Metal	Non-metallic mineral products	Paper	Textile	Transport	Grand Mean
<0%	7.14%	0.00%	0.00%	17.28%	5.00%	0.00%	35.71%	23.08%	14.81%	11.45%
0%-10%	51.19%	78.57%	54.55%	49.38%	45.00%	42.86%	35.71%	46.15%	48.15%	50.17%
10%-20%	30.95%	21.43%	45.45%	19.75%	10.00%	28.57%	7.14%	15.38%	25.93%	22.73%
20%-30%	5.95%	0.00%	0.00%	7.41%	0.00%	7.14%	7.14%	7.69%	3.70%	4.34%
30%-40%	1.19%	0.00%	0.00%	4.94%	15.00%	7.14%	0.00%	0.00%	3.70%	3.55%
40%-50%	2.38%	0.00%	0.00%	4.94%	10.00%	7.14%	0.00%	7.69%	0.00%	3.57%
50%-60%	1.19%	0.00%	0.00%	0.00%	5.00%	0.00%	7.14%	0.00%	0.00%	1.48%
60%-70%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	7.14%	0.00%	0.00%	0.79%
70%-80%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
80%-90%	0.00%	0.00%	0.00%	0.00%	10.00%	0.00%	0.00%	0.00%	0.00%	1.11%
90%-100%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
>100%	0.00%	0.00%	0.00%	0.00%	0.00%	7.14%	0.00%	0.00%	0.00%	0.79%

Source: Author’s Calculation

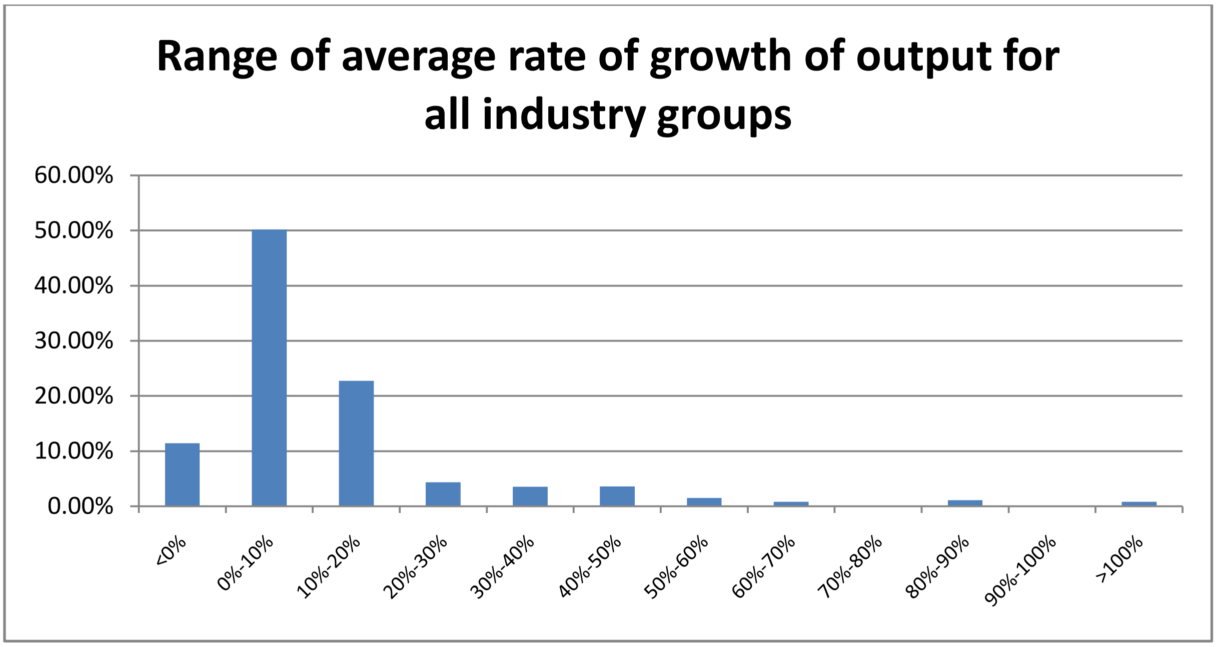

Figure 4.3. Range of average rate of growth of output for all industry groups

Table 4.3 and Figure 4.3. suggest that 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%.

4.4 Determinants of Growth

A second stage panel regression has been carried out to relate the growth of output (GROUT) of Indian manufacturing firms with the strategic variables perused by firms as well as firms' characteristics namely ADV Intensity, MKT Intensity, R&D Intensity, Net Export Intensity, Age, Diversification Index, Size and Age of the firm. The explanations for the inclusion of different explanatory variables can be summarized as follows:

Advertising Intensity (ADV):

Advertising, which initiates the scope of product substitutability on the part of consumers, has a definite influence on the growth of the firms. Akanbi and Adeyeye (2011) showed that the advertising is a tool for growth in the company's sales, market share and profitability. This study also showed that there is a remarkable increase in the sales of the company as a result of increase in advertising. The advertising activity affects growth, on the other hand, advertising expenditure can in turn get affected by the growth of the firm and also by the other economic and strategic variables like market share, marketing and R&D behavior. Further advertisement activity can be influenced by age and size of the firm. The basic question thus is to what extent advertising expenditures foster growth and at the same time get affected by the same and other economic and strategic variables? Thus, in order to determine the major factors influencing advertisement expenditure, one needs to formulate and estimate a simultaneous kind of relation between all these variables.

Marketing Intensity (MKT):

This variable also serves as a proxy for product differentiation. The article by Rust et al. (2004) focuses on the raising marketing's vitality in the firm and raising the performance of the firm itself. There has been much research in the area of marketing performance measurement (MPM) and there are several conceptual and empirical research papers. Mention may be made of studies by Donthu et al. (2005) and Lukas et al. (2005) among many others.

As in the case of advertising expenditure, this chapter tries to find out a relation between marketing activity and growth of the Indian manufacturing firms and other economic and strategic variables like market share, advertisement and R&D behavior, the age and size of the company. The basic question is to what extent marketing expenditures foster growth and in turn gets affected by the growth and other strategic variables and age of the company. The answer to the question will be dependent on the estimation of a simultaneous kind of model where marketing expenditure is determined jointly by the other endogenous variables of the model.

R&D Intensity (RD):

The recent theoretical models of endogenous growth focus on the R&D expenditures of the individual firms contributing towards the sustained long run growth of an economy through their industry-wide spillover effect.

The companies engaged in R&D activities are capable of developing improved technologies which enhances their growth. Here the idea is that the increased technical knowledge helps them to improve their level of output production. Thus one can expect a positive relationship between growth of firms and their R&D activity. Morbey (1988) gets a strong relationship between R&D spending and subsequent growth in sales. However, he detects a critical R&D funding level which must be crossed for achieving the contribution of R&D towards future sales growth.

The R&D decision of the firm is determined by the growth of the firms. The reason is that growing firms undertake R&D decision, because R&D requires some additional cost. Hence, correlation between R&D and growth of firms may arise as a result of the self-selection of better companies into the R&D decision.

At the same time R&D can be influenced by other economic variables like market share of the companies, and also by the companies' strategic variables like advertisement and marketing behavior. Age and size of the company can also be a significant determinant of R&D expenditure. It is expected that R&D decision of the company will be determined by the joint interactions of all these variables.

Thus the question can be asked to what extent increase in R&D helps to enhance the growth of the firms belonging to the Indian manufacturing sector? At the same time one may be interested in knowing to what extent R&D decision of the firms is influenced by market share as well as other strategic variables. Hence one has to formulate a simultaneous kind of relation between these variables showing the joint interactions of each other.

Net Export Intensity (NX):

While detecting the factors determining the growth of Indian manufacturing firms, the role of export behavior and that of import behavior are relevant. An enormous amount of literature is available supporting the role of exports and imports in enhancing the growth both at the theoretical level and empirical level. The theoretical literature suggests that international trade in general and export in particular increases economic growth. Mukim (2011) proves that the entry into the export markets has a positive impact on the firm performance at the very beginning but there is no proof of sustained learning-by exporting.

For the Indian manufacturing firms import is important. This is mainly essential to carry out the R&D activities. The literature review shows that many studies have been focused relating both to the theoretical aspect and empirical aspect concerning import and productivity of firms. The World Bank Report (1993, 1997) discussed about the firm's import for foreign technology and its positive impact on firms performance. Such activities enable firms to build up their internal production capabilities and competency. Lawrence and Weinstein (2001) argue that imports, not exports, have significant contribution towards the productivity growth in Japan and Korea.

There is a common view that international export enhances economic growth of firms (Balassa, 1988). The economic policies under export-led growth strategy have been widely supported on the argument that the exposure to worls market through export helps in increasing growth of exporters. Similarly, advocates of endogenous growth theory think that export plays a vital role by improving productivity and hence growth through innovation (Grossman and Helpman, 1991) and technology transfer (Barro and Sala-i-Martin, 1995). Through participation in export, growth can occur as a result of many factors such as capital accumulation, adoption of new technologies, research and development, changes in the organization of firms, etc. The imported intermediary good is an important channel through which technological diffusion takes place (Tybout 2000); this may favoubly affect productivity and growth. Imports allow countries to get the benefits of other countries technology embodied in imported inputs. Suffice here to mention theories of import-led growth due to Grossman and Helpman (1991). The removal of quantitative restrictions on imports and lowering of customs duties in the post liberalization era of the Indian economy should have improved access of imported raw materials and capital goods. Imports of materials embodying latest technologies should foster productivity, efficiency and the growth of the firms.

The above discussion shows that both import and export has a role to play in determining productivity. So it is important to find out the relative strength of exports vis á vis imports in enhancing productivity. In order to find out this relative role the present chapter takes net exports **(NX)** as an explanatory variable while determining growth. The question is to what extent the net exports matter?

Many empirical studies have been conducted where focus is given either on export or on import and they are unable to separate the impact of exports and imports. Mention may be made of study by Kim et al. (2009), where they investigate the relationship between trade and economic growth in Korea during 1980–2003.

At the same time net export can be influenced by other economic variables like market share of the firm, and also by the firm's strategic variables like R&D activity, advertisement and marketing behavior. Age and size of the firm can also be a significant determinant of net export. NX can also be influenced by Real effective exchange rate (REER). It is expected that net export decision of the firm will be determined by the joint interactions of all these variables.

Thus question can be raised to what extent net export activities help to foster the growth of the companies belonging to the Indian manufacturing sector and reciprocally get affected by the growth of the companies and by other economic and strategic variables like market share, R&D activity, advertising expenditures, marketing expenditures and age of the company? The present chapter tests these hypotheses empirically formulating a simultaneous kind of relation between these variables showing the joint interactions of each other.

Diversification Index (DIVIND): DIVIND of a particular industry groups captures the effect of market structure on growth of the firms. DIVIND is the reciprocal of concentration ratio. The Herfindahl Index or Concentration Index is calculated as follows: $H = \Sigma s_i^2$; where s_i is the market share of the i^{th} firm in the market N is the number of firms.

The economic diversification contributes positively to economic performance, much of the economic and sustainable growth policy discussion revolves around the development of strategies designed to induce greater economic diversification (Hackbart, 1975).

Age: There are counter arguments regarding the effect of age on firm's performances. One argument is that older firms are displaying superior performances since they are more experienced for having the benefits of learning earlier. So, they do not experience the hazards that the newcomers usually face (Stinchcombe, 1965). On the other hand, the counter argument is that older firms do lack the enough flexibility to adopt quickly to the changing economic circumstances which the younger firms can do much more rapidly and efficiently (Marshall, 1920).

The present study has divided the sample companies into two groups:

Agedum = 1, if Mean Age of the firm < Grand Mean Age (considering all the firms and all time Points taken together)

= 0, Otherwise

Size: The growth differs due to difference in relative size. A larger sized firm may have an easier access to the cheaper and superior quality inputs which helps to enhance its growth. It is easier for such firms to exploit economies of scale and to widen the scope of production by making its operation more effective, allowing it to perform better compared to the smaller firms (Penrose, 1959). 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. rupees

= 0, otherwise

Mediumdum = 1, if mean investment < 10 Cr. rupees

= 0, otherwise

Largedum = 1, if mean investment > 10 Cr. rupees

= 0, otherwise

In order to avoid dummy variable trap, Mediumdum has been dropped.

It may be possible that the effect of different explanatory variables may be non-linear in nature. To get this effect, the sole effect of different variables, their square terms and the joint effect of different variables will be incorporated. The effects of the lag value (one year lag) of different strategic variables (i.e. the effects of different strategic variable in the previous period) have also been considered.

Since we are dealing with simultaneous equation model one important problem is the problem of Identification of the model, we have solved the problem of Identification by taking into account exclusion restriction. We have checked that the rank and order condition of Identification under exclusion restriction has got satisfied for the model. We make sure that at least one variable is specific to one particular equation and appears only in that equation. The model is identified.

4.4.1 Explaining the Factors Influencing Growth of Output of the Firms: The Results from a Two Stage Least Square Type Approach in a Simultaneous Panel Model.

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

Since we are doing with simultaneous equation model in a panel setup, for purpose of estimation we have used two stage procedures.

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.

Significant Factors explaining the growth of output from a Simultaneous Equation Panel Model: The Growth Block

The estimated growth of output of Indian manufacturing firms and also the other endogenous variables explaining the growth corresponding to growth block can be visualized below.

4.4.1.a Chemical Industry

The estimated growth of output of Indian chemical firms and also the other endogenous variables explaining the growth corresponding to growth block can be visualized from Table 4.4.1 to Table 4.4.5.

Table 4.4.1 Factors explaining the growth from a Simultaneous Equation Panel Model of Growth Block

Endogenous Variable: Growth of Output (GROUT)

Independent Variable	Coefficient	z-value	p>|z|
ADV	-1.724939	-4.87	0.000
$(ADV)^2$	.0039582	3.61	0.000
ADVlag	1.845739	5.20	0.000
MKT	-1.393621	-8.67	0.000
$(MKT)^2$	.0019416	6.83	0.000
MKTlag	1.470779	8.75	0.000
NX*RD	1.83e-06	3.70	0.000
Agedum	8.047219	3.72	0.000
Largedum	3.352915	1.04	0.300
Wald chi2 = 192.05 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
ADV		-0.6050	
MKT		-1.3568	
RD		0.4027	
NX		0.0370	

The first equation of Growth Block: The estimated GROUT relation

The estimated GROUT relation as presented in Table 4.4.1 shows that it is positively related to ADV of the previous period and MKT of the previous period. Higher levels of ADV and MKT in the previous period increase the GROUT in the current period.

Considering ADV and MKT of the current period, both have U-relationship with GROUT. Their initial sole effects are negative. Beyond their critical levels, their positive effects on GROUT can be obtained. If the net effects are calculated, the marginal effects of ADV and MKT are negative as their mean values are lesser than their critical values.

Considering NX and RD of the current period, there exists a joint interaction term of NX and RD. The effect of this term on GROUT is positive. The effect of RD on GROUT depends on NX and vice-versa. Considering all these effects, the positive marginal effects of NX and RD on GROUT can be achieved.

Another factor positively affecting GROUT is Agedum. Younger firms are experiencing higher level of growth of output than the older firms.

Another factor having positive impact on GROUT is Largedum. The larger sized firms are having higher levels of growth of output than the smaller sized firms.

Table 4.4.2 Factors explaining the ADV behaviour from a Simultaneous Equation Panel Model of Growth Block

Endogenous Variable: ADV

Independent Variable	Coefficient	z-value	p>|z|
GROUT	-.0437078	-2.06	0.039
$(GROUT)^2$	.0000729	1.93	0.054
MKT	.0895663	3.42	0.001
$(MKT)^2$	-.0000966	-1.67	0.096
GROUT*MKT	.0002458	0.88	0.377
$(GROUT*MKT)^2$	8.82e-09	0.97	0.331
RD	.0374527	3.49	0.000
$(RD)^2$	-.0000328	-4.01	0.000
RD*MKT	.0001658	4.39	0.000
NX	-.0006597	-1.64	0.101
$(NX)^2$	2.68e-08	1.15	0.250
Largedum	6.097338	1.02	0.307
Wald chi2 = 156.96 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
GROUT		1.5287	
MKT		2.0618	
RD		0.0412	
NX		0.1590	
GROUT*MKT		-0.0455	

The second equation of Growth Block: The estimated ADV relation

The estimated ADV relation as presented in Table 4.4.2 shows that GROUT has U-relationship with ADV. The initial sole effect of GROUT is negative. Beyond its critical level, its positive effect on ADV will be realised.

There exists a composite effect of GROUT and MKT. Its marginal effect is negative. The effect of GROUT on ADV is operated through MKT. As GROUT increases, the firms spend more on MKT and less on ADV.

Considering all these effects, the marginal effects of GROUT on ADV is positive.

MKT and RD both have inverted U-relationship with ADV. Their sole effects on ADV are positive but beyond their critical levels, their negative effects on ADV will be obtained as all are the sunk costs.

There exists another composite effect of RD and MKT. It has positive effect on ADV. All these effects taken into account, the marginal effects of both RD and MKT are positive.

Considering NX of the current period, it can be seen that it has U-relationship with ADV. Its initial sole effect is negative. Beyond its critical level, its positive effect on NX will be obtained. The marginal effect of NX on ADV is positive.

Another factor positively influencing ADV is Largedum. Larger sized firms are doing higher level of ADV than the smaller ones.

Table 4.4.3 Factors explaining the MKT behaviour from a Simultaneous Equation Panel Model of Growth Block

Endogenous Variable: MKT

Independent Variable	Coefficient	z-value	p>|z|
GROUT	-.0961646	-2.23	0.026
$(GROUT)^2$	.0001742	2.30	0.021
ADV	.5485051	5.66	0.000
$(ADV)^2$	-.0021905	-6.04	0.000
GROUT*ADV	-.0040231	-2.19	0.029
$(GROUT*ADV)^2$	5.02e-07	2.83	0.005
RD	.2713373	13.44	0.000
$(RD)^2$	-.0002729	-24.94	0.000
RDlag	.0516006	7.20	0.000
RD*ADV	.0181674	28.69	0.000
NX	-.0017048	-1.86	0.063
$(NX)^2$	4.92e-07	10.01	0.000
NXlag	-.0012125	-1.26	0.206
$(NXlag)^2$	5.66e-07	10.30	0.000
Wald chi2 = 2799.78 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
GROUT		3.0422	
ADV		6.3030	
RD		0.3824	
NX		0.7957	
NXlag		0.6462	
GROUT*ADV		0.5857	

The third equation of Growth Block: The estimated MKT relation

The estimated MKT relation as presented in Table 4.4.3 shows that it is positively related to RD of the previous period. Increase in RD in the previous period increases MKT of the current period.

Considering GROUT of the current period, it has U-relationship with MKT. Its initial sole effect is negative. Beyond its critical level, its positive effect on MKT will be realised.

There exists a composite effect of GROUT and ADV. Its marginal effect on MKT is positive.

Considering all these effects, the marginal effect of GROUT on MKT is positive.

Considering RD and ADV of the current period, it can be seen that both are having inverted U-relationship with MKT. Their initial sole effects are positive. Beyond their critical levels, their negative effects on MKT will be obtained.

There exists a composite effect of RD and ADV on MKT. Its effect on MKT is positive. Considering all these effects, the marginal effects of RD and ADV are positive.

Considering NX of the current period as well as of previous period, both have U-relationship with MKT. Their initial sole effects are negative. Beyond their critical levels, their positive effects on MKT will be realised. Their marginal effects on MKT are positive.

Table 4.4.4 Factors explaining the RD behaviour from a Simultaneous Equation Panel Model of Growth Block

Endogeneous Variable: RD

Independent Variable	Coefficient	z-value	p>|z|
GROUT	.9613394	5.42	0.000
ADV	-.2626461	-1.67	0.095
MKT	4.88862	11.71	0.000
$(MKT)^2$	-.0106071	-11.88	0.000
ADV*MKT	.0380626	10.05	0.000
NX	.0372351	18.18	0.000
Wald chi2 = 839.49 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
GROUT		0.9613	
ADV		0.1324	
MKT		4.9538	
NX		0.0372	

The fourth equation of Growth Block: The estimated RD relation

The estimated RD relation as presented in Table 4.4.4 shows that it is positively related to GROUT and NX. Increase in both of these factors increases RD.

Considering ADV of the current period, it can be seen that its sole effect is negative. There exists a composite effect of ADV and MKT on RD. This effect is positive. Considering all these effects, the marginal effect of ADV is positive.

Considering MKT of the current period, it can be seen that it has inverted U-relationship with RD. Its initial sole effect is positive. Beyond its critical level, its negative effect on RD will be obtained. Considering all these effects, the marginal effect of MKT on RD is positive.

Table 4.4.5 Factors explaining the NX behaviour from a Simultaneous Equation Panel Model of Growth Block

Endogenous Variable: NX

Independent Variable	Coefficient	z-value	p>|z|
GROUT*RD	.0010357	6.11	0.000
RD	-.2577657	-10.03	0.000
$(RD)^2$	.0001668	11.09	0.000
RDlag	.134813	8.91	0.000
MKT	.1104744	7.19	0.000
$(MKT)^2$	.0001178	2.77	0.006
Agedum	.6259078	1.41	0.159
DIVIND	-.1063288	-1.87	0.062
Largedum	1.417755	2.12	0.034
Wald chi2 = 1964.33 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
GROUT		0.0081	
MKT		0.1017	
RD		-0.1863	

The fifth equation of Growth Block: The estimated NX relation

The estimated NX relation as presented in Table 4.4.5 shows that NX is positively related to RD of the previous period. Increase in RD of previous period increases NX of the current period.

There exists a composite effect of GROUT and RD on NX. The effect of GROUT on NX depends on RD. The marginal effect of GROUT on NX is positive.

Considering RD of the current period, it can be seen that it has U-relationship with NX. Its initial sole effect is negative and beyond the critical value, its positive effect on NX will be realised.

Considering all these effects, the marginal effect of RD on NX is negative as the mean RD is lesser than the critical level of RD, its negative effect on NX has been obtained.

Considering MKT of the current period, it can be seen that it has non-linear relationship with NX. The marginal effect of MKT on NX is positive.

Another factor positively influencing NX is Agedum. Younger firms are having level of NX than the older firms.

Another factor affecting NX is DIVIND. It is indirectly affecting GROUT. It has negative effect on NX. As the market share gets concentrated, NX of the firms rises.

The final factor having positive effect on NX is Largedum. Larger sized firms are having higher level of NX than the smaller sized firms.

4.4.1.b Food Products Industry

The estimated growth of output of Indian food products firms and also the other endogenous variables explaining the growth corresponding to growth block can be visualized from Table 4.5.1 to Table 4.5.5.

Table 4.5.1 Factors explaining the growth from a Simultaneous Equation Panel Model of Growth Block

Endogenous Variable: Growth of Output (GROUT)

Independent Variable	Coefficient	z-value	p>|z|
ADV	-3.08646	-3.37	0.001
$(ADV)^2$	.0452649	1.76	0.079
ADVlag	1.987714	2.82	0.005
MKT	2.085863	2.44	0.015
$(MKT)^2$	-.0090124	-0.45	0.652
MKTlag	1.850815	2.72	0.006
NX	-.2593252	-2.25	0.024
$(NX)^2$	.0003347	1.05	0.296
NXlag	.1741547	1.96	0.050
NX*RD	.0510343	1.17	0.241
RDlag	4.942417	0.76	0.450
$(RDlag)^2$	1.570241	1.78	0.074
Wald chi2 = 143.06 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
ADV		-2.3680	
MKT		2.0893	
RD		1.6220	
RDlag		7.1380	
NX		-0.1805	

The first equation of Growth Block: The estimated GROUT relation

The estimated GROUT relation as presented in the Table 4.5.1 shows that it is positively related to ADV of the previous year, MKT of the previous year and NX of the previous year. Increase in ADV, MKT & NX in the previous year increases the GROUT in the current year in food products industry.

Considering ADV of the current period, it can be observed that it has U-relationship with GROUT. The initial impact of increase in ADV on GROUT is negative as it is the sunk cost to the firms but there exists a critical level of ADV beyond which its positive effect on GROUT can be realised. As the mean ADV is lesser than the threshold level of ADV for our sample firms, the negative marginal effect of ADV has been obtained.

Considering MKT of the current period, it can be observed that MKT has inverted U-relationship with GROUT. Initially with the increase in MKT, GROUT increases as growth of output of manufactured food products is highly influenced by MKT. Beyond its critical level, increase in MKT leads to a fall in GROUT as too much marketing is costly for the firms. Marginal effect of MKT is positive.

Considering NX of the current period, it can be observed that NX has U-relationship with GROUT. The initial impact of increase in NX on GROUT is negative but there exists a critical level of NX beyond which its positive effect on GROUT can be realised.

There exists a composite effect of NX & RD of current period on GROUT. It has positive effect on GROUT. Through RD the product quality will get enhanced, as a result NX will be increased and it in turn increases GROUT. Considering all these effects, the marginal effects of NX is negative as the imports dominate over the exports.

Considering RD of the previous year, it can be observed that it has non-linear relationship with GROUT. The marginal effect of RD of previous year on GROUT is positive. The increase in RD in the previous period increases the GROUT in the current period.

Table 4.5.2 Factors explaining the ADV behaviour from a Simultaneous Equation Panel Model of Growth Block

Endogenous Variable: ADV

Independent Variable	Coefficient	z-value	p>|z|
GROUT	.1299163	4.54	0.000
MKT	.5155894	3.37	0.001
MKTlag	.4305077	1.30	0.192
RD	1.790959	2.22	0.026
NX	-.1138651	-2.98	0.003
$(NX)^2$	.0004797	2.45	0.014
NXlag	.0339669	1.10	0.271
NX*RD	.0622939	4.65	0.000
$(NX*RD)^2$	-.0000379	-4.71	0.000
Agedum	2.643015	2.90	0.004
Largedum	6.333765	2.90	0.004
Wald chi2 = 237.69 Prob > chi2 = 0.0000			

Determinants	Marginal effects
GROUT	0.1299
MKT	0.5156
RD	3.6922
NX	-0.0085
NX*RD	0.0592

The second equation of Growth Block: The estimated ADV relation

The estimated ADV relation of Growth Block as presented in Table 4.5.2 shows that ADV is positively related to MKT of current period as well as previous period, NX of the previous period and GROUT of the current period. Increase in MKT in current period as well as previous period and increase in NX of the previous period increase ADV of the current period. Increase in GROUT in the current period also increases ADV.

Considering RD of the current period, it can be observed that its sole effect is positive. There exists a joint interaction term of NX & RD. Its marginal effect on ADV is positive. Considering all these effects, the marginal effect of RD is positive.

Considering NX of the current period, it can be observed that it has U-relationship with ADV. Initially, an increase in NX reduces ADV but beyond a critical level of NX, its positive effect on ADV will be realised. All these effects taken into account, the marginal effect of NX on ADV is negative as the imports dominate over the exports.

The other two factors positively affecting ADV are Agedum and Largedum, indirectly influencing GROUT through ADV. Younger firms and larger sized firms are doing higher level of ADV.

Table 4.5.3 Factors explaining the MKT behaviour from a Simultaneous Equation Panel Model of Growth Block

Endogenous Variable: MKT

Independent Variable	Coefficient	z-value	p>|z|
GROUT	.0319875	1.62	0.106
$(GROUT)^2$	-.0001975	-1.04	0.296
ADV	.8113499	2.49	0.013
$(ADV)^2$	-.0239886	-2.39	0.017
RD	2.658415	2.55	0.011
$(RD)^2$	-.471412	-3.23	0.001
RDlag	1.688387	3.20	0.001
RD*ADV	.0934814	1.54	0.123
NX	-.0449334	-4.25	0.000
$(NX)^2$	.0003543	7.91	0.000
Smalldum	-8.02861	-7.83	0.000
Wald chi2 = 974.84 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
GROUT		0.0286	
ADV		0.5912	
RD		2.7240	
NX		-0.0140	

The third equation of Growth Block: The estimated MKT relation

The estimated MKT relation as presented in Table 4.5.3 shows that MKT is positively related to RD of the previous period. Increase in RD in the previous period leads to increase in MKT of the current period.

Considering GROUT, it can be observed that GROUT has inverted U-relationship with MKT with positive marginal effects. Initially with the increase in GROUT increases MKT but beyond the critical level of GROUT, increase in GROUT reduces MKT. After reaching the critical level of GROUT, the firms reduce their expenditure on marketing.

Considering RD and ADV of the current period, it can be observed that both have inverted U-relationship with MKT. The sole effects of RD and ADV on MKT are positive but the effects of the square terms are negative. This means that initially the increase in RD and ADV increases MKT but beyond their critical values, their effects on MKT will be negative as all these are sunk costs to the firms.

There exists a composite effect of RD and ADV on MKT. It is having a positive effect on MKT. The marginal effects of RD and ADV will be positive when all these effects will be taken into account.

Considering NX of the current year, it can be observed that it has U-relationship with MKT. Initially an increase in NX reduces MKT and beyond the critical level of NX, it has positive effect on MKT. The marginal effect of NX on MKT is negative as the mean level of MKT is lesser than the critical level of MKT for the sample firms.

Another factor influencing MKT is Smalldum. It has negative effect on MKT, indirectly affecting GROUT. Larger sized firms are doing higher level of MKT than the smaller sized firms.

Table 4.5.4 Factors explaining the RD behaviour from a Simultaneous Equation Panel Model of Growth Block

Endogeneous Variable: RD

Independent Variable	Coefficient	z-value	p>|z|
GROUT	-.0186165	-5.98	0.000
$(GROUT)^2$	.0001299	4.02	0.000
ADV	-.148278	-3.50	0.000
$(ADV)^2$	.0037654	3.85	0.000
ADVlag	.0971544	2.07	0.039
MKT	.0690993	1.77	0.077
$(MKT)^2$	-.0014745	-1.34	0.182
MKTlag	.1195713	2.41	0.016
$(MKTlag)^2$	-.0036038	-1.74	0.082
NX	-.0066021	-7.77	0.000
GROUT*NX	.0000951	2.75	0.006
$(GROUT*NX)^2$	1.35e-08	2.56	0.010
Largedum	1.312959	5.65	0.000
Wald chi2 = 457.04 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
GROUT		6.5715	
ADV		-0.0422	
MKT		0.0907	
MKTlag		0.0964	
NX		1.3936	
GROUT*NX		0.0105	

The fourth equation of Growth Block: The estimated RD relation

The estimated RD relation as presented in Table 4.5.4 shows that RD is positively related to ADV of the previous period. Increase in ADV of the previous period increases the RD of the current period.

Considering GROUT, it can be seen that it has U-relationship with RD. Initially an increase GROUT does not lead to a rise in RD but beyond the critical level of GROUT, its positive effect on RD will be realised.

Considering NX, it can be observed that its sole effect on RD is negative.

There exists a composite effect of GROUT and NX on RD. Its marginal effect on RD is positive. Increase in growth of output increases NX which in turn increase RD. Considering all these effects, the marginal effect of both GROUT and NX are positive.

Considering ADV of the current period, it can be observed that it has U-relationship with RD. Its sole effect is negative but the effect of the square term is positive. This means that the positive effect of ADV on RD will be felt beyond the critical level of ADV. The marginal effect of ADV is negative as the mean level of ADV is lesser than the critical level of ADV.

Considering MKT of current period as well as previous period, it can be seen that both have inverted U-relationship with RD with positive marginal effects. Their positive effects on RD will be realised beyond their critical levels.

Other factor affecting RD is Largedum, indirectly influencing GROUT. It has positive effect on RD, implying that larger sized firms are having level of RD than the smaller sized firms.

Table 4.5.5 Factors explaining the NX behaviour from a Simultaneous Equation Panel Model of Growth Block

Endogenous Variable: NX

Independent Variable	Coefficient	z-value	p>|z|
GROUT	.0081778	0.12	0.901
ADV	3.583447	4.14	0.000
$(ADV)^2$	-.0817894	-5.42	0.000
MKT	3.40705	10.44	0.000
REER	-.8900682	-2.58	0.010
Wald chi2 = 153.02 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
GROUT		0.0082	
ADV		2.4248	
MKT		3.4071	

The fifth equation of Growth Block: The estimated NX relation

The estimated NX relation as presented in Table 4.5.5 shows that NX is positively related to GROUT and MKT of the current period. Increase in GROUT and MKT of the current period increases NX of the current period. NX is negatively related to REER.

Considering ADV of the current period, it can be observed that it has inverted U-relationship with NX with positive marginal effect. The initial sole effect of ADV on NX is positive. Beyond the critical level of ADV, it has negative effect on NX.

4.4.1.c Leather Industry

The estimated growth of output of Indian leather firms and also the other endogenous variables explaining the growth corresponding to growth block can be visualized from Table 4.6.1 to Table 4.6.5.

Table 4.6.1 Factors explaining the growth from a Simultaneous Equation Panel Model of Growth Block

Endogenous Variable: Growth of Output (GROUT)

Independent Variable	Coefficient	z-value	p>|z|
RD*ADV	.7720282	1.70	0.090
$(RD*ADV)^2$	-.0021112	-1.19	0.233
MKT	.5676515	6.00	0.000
MKTlag	.6604989	9.69	0.000
NX	-1.961192	-2.19	0.028
$(NX)^2$	-.0327795	-3.95	0.000
DIVIND	9.354836	1.80	0.072
Wald chi2 = 198.69 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
ADV		0.7767	
MKT		0.5677	
RD		5.3405	
NX		-2.1064	
RD*ADV		0.7546	

The first equation of Growth Block: The estimated GROUT relation

The estimated GROUT relation as presented in Table 4.6.1 shows that GROUT is positively related to MKT of the current period as well as previous period. Increase in MKT in the current period as well as in the previous period increases GROUT.

There exists a joint interaction term of RD and ADV. Its marginal effect on GROUT is positive. Through RD, new advertising strategy will be invented and GROUT will be enhanced. Considering all these effects, the marginal effects of both RD and ADV on GROUT are positive.

Considering NX of the current period, it can be observed that NX has non-linear relationship with GROUT with negative marginal effect, implying that imports dominate over exports.

Another factor positively affecting GROUT is DIVIND, implying that as market gets diversified, GROUT of the firms increases.

Table 4.6.2 Factors explaining the ADV behaviour from a Simultaneous Equation Panel Model of Growth Block

Endogenous Variable: ADV

Independent Variable	Coefficient	z-value	p>|z|
GROUT*RD	.0078169	0.52	0.600
MKT	.0326639	2.20	0.028
MKTlag	.0234527	2.47	0.013
NX	-.3321261	-2.18	0.029
$(NX)^2$	.0008776	0.40	0.687
Agedum	-3.982707	-2.13	0.033
Largedum	-6.205146	-2.51	0.012
Wald chi2 = 70.73 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
GROUT		0.0105	
MKT		0.0327	
RD		0.0849	
NX		-0.3251	

The second equation of Growth Block: The estimated ADV relation

The estimated ADV relation as presented in Table 4.6.2 shows that ADV is positively related to MKT of the current period as well as the previous period. Through the increase in MKT in the current period as well as in the previous period, ADV can be increased.

There exists a joint interaction term of GROUT and RD. It has positive effect on ADV. Through RD, GROUT will be increased; as a result ADV will be increased. The marginal effects of GROUT and RD on ADV are positive.

Considering NX of the current period, NX has U-relationship with ADV. There exists a critical level of NX beyond which its positive effect on ADV will be achieved. The marginal effect of NX is negative as the imports dominate over the exports.

Another factor affecting ADV is Agedum. It has negative effect on ADV, implying that older firms are having higher level of ADV. Agedum is indirectly affecting GROUT through ADV.

Other factor affecting ADV is Largedum, indirectly affecting GROUT. It has negative impact on ADV, meaning that smaller sized firms are having higher level of ADV than the larger sized firms.

Table 4.6.3 Factors explaining the MKT behaviour from a Simultaneous Equation Panel Model of Growth Block

Endogenous Variable: MKT

Independent Variable	Coefficient	z-value	p>|z|
GROUT	.4033145	2.79	0.005
ADV	4.178913	2.18	0.029
$(ADV)^2$	-.0691303	-2.04	0.041
RD	7.998172	1.27	0.203
$(RD)^2$	-.8182682	-1.22	0.222
NX	3.213052	3.68	0.000
$(NX)^2$	.0852943	8.26	0.000
NXlag	2.574345	4.45	0.000
Wald chi2 = 980.72 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
GROUT		0.4033	
ADV		3.3036	
RD		6.3100	
NX		3.6492	

The third equation of Growth Block: The estimated MKT relation

The estimated MKT relation as presented in Table 4.6.3 shows that MKT is positively related to GROUT of the current period and NX of the previous period. As the GOUT increases, MKT increases. NX in the previous period also increases MKT of the current period, indirectly affecting GROUT.

Considering ADV of the current period, ADV has inverted U-relationship with MKT. Initially increase in ADV increases MKT but beyond the critical level of ADV, increase in ADV leads to a fall in MKT. The firms will not spend simultaneously on both ADV and MKT beyond the critical level of ADV as both are sunk costs. The marginal effect of ADV is positive.

Considering RD of the current period, RD has inverted U-relationship with MKT. Initially increase in RD increases MKT, beyond the critical level of RD, its increase will lead to the fall in MKT as both are the sunk costs. All these effects taken into consideration, the marginal effect of RD on MKT is positive.

Considering NX of the current period, NX has non-linear relationship with MKT with positive marginal effect. Increase in NX of the current period increases MKT of the current period.

Table 4.6.4 Factors explaining the RD behaviour from a Simultaneous Equation Panel Model of Growth Block

Endogenous Variable: RD

Independent Variable	Coefficient	z-value	p>|z|
GROUT*NXlag	.0004707	1.98	0.048
ADV	-.1353899	-5.52	0.000
$(ADV)^2$	.0026094	4.89	0.000
DIVIND	.2712286	1.03	0.304
Agedum	-1.256904	-4.97	0.000
Wald chi2 = 52.33 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
GROUT		0.0011	
ADV		-0.0898	
NXlag		0.0043	

The fourth equation of Growth Block: The estimated RD relation

The estimated RD relation as presented in Table 4.6.4 shows that there exists a joint interaction term of GROUT of the current period and NX of the previous period. NX of the previous period increases GROUT in the current period, as a result RD will be increased. This joint interaction term has positive effect on RD. The marginal effects of GROUT of the current period and NX of the previous period are positive.

Considering ADV of the current period, ADV has U-relationship with RD. The positive effect on ADV on RD will be realised beyond the critical level of ADV. The marginal effect of ADV on RD is negative, as the mean ADV is lesser than the critical level of ADV.

Another factor positively affecting RD is DIVIND. As the market share gets diversified, RD increases.

Other factor affecting RD is Agedum. It has negative effect on RD, indirectly affecting GROUT. Older firms are having higher level of RD.

Table 4.6.5 Factors explaining the NX behaviour from a Simultaneous Equation Panel Model of Growth Block

Endogenous Variable: NX

Independent Variable	Coefficient	z-value	p>|z|
GROUT	.052181	1.44	0.151
$(GROUT)^2$	-.0005276	-4.05	0.000
ADVlag	.6629357	2.77	0.006
$(ADVlag)^2$	-.0250091	-3.37	0.001
MKT	-.2502993	-4.17	0.000
$(MKT)^2$	.0002161	5.40	0.000
MKTlag	.1079782	4.49	0.000
RD	-4.896386	-1.94	0.053
$(RD)^2$	.3776087	1.76	0.079
RDlag	3.663742	1.72	0.086
Smalldum	9.261585	2.89	0.004
Wald chi2 = 183.19 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
GROUT		0.0915	
ADVlag		0.3896	
MKT		-0.2360	
RD		-4.0600	

The fifth equation of Growth Block: The estimated NX relation

The estimated NX relation as presented in Table 4.6.5 shows that NX is positively related to MKT of the previous period and RD of the previous period. Increase in both of these factors increases NX of the current period. RD of the previous period indirectly affects GROUT through NX.

Considering GROUT of the current period, GROUT has inverted U-relationship with NX. Initially with the increase in GROUT increases NX. But beyond the critical level, the increase in GROUT will result in a fall in NX. The marginal effect of GROUT on NX is positive.

Considering ADV of the previous period, it has inverted U-relationship with NX. Initially with the increase in ADV of the previous period, NX increases. But beyond the critical level of ADV of previous period, its increase will lead to a fall in NX. The marginal effect of ADV of the previous period is positive, indirectly affecting GROUT.

Considering MKT and RD of current period, both have U-relationship with NX. The positive effects of MKT and RD on NX will be realised beyond their critical levels. But the marginal effects of both MKT and RD on NX are negative as the mean levels of RD and MKT are lesser than critical levels of RD and MKT.

Another factor positively affecting NX is Smalldum, indirectly affecting GROUT. Smaller sized firms are having higher level of NX than the larger sized firms.

4.4.1 d Machinery Industry

The estimated growth of output of Indian machinery firms and also the other endogenous variables explaining the growth corresponding to growth block can be visualized from Table 4.7.1 to Table 4.7.5.

Table 4.7.1 Factors explaining the growth from a Simultaneous Equation Panel Model of Growth Block

Endogenous Variable: Growth of Output (GROUT)

Independent Variable	Coefficient	z-value	p>|z|
RD*ADV	.0021	7.04	0.000
ADVlag	.6514103	4.82	0.000
$(ADVlag)^2$	-.000751	-5.72	0.000
RD	-.7166524	-4.60	0.000
$(RD)^2$	.0006341	8.26	0.000
RDlag	.6579437	4.56	0.000
MKT	-.6661554	-5.60	0.000
$(MKT)^2$	.000629	3.70	0.000
MKTlag	.3665218	4.11	0.000
NX	.0009341	1.70	0.088
NXlag	.0023114	3.92	0.000
Wald chi2 = 396.27 Prob > chi2 = 0.0000			

Determinants	Marginal effects
ADV	0.0282
ADVlag	0.6881
MKT	-0.5672
RD	-0.6544
NX	0.0009

The first equation of the Growth Block: The estimated GROUT relation

The estimated GROUT relation as presented in Table 4.7.1 shows that GROUT is positively related to RD of the previous period, MKT of the previous period and NX of the previous period as well as current period.

Considering ADV of the previous period, it can be seen that ADV of the previous period has inverted U-relationship with GROUT. Initially increase in ADV of the previous period increases GROUT but beyond the critical level of ADV of the previous period, the negative effect of ADV of previous period will be felt on GROUT. Considering all these effects, the marginal effect of ADV of previous period on GROUT is positive.

Considering RD of the current period, it can be seen that RD has U-relationship with GROUT. The sole effect of RD is negative and the effect of the square term is positive. This means that the positive effect of RD on GROUT will be realised beyond the critical level of RD.

There exists a joint interaction term of RD and ADV. It has a positive effect on GROUT. Considering all these effects, the marginal effect of RD is negative as the mean level of RD is lesser than the critical level of RD.

Considering MKT of the current period, it can be seen that MKT has U-relationship with GROUT. The sole effect of MKT is negative and the effect of the square term is positive. The positive effect of MKT on GROUT will be felt beyond its critical level. All these effects taken into consideration, the marginal effect of MKT is positive.

Table 4.7.2 Factors explaining the ADV behaviour from a Simultaneous Equation Panel Model of Growth Block

Endogenous Variable: ADV

Independent Variable	Coefficient	z-value	p>|z|
GROUT	.0295421	1.12	0.263
MKT	.5281827	17.81	0.000
$(MKT)^2$	.0000531	4.55	0.000
RD	.0981605	4.77	0.000
$(RD)^2$	-.0000881	-15.41	0.000
NX	.0048019	64.96	0.000
GROUT*NX	4.34e-06	6.02	0.000
Agedum	2.193255	1.78	0.075
DIVIND	-.209291	-2.02	0.044
Largedum	3.826924	2.24	0.025
Wald chi2 = 11963.97 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
GROUT		0.0896	
MKT		0.5033	
RD		0.0977	
NX		0.1187	

The second equation of Growth Block: The estimated ADV relation

The estimated ADV relation as presented in Table 4.7.2 shows that the sole effects of GROUT and NX on ADV are positive. There exists a joint interaction term of GROUT and NX. It has positive effect on ADV. Considering all these effects, the marginal effects of both GROUT and NX on ADV come out to be positive.

Considering MKT of the current period, it can be seen that MKT has non-linear positive relationship with ADV. The marginal effect of MKT on ADV is positive.

Considering RD of current period, it can be seen that RD has inverted U-relationship with ADV. The sole effect of RD is positive and the effect of square term is negative. Initially increase in RD increases ADV, but beyond the critical level of RD, its negative effect on RD will be felt. All these effects taken into account, the marginal effect of RD on ADV is positive.

Another factor positively affecting ADV is Agedum, indirectly affecting GROUT. Younger firms have higher level of ADV than the older firms.

Another factor affecting ADV is DIVIND, indirectly affecting GROUT. It has negative effect on ADV. As the market share gets concentrated, ADV of the firms increases.

Another factor positively affecting ADV is Largedum, indirectly affecting GROUT. The larger sized firms are having higher level of ADV than smaller sized firms.

Table 4.7.3 Factors explaining the MKT behaviour from a Simultaneous Equation Panel Model of Growth Block

Endogenous Variable: MKT

Independent Variable	Coefficient	z-value	p>|z|
GROUT	-.2490826	-7.08	0.000
$(GROUT)^2$	.0004106	5.90	0.000
ADV	1.059637	15.60	0.000
$(ADV)^2$	-.0005528	-7.72	0.000
ADVlag	.2609372	4.74	0.000
$(ADVlag)^2$	-.0002395	-3.16	0.002
RD	.4353557	10.96	0.000
$(RD)^2$	-.0000409	-3.97	0.000
RD*ADV	.0002004	1.99	0.046
$(RD*ADV)^2$	9.00e-11	3.12	0.002
GROUT*ADV	.0093304	17.77	0.000
NX	-.0010974	-1.86	0.063
$(NX)^2$	1.66e-08	7.28	0.000
GROUT*NX	7.26e-06	1.47	0.141
Wald chi2 = 5213.03 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
GROUT		-0.0433	
ADV		1.6800	
ADVlag		0.2966	
RD		0.7609	
NX		0.1954	
RD*ADV		1.2809	

The third equation of Growth Block: The estimated MKT relation

The estimated MKT relation as presented in Table 4.7.3 shows that GROUT has U-relationship with MKT. The sole effect of GROUT is negative but the effect of the square term is positive, meaning that the positive effect of GROUT on MKT will be realised beyond the critical level of GROUT.

There exists a composite effect of GROUT and NX. This joint interaction term of GROUT and NX has positive effect on MKT. The increase in NX increases GROUT which will lead to a rise in MKT. There exists another joint interaction term of GROUT and ADV. It is also having positive effect on MKT, meaning that increase in ADV increases GROUT; as a result MKT will be increased. All these effects taken into consideration, the marginal effect of GROUT is negative as the mean GROUT is lesser than critical level of GROUT beyond which the positive effect can be felt.

Considering ADV of the current period as well as previous period, it can be seen that both have inverted U-relationships with MKT. Initially with the increase in ADV both in the current period and in previous period increases MKT. But beyond the critical levels of ADV in the current period and in the previous period, increase in ADV reduces MKT.

Considering RD of the current period, it can be seen that RD has inverted U-relationship with MKT. Initially the increase in RD will lead to an increase MKT. But beyond the critical level of RD, increase in RD will reduce MKT.

There exists a joint interaction term of RD and ADV. The marginal effect of this joint interaction term of RD and ADV is positive. Joint spending on RD and ADV increases MKT. All these effects taken into consideration, the marginal effects of ADV of the current period as well as of the previous period, RD of the current period are positive.

Considering NX of the current period, it can be seen that NX has U-relationship with MKT. The positive effect of NX on MKT will be felt beyond the critical level of NX. Considering all these effects, the marginal effect of NX comes out to be positive.

Table 4.7.4 Factors explaining the RD behaviour from a Simultaneous Equation Panel Model of Growth Block

Endogenous Variable: RD

Independent Variable	Coefficient	z-value	p>|z|
GROUT	-.4811174	-5.92	0.000
$(GROUT)^2$	.0008643	5.17	0.000
ADV	-1.449152	-10.53	0.000
$(ADV)^2$	.0000434	0.28	0.781
MKT	1.277062	24.59	0.000
$(MKT)^2$	.0001592	8.98	0.000
MKTlag	.1249298	3.82	0.000
NX	.012641	19.74	0.000
GROUT*NX	.000029	3.67	0.000
$(GROUT*NX)^2$	4.48e-13	1.02	0.307
Agedum	8.610215	2.91	0.004
Largedum	6.807245	1.66	0.098
Wald chi2 = 10758.20 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
GROUT		-0.4519	
ADV		-1.4393	
MKT		1.2866	
NX		0.0231	
GROUT*NX		0.0003	

The fourth equation of Growth Block: The estimated RD relation

The estimated RD relation as presented in Table 4.7.4 shows that RD is positively related to MKT of the previous period.

Considering GROUT of the current period, it can be seen that GROUT has U-relationship with RD. The sole effect of GROUT is negative but the effect of the square term is positive. This means that the positive effect of GROUT on RD will be obtained beyond the critical level of GROUT.

The sole effect of NX on RD is positive. There exists a composite effect of GROUT and NX on RD. The marginal effect of the joint interaction term on RD is positive. The effect of GROUT on RD depends on NX and vice-versa. The increase in NX increases GROUT; as a result RD will be increased. The marginal effect of NX is positive. But the marginal effect of GROUT is negative as mean GROUT is lesser than the critical level of GROUT.

Considering ADV of the current period, it can be seen that it has U-relationship with RD. The positive effect of ADV on RD will be realised beyond the critical level of ADV. All these effects taken into consideration, the marginal effect of ADV is negative as the mean ADV is lesser than critical level of ADV.

Considering MKT of the current period, it can be seen that the MKT has non-linear positive relationship with RD. The marginal effect of MKT on RD is positive.

Another factor positively affecting RD is Agedum, indirectly affecting GROUT. This means that younger firms have higher level of RD.

Other factor positively affecting RD is Largedum, indirectly affecting GROUT. This means that larger sized firms are having higher level of RD.

Table 4.7.5 Factors explaining the NX behaviour from a Simultaneous Equation Panel Model of Growth Block

Endogenous Variable: NX

Independent Variable	Coefficient	z-value	p>|z|
GROUT	-.0660813	-1.65	0.099
$(GROUT)^2$	.0000886	1.08	0.279
ADV	.4058688	7.47	0.000
$(ADV)^2$	.0009018	18.22	0.000
ADVlag	.3964044	19.12	0.000
RD	.2162631	8.60	0.000
GROUT*RD	-.0003294	-2.54	0.011
$(GROUT*RD)^2$	1.46e-09	2.87	0.004
REER	-.1971284	-1.37	0.171
Wald chi2 = 10152.34 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
GROUT		0.6962	
ADV		0.4174	
RD		0.7849	
GROUT*RD		0.0004	

The fifth equation of Growth Block: The estimated NX relation

The estimated NX relation as presented in Table 4.7.5 shows that NX is positively related to ADV of the previous period and negatively related to REER.

Considering GROUT of the current period, it can be seen that GROUT has U-relationship with NX. The sole effect of GROUT is negative but the effect of the square term is positive. This means that initially increase in GROUT will not initiate NX but the positive effect of GROUT on NX will be achieved beyond the critical level of GROUT.

The sole effect of RD is positive. There exists a composite effect of GROUT and RD. The marginal effect of this joint interaction term is positive. Through RD, GROUT of the firms will be increased, as a result NX will be increased. Considering all these effects, the marginal effects of GROUT and RD are positive.

Considering ADV of the current period, it can be seen that ADV has positive non-linear relationship with NX. The marginal effect of ADV on NX is positive, meaning that the increase in ADV increases NX of the current period.

4.4.1. e Metal Industry

The estimated growth of output of Indian metal firms and also the other endogenous variables explaining the growth corresponding to growth block can be visualized from Table 4.8.1 to Table 4.8.5.

Table 4.8.1 Factors explaining the growth from a Simultaneous Equation Panel Model of Growth Block

Endogenous Variable: Growth of Output (GROUT)

Independent Variable	Coefficient	z-value	p>|z|
ADV	1.502849	3.28	0.001
$(ADV)^2$	.0005938	2.79	0.005
MKT	-.7167429	-4.27	0.000
$(MKT)^2$	.0000279	4.25	0.000
MKTlag	.1760471	3.45	0.001
RD	-1.568123	-2.58	0.010
$(RD)^2$	.0008134	4.07	0.000
RDlag	1.762931	2.62	0.009
NX	.0041147	3.69	0.000
Wald chi2 = 31.88 Prob > chi2 = 0.0042			
Determinants	Marginal effects		
ADV	1.5088		
MKT	-0.7097		
RD	-1.5693		
NX	0.0041		

The first equation of Growth Block: The estimated GROUT relation

The estimated GROUT relation as presented in Table 4.8.1 shows that GROUT is positively related to MKT of the previous period, RD of the previous period and NX of the current period. Increase in MKT and RD in the previous period and NX in the current period increases GROUT in the current period.

Considering ADV of the current period, it can be seen that ADV has non-linear positive relationship with GROUT. Both the sole effect of ADV and the effect of square term are positive. Therefore, the marginal effect of ADV on GROUT is positive, implying that increase in ADV increases GROUT of the firms.

Considering MKT of the current period, it can be seen that MKT has U-relationship with GROUT. The sole effect of MKT is negative and the effect of square term is positive, implying that the positive effect of MKT on GROUT can be obtained beyond the critical level of MKT. The marginal effect of MKT is negative as the mean MKT is lesser than the critical level of MKT.

Considering RD of the current period, it can be seen that RD has U-relationship with GROUT. The sole effect is negative and the effect of the square term is positive. The positive effect of RD on GROUT will be realised beyond the critical level of RD. The marginal effect of RD is negative as mean RD is lesser than the critical level of RD.

Table 4.8.2 Factors explaining the ADV behaviour from a Simultaneous Equation Panel Model of Growth Block

Endogenous Variable: ADV

Independent Variable	Coefficient	z-value	p>|z|
GROUT	.1407955	1.31	0.191
$(GROUT)^2$	-.0001519	-1.77	0.077
MKT	.1251586	5.72	0.000
$(MKT)^2$	-2.65e-06	-4.33	0.000
MKTlag	.0921284	3.77	0.000
RD	-.4851868	-4.13	0.000
$(RD)^2$	.0001693	4.92	0.000
RDlag	.5119077	2.35	0.019
NX	1.678886	6.50	0.000
GROUT*MKT	.0001037	0.46	0.643
$(GROUT*MKT)^2$	9.52e-10	5.31	0.000
Wald chi2 = 737.51 Prob > chi2 = 0.0000			

Determinants	Marginal effects
GROUT	0.5903
MKT	2.4733
RD	-0.4798
NX	1.6789
GROUT*MKT	3.1474

The second equation of Growth Block: The estimated ADV relation

The estimated ADV relation as presented in Table 4.8.2 shows that ADV is positively related to MKT of the previous period, RD of the previous period and NX of the current period. Increase in these factors increases ADV of the firms.

Considering GROUT of the current period, it can be seen that GROUT has inverted U-relationship with ADV. Initially increase in GROUT increases ADV but beyond the critical level of GROUT, increase in GROUT reduces ADV.

There exists a joint interaction term of GROUT and MKT. The marginal effect of this joint interaction term is positive. The effect of GROUT on ADV depends on MKT and vice-versa.

Considering MKT of the current period, it can be seen that MKT has inverted U-relationship with ADV. Initially the increase in MKT increases ADV but beyond the critical level of MKT, its negative effect on ADV will be realised. Considering these effects, the marginal effects of GROUT and MKT on ADV come out to be positive.

Considering RD of the current period, it can be seen that RD has U-relationship with ADV. The positive effect of RD on ADV will be felt beyond the critical level of RD. The marginal effect of RD is negative as the mean level of RD is lesser than the critical level of RD.

Table 4.8.3 Factors explaining the MKT behaviour from a Simultaneous Equation Panel Model of Growth Block

Endogenous Variable: MKT

Independent Variable	Coefficient	z-value	p>|z|
GROUT	1.883301	3.86	0.000
$(GROUT)^2$	-.001108	-2.82	0.005
RD	3.840246	5.25	0.000
$(RD)^2$	-.0033042	-12.20	0.000
Wald chi2 = 24910.48 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
GROUT		1.8323	
RD		3.5677	

The third equation of Growth Block: The estimated MKT relation

The estimated MKT relation as presented in Table 4.8.3 shows that both GROUT and RD of the current period have inverted U-relationship with MKT. Initially increase in GROUT and RD increases MKT. But beyond the critical levels of GROUT and MKT, their negative effects on MKT will be felt. The marginal effects of GROUT and RD are positive.

Table 4.8.4 Factors explaining the RD behaviour from a Simultaneous Equation Panel Model of Growth Block

Endogenous Variable: RD

Independent Variable	Coefficient	z-value	p>|z|
GROUT	.200385	4.26	0.000
$(GROUT)^2$	-.0001389	-3.81	0.000
ADV	.6240135	0.76	0.450
$(ADV)^2$	-.0028606	-1.05	0.293
MKTlag	.0686783	5.15	0.000
NX	.4989398	2.03	0.043
Agedum	-5.076127	-1.65	0.099
Largedum	-7.524131	-1.46	0.145
Wald chi2 = 37151.05 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
GROUT		0.1952	
ADV		0.5825	
NX		0.4989	

The fourth equation of Growth Block: The estimated RD relation

The estimated RD relation as presented in Table 4.8.4 shows that RD is positively related to MKT of the previous period and NX of the current period.

Considering GROUT of the current period, it can be seen that GROUT has inverted U-relationship with RD. Initially increase in GROUT increases RD, beyond the critical level of GROUT, the increase in GROUT decreases RD. Marginal effects of GROUT is positive.

Considering ADV of the current period, it can be seen that ADV has inverted U-relationship with RD. Initially increase in ADV increases RD, but beyond the critical level of ADV, increase in ADV will lead to the fall in RD. Considering all these effects, the marginal effect of ADV comes out to be positive.

Another factor affecting RD is Agedum, indirectly affecting GROUT. It has negative effect on RD, meaning that older firms are having higher level of RD.

Another factor affecting RD is Largedum, indirectly affecting GROUT. It has negative effect on RD, meaning that smaller firms are having higher level of RD.

Table 4.8.5 Factors explaining the NX behaviour from a Simultaneous Equation Panel Model of Growth Block

Endogenous Variable: NX

Independent Variable	Coefficient	z-value	p>|z|
GROUT	.0011432	0.09	0.932
ADV	.1481605	4.02	0.000
MKT	.0675434	5.88	0.000
$(MKT)^2$	-3.03e-06	-7.12	0.000
RD	-.9068201	-11.17	0.000
$(RD)^2$	.0001256	7.87	0.000
RDlag	.0158078	1.98	0.047
REER	-2.914432	-5.34	0.000
DIVIND	8.568993	2.99	0.003
Wald chi2 = 4521.51 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
GROUT		0.0011	
ADV		0.1482	
MKT		0.0264	
RD		-0.8999	

The fifth equation of Growth Block: The estimated NX relation

The estimated NX relation as presented in Table 4.8.5 shows that NX is positively related to GROUT, ADV of the current period and RD of previous period. Increase in GROUT and ADV of the current period and RD in the previous period increases NX of the current period. NX is negatively related to REER.

Considering MKT of the current period, it can be seen that MKT has inverted U-relationship with NX. The sole effect of MKT is positive and the effect of the square term is negative. This means that initially increase in MKT increases NX but beyond the critical level of MKT, its negative effect on NX will be felt. Considering all these effects, the marginal effect of MKT on NX is positive.

Considering RD of the current period, it can be seen that RD has U-relationship with NX. The positive effect of RD on NX can be obtained beyond the critical effect of RD. All these effects taken into account, the marginal effect of RD on NX comes out to be negative as the mean level of RD is lesser than the critical level of RD beyond which its positive effect can be achieved.

Another factor positively affecting NX is DIVIND, indirectly affecting GROUT. As the market share gets diversified, NX of the firms increases.

4.4.1.f Non-metallic mineral products Industry

The estimated growth of output of Indian non-metallic mineral products firms and also the other endogenous variables explaining the growth corresponding to growth block can be visualized from Table 4.9.1 to Table 4.9.5.

Table 4.9.1 Factors explaining the growth from a Simultaneous Equation Panel Model of Growth Block

Endogenous Variable: Growth of Output (GROUT)

Independent Variable	Coefficient	z-value	p>|z|
ADVlag	1.487698	3.93	0.000
ADV*MKT	.0040202	7.79	0.000
MKT	.208085	2.73	0.006
$(MKT)^2$	-.0001534	-5.39	0.000
MKTlag	.2835876	11.11	0.000
RD	-1.60364	-4.03	0.000
$(RD)^2$	.0016461	5.00	0.000
RDlag	.3508032	1.04	0.297
NX	-.1472659	-7.28	0.000
$(NX)^2$	.0000127	4.06	0.000
NXlag	.1070176	7.43	0.000
NX*RD	.0000821	2.13	0.033
Wald chi2 = 7585.88 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
ADV		0.5979	
MKT		0.3626	
RD		-1.3905	
NX		-0.0948	

The first equation of Growth Block: The estimated GROUT relation

The estimated GROUT relation as presented in Table 4.9.1 shows that GROUT is positively related to ADV of the previous period, MKT of the previous period, RD of the previous period and NX of the previous period. Increase in these factors increases GROUT.

Considering MKT of the current period, it can be seen that MKT has inverted U-relationship with GROUT. Initially increase in MKT increases GROUT but the effect of the square term is negative. This means that too much MKT is costly for the firms.

There exists a joint interaction term of ADV and MKT. It has positive effect on GROUT. The joint spending on ADV and MKT increases GROUT.

All these effects taken into account, the positive marginal effects of ADV and MKT can be obtained.

Considering RD and NX of the current period, it can be seen that both have U-relationship with GROUT. Their sole effects are negative but the effects of their square terms are positive. Their positive effect on RD and NX will be obtained beyond their critical levels.

There exists a joint interaction term of NX and RD. It has a positive effect on GROUT. All these effects taken into account, the marginal effects of both NX and RD come out to be negative as their mean levels are lesser than their critical levels beyond which their positive effects can be obtained.

Table 4.9.2 Factors explaining the ADV behaviour from a Simultaneous Equation Panel Model of Growth Block

Endogenous Variable: ADV

Independent Variable	Coefficient	z-value	p>|z|
GROUT	-.1129191	-1.92	0.054
$(GROUT)^2$	1.92e-06	0.18	0.857
MKT	-.0985345	-7.80	0.000
$(MKT)^2$	.0000198	19.43	0.000
MKTlag	.0232731	3.11	0.002
GROUT*MKT	.0002118	2.22	0.026
RD	1.218301	21.04	0.000
$(RD)^2$	-.0007522	-12.73	0.000
NX	-.0660031	-10.52	0.000
$(NX)^2$	1.81e-06	2.91	0.004
NXlag	.0120072	2.30	0.021
NX*RD	.0000709	5.99	0.000
Wald chi2 = 11138.95 Prob > chi2 = 0.0000			

Determinants	Marginal effects
GROUT	0.2744
MKT	-0.0768
RD	1.1468
NX	-0.0466

The second equation of Growth Block: The estimated ADV relation

The estimated ADV relation as presented in Table 4.9.2 shows that ADV is positively related to MKT of the previous period and NX of the previous period.

Considering GROUT and MKT of the current period, it can be seen that both have U-relationship with ADV. Their sole effects are negative but the effects of the square term terms are positive. Their positive effects on ADV will be realised beyond their critical levels.

There exists a composite effect of GROUT and MKT. This joint interaction term of GROUT and MKT has positive effect on ADV. Considering all these effects, a positive marginal effects of GROUT can be obtained but the marginal effect of MKT is negative as the mean level of MKT is lesser than critical level of MKT beyond which its positive effect can be achieved.

Considering RD of the current period, it can be seen that RD has inverted U-relationship with ADV. Initially the increase in RD increases ADV but beyond the critical level of RD, its negative effect on ADV will be felt.

Considering NX of the current period, it can be seen that NX has U-relationship with ADV. Its positive effect on ADV will be felt beyond its critical level.

There exists a joint interaction term of NX and RD. It has positive effect on ADV. All these effects taken into account, the positive marginal effect of RD will be obtained but the marginal effect of NX is negative as the imports dominate over the exports.

Table 4.9.3 Factors explaining the MKT behaviour from a Simultaneous Equation Panel Model of Growth Block

Endogenous Variable: MKT

Independent Variable	Coefficient	z-value	p>|z|
GROUT	.5453444	3.26	0.001
ADV	-4.756178	-4.86	0.000
$(ADV)^2$	.0026716	3.67	0.000
ADVlag	4.626834	9.56	0.000
RD	5.793156	4.97	0.000
$(RD)^2$	-.0050741	-7.11	0.000
GROUT*RD	-.0137738	-2.77	0.006
$(GROUT*RD)^2$	2.14e-08	0.63	0.527
NX	.0976198	1.91	0.056
$(NX)^2$	.0000106	2.44	0.015
RD*ADV	-.0024403	-1.00	0.320
$(RD*ADV)^2$	1.06e-08	5.40	0.000
Wald chi2 = 3365.62 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
GROUT		3.9599	
ADV		-4.7583	
RD		6.2690	
NX		0.1000	
GROUT*RD		0.6886	

The third equation of Growth Block: The estimated MKT relation

The estimated MKT relation as presented in Table 4.9.3 shows that MKT is positively related to ADV of the previous period.

Considering GROUT of the current period, it can be seen that the sole effect of GROUT is positive. There exists a joint interaction term of GROUT and RD. The marginal effect of this joint interaction term is positive. All these effects taken into account, the positive marginal effect of GROUT can be obtained.

Considering ADV of the current period, it can be seen that ADV has U-relationship with MKT. The positive effect of ADV on MKT will be obtained beyond its critical level.

Considering RD of the current period, it can be seen that RD has inverted U-relationship with MKT. Initially increase in RD increases MKT but beyond its critical level, its negative effect on MKT can be felt.

There exists a joint interaction term of RD and ADV. It has positive effect on MKT.

Considering all these effects, a positive marginal effect of RD can be obtained but the marginal effect of ADV is negative as the mean level of ADV is lesser than the critical level of ADV.

Considering NX of the current period, it can be seen that NX has positive non-linear relationship with MKT. The marginal effect of NX on MKT is positive.

Table 4.9.4 Factors explaining the RD behaviour from a Simultaneous Equation Panel Model of Growth Block

Endogenous Variable: RD

Independent Variable	Coefficient	z-value	$p>\lvert z\rvert$
ADV	.7589292	3.26	0.001
$(ADV)^2$	.0005177	1.56	0.119
ADVlag	.5021717	4.22	0.000
MKT	.1920269	5.41	0.000
$(MKT)^2$	-.0000344	-4.53	0.000
NX	.0264008	3.42	0.001
$(NX)^2$	-6.09e-06	-7.25	0.000
NXlag	.0739676	9.37	0.000
GROUT*NX	-.0008968	-9.85	0.000
$(GROUT*NX)^2$	1.32e-09	6.56	0.000
Wald chi2 = 2047.18 Prob > chi2 = 0.0000			

Determinants	Marginal effects
GROUT	0.0090
ADV	0.7950
MKT	0.1811
NX	-0.0267
GROUT*NX	0.0169

The fourth equation of Growth Block: The estimated RD relation

The estimated RD relation as presented in Table 4.9.4 shows that RD is positively related to ADV of the previous period and NX of the previous period.

Considering ADV of the current period, it can be seen that ADV has positive non-linear relationship with RD. Considering all these effects, the positive marginal effect of ADV on RD can be obtained.

Considering MKT of the current period, it can be seen that MKT has inverted U-relationship with RD. Initially with increase in MKT, RD increases but beyond its critical level, its negative effect on MKT will be felt. All these effects taken into account, the positive marginal effect of MKT on RD can be obtained.

Considering NX of the current period, it can be seen that NX has inverted U-relationship with RD. Initially the increase in NX increases RD but beyond the critical level of NX, its negative effect on RD will be felt.

There exists a joint interaction term of GROUT and NX. The marginal effect of this joint interaction term on RD is positive.

Considering all these effects, a positive marginal effect of GROUT can be obtained but the marginal effect of NX is negative as the imports dominate over the exports.

Table 4.9.5 Factors explaining the NX behaviour from a Simultaneous Equation Panel Model of Growth Block

Endogenous Variable: NX

Independent Variable	Coefficient	z-value	p>|z|
GROUT	.0845597	4.07	0.000
MKT	.1005359	5.55	0.000
RD	.5912738	7.09	0.000
Wald chi2 = 50.83 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
GROUT		0.0846	
MKT		0.1005	
RD		0.5913	

The fifth equation of Growth Block: The estimated NX relation

The estimated NX relation as presented in Table 4.9.5 shows that NX is positively related to GROUT, MKT and RD of the current period. The increase in all these factors increases NX of the firms.

4.4.1.g Paper Industry

The estimated growth of output of Indian paper firms and also the other endogenous variables explaining the growth corresponding to growth block can be visualized from Table 4.10.1 to Table 4.10.5.

Table 4.10.1 Factors explaining the growth from a Simultaneous Equation Panel Model of Growth Block

Endogenous Variable: Growth of Output (GROUT)

Independent Variable	Coefficient	z-value	p>|z|
ADVlag	5.390546	2.32	0.020
MKT	-.76875	-3.83	0.000
$(MKT)^2$	.0005733	3.22	0.001
MKTlag	.2432866	1.18	0.238
ADV*MKT	.0411843	1.61	0.108
RD	-3.910961	-3.42	0.001
$(RD)^2$	.0058784	3.59	0.000
RDlag	3.985098	3.23	0.001
NX	-1.386434	-0.73	0.463
$(NX)^2$	-.0039904	-2.27	0.023
NX*RD	.6820255	2.41	0.016
Wald chi2 = 398.10 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
ADV		0.0140	
MKT		-0.5572	
RD		0.9416	
NX		3.4906	

The first equation of Growth Block: The estimated GROUT relation

The estimated GROUT relation as presented in Table 4.10.1 shows that GROUT is positively related to ADV of the previous period, MKT of the previous period and RD of the previous period. The increase In ADV, MKT and RD in the previous period increases GROUT in the current period.

Considering MKT of the current period, it can be seen that MKT has U-relationship with GROUT. The sole effect of MKT is negative and the effect of the square term is positive, meaning that the positive effect of MKT can be realised beyond the critical level of MKT.

There exists a joint interaction term of ADV and MKT. It has positive effect on GROUT. The effect of MKT on GROUT depends on ADV and vice-versa. Considering all these effects, the positive marginal effect of ADV but the marginal effect of MKT is negative as the mean level of MKT is lesser than the critical level of MKT.

Considering RD of the current period, it can be seen that RD has U-relationship with GROUT. Its sole effect is positive and the effect of the square term is negative. The positive effect of RD on GROUT will be realised beyond the critical level of RD.

Considering NX of the current period, it can be seen that NX has negative non-linear relationship with GROUT. There exists a joint interaction term of NX and RD. It has positive effect on GROUT. Considering all these effects, the positive marginal effects of RD and NX can be obtained.

Table 4.10.2 Factors explaining the ADV behaviour from a Simultaneous Equation Panel Model of Growth Block

Endogenous Variable: ADV

Independent Variable	Coefficient	z-value	p>|z|
GROUT	.0091641	0.98	0.327
MKTlag	-.0783669	-3.82	0.000
$(\text{MKTlag})^2$	.0000594	3.24	0.001
RD	-.2899769	-4.20	0.000
$(\text{RD})^2$	.0002979	3.89	0.000
RDlag	.3967383	4.60	0.000
NXlag	-.7051097	-1.65	0.098
$(\text{NXlag})^2$	.0543444	1.73	0.083
Wald chi2 = 96.13 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
GROUT		0.0092	
MKTlag		-0.0643	
RD		-0.1958	
NXlag		-0.7070	

The second equation of Growth Block: The estimated ADV relation

The estimated ADV relation as presented in Table 4.10.2 shows that ADV is positively related to GROUT of the current period and RD of the previous period. Increase in GROUT of the current period and RD of the previous period increases ADV of the current period.

Considering RD of the current period, MKT of the previous period and NX of the previous period, it can be seen that all have U-relationship with ADV. Their positive effects on ADV will be realised beyond their critical levels. All these effects taken into account, the marginal effects of RD of the current period, MKT and NX of the previous period come out to negative as their mean values are lesser than their critical levels beyond which their positive effects can be felt.

Table 4.10.3 Factors explaining the MKT behaviour from a Simultaneous Equation Panel Model of Growth Block

Endogenous Variable: MKT

Independent Variable	Coefficient	z-value	p>|z|
GROUT	-.7130839	-3.23	0.001
$(GROUT)^2$	.0014622	2.62	0.009
ADV	3.418874	1.16	0.247
$(ADV)^2$	-.1341853	-1.20	0.230
RD	3.626858	4.60	0.000
$(RD)^2$	-.0043984	-4.64	0.000
NX	-8.543313	-3.21	0.001
$(NX)^2$	.0045171	3.32	0.001
Wald chi2 = 66.66 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
GROUT		-0.6838	
ADV		2.1018	
RD		3.5738	
NX		-8.4727	

The third equation of Growth Block: The estimated MKT relation

The estimated MKT relation as presented in Table 4.10.3 shows that GROUT and NX of the current period have U-relationship with MKT. Their positive effect on MKT can be realised beyond their critical levels. Taking into account all these effects, the marginal effects of

GROUT and NX on MKT come out to be negative as their mean levels are lesser their critical levels.

Considering ADV and RD of the current period, it can be seen that both have inverted U-relationship with MKT. Initially increase in these factor increases MKT but beyond their critical levels, their negative effect on MKT can be felt.

Table 4.10.4 Factors explaining the RD behaviour from a Simultaneous Equation Panel Model of Growth Block

Endogenous Variable: RD

Independent Variable	Coefficient	z-value	p>|z|
GROUT	.013625	0.37	0.711
ADV	-2.898687	-1.40	0.161
$(ADV)^2$	.0752431	1.43	0.153
MKT	.1469177	1.87	0.061
$(MKT)^2$	-.0001476	-1.61	0.107
Agedum	8.880852	1.32	0.186
Wald chi2 = 8.45 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
GROUT		0.0136	
ADV		-2.0804	
MKT		0.1571	

The fourth equation of Growth Block: The estimated RD relation

The estimated RD relation as presented in Table 4.10.4 shows that RD is positively related GROUT. Increase in GROUT will increase RD in the current period.

Considering ADV of the current period, it can be seen that ADV has U-relationship with RD. The positive effect of ADV on RD can be achieved beyond the critical level of ADV. The marginal effect of ADV is negative as the mean ADV is lesser than the critical level of ADV.

Considering MKT of the current period, it can be seen that MKT is inverted U-relationship with RD with positive marginal effect. Initially the increase in MKT increases RD but beyond its critical level, its negative effect on RD will be felt.

Another factor positive influencing RD is Agedum, indirectly affecting GROUT. The younger firms are having higher level of RD than the older firms.

Table 4.10.5 Factors explaining the NX behaviour from a Simultaneous Equation Panel Model of Growth Block

Endogenous Variable: NX

Independent Variable	Coefficient	z-value	p>|z|
GROUT	-4.773046	-4.62	0.000
$(GROUT)^2$	.013608	4.43	0.000
RD	5.678268	2.81	0.005
GROUT*RD	.0670576	3.07	0.002
MKT	-1.600206	-1.95	0.051
$(MKT)^2$	.0006649	0.91	0.364
MKTlag	1.564678	1.99	0.047
Wald chi2 = 27.51 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
GROUT		-3.8054	
RD		6.6880	
MKT		-1.5289	

The fifth equation of Growth Block: The estimated NX relation

The estimated NX relation as presented in Table 4.10.5 shows that NX is positively related to MKT of the previous period.

Considering GROUT of the current period, it can be seen that GROUT has U-relationship with NX. Its sole effect on NX is negative and the effect of the square term is positive. The positive effect of GROUT on NX can be realised beyond its critical level.

Considering RD of the current period, it can be seen that the sole effect of RD is positive. There exists a joint interaction term of GROUT and RD. It has positive effect on NX. The effect of GROUT on NX depends on the mean level of RD and vice-versa. All these effects taken into account, the positive marginal effect of RD can be obtained but the effect of GROUT is negative as the mean GROUT is lesser than the critical level of GROUT.

Considering MKT of the current period, it can be seen that MKT has U-relationship with NX. The positive effect of MKT on NX can be obtained beyond the critical level of MKT. The marginal level of MKT is negative as the mean MKT is lesser than critical level of MKT.

4.4.1.h Textile Industry

The estimated growth of output of Indian textile firms and also the other endogenous variables explaining the growth corresponding to growth block can be visualized from Table 4.11.1 to Table 4.11.5.

Table 4.11.1 Factors explaining the growth from a Simultaneous Equation Panel Model of Growth Block

Endogenous Variable: Growth of Output (GROUT)

Independent Variable	Coefficient	z-value	p>|z|
ADV	-9.282249	-3.21	0.001
$(ADV)^2$	.0279663	0.12	0.907
ADVlag	6.881923	3.26	0.001
MKTlag	6.793169	3.31	0.001
ADV*MKT	.6590851	2.01	0.044
RD	-5.578741	-2.17	0.030
$(RD)^2$	.0735679	1.83	0.068
RDlag	3.669789	1.91	0.057
NX	.0566663	2.09	0.037
Wald chi2 = 2103.24 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
ADV		-5.4754	
MKT		0.7315	
RD		-5.4140	
NX		0.0567	

The first equation of Growth Block: The estimated GROUT relation

The estimated GROUT relation as presented in Table 4.11.1 shows that GROUT is positively related to ADV of the previous periods, MKT of the previous period and RD of the previous period and NX of the current period. Increase in these factors increases GROUT in the current period.

Considering ADV and RD of the current period, it can be seen that both have U-relationship with GROUT. The sole effects are negative but the effects of the square terms are positive. This means that the positive effects of ADV and RD on GROUT will be achieved beyond their critical levels.

There exists a joint interaction term of ADV and MKT. It has positive effect on GROUT. The effect of ADV on GROUT depends on MKT and vice-versa.

All these effects taken under consideration, the positive marginal effect of MKT can be obtained but the marginal effects of ADV and RD will be negative as their mean levels are lesser than their critical beyond which their positive effects can be achieved.

Table 4.11.2 Factors explaining the ADV behaviour from a Simultaneous Equation Panel Model of Growth Block

Endogenous Variable: ADV

Independent Variable	Coefficient	z-value	p>|z|
GROUT	.0021019	0.33	0.738
$(GROUT)^2$	.0000591	1.78	0.076
MKT	.2983487	2.87	0.004
$(MKT)^2$	-.0059744	-3.28	0.001
MKTlag	.272857	3.36	0.001
RD	-1.053971	-3.64	0.000
$(RD)^2$	.0500996	1.54	0.122
RDlag	.3210456	2.52	0.012
NX	-.0442813	-5.56	0.000
$(NX)^2$	.0002304	5.02	0.000
NXlag	.0211009	3.17	0.001
NX*RD	.0064131	1.97	0.049
Agedum	.4087597	1.57	0.117
Wald chi2 = 326.25 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
GROUT		0.0037	
MKT		0.2466	
RD		-0.5133	
NX		-0.0169	

The second equation of Growth Block: The estimated ADV relation

The estimated ADV relation as presented in Table 4.11.2 shows that ADV is positively related to MKT of the previous period, RD of the previous period and NX of the previous period. Increase in these factors increases ADV of the current period.

Considering GROUT of the current period, it can be seen that GROUT has positive non-linear relationship with ADV. The marginal effect is positive. The increase in GROUT increases ADV of the firms.

Considering MKT of the current period, it can be seen that MKT has inverted U-relationship with ADV. Initially increase in MKT increases ADV but beyond the critical level of MKT, the increase in MKT will lead to the fall in ADV. The marginal effect of MKT is positive.

Considering RD and NX of the current period, it can be seen that both have U-relationship with ADV. Their positive effect on ADV will be felt beyond their critical levels.

There exists a composite effect of NX and RD. This joint interaction term of NX and RD has positive effect on ADV. The effect of RD on ADV depends on NX and vice-versa. All these effects taken into consideration, the marginal effects of RD and NX come out to be negative as their mean levels are lesser than their critical levels.

Another factor positively affecting ADV is Agedum, indirectly affecting GROUT. The younger firms are having higher level of GROUT than the older firms.

Table 4.11.3 Factors explaining the MKT behaviour from a Simultaneous Equation Panel Model of Growth Block

Endogenous Variable: MKT

Independent Variable	Coefficient	z-value	p>|z|
GROUT	-.0648121	-3.31	0.001
$(GROUT)^2$	.0003437	1.35	0.175
ADV	.8842064	3.45	0.001
RD	-.3679332	-0.76	0.446
$(RD)^2$	.0578561	2.37	0.018
RDlag	1.403458	2.60	0.009
GROUT*RD	.0273765	1.80	0.072
RD*ADV	.5377298	2.24	0.025
NX	.0304328	3.30	0.001
$(NX)^2$	-.0001862	-3.61	0.000
GROUT*NXlag	.0001573	0.74	0.459
$(GROUT*NXlag)^2$	5.03e-09	3.95	0.000
Wald chi2 = 533.69 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
GROUT		4.8008	
ADV		1.4350	
RD		0.3943	
NX		0.0226	
NXlag		0.0017	
GROUT*NXlag		0.0002	

The third equation of Growth Block: The estimated MKT relation

The estimated MKT relation as presented in Table 4.11.3 shows that MKT is positively related to RD of the previous period.

Considering GROUT and RD of the current period, it can be seen that both have U-relationship with MKT. Their positive effects on MKT will be realised beyond their critical levels. There exists a composite effect of GROUT and RD which has positive effect on MKT, implying that the effect on GROUT on MKT depends on mean level of RD and vice-versa.

Considering ADV of the current period, it can be seen that the sole effect of ADV on MKT is positive. There exists a joint interaction term of RD and ADV which has positive effect on MKT. Taking into account these effects, the positive marginal effects of RD and ADV can be obtained.

There exists another joint interaction term of GROUT of the current period and NX of the previous period and its marginal effect on MKT is positive. Considering all these effects, the marginal effects of GROUT and NX of the previous period on MKT come out to be positive.

Considering NX of the current period, it can be seen that NX has inverted U-relationship with MKT. Initially the increase in NX increases MKT. Beyond its critical level, the increase in NX will lead to the fall in MKT. All these effects taken into account, the marginal effect of NX on MKT come out to be positive.

Table 4.11.4 Factors explaining the RD behaviour from a Simultaneous Equation Panel Model of Growth Block

Endogenous Variable: RD

Independent Variable	Coefficient	z-value	p>|z|
GROUT	.0010708	0.40	0.689
$(GROUT)^2$	-.0000272	-1.78	0.075
MKT	.0669781	2.97	0.003
$(MKT)^2$	-.0012717	-2.51	0.012
NX	-.005342	-2.38	0.018
$(NX)^2$	.0000426	2.39	0.017
NXlag	.0049036	2.49	0.013
Agedum	.333361	3.72	0.000
Wald chi2 = 2335.53 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
GROUT		0.0007	
MKT		0.0593	
NX		-0.0020	

The fourth equation of Growth Block: The estimated RD relation

The estimated RD relation as presented in Table 4.11.4 shows that RD is positively related to NX of the previous period.

Considering GROUT and MKT of the current period, it can be seen that both have inverted U-relationship with RD. Initially the increase in these factors increases RD. But beyond their critical levels, their negative effects on RD can be felt. Considering all these effects, the positive marginal effects of GROUT and MKT can be felt.

Considering NX of the current period, it can be seen that NX has U-relationship with RD. The positive effect of NX on RD will be realised beyond its critical level. The marginal effect of NX is negative, implying that imports dominate over exports.

Another factor positively influencing RD is Agedum, indirectly affecting GROUT. The younger firms are having higher level of RD than the older firms.

Table 4.11.5 Factors explaining the NX behaviour from a Simultaneous Equation Panel Model of Growth Block

Endogenous Variable: NX

Independent Variable	Coefficient	z-value	p>|z|
GROUT	.3697896	2.14	0.032
$(GROUT)^2$	-.0008956	-2.10	0.036
RD	7.641856	1.23	0.217
$(RD)^2$	-.2500688	-2.60	0.009
Wald chi2 = 369.33 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
GROUT		0.3864	
RD		7.2250	

The fifth equation of Growth Block: The estimated NX relation

The estimated NX relation as presented in Table 4.11.5 shows that both GROUT and RD have inverted U-relationship with NX. Initially increase in these factors increases NX but beyond their critical levels, their negative effects on NX will be felt. Considering all these effects, the positive marginal effects of GROUT and RD can be obtained.

4.4.1.i Transport Industry

The estimated growth of output of Indian transport firms and also the other endogenous variables explaining the growth corresponding to growth block can be visualized from Table 4.12.1 to Table 4.12.5.

Table 4.12.1 Factors explaining the growth from a Simultaneous Equation Panel Model of Growth Block

Endogenous Variable: Growth of Output (GROUT)

Independent Variable	Coefficient	z-value	p>|z|
ADV	-2.52509	-4.65	0.000
$(ADV)^2$	.0020954	1.82	0.068
ADVlag	3.479114	4.86	0.000
MKT	-.0914002	-1.30	0.195
$(MKT)^2$	.0000303	2.62	0.009
RD	-2.392673	-3.76	0.000
$(RD)^2$	.002325	3.33	0.001
RDlag	3.159474	4.12	0.000
NX	.0907612	4.92	0.000
$(NX)^2$	-2.85e-06	-3.32	0.001
Wald chi2 = 73.46 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
ADV		-2.5156	
MKT		-0.0897	
RD		-2.3867	
NX		0.0998	

The first equation of Growth Block: The estimated GROUT relation

The estimated GROUT relation as presented in Table 4.12.1 shows that GROUT is positively related to ADV of the previous period and RD of the previous period. Increase in these factors increases GROUT in the current period.

Considering ADV, MKT and RD of the current period, it can be seen that all have U-relationship with GROUT. Their sole effects are negative and the effects of their square terms are positive. The positive effects of these factors on GROUT will be felt beyond their critical levels. All these effects taken into account, the marginal effects of these factors come out to be negative as their mean levels are lesser than their critical levels beyond which their positive effects on GROUT can be realised.

Considering NX of the current period, it can be seen that NX has inverted U-relationship with GROUT. Initially the increase in NX increases GROUT but beyond the critical level of NX, its negative effect on GROUT will be felt. Considering all these effects, the positive marginal effect of NX can be obtained, meaning the exports dominate over imports.

Table 4.12.2 Factors explaining the ADV behaviour from a Simultaneous Equation Panel Model of Growth Block

Endogenous Variable: ADV

Independent Variable	Coefficient	z-value	p>|z|
GROUT	-.2399284	-5.51	0.000
$(GROUT)^2$	.0004859	4.71	0.000
MKT	-.0451571	-1.77	0.076
$(MKT)^2$	.0000342	12.16	0.000
GROUT*MKT	.0007222	2.32	0.020
$(GROUT*MKT)^2$	6.31e-09	9.00	0.000
RD	.8062861	3.89	0.000
$(RD)^2$	-.0039885	-13.44	0.000
RDlag	.2496041	1.12	0.264
$(RDlag)^2$	-.003476	-9.69	0.000
NX	-.0336574	-7.11	0.000
$(NX)^2$	6.49e-07	4.74	0.000
NXlag	.0337691	10.87	0.000
DIVIND	-2.850628	-1.89	0.059
Agedum	-1.518628	-1.30	0.193
Wald chi2 = 3191.31 Prob > chi2 = 0.0000			

Determinants	Marginal effects
GROUT	-0.1413
MKT	-0.0270
RD	0.6894
RDlag	0.2046
NX	-0.0301
GROUT*MKT	0.0006

The second equation of Growth Block: The estimated ADV relation

The estimated ADV relation as presented in Table 4.12.2 shows that ADV is positively related to NX of the previous period.

Considering GROUT, MKT and NX of the current period, it can be seen that all have U-relationship with ADV. Their positive effects on ADV can be felt beyond their critical levels.

There exists a joint interaction term of GROUT and MKT. The marginal effect of this joint interaction term on ADV is positive. The effect of GROUT on ADV depends on MKT and vice-versa. All these effects taken into account, the marginal effect of GROUT, MKT and NX come out to be negative as their mean levels are lesser than their critical levels, beyond which their positive effects can be achieved.

Considering RD of the current period as well as the previous period, it can be seen that both have inverted U-relationship with ADV. Initially the increase in RD both in the current period and previous period increases ADV. But beyond their critical levels, their increase will lead to the fall in ADV. Considering all these effects, the positive marginal effects of RD in the current period as well as in the previous period on ADV can be obtained.

Another factor affecting ADV is DIVIND, indirectly affecting GROUT. It has negative effect on ADV, meaning that as the market share gets concentrated, the firms will be having higher level of ADV.

The last factor affecting ADV is Agedum, indirectly affecting GROUT. It also has negative effect on GROUT, implying that the older firms have higher level of GROUT than the younger firms.

Table 4.12.3 Factors explaining the MKT behaviour from a Simultaneous Equation Panel Model of Growth Block

Endogenous Variable: MKT

Independent Variable	Coefficient	z-value	p>|z|
GROUT	-.6443321	-3.14	0.002
$(GROUT)^2$	.001792	3.90	0.000
ADV	1.482316	16.09	0.000
$(ADV)^2$	-.0277977	-15.13	0.000
GROUT*ADV	.0816035	8.75	0.000
RD	3.085063	3.83	0.000
$(RD)^2$	.0158698	17.66	0.000
NX	.2950275	14.96	0.000
$(NX)^2$	-.0000169	-19.57	0.000
Wald chi2 = 517679.30 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
GROUT		0.1523	
ADV		1.1752	
RD		0.1552	
NX		0.3029	

The third equation of Growth Block: The estimated MKT relation

The estimated MKT relation as presented in Table 4.12.3 shows that GROUT has U-relationship with MKT. The sole effect of GROUT is negative but the effect of the square term is positive. The positive effect of GROUT can be obtained beyond the critical level of GROUT.

Considering ADV and NX of the current period, it can be seen that both have inverted U-relationship with MKT. Initially their increase will increase MKT but beyond their critical levels, their negative effects on MKT will be felt.

There exists a joint interaction term of GROUT and ADV which has positive effect on MKT. The effect of GROUT on MKT depends on ADV and vice-versa. All these effects taken into account, the positive marginal effects of GROUT, ADV and NX can be obtained.

Considering RD of the current period, it can be seen that RD has positive non-linear relationship with MKT. The marginal effect of RD is positive, implying that increases in RD increases MKT.

Table 4.12.4 Factors explaining the RD behaviour from a Simultaneous Equation Panel Model of Growth Block

Endogenous Variable: RD

Independent Variable	Coefficient	z-value	p>|z|
GROUT	.0392493	2.42	0.016
$(GROUT)^2$	-.0000935	-2.44	0.015
ADV	.3226699	11.43	0.000
$(ADV)^2$	-.0008287	-18.17	0.000
MKT	.025358	7.27	0.000
MKTlag	.1363206	14.99	0.000
NX	-.0136793	-12.96	0.000
$(NX)^2$	2.39e-07	29.18	0.000
NXlag	-.0019583	-1.37	0.170
$(NXlag)^2$	3.79e-07	9.65	0.000
DIVIND	-.9702821	-1.78	0.076
Wald chi2 = 20524.02 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
GROUT		0.0286	
ADV		0.3078	
MKT		0.0254	
NX		-0.0100	
NXlag		-0.0009	

The fourth equation of Growth Block: The estimated RD relation

The estimated RD relation as presented in Table 4.12.4 shows that RD is positively related to MKT of the current period as well as previous period. Increase in MKT both in the current period as well as in previous period increases RD.

Considering GROUT and ADV of the current period, it can be seen that both have inverted U-relationship with RD. Initially their increase will result in a rise in RD but beyond their critical levels, increase in these factors leads to the fall in RD. Taking into account all these effects, the positive marginal effects of both GROUT and ADV can be obtained.

Considering NX of the current period as well as previous period, it can be seen that both have U-relationship with RD. Their positive effects can be obtained beyond their critical levels. Considering all these effects, the marginal effects of both NX of the current period and previous period come out to be negative as imports dominate over exports.

Another factor affecting RD is DIVIND, indirectly influencing GROUT. This means that as the market share gets concentrated, the firms will be having higher level of RD.

Table 4.12.5 Factors explaining the NX behaviour from a Simultaneous Equation Panel Model of Growth Block

Endogenous Variable: NX

Independent Variable	Coefficient	z-value	p>|z|
GROUT	-5.250333	-2.92	0.004
$(GROUT)^2$	.0116656	2.67	0.008
MKT	3.559809	14.98	0.000
$(MKT)^2$	-.0003414	-29.11	0.000
MKTlag	1.330865	8.13	0.000
RD	13.41222	5.22	0.000
Wald chi2 = 68944.12 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
GROUT		-5.0984	
MKT		3.4732	
RD		13.412	

The fifth equation of Growth Block: The estimated NX relation

The estimated NX relation as presented in Table 4.12.5 shows that NX is positively related to MKT of the previous period, RD of the current period. Increase in these factors increases NX of the current period.

Considering GROUT of the current period, it can be seen that GROUT has U-relationship with NX. The positive effect of GROUT on NX can be achieved beyond the critical level of GROUT. The marginal effect of GROUT is negative as the mean level of GROUT is lesser than the critical level of GROUT beyond which their positive effects can be obtained.

Considering MKT of the current period, it can be seen that MKT has inverted U-relationship with NX. Initially increase in MKT increases NX but beyond the critical level of MKT, its negative effect on NX can be felt. All these effects taken under consideration, the positive marginal effects of MKT can be obtained.

4.5 Conclusion

The sample manufacturing firms are experiencing 13.95% of growth 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 of the current period has positive marginal effect on GROUT in leather, machinery, metal, non-metallic mineral products and paper industries. Increase in ADV increases growth of output (GROUT) in these industries in the current period. But, ADV of the current period has U-relationship with GROUT with negative marginal effects in chemical, food products, textile and transport industries. For the 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 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 of the current period has positive marginal effect on GROUT in food products, leather, non-metallic mineral products and textile industries. Increase in MKT increases GROUT in these industries in the current period. But MKT of the current period has U-relationship with GROUT with negative marginal effect in chemical, machinery, metal, paper and transport industries. 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. 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 dominates 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 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, machineryand 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 implies that its exports have become costlier and its imports have become 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 can further influence 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.

Chapter 5

Analysis of Efficiency

5.1 Introduction

There are two alternative concepts of efficiency. One is allocative efficiency which is a property of an efficient market where all goods and services are optimally distributed among buyers in an economy. The other one is technical efficiency which is the effectiveness with which a given set of inputs is used to produce an output. The present study measures technical efficiency.

Technical efficiency can be measured either input-oriented (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) or output-oriented approach (the ratio of actual output produced to the maximum level of output that can be produced given the input usage). The present study will consider both these input oriented and output oriented approach.

The question can be raised whether the firms under Indian manufacturing sector are operating efficiently, what happens to the efficiency of output in the production process also how efficiently the inputs are utilized? This in turn raises some interesting questions: how is the economic performance or to be specific, the technical efficiency (TE) of a company to be estimated? And what are the factors that explain its variation among different companies?

The perusal of the literature relating to studies on technical efficiencies as discussed in Chapter 2 suggests that, there is dearth in studies dealing with the measurement of output oriented and input oriented TE and finds its determinants for Indian manufacturing firms in a simultaneous panel set up considering the endogenous variables TE (ITE for ITE Block and OTE for OTE Block), ADV, MKT, RD and NX. The present chapter adds the literature to this direction.

The present chapter measures the input oriented technical efficiency (ITE) and output oriented technical efficiency (OTE) of the unit of a sample of Indian manufacturing firms under nine industry groups applying the method of non parametric Data Envelopment Approach (DEA) over the period 1995-2016 and tries to find out their determinants in a simultaneous panel set up considering the endogenous variables TE (ITE for ITE Block and OTE for OTE Block), ADV, MKT, RD and NX. This chapter finds out the determinants of

TE (both for ITE and OTE) in a simultaneous panel set up as developed by Baltagi (EC2SLS random-effects IV regression) for all the nine industry groups. It also tries to assess the inefficiency of utilization of different inputs used in the production process by taking into account the slack of the inputs.

The chapter unfolds as follows. Section 5.2 reports DEA methodologies for measuring output and input oriented TE of the companies. It also reports the methodologies for measuring input slack and the data source. The estimated results of input oriented technical efficiency of the sample firms are presented in Section 5.3. Section 5.4 finds out the determinants of input oriented technical efficiency in a simultaneous panel set up considering the endogenous variables ITE, ADV, MKT, RD and NX. Section 5.5 reports the estimated results of output oriented technical efficiency of the sample firms. Section 5.6 finds out the determinants of input oriented technical efficiency in a simultaneous panel set up considering the endogenous variables ITE, ADV, MKT, RD and NX. Section 5.7 concludes the study.

5.2 Methodology and Data Source

The chapter uses two stage methodologies. In the first stage, the output and input oriented technical efficiency (TE) of the firms is computed using the Data Envelopment Analysis (DEA). The estimated technical efficiency score (input and output oriented) is then used to find out the determinants of TE in a simultaneous panel set up considering the endogenous variables TE (ITE for ITE Block and OTE for OTE Block), ADV, MKT, RD and NX . The input slack of different inputs used is measured.

5.2.1 Measurement of technical efficiency (TE)

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

TE of a firm can be measured either by (i) output-oriented measure or by (ii) input-oriented measure.

In case of output oriented measure the TE of a firm can be computed by comparing its actual output with the maximum producible quantity from its observed inputs i.e. by how much can output quantities be proportionally expanded without altering the inputs quantities used.

In input oriented measure, the TE of a firm can be measured by comparing its actual input in use with the minimum input that would produce the targeted output level i.e. by how much can input quantities be proportionally reduced without changing the actual output bundle .

Both the input and output oriented measures of technical efficiencies in case of single input and output, can be visualized from figure 5.1.

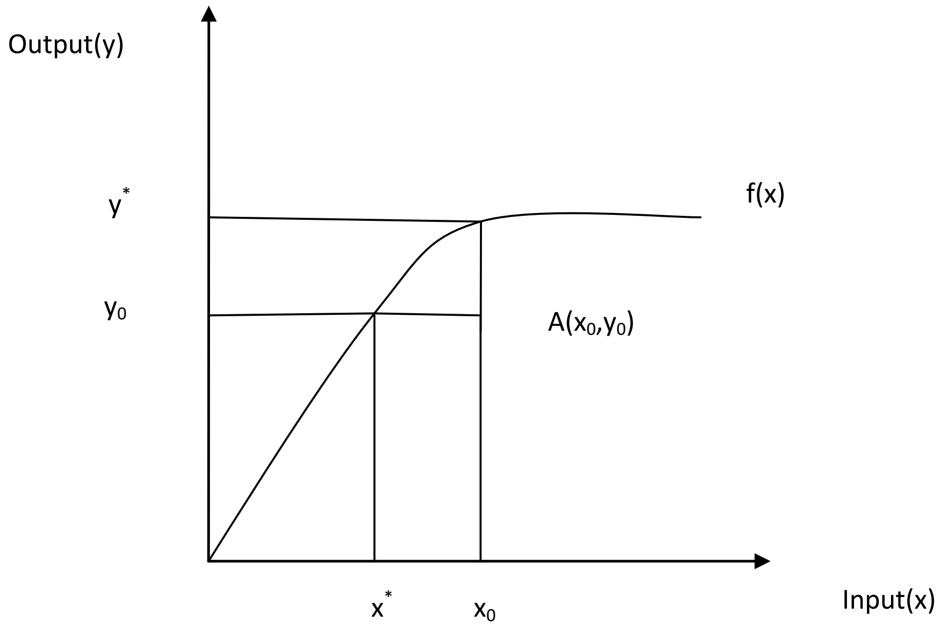

Figure 5.1. The input and output oriented measure of technical efficiency

In figure 5.1. input x is measured along horizontal axis and output y along the vertical axis. Point A (x_0, y_0) represents the actual input-output bundle of a firm, A. Now, $y^* = f(x_0)$, where y * is the maximum output producible from input x_0. The output-oriented measure of technical efficiency of firm A = $\frac{y_0}{y^*}$ which is the comparison of actual output with the maximum producible quantity from the observed input. Now for the same output bundle y_0 , the input quantity can be reduced proportionately till the frontier is reached. So, y_0 can be produced from input x *. Thus the input-oriented technical efficiency measure for firm A = $\frac{x^*}{x_0}$.

The TE score of a firm takes a value between 0 & 1. A value of one indicates the firm is fully technically efficient.

In DEA, a benchmark technology is constructed from the observed input-output bundles of the firm in the sample without any assumption regarding the production frontier. The general assumptions made about the production technology are: i) All actually observed input-output combinations are feasible. ii) The production possibility set is convex. iii) Inputs are freely disposable. iv) Outputs are freely disposable. These are weak assumptions. These assumptions hold for all technologies represented by quasi-concave and weak monotonic production function

Figure 5.2. illustrate the basic ideas behind DEA and return to scale. Four data points (A, B, C, and D) are used here to describe the efficient frontier and the level of capacity utilization under VRS and CRS assumptions. In a simple one output and one input DEA problem, A, C and D are found to be efficient, while B is inefficient. So unit B can produce more output at point B' on the frontier (which is equal to theoretical maximum) utilizing same level of input at X_1. With constant returns to scale, the frontier is defined by point C for all points along the frontier, with all other points falling below the frontier (hence indicating capacity underutilization). With variable returns to scale, the frontier is defined by points A, C and D, and only B lies below the frontier i.e. shows capacity underutilization. So capacity output corresponding to VRS is smaller than the capacity output corresponding to CRS.

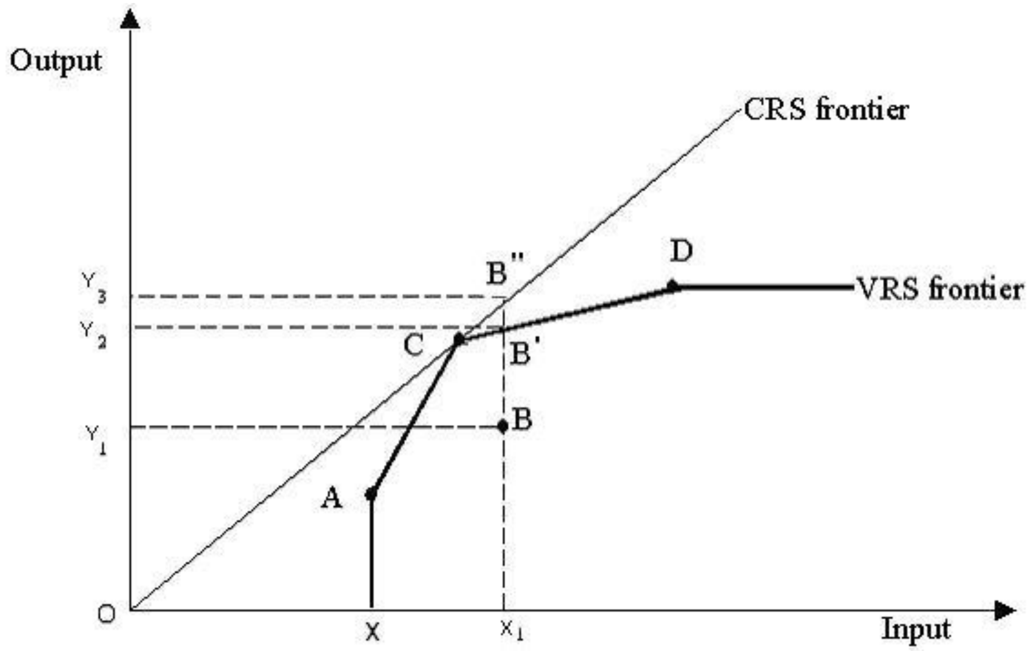

Figure 5.2. The Production Frontier and Returns to scale

The present chapter measure technical efficiency of Indian manufacturing firms assuming variable return to scale (VRS) using nonparametric method of Data Envelopment Analysis (DEA) and rests on both output and input oriented measure of TE.

Output Oriented TE

It is supposed that there are *N* firms. Each of them is producing 'g' outputs using 'h' inputs. The firm t uses input bundle $x^t = \left(x_{1t,} x_{2t,\ldots\ldots\ldots} x_{ht}\right)$ and produces the output bundle $y^t = \left(y_{1t,} y_{2t,\ldots\ldots\ldots} y_{gt}\right)$. Technology can either follow constant returns to scale (CRS) or variable returns to scale (VRS).

The production possibility set corresponding to CRS can be defined as

$$T^{CRS} = \left\{(x, y) : x \geq \sum_{j=1}^{N} \lambda_j x^t ; y \leq \sum_{j=1}^{N} \lambda_j y^t ; \lambda_j \geq 0; \left(j = 1,2,\ldots\ldots N\right)\right\} \qquad \cdots 5.1$$

The specific production possibility set under VRS is given by

$$T^{VRS} = \left\{(x, y) : x \geq \sum_{j=1}^{N} \lambda_j x^t ; y \leq \sum_{j=1}^{N} \lambda_j y^t ; \sum_{j=1}^{N} \lambda_j = 1; \lambda_j \geq 0; \left(j = 1,2\ldots N\right)\right\} \qquad \ldots..5.2$$

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

$$\max \phi$$

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

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

$$\phi \text{ free} \qquad \lambda_j \geq 0; , \qquad \left(j = 1,2\ldots\ldots N\right) \qquad \ldots.5.3$$

Output oriented TE of firm t can be determined by using equation (5.4).

$$TE_o^{ct} = TE_o^{ct}(x^t, y^t) = \frac{1}{\phi^*} \qquad \text{…. 5.4}$$

Where ϕ^* is the solution of equation (5.3) showing the maximum value of ϕ . y* is the maximum output bundle producible from input bundle x^t and is defined as y*= $\phi^* y^t$. Under VRS, max $\phi, \phi^\bullet$, can be determined by solving equation (5.3) along with the constraint $\sum_{j=1}^{N} \lambda_j = 1$, taking into account the VRS frontier (equation 5. 2) .Knowing $\phi^\bullet$, technical efficiency of the firm can be solved using similar methodology corresponding to CRS.

Input Oriented TE

The input-oriented measure of technical efficiency of any firm t under CRS requires the solution of the following LP problem

$$\min \theta$$

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

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

$$\theta \quad \text{free,} \qquad \lambda_j \geq 0, \quad \text{(j=1,2………..N)} \qquad \text{…5.5}$$

The input-oriented technical efficiency of firm t under CRS is

$$TE_{IN}^{ct} = TE_{IN}^{ct}(x^t, y^t) = \theta^* \in T^{CRS} \qquad \text{….5.6}$$

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

Thus knowing θ^* by solving equation (5.5) input oriented TE of firm t can be determined by using equation (5.6). The equation (5.6) is the derived value of technical efficiency (TE) by solving the problem specified in equation (5.5) which shows determination of TE under CRS and not under VRS and hence (5.6) in fact shows measured value of TE for CRS frontier.

However, the present chapter has not used (5.6) to calculate TE of the sample companies. (5.6) is used for getting a clear idea about the difference between method of estimation of TE under CRS and VRS. Rather, this chapter 5 considers estimation of TE under VRS frontier.

Under **VRS, the input oriented TE of any firm t** can be determined by solving problem (5.5) along with the constraint $\sum_{j=1}^{N} \lambda_j = 1$, taking into consideration the VRS frontier.

Thus all the estimated values of TE as presented in this chapter are VRS measure.

5.2.2 Determination of input slack

In LP models radial measures of efficiency is obtained. Here efficiencies are measured along a ray from the origin to the observed production point. In such a radial projection of an observed input-output bundle onto the frontier, sometimes the output is not optimally expanded and also all the inputs used are not potentially reduced. The horizontal or vertical portion of an isoquant or product transformation curve accounts for inefficiency in usage of inputs or output production. As a result there may be the possibility of the existence of output and input slack for the case of multiple input output production process.

Among the output produced by firm t, It is also possible that firm t may not entirely use up all the individual components of the input bundle to produce the expanded output bundle.

And the input slack variable can be defined as

$$s_i^- = x_{it} - x_{it}^* \quad , \quad (i = 1,2.......h) \qquad ......5.7$$

The input slack is explained in fig 5.3.

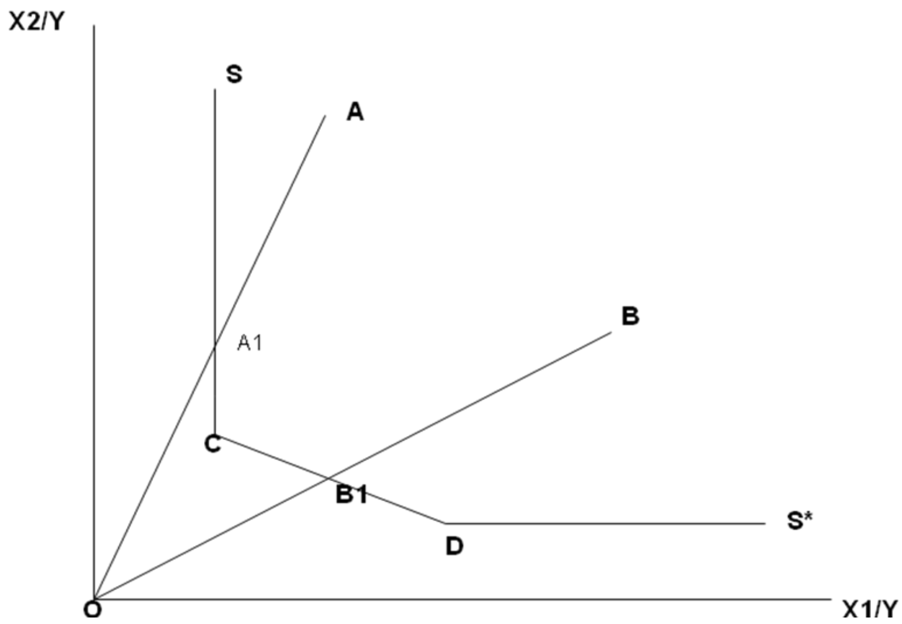

Figure 5.3. Measurement of input slack

In the figure C & D are two efficient firms which are on the frontier. Firm A & B are inefficient. Now point A_1 is on the frontier but here also the firm is inefficient as one can reduce the amount of x_2 input by CA_1 and still produce the same output. So CA_1 is the input slack movement of input x_2.

5.2.3 Data Source

Data regarding the Input-Output variables and factors determining the technical efficiency have been collected from CMIE Prowess Database for the time period March, 1995 – March, 2016.

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) deflated by WPI (base 1993-94 = 100), and (v) Capital (measured in terms of value of the net fixed assets) deflated by WPI of machinery (base: 1993-94 =100).

After estimating technical efficiency, this chapter tries explain the variation of technical efficiency in term of other economic and strategic variables like R&D, Marketing, advertisement, net export, diversification index, size and age of the companies. The data for all these are also collected from CMIE Prowess data. Technical efficiency (ITE for ITE Block and OTE for OTE Block), ADV, MKT, RD and NX are assumed to be jointly determined in a simultaneous equation frame. ADV, MKT, RD and NX affect the technical efficiency of the firms and in turn get reciprocally affected by technical efficiency. In order to explain net export behavior I have used real effective exchange rate, the data of which are collected from Reserve Bank of India.

5.3 Estimated Results of Input Oriented Technical Efficiency of Firms

The input oriented efficiency score of the companies as well as the input slack for respective usage of the inputs are obtained on the basis of a computer program DEAP Version 2.1, developed by Tim Coelli.

Table 5.1 Mean Input Oriented Technical Efficiency of the Firms

Year	Chemical	Food Products	Leather	Machinery	Metal	Non-metallic mineral products	Paper	Textile	Transport	Grand Mean
1995	0.744	0.794	0.886	0.895	0.73	0.94	0.931	0.756	0.933	0.845
1996	0.820	0.863	0.91	0.903	0.882	0.941	0.954	0.887	0.938	0.900
1997	0.765	0.877	0.955	0.905	0.927	0.965	0.892	0.877	0.935	0.900
1998	0.763	0.831	0.919	0.936	0.932	0.932	0.88	0.91	0.944	0.894
1999	0.836	0.851	0.917	0.905	0.936	0.966	0.876	0.908	0.927	0.902
2000	0.910	0.841	0.967	0.933	0.922	0.96	0.891	0.92	0.927	0.919
2001	0.904	0.827	0.954	0.879	0.928	0.977	0.846	0.784	0.924	0.891
2002	0.868	0.792	0.939	0.895	0.917	0.981	0.872	0.856	0.898	0.891
2003	0.870	0.797	0.924	0.857	0.875	0.949	0.842	0.882	0.891	0.876
2004	0.748	0.822	0.99	0.866	0.899	0.85	0.840	0.897	0.908	0.869
2005	0.807	0.842	0.968	0.904	0.911	0.826	0.898	0.888	0.923	0.885
2006	0.838	0.864	0.886	0.919	0.927	0.731	0.893	0.918	0.925	0.878
2007	0.870	0.85	0.928	0.918	0.89	0.767	0.873	0.894	0.934	0.880
2008	0.853	0.849	0.918	0.920	0.781	0.848	0.894	0.891	0.946	0.878
2009	0.864	0.834	0.918	0.907	0.843	0.868	0.909	0.883	0.957	0.887
2010	0.865	0.844	0.914	0.894	0.906	0.883	0.907	0.866	0.935	0.890
2011	0.826	0.784	0.970	0.902	0.882	0.899	0.852	0.861	0.930	0.878
2012	0.873	0.759	0.979	0.882	0.867	0.853	0.864	0.861	0.923	0.873
2013	0.905	0.81	0.976	0.879	0.858	0.921	0.878	0.881	0.937	0.894
2014	0.851	0.806	0.963	0.869	0.888	0.912	0.900	0.893	0.879	0.885
2015	0.737	0.822	0.955	0.893	0.852	0.903	0.899	0.844	0.909	0.868
2016	0.783	0.795	0.945	0.854	0.896	0.888	0.918	0.795	0.939	0.868

Source: Compiled by the Author

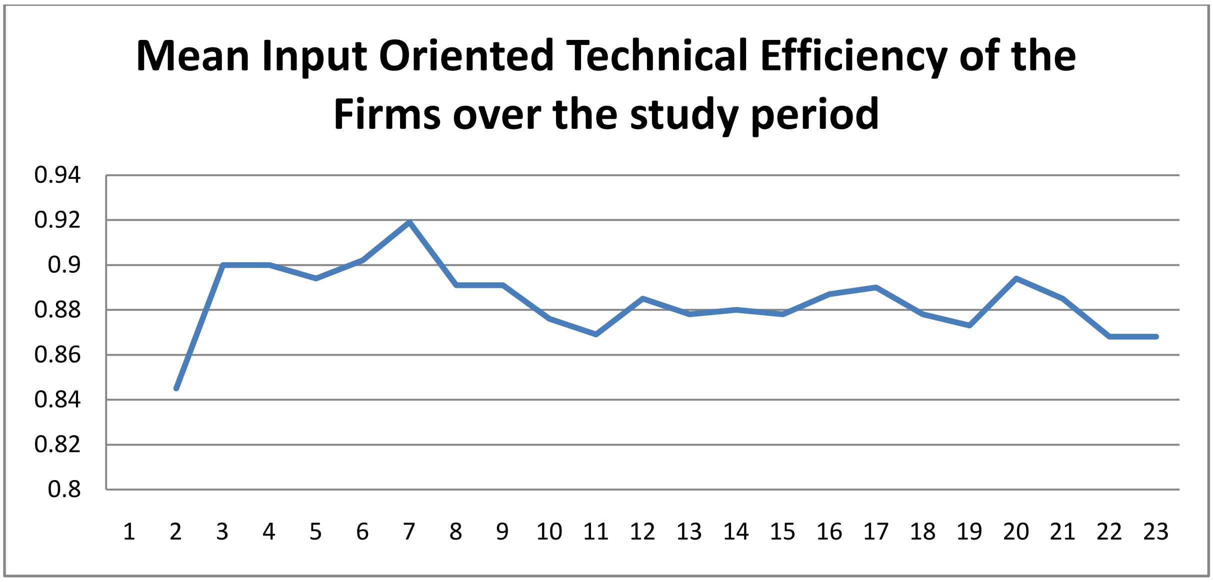

Figure 5.4. Mean Input Oriented Technical Efficiency of the Firms

Table 5.1 and Figure 5.4. shows 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 & 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.

Table 5.2 Mean Input Oriented Technical Efficiency (all the years taken together)

Industry	**Mean Input Oriented Technical Efficiency**
Chemical	0.832
Food Products	0.825
Leather	0.940
Machinery	0.896
Metal	0.884
Non-metallic mineral products	0.898
Paper	0.887
Textile	0.871
Transport	0.926
Grand Mean	0.884

Source: Compiled by the Author

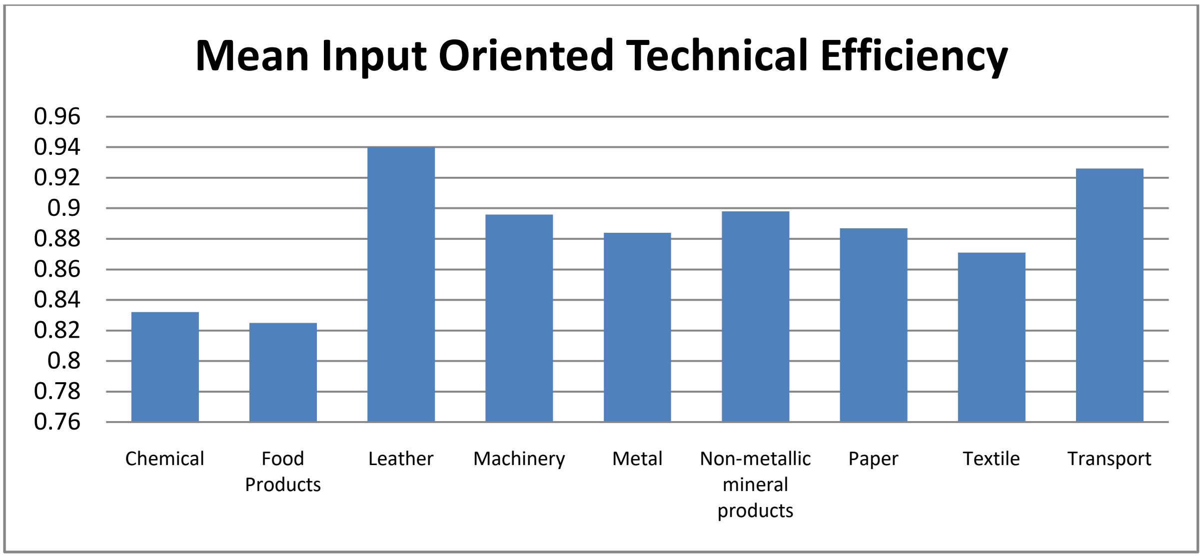

Figure 5.5. Mean Input Oriented Technical Efficiency (all the years taken together)

Table 5.2 shows that the grand mean input oriented technical efficiency 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. Figure 5.5. shows that 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.

Table 5.3 Percentage of Efficient firms for all industry groups (ITE)

Industry	**% of Efficient firms**
Chemical	12
Food Products	26
Leather	64
Machinery	17
Metal	21
Non-metallic mineral products	32
Paper	55
Textile	17
Transport	23
Grand Mean	30

Source: Compiled by the Author

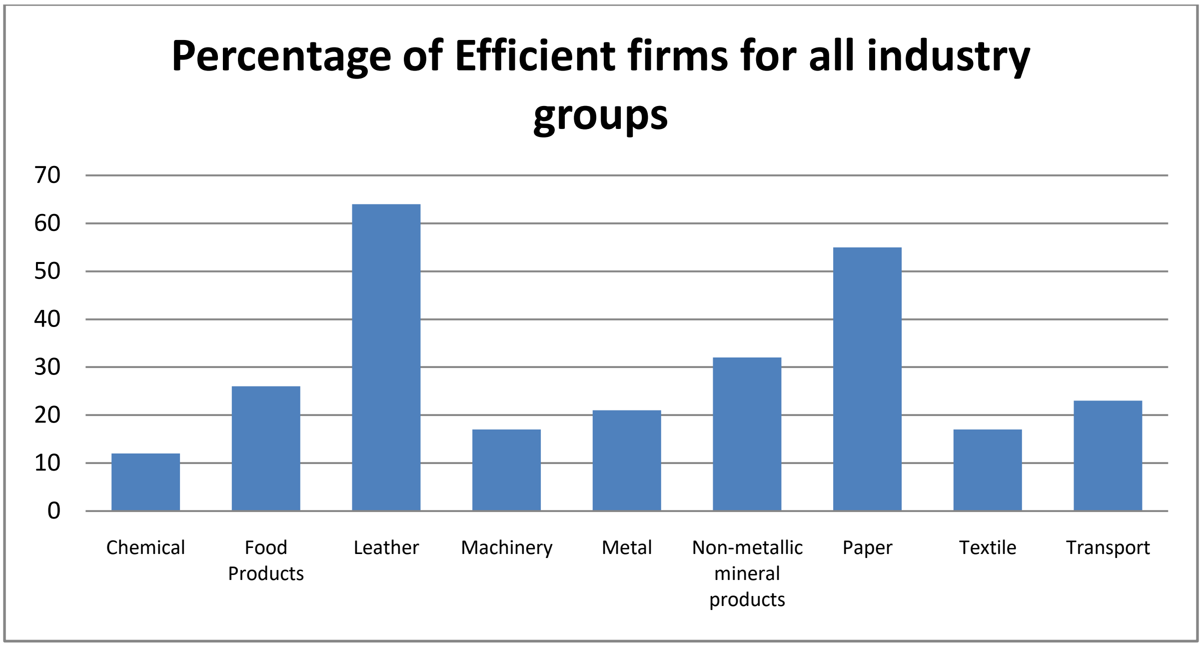

Figure 5.6. Percentage of Efficient firms for all industry groups (ite)

Table 5.3 shows that 30% of the total sample firms were producing efficiently on an average. This means that their efficiency score is equal to 1 and others are producing below the production frontier. Figure 5.6. shows that the highest 64% of sample firms in leather industry are input-efficient whereas the lowest 12% of sample firms under chemical industry are input-efficient.

Table 5.4 Mean Input Slacks (industry-wise analysis)

Industry	Raw materials input	Energy & water input	Labour	Land	Capital
Chemical	30.484	74.884	18.236	14.213	327.526
Food Products	29.305	16.262	33.376	2.58	99.141
Leather	13.495	2.147	3.583	0.07	14.943
Machinery	43.77	13.639	31.647	2.843	85.947
Metal	35.744	40.303	23.943	2.127	152.883
Non-metallic mineral products	64.504	6.169	26.421	2.205	147.236
Paper	20.465	16.917	9.616	1.063	48.272
Textile	12.034	22.136	18.682	1.128	73.325
Transport	14.98	21.925	72.874	9.242	305.842
Grand Mean	29.420	23.820	26.486	3.941	139.457

Source: Compiled by the Author

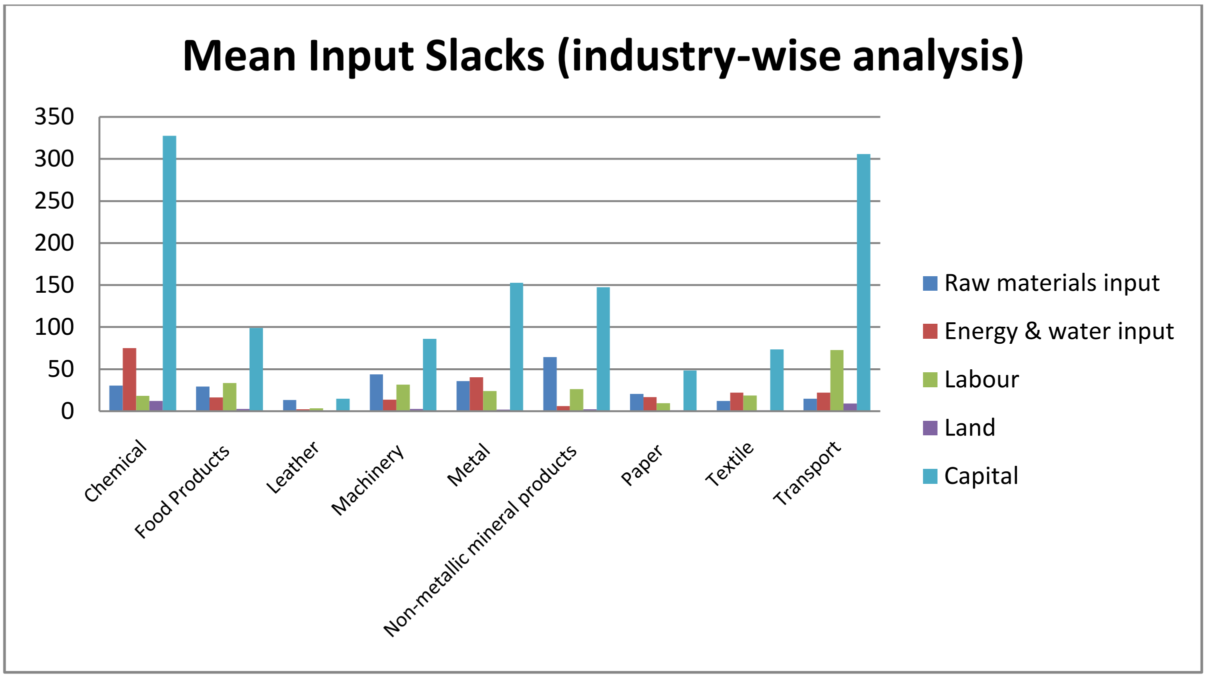

Figure 5.7. Mean Input Slacks (industry-wise analysis)

Table 5.4 & Figure 5.7. represent that the same amount of output can be produced by reducing raw materials input 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.

5.4 Determinants of Input Oriented Technical Efficiency (ITE)

A second stage panel regression has been carried out to relate the input oriented technical efficiency of the Indian manufacturing firms with the strategic variables perused by firms as well as firms' characteristics namely R&D Intensity, Net Export Intensity, Advertising Intensity, Marketing Intensity, Age, Diversification Index and Size of the company. The explanations for the inclusion of different explanatory variables can be summarized as follows:

Advertising Intensity (ADV):

The consumers are exposed to a multiple choice of products when the firms are carrying on advertising. So in order to attract the consumers firm has to produce quality product at an economic rate and this becomes possible when the firm is able to use its inputs efficiently. Goldar et al. (2004) and Carod and Blasco (2004) pointed out the association between advertising intensity and technical efficiency for the Indian Engineering goods industries and Spanish manufacturing firms respectively. Ray (2006) did not find any effect of product differentiation on technical efficiency in the Indian manufacturing industries.

Thus the basic question is to what extent advertising expenditures foster input oriented efficiency? But on the other hand advertising expenditure can in turn get affected by the efficiency of the companies and also by the other economic and strategic variables like market share, marketing and R&D behavior. Further advertisement activity can be influenced by age and size of the company. Thus, in order to determine the major factors influencing advertisement expenditure, one needs to formulate and estimate a simultaneous kind of relation between all these variables.

Marketing Intensity (MKT):

In order to market a product successfully once again company has to produce quality product at an economic rate and this becomes possible when the company is able to use its inputs efficiently. Sheth and Sisodia (2002) claimed that low productivity or efficiency occurs due to the fall in the marketing effectiveness. Their study suggests some changes which are needed at the corporate level and the most fundamental point is that corporations should treat marketing as an investment rather than an expense. Kao et al. (2006) evaluates technical efficiency and allocative efficiency in marketing and obtains the direct relation between return and marketing expenditure.

The main question here is to what extent marketing expenditures foster input efficiency? But at the same time marking activity can be influenced by efficiency and other economic and strategic variables like market share, advertisement and R&D behavior, the age and size of the company. So in order to determine to what extent marketing expenditures foster efficiency and in turn gets affected by the efficiency, strategic variables, age and size of the firm, one needs to estimate a simultaneous kind of model where marketing expenditure is determined jointly by the other endogenous variables of the model.

R&D Intensity (RD):

While determining the factors explaining input oriented efficiency of Indian manufacturing firms, the role of R&D is relevant.

R&D activities not only innovate new technologies but at the same time enhance a firm's ability to exploit existing technology. Thus R&D leads to expansion in output at the same time it economizes on input. Here the idea is that as the firm undertakes more R&D, its technical knowledge gradually increases and thus the firm is more capable of producing output with fewer amounts of inputs. Thus one can expect a positive relationship between input oriented TE and R&D. Many studies in the international literature have tested the role of R&D as the determinant of efficiency at an aggregate country level or by sector, although some studies have taken the firm as the unit of analysis. To mention a few Yang et al. (2009) , Kumbhakar et al. (2009), Scannell et al. (2012) . Some studies are available showing the linkage between the R&D activities and efficiency of the firm for Indian industry. Mention may be made of Ferrantino (1992), Driffield and Kambhampti (2003), Mazumder et al. (2010) among others.

At the same time R&D can be influenced by other economic variables like market share of the company, and also by the company's strategic variables like advertisement and marketing behavior. Age and size of the firm can also be a significant determinant of R&D expenditure. It is expected that R&D decision of the company will be determined by the joint interactions of all these variables.

Thus to answer the question to what extent increase in R&D helps to foster the input efficiency of the companies belonging to the Indian manufacturing sector and at the same time to what extent R&D decision of the companies is influenced by its input efficiency, market share as well as other strategic variables and firms' characteristics, one has to formulate a simultaneous kind of relation between these variables showing the joint interactions of each other.

Net Export Intensity (NX):

Exports intensify market competition in both overseas and domestic markets, and tend to force enterprises to be more efficient through the rationalization of management and the adoption of new technologies (Balassa, 1988; Kwon, 1986; Greenaway, 1986; Chen and

Tang, 1990; Greenaway and Sapsford, 1994). World Bank Report (1993, 1997) talked about the firm's import for foreign technology and its positive impact on its efficiency. In the context of India, a direct relationship between technical efficiency and imports has been reported by Goldar et al. (2004) and Mazumder et al. (2010).

The argument in favor of the idea that input oriented efficiency is improved by net export is that as the firms are getting more and more involved in export activities they are exposed to more sophisticated and improved technologies which economizes the input usage and makes them more efficient.

As in the case of the explanations used for variation of input oriented technical efficiency, we will assume net export activities help to foster the input oriented efficiency of the companies belonging to the manufactoring sector and reciprocally get affected by the efficiency and by other economic and strategic variables like market share, R&D expenditure, advertising expenditures, marketing expenditures and age of the companies by the joint interactions of each other.

Diversification Index (DIVIND):

DIVIND of a particular industry groups captures the effect of market structure on efficiency of the firms. DIVIND is the reciprocal of concentration ratio. The Herfindahl Index or Concentration Index is calculated as follows: $H = \Sigma s_i^2$; where s_i is the market share of the i^{th} firm in the market and N is the number of firms.

An inverse relationship between CR and efficiency is expected by some researchers because competition may lead to cost-consciousness and drive for technological advancement. Others may point out the advantages of big size, secured market and expect a positive association between CR and efficiency. The conclusion from the empirical literature also varies and does not provide us a single answer [(Katz, 1969); (Kendrick, 1973)].

Age: There are counter arguments regarding the effect of age on firm's performances. One argument is that older firms are displaying superior performances since they are more experienced for having the advantages of learning earlier and they do not experience the hazards that the newcomers usually face (Stinchcombe, 1965). On the other hand, the counter argument is that older firms do lack enough flexibility to adopt quickly to the changing economic circumstances which the younger firms can do much more rapidly and efficiently (Marshall, 1920).

The present study has divided the sample companies into two groups:

Agedum = 1, if Mean Age of the firm < Grand Mean Age (considering all the firms and all time Points taken together)

= 0, Otherwise

Size: The efficiency differs due to difference in relative size. A larger sized firms may have an easier access to the cheaper and superior quality inputs which helps to increase its productivity. It is easier for such firms to exploit economies of scale, widen scope of productio by making its operation more effective and allowing it to perform better compared to the smaller sized firms (Penrose,1959). 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. rupees

= 0, otherwise

Mediumdum = 1, if mean investment < 10 Cr. rupees

= 0, otherwise

Largedum = 1, if mean investment > 10 Cr. rupees

= 0, otherwise

In order to avoid dummy variable trap, Mediumdum has been dropped.

It may be possible that the effect of different explanatory variables may be non-linear in nature. To get this effect, the sole effect of different variables, their square terms and the joint effect of different variables will be incorporated. The effects of the lag value (one year lag) of different strategic variables (i.e. the effects of different strategic variable in the previous period) have also been considered.

Since we are dealing with simultaneous equation model one important problem is the problem of Identification of the model, we have solved the problem of Identification by taking into account exclusion restriction. We have checked that the rank and order condition of Identification under exclusion restriction have got satisfied for the model. We make sure that at least one variable is specific to one particular equation and appears only in that equation. The model is identified.

5.4.1 Explaining the Factors Influencing ITE of the Firms: The Results from a Two Stage Least Square Type Approach in a Simultaneous Panel Model.

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

Since we are doing with simultaneous equation model in a panel setup, for purpose of estimation we have used two stage procedures.

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.

Significant Factors explaining ITE from a Simultaneous Equation Panel Model: The ITE Block

The estimated ITE of Indian manufacturing firms and also the other endogenous variables explaining the ITE corresponding to ITE block can be visualized below.

5.4.1.a Chemical Industry

The estimated ITE of Indian chemical firms and also the other endogenous variables explaining the ITE corresponding to ITE block can be visualized from Table 5.5.1 to Table 5.5.5.

Table 5.5.1 Factors explaining ITE from a Simultaneous Equation Panel Model: The ITE Block

Endogenous Variable: ITE

Independent Variable	Coefficient	z-value	p>|z|
ADV	.0007536	2.23	0.026
MKT	-.0053504	-11.55	0.000
$(MKT)^2$	7.16e-06	8.93	0.000
MKTlag	.0003258	1.26	0.209
RD	-.0000457	-0.28	0.779
$(RD)^2$	5.58e-08	0.65	0.514
RDlag	.0000798	1.61	0.108
NX	-4.36e-06	-0.57	0.571
$(NX)^2$	2.06e-10	0.50	0.616
DIVIND	-.0054049	-7.66	0.000
Wald chi2 = 374.59 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
ADV		0.0008	
MKT		0.2899	
RD		0.0304	
NX		0.0058	

The first equation of ITE Block: The estimated ITE relation

The estimated ITE relation as presented in Table 5.5.1 shows that ITE of the firms is positively related to ADV of the current period and MKT of the previous period and RD of the previous period. Increase in these factors increase ITE. Higher level of ADV in the current period, MKT of previous period, RD of the previous period increases ITE of the current period.

Considering MKT, RD and NX of the current period, both are having U-relationship with ITE with positive marginal effects. Their initial sole effects are negative; beyond their critical levels their positive effect on ITE will be felt.

Another factor affecting ITE is DIVIND. It has negative effect on ITE. As the market share gets concentrated, ITE of the firms rises.

Table 5.5.2 Factors explaining ADV behaviour from a Simultaneous Equation Panel Model: The ITE Block

Endogenous Variable: ADV

Independent Variable	Coefficient	z-value	p>|z|
ITE	3.25596	1.94	0.052
MKT	.1217909	3.62	0.000
$(MKT)^2$	-.0001542	-2.32	0.020
RD	.0378382	3.62	0.000
$(RD)^2$	-.0000338	-4.22	0.000
RD*MKT	.0001757	4.63	0.000
NX	-.0007261	-1.66	0.097
$(NX)^2$	2.64e-08	1.10	0.271
Largedum	6.295733	1.06	0.291
Wald chi2 = 161.71 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
ITE		3.2560	
MKT		0.1199	
RD		0.0412	
NX		0.1566	

The second equation of ITE Block: The estimated ADV relation

The estimated ADV relation as presented in Table 5.5.2 shows that ADV is positively related to ITE. Increase in ITE increases ADV.

Considering MKT and RD of the current period, it can be seen that both are having inverted U-relationship with positive marginal effects. Their initial sole effects are positive but the effects of their square terms are negative. As these are the sunk costs, beyond their critical levels their negative effects of ADV will be felt.

There is a composite effect of RD and MKT on ADV. The effect of this joint interaction term is positive. All these effects taken into account, the marginal effects of MKT and RD on ADV are positive.

Considering NX of the current period, it has U-relationship with ADV. Its sole effect is negative and the effect of the square term is positive. Beyond its critical level, its positive effect on ADV can be achieved. While calculating the net impact, the marginal effect of NX on ADV comes out to be positive.

Another factor positively influencing ADV is Largedum. It indirectly affects ITE through ADV. The larger sized firms have higher level of input efficiency than the smaller sized firms.

Table 5.5.3 Factors explaining MKT behaviour from a Simultaneous Equation Panel Model: The ITE Block

Endogenous Variable: MKT

Independent Variable	Coefficient	z-value	p>|z|
ITE	.1694977	-5.53	0.000
ADV	.3200426	3.77	0.000
$(ADV)^2$	-.0017153	-4.68	0.000
RD	.3926445	21.23	0.000
$(RD)^2$	-.0003262	-28.53	0.000
RD*ADV	.017863	28.91	0.000
NX	-.0044394	-3.93	0.000
$(NX)^2$	6.74e-07	11.84	0.000
NXlag	.0106993	13.24	0.000
ITE*NXlag	-.0003417	-5.99	0.000
$(ITE*NXlag)^2$	5.44e-10	2.49	0.013
Agedum	3.320209	1.58	0.114
Wald chi2 = 2350.40 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
ITE		0.1699	
ADV		0.4713	
RD		0.5101	
NX		1.0874	
NXlag		0.0219	
ITE*NXlag		0.0088	

The third equation of ITE Block: The estimated MKT relation

The estimated MKT relation as presented in Table 5.5.3 shows that the sole effects of ITE of the current period and NX of the previous period on MKT are positive. There exists a composite effect of ITE of the current period and NX of the previous period. The marginal effect of this joint interactive term is positive. This means that the positive effect of ITE on MKT depends on NX of the previous period. All these effects taken into account, the marginal effects of ITE of the current period and NX of the previous period come to out to be positive.

Considering ADV and RD of the current period, both have inverted U-relationship MKT. Their sole effects on MKT are positive. Beyond their critical levels, their negative impacts on MKT will be felt as all these are sunk costs to the firms.

There exists a composite effect of RD and ADV on MKT. The effects of RD on MKT depend on ADV and vice-versa. Considering all these effects, the marginal effects of RD and ADV on MKT are positive.

Considering NX of current period, it has U-relationship with MKT with positive marginal effect. The initial sole effect is negative. Beyond its critical level, its positive effect on MKT will be realised.

Another factor positively influencing MKT is Agedum. It has indirect effect on ITE through MKT. Younger firms are having higher level of MKT than the older firms.

Table 5.5.4 Factors explaining RD behaviour from a Simultaneous Equation Panel Model: The ITE Block

Endogenous Variable: RD

Independent Variable	Coefficient	z-value	p>|z|
ITE	-.0545212	-2.29	0.022
ADVlag	.8924364	1.35	0.175
$(\text{ADVlag})^2$	-.0024072	-1.16	0.245
MKT	.6210515	4.97	0.000
MKTlag	.3082275	1.44	0.150
NX	-.0355844	-8.65	0.000
$(\text{NX})^2$	1.47e-06	8.00	0.000
ITE*NX	.0012737	14.04	0.000
NXlag	.0139719	5.46	0.000
Wald chi2 = 1538.30 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
ITE		0.0388	
ADVlag		0.8775	
MKT		0.6211	
NX		0.6179	

The fourth equation of ITE Block: The estimated RD relation

The estimated RD relation as presented in Table 5.5.4 shows that RD is positively related to MKT of the current period as well as previous period and NX of the previous period. Higher level of MKT in the current period and previous period increase RD practices. Increase in NX of the previous period also increases RD of the current period.

Considering ITE of the current period, its sole effect on RD is negative. Considering NX of the current period, it has U-relationship with RD. Beyond the critical level of NX, its positive effect on RD will be felt. Through imports of capital goods, RD will be enhanced.

There exists a composite effect of ITE and NX. The effect of ITE on RD depends on NX and vice-versa. Considering these effects, the marginal effects of ITE and NX on RD are positive.

Considering ADV of the previous period, it has inverted U-relationship with RD with positive marginal effects. Its sole effect is positive and the effect of the square term is negative.

Table 5.5.5 Factors explaining NX behaviour from a Simultaneous Equation Panel Model: The ITE Block

Endogenous Variable: NX

Independent Variable	Coefficient	z-value	p>|z|
ITE	.4780965	2.73	0.006
ADVlag	6.573938	1.33	0.185
MKT	7.625911	2.90	0.004
$(MKT)^2$	.0062675	1.44	0.149
MKTlag	3.333262	1.94	0.053
RD	-5.20374	-3.59	0.000
$(RD)^2$	.0058959	10.09	0.000
RDlag	12.0578	7.32	0.000
ITE*RD	-.1730018	-4.78	0.000
$(ITE*RD)^2$	1.16e-06	4.16	0.000
Wald chi2 = 1993.19 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
ITE		0.0061	
MKT		7.7297	
RD		-5.1469	
ITE*RD		3.5033	

The fifth equation of ITE Block: The estimated NX relation

The estimated NX relation as presented in Table 5.5.5 shows that NX is positively related to ADV of the previous period, MKT of the previous period and RD of the previous period. Increase in ADV, MKT and RD in the previous period increases the NX of the current period.

Considering ITE of current period, it can be seen that its sole effect is positive. Considering RD of the current period, it can be seen that it has U-relationship with NX. Its sole effect is negative and the effect of the square term is positive. This implies that beyond the critical level of RD, its positive effect on NX will be realised.

There exists a joint interaction term of ITE and RD. Its marginal effect on NX is positive. This means that the effect of ITE on NX depends on RD and vice-versa. Considering all these effects, the marginal effect of ITE on NX is positive but that of RD on NX is negative as mean RD is lesser than the critical level of RD beyond which its positive effect on NX will be felt.

Considering MKT of the current period, it can be seen that it has a non-linear relationship with NX. Both the sole effect and the effect of the square term are positive. The marginal effect of MKT on NX is positive.

5.4.1.b Food Product Industry

The estimated ITE of Indian food products firms and also the other endogenous variables explaining the ITE corresponding to ITE block can be visualized from Table 5.6.1 to Table 5.6.5.

Table 5.6.1 Factors explaining ITE from a Simultaneous Equation Panel Model: The ITE Block

Endogenous Variable: ITE

Independent Variable	Coefficient	z-value	p>|z|
ADV	-.0030345	-1.05	0.292
$(ADV)^2$	.0000758	0.66	0.508
MKT	.0109954	2.32	0.020
$(MKT)^2$	-.0003861	-1.58	0.114
RD	-.0511586	-2.07	0.039
RD*MKT	-.0026749	-1.12	0.262
$(RD*MKT)^2$	7.20e-06	1.45	0.147
NX	-.000611	-4.32	0.000
NX*RD	-.0002195	-0.99	0.323
$(NX*RD)^2$	5.82e-07	2.53	0.011
Wald chi2 = 120.80 Prob > chi2 = 0.0000			

Determinants	Marginal effects
ADV	-0.0016
MKT	0.0870
RD	0.4787
RD*MKT	0.2846
NX	0.1680
NX*RD	0.1412

The first equation of ITE Block: The estimated ITE relation

The estimated relation as presented in Table 5.6.1 shows that ADV of the current period has U-relationship with ITE. Initially the increase in ADV will not increase ITE but beyond its critical level the positive effect of ADV on ITE will be realised. The marginal effect of ADV is negative as the mean level of ADV is lesser than the critical level of ADV.

Considering MKT of the current period, it can be seen that MKT has inverted U-relationship with ITE. Initially with the increase in MKT, ITE increases, but beyond the critical value of MKT, ITE falls.

There exists a joint interaction term of RD and MKT. Its marginal effect on ITE is positive. All these effects taken into account, the marginal effect of MKT is positive.

Considering RD and NX of the current period, it can be seen that their sole effects on ITE negative.

There exists a joint interaction term of NX and RD. Its marginal effect on ITE is positive. Considering all these effects, the marginal effects of RD and NX come out to be positive.

Table 5.6.2 Factors explaining ADV behaviour from a Simultaneous Equation Panel Model: The ITE Block

Endogenous Variable: ADV

Independent Variable	Coefficient	z-value	p>|z|
ITE	.0779101	1.72	0.085
MKT	5.694541	3.62	0.000
$(MKT)^2$	-.0961052	-2.28	0.022
MKTlag	.8870011	1.86	0.063
$(MKTlag)^2$	-.0486548	-2.33	0.020
ITE*MKT	-.0502419	-3.84	0.000
$(ITE*MKT)^2$	7.27e-06	2.90	0.004
RD	2.386689	1.75	0.080
NX	-.0342671	-2.10	0.036
$(NX)^2$	.0000524	0.69	0.491
DIVIND	-3.553793	-3.40	0.001
Largedum	5.610546	2.74	0.006
Agedum	1.74409	1.95	0.051
Wald chi2 = 329.07 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
ITE		0.5741	
MKT		4.9478	
ITE*MKT		0.0974	
MKTlag		0.5856	
RD		2.3867	
NX		-0.0235	

The second equation of ITE Block: The estimated ADV relation

The estimated ADV relation as presented in Table 5.6.2 shows that ADV is positively related to RD. Increase in RD increases the current year ADV.

Considering ITE, it can be seen that sole effect of ITE on ADV is positive.

There exists a joint interaction term of ITE and MKT. Its marginal effect on ADV is positive. Considering these effects, the marginal effect of ITE is positive.

Considering MKT of the current period as well as the previous period, both have inverted U-relationship with ITE. Initially with the increase in MKT of the current period and the previous period, ADV increases. Beyond their critical levels, their negative effect on ADV will be felt. Marginal effects of MKT of current period and previous period are positive.

Considering NX of the current period, it can be seen that NX has U-relationship. Beyond the critical level of NX, its positive effect on ADV will be realised. The marginal effect of NX on ADV is negative as the imports dominate over the exports.

Another factor affecting ADV is DIVIND, indirectly affecting ITE. It has negative effect on ADV, meaning that as the market share gets concentrated, the firms will be having higher level of ADV.

Other factor positively affecting ADV is Largedum, indirectly affecting ITE. The larger sized firms are doing higher level of ADV.

The last factor positively affecting ADV is Agedum, indirectly affecting ITE. The younger firms are doing higher level of ADV than the older firms.

Table 5.6.3 Factors explaining MKT behaviour from a Simultaneous Equation Panel Model: The ITE Block

Endogenous Variable: MKT

Independent Variable	Coefficient	z-value	p>|z|
ITE	.2510644	1.65	0.100
$(ITE)^2$	-.0010299	-1.23	0.218
ADV	-.1618548	-1.99	0.047
$(ADV)^2$	.0052336	1.33	0.182
RD	3.584054	6.03	0.000
$(RD)^2$	-.1628239	-1.53	0.125
RD*ADV	.0367964	1.44	0.151
NX	-.0327761	-4.00	0.000
$(NX)^2$	.0002636	7.06	0.000
NX*RD	.0177472	7.05	0.000
DIVIND	-1.224342	-2.15	0.031
Smalldum	-8.732567	-9.28	0.000
Agedum	.823018	1.73	0.083
Wald chi2 = 1133.01 Prob > chi2 = 0.0000			

Determinants	Marginal effects
ITE	0.2482
ADV	-0.0598
RD	4.2936
NX	0.0035

The third equation of ITE Block: The estimated MKT relation

The estimated MKT relation as presented in Table 5.6.3 shows that ITE has inverted U-relationship with ITE with positive marginal effect. Initially with the increase in ITE increases MKT. But beyond the critical level of ITE, increase in ITE reduces MKT. This means that after reaching the critical level of ITE, the firms will reduce spending on MKT.

Considering ADV of the current period, it can be seen that ADV has U-relationship with MKT. The sole effect of ADV is negative and the effect of the square term is positive. This means that initially with the increase in ADV will not increase MKT but beyond the critical level of ADV, the positive effect of ADV on MKT will be realised.

There exists a composite effect of RD and ADV on MKT. The joint interaction term of RD and ADV has positive effect on MKT. Considering these effects together, the marginal effect of ADV is negative as the mean ADV is lesser than the critical level of ADV beyond which its positive effect can be felt.

Considering RD of the current period, it has inverted U-relationship with MKT. Initially with the increase in RD increases MKT but beyond its critical value, increase in RD reduces MKT. This means that beyond their critical level, the firms spend on RD by reducing the spending on MKT.

Considering NX of the current period, it has U-relationship with MKT. The positive effect of NX on MKT will be felt beyond the critical level of NX.

There exists a composite effect of NX and RD. This joint interaction term have positive effect on MKT. All these effects taken into account, the marginal effects of NX and RD are positive.

Another factor affecting MKT is DIVIND, indirectly affecting ITE. It has negative effect on MKT, meaning that as the market gets concentrated, MKT of the firms increases.

Other factor affecting MKT is Smalldum, indirectly affecting ITE. It has negative effect on MKT, meaning that the larger sized firms are doing higher level of MKT than the smaller sized firms.

The last factor affecting MKT is Agedum, indirectly affecting ITE. It has positive effect on MKT, meaning that younger firms are doing higher level of MKT than the older firms.

Table 5.6.4 Factors explaining RD behaviour from a Simultaneous Equation Panel Model: The ITE Block

Endogenous Variable: RD

Independent Variable	Coefficient	z-value	p>|z|
ITE	-.1754481	-7.25	0.000
$(ITE)^2$	.0008185	6.03	0.000
ADV	-.0408885	-2.56	0.011
$(ADV)^2$	.0019036	2.89	0.004
MKT	.0452132	1.98	0.048
$(MKT)^2$	.0017339	4.34	0.000
MKTlag	.1814714	5.00	0.000
ADV*MKT	-.0066982	-3.68	0.000
$(ADV*MKT)^2$	1.10e-06	3.20	0.001
Largedum	.7330889	3.65	0.000
Wald chi2 = 759.85 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
ITE		-0.1685	
ADV		0.8087	
MKT		1.3343	
ADV*MKT		0.2432	

The fourth equation of ITE Block: The estimated RD relation

The estimated RD relation as presented in the Table 5.6.4 shows that RD is positively related to MKT of the previous period. Increase in MKT of the previous period increases the RD of the current period.

Considering ITE of the current period, it can be seen that ITE has U-relationship with RD. Initially with the increase in ITE will not increase RD but beyond the critical level of ITE, its positive effect on RD will be felt. These two effects taken into account, the marginal effect of ITE on RD is negative as the mean ITE is lesser than the critical level of ITE beyond which its positive effect will be realised.

Considering ADV of the current period, it can be seen that it has U-relationship with RD. The sole effect of ADV is negative but the effect of the square term is positive, meaning that beyond the critical level of ADV, the positive effect of ADV on RD will be realised.

Considering MKT of the current period, it can be seen that it has non-linear relationship with RD.

There exists a joint interaction term of ADV and MKT. Its marginal effect on RD is positive. All these effects taken into account, the marginal effects of ADV and MKT are positive.

Another factor positively affecting RD is Largedum, indirectly affecting ITE. This means that larger sized firms are doing higher level of RD than the smaller firms.

Table 5.6.5 Factors explaining NX behaviour from a Simultaneous Equation Panel Model: The ITE Block

Endogenous Variable: NX

Independent Variable	Coefficient	z-value	p>|z|
ITE	.04871	0.26	0.795
ADV	3.005101	3.69	0.000
$(ADV)^2$	-.0693073	-4.73	0.000
MKT	3.51153	9.35	0.000
REER	-.8577322	-2.34	0.019
Wald chi2 = 150.23 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
ITE		0.0487	
ADV		2.1386	
MKT		3.5115	

The fifth equation of ITE Block: The estimated NX relation

The estimated NX relation as presented in Table 5.6.5 shows that NX is positively related to ITE and MKT. Increase in ITE and MKT in the current period increase NX. NX is negatively related to REER.

Considering ADV of the current period, it can be seen that ADV has inverted U-relationship with NX. Initially with the increase in ADV increases NX but beyond the critical level of NX, the negative effect of ADV on NX will be felt. The marginal effect of ADV on NX is positive.

5.4.1.c Leather Industry

The estimated ITE of Indian leather firms and also the other endogenous variables explaining the ITE corresponding to ITE block can be visualized from Table 5.7.1 to Table 5.7.5.

Table 5.7.1 Factors explaining ITE from a Simultaneous Equation Panel Model: The ITE Block

Endogenous Variable: ITE

Independent Variable	Coefficient	z-value	p>|z|
ADV	.0042295	1.10	0.272
$(ADV)^2$	9.76e-06	0.13	0.894
MKT	-.0028865	-3.48	0.000
$(MKT)^2$	2.68e-06	2.98	0.003
MKTlag	.0007685	2.81	0.005
NX	.0002065	3.65	0.000
$(NX)^2$	-2.67e-08	-3.07	0.002
NX*RD	-.0002064	-4.41	0.000
$(NX*RD)^2$	1.61e-08	2.93	0.003
Agedum	-.0686982	-2.29	0.022
DIVIND	.0387612	1.48	0.139
Smalldum	.0626965	1.93	0.053
Wald chi2 = 74.10 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
ADV		0.4090	
MKT		0.4623	
RD		0.0063	
NX		-0.0015	
NX*RD		0.0015	

The first equation of ITE Block: The estimated ITE relation

The estimated ITE relation as presented in Table 5.7.1 shows that ITE is positively related to MKT of the previous period. Increase in MKT in the previous period increases the ITE of the current period.

Considering ADV of the current period, ADV has non-linear positive relationship with ITE. Marginal effect of ADV is positive.

Considering MKT of the current period, MKT has U-relationship with ITE. The sole effect of MKT is negative and the effect of the square term is positive. The positive effect of MKT on ITE can be achieved beyond the critical level of MKT. The marginal effect of MKT is positive.

Considering NX of the current period, NX has inverted U-relationship with ITE. Initially with the increase in NX, ITE increases. Beyond the critical level of NX, its negative effect on ITE will be felt.

There exists a composite effect of NX and RD. Its marginal effect on ITE is positive. Increase in RD will enhance product quality, as a result, NX will be increased. The marginal effect of NX is negative, implying that the imports dominate over the exports.

Another factor affecting ITE is Agedum. It has negative effect on ITE, meaning that older firms are having higher level of ITE than the younger firms.

Another factor positively affecting ITE is DIVIND. As the market share gets diversified, ITE of the firms increases.

The last factor positively affecting ITE is Smalldum. The smaller sized firms are having higher level of ITE than the larger sized firms.

Table 5.7.2 Factors explaining ADV behaviour from a Simultaneous Equation Panel Model: The ITE Block

Endogenous Variable: ADV

Independent Variable	Coefficient	z-value	p>|z|
ITE	.7437389	1.95	0.051
$(ITE)^2$	-.0036317	-1.88	0.060
MKT	.1000661	1.63	0.104
$(MKT)^2$	-.0000584	-1.11	0.265
MKTlag	.0396295	2.37	0.018
NX	-.0029652	-1.77	0.076
$(NX)^2$	3.81e-07	0.46	0.645
Agedum	-4.773061	-2.43	0.015
Wald chi2 = 80.55 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
ITE		0.6943	
MKT		0.0965	
NX		0.0149	

The second equation of ITE Block: The estimated ADV relation

The estimated ADV relation as presented in Table 5.7.2 shows that ADV is positively related to MKT of the previous period. Increase in MKT in the previous period increases ADV in the current period.

Considering ITE of the current period, it can be seen that ITE has inverted U-relationship with ADV. Initially with the increase in ITE leads to an increase in ADV but beyond the critical value of ITE, the firm will reduce spending on ADV. The marginal effect of ITE is positive.

Considering MKT of the current period, it can be seen that MKT has inverted U-relationship with ADV. Initially with the increase in MKT, ADV increases but beyond the critical level of MKT, increase in MKT will result in a fall in ADV. The marginal effect of MKT is positive.

Considering NX of the current period, it can be seen that NX has U-relationship with ADV. The positive effect of NX on ADV will be realised beyond the critical level of NX. The marginal effect of NX is positive.

Another factor affecting ADV is Agedum. It has negative effect on ADV. The older firms are having higher level of ADV than the younger firms.

Table 5.7.3 Factors explaining MKT behaviour from a Simultaneous Equation Panel Model: The ITE Block

Endogenous Variable: MKT

Independent Variable	Coefficient	z-value	p>|z|
ITE	-1.830738	-5.46	0.000
$(ITE)^2$	.016319	5.48	0.000
ADV	4.129345	4.27	0.000
$(ADV)^2$	-.0838619	-2.88	0.004
RD	9.816805	1.49	0.136
RD*ADV	.6426344	1.69	0.091
NX	.0408486	5.02	0.000
$(NX)^2$	8.09e-06	8.46	0.000
Wald chi2 = 1176.90 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
ITE		-1.7920	
ADV		3.4628	
RD		15.1768	
NX		0.1379	

The third equation of ITE Block: The estimated MKT relation

The estimated MKT relation as presented in Table 5.7.3 shows that ITE has U-relationship with MKT. The sole effect of ITE is negative but the effect of the square term is positive.

Initially with the increase in ITE, MKT will not be initiated. But beyond the critical level of ITE, the positive effect of ITE on MKT will be realised. All these effects taken into consideration, the marginal effect of ITE will be negative as the mean level of ITE is lesser than the critical level of ITE.

Considering ADV of the current period, it can be seen that ADV has inverted U-relationship with MKT. Initially with increase in MKT, ADV increases but beyond the critical level of ADV, the increase in ADV will reduce MKT.

Considering RD of the current period, it can be seen that the sole effect of RD is positive.

There exists a composite effect of RD and ADV. This joint interaction term of RD and ADV has positive effect on MKT. Joint spending on RD and ADV increases MKT. All these effects taken into consideration, the marginal effects of both RD and ADV come out to be positive.

Considering NX of the current period, it can be seen that NX has non-linear positive relationship with MKT. The marginal effect of NX is positive.

Table 5.7.4 Factors explaining RD behaviour from a Simultaneous Equation Panel Model: The ITE Block

Endogenous Variable: RD

Independent Variable	Coefficient	z-value	p>|z|
ITE	.0354836	2.09	0.037
$(ITE)^2$	-.0004982	-3.52	0.000
ADV	-.2433042	-2.99	0.003
$(ADV)^2$	.0039456	2.94	0.003
ADVlag	.1159716	1.26	0.207
NX	-.0022899	-2.34	0.020
$(NX)^2$	2.70e-07	1.92	0.054
ITE*NX	.0000165	2.10	0.036
Agedum	-1.340618	-4.24	0.000
Wald chi2 = 67.16 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
ITE		0.0393	
ADV		-0.1730	
NX		0.0100	

The fourth equation of ITE Block: The estimated RD relation

The estimated RD relation as presented in Table 5.7.4 shows that RD is positively related to ADV of the previous period.

Considering ADV of the current period, it can be seen that ADV has U-relationship with RD. The positive effect of ADV on RD will be realised beyond the critical level of ADV. The marginal effect of ADV is negative as the mean level of ADV is lesser than critical level of ADV.

Considering ITE of the current period, it can be seen that ITE has inverted U-relationship RD. Initially with the increase ITE, RD increases. But after reaching the critical level of ITE, increase in ITE will reduce the spending on RD.

Considering NX of the current period, it can be seen that NX has U-relationship with RD. The sole effect of NX is negative and the effect of its square term is positive. The positive effect of NX on RD will be felt beyond its critical level.

There exists a composite effect of ITE and NX. This joint interaction term has a positive effect on RD. Increase in NX increases ITE that will lead to an increase in RD. All these effects taken into consideration, the marginal effects of ITE and NX are positive.

Another factor affecting RD is Agedum. It has negative effect on RD. The older firms are having higher level of RD than the younger firms.

Table 5.7.5 Factors explaining NX behaviour from a Simultaneous Equation Panel Model: The ITE Block

Endogenous Variable: NX

Independent Variable	Coefficient	z-value	p>|z|
ITE	3.224135	1.20	0.230
MKT	1.100844	1.08	0.281
$(MKT)^2$	.0047253	5.30	0.000
MKTlag	1.243972	2.74	0.006
Wald chi2 = 650.25 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
ITE		3.2241	
MKT		1.4465	

The fifth equation of ITE Block: The estimated NX relation

The estimated NX relation as presented in Table 5.7.5 shows that NX is positively related to ITE of the current period, MKT of the previous period. Increase in all these factors increases NX.

Considering MKT of the current period, it can be seen that MKT has non-linear positive relationship with NX. The marginal effect of NX on ITE is positive. Increase in MKT in the current period increases the NX of the current period.

5.4.1.d Machinery Industry

The estimated ITE of Indian machinery firms and also the other endogenous variables explaining the ITE corresponding to ITE block can be visualized from Table 5.8.1 to Table 5.8.5.

Table 5.8.1 Factors explaining ITE from a Simultaneous Equation Panel Model: The ITE Block

Endogenous Variable: ITE

Independent Variable	Coefficient	z-value	p>|z|
ADV	-.0005247	-1.76	0.078
$(ADV)^2$	4.94e-07	1.68	0.094
ADVlag	.0001862	2.24	0.025
ADV*MKT	6.95e-07	2.68	0.007
RD	-.0007195	-6.43	0.000
$(RD)^2$	2.55e-07	4.78	0.000
NX*RD	6.88e-09	2.21	0.027
DIVIND	-.0013776	-2.13	0.034
Smalldum	-.0900051	-2.59	0.010
Wald chi2 = 140.31 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
ADV		0.0013	
MKT		0.0006	
RD		0.0047	
NX		0.0001	

The first equation of ITE Block: The estimated ITE relation

The estimated ITE relation as presented in Table 5.8.1 shows that ITE is positively related to ADV of the previous period. Increase in ADV of the previous period increases the ITE of the current period.

Considering ADV of the current period, it can be seen that ADV has U-relationship with ITE. The sole effect of ADV is negative but the effect of the square term is positive. Initially the increase in ADV will not initiate ITE but beyond the critical level of ITE, the positive effect of ADV on ITE will be realised.

There exists a joint interaction term of ADV and MKT. It has positive effect on ITE. The joint spending on MKT and ADV increases ITE. Considering all these effects, the marginal effects of ADV and MKT are positive.

Considering RD of the current period, it can be seen that RD has U-relationship with ITE. Initially with the increase in RD, ITE will not be initiated but beyond the critical of RD, its positive effect on ITE will be obtained.

Another factor affecting ITE is DIVIND. It has negative effect on ITE. As the market share gets concentrated, ITE increases.

Other factor affecting ITE is Smalldum. It also has negative effect on ITE, meaning that the larger sized firms are having higher level of ITE than the smaller sized firms.

Table 5.8.2 Factors explaining ADV behaviour from a Simultaneous Equation Panel Model: The ITE Block

Endogenous Variable: ADV

Independent Variable	Coefficient	z-value	p>|z|
ITE	11.44218	3.38	0.001
MKT	.2867231	10.55	0.000
$(MKT)^2$	.0002693	16.59	0.000
RD	1.005278	14.59	0.000
$(RD)^2$	-.0002963	-18.78	0.000
NX	.002686	17.45	0.000
NXlag	.0013359	14.30	0.000
DIVIND	-.1311036	-1.39	0.165
Agedum	1.760317	1.25	0.210
Largedum	4.274417	2.19	0.028
Wald chi2 = 13405.68 Prob > chi2 = 0.0000			

Determinants	Marginal effects
ITE	11.4422
MKT	0.3052
RD	1.0044
NX	0.0027

The second equation of ITE Block: The estimated ADV relation

The estimated ADV relation as presented in Table 5.8.2 shows that ADV is positively related to ITE of the current period, NX of the current period as well as the previous period. Increase in these factors increases ADV of the current period.

Considering MKT of the current period, it can be seen that MKT has positive non-linear relationship with ADV. The marginal effect of MKT on ADV is positive, meaning that the increase in MKT increases ADV in the current period.

Considering RD of the current period, it can be seen that RD has inverted U-relationship with ADV. Initially increase in RD increases ADV. But beyond the critical level of RD, the negative effect of RD on ADV will be felt. All these effects taken under consideration, the marginal effect of RD on ADV is positive.

Another factor positively influencing ADV is Agedum, indirectly affecting ITE. The younger firms have higher level of ADV than the older firms.

Other factor affecting ADV is DIVIND. It has negative effect on ADV. As the market share gets concentrated, ADV of the firms increases.

The last factor positively affecting is Largedum, implying that the larger sized firms are having higher level of ADV than the smaller sized firms.

Table 5.8.3 Factors explaining MKT behaviour from a Simultaneous Equation Panel Model: The ITE Block

Endogenous Variable: MKT

Independent Variable	Coefficient	z-value	p>|z|
ITE*ADV	.688254	6.74	0.000
ADV	.2440194	2.70	0.007
$(ADV)^2$	-.0000938	-1.83	0.067
ADVlag	.3724316	14.61	0.000
RD	.026809	1.01	0.311
$(RD)^2$	.0000591	8.14	0.000
RDlag	.5010203	25.38	0.000
RD*ADV	.0002971	14.44	0.000
NX	-.0013455	-4.31	0.000
NXlag	-.0026896	-17.52	0.000
Wald chi2 = 26710.14 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
ITE		6.0830	
ADV		0.8257	
RD		0.0243	
NX		-0.0013	

The third equation of ITE Block: The estimated MKT relation

The estimated MKT relation as presented in Table 5.8.3 shows that MKT is positively related to ADV of the previous period and RD of the previous period. Increase in ADV and RD in the previous period increases MKT of the current period. MKT is negatively related to NX in the current period as well as in the previous period, implying that imports dominate over exports.

Considering ADV of the current period, it can be seen that ADV has inverted U-relationship with MKT. Initially increase in ADV increases MKT, but beyond the critical level of ADV, its negative effect on MKT will be realised.

There exists a composite effect of ITE and ADV. This joint interaction term has positive effect on MKT. Increase in ADV increases ITE, as a result MKT will be increased. There exists another joint interaction term of RD and ADV. It is also having positive effect on MKT. Joint spending on RD and ADV increases MKT of the firms.

Considering RD of the current period, it can be seen that RD has non-linear positive relationship with MKT. Through RD, MKT of the firms will be increased.

All these effects taken into consideration, the marginal effects of ITE, ADV and RD are positive.

Table 5.8.4 Factors explaining RD behaviour from a Simultaneous Equation Panel Model: The ITE Block

Endogenous Variable: RD

Independent Variable	Coefficient	z-value	p>|z|
ADV	-2.664827	-11.52	0.000
$(ADV)^2$	.0018637	11.68	0.000
ITE*ADV	3.326782	11.14	0.000
MKT	1.056138	18.24	0.000
$(MKT)^2$	.0009146	21.20	0.000
MKTlag	.2517518	8.74	0.000
NX	.0102469	14.09	0.000
NXlag	.0043023	3.97	0.000
ITE*NXlag	-.0025408	-1.39	0.163
$(ITE*NXlag)^2$	3.11e-07	4.32	0.000
Agedum	10.1763	1.42	0.155
Wald chi2 = 11694.05 Prob > chi2 = 0.0000			

Determinants	Marginal effects
ITE	0.2997
ADV	0.3385
MKT	1.0928
NX	0.0102
NXlag	0.0279
ITE*NXlag	0.0076

The fourth equation of ITE Block: The estimated RD relation

The estimated RD relation as presented in Table 5.8.4 shows that RD is positively related to MKT of the previous period and NX of the current period.

Considering ADV of the current period, it can be seen that ADV has U-relationship with RD. The positive effect of ADV on RD will be felt beyond the critical level of ADV.

There exists a joint interaction term of ITE and ADV. Increase in ADV increases ITE, as a result RD increases.

Considering NX of the previous period, it can be seen that its sole effect is positive. There exists another interaction term of ITE of the current period and NX of the previous period. NX of the previous period increases ITE of the current period, as a result RD of the current period increases. All these effect taken into consideration, the marginal effects of ITE, ADV of the current period and NX of previous period are positive.

Considering MKT of the current period, it can be seen that MKT has non-linear positive relationship with RD. Increase in MKT increases RD. The marginal effect of MKT is positive.

Another factor positively influencing RD is Agedum, indirectly affecting ITE through RD. This means that the younger firms are having higher level of RD than the older firms.

Table 5.8.5 Factors explaining NX behaviour from a Simultaneous Equation Panel Model: The ITE Block

Endogenous Variable: NX

Independent Variable	Coefficient	z-value	p>|z|
ITE	-3.673035	-10.24	0.000
$(ITE)^2$	.0141739	9.97	0.000
ADV	.095715	1.25	0.210
$(ADV)^2$	.0011231	17.21	0.000
ADVlag	.3707653	14.24	0.000
MKT	-.6038238	-11.97	0.000
$(MKT)^2$	4.91e-06	0.22	0.825
MKTlag	.1245413	2.63	0.009
RD	.0237506	0.53	0.598
$(RD)^2$	.0000531	4.19	0.000
RDlag	.055947	3.90	0.000
REER	-.570493	-2.74	0.006
DIVIND	-.2529001	-1.04	0.299
Wald chi2 = 6797.95 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
ITE		-3.6520	
ADV		0.1174	
MKT		-0.2006	
RD		0.0228	

The fifth equation of ITE Block: The estimated NX relation

The estimated NX relation as presented in Table 5.8.5 shows that NX is positively related to ADV of the previous period, MKT of the previous period and RD of the previous period. Increase in ADV, MKT & RD of the previous period increases NX of the current period. NX is negatively related to REER.

Considering ITE of the current period, it can be seen that ITE has U-relationship with NX. The sole effect of ITE is negative and the effect of the square term is positive. This implies that the positive effect of ITE on NX will be felt beyond the critical level of ITE. The marginal effect of ITE is negative as the mean level of ITE is lesser than the threshold level of ITE.

Considering RD and ADV of the current period, it can be seen that both has positive non-linear relationship with NX. The marginal effects of both RD and ADV are positive, implying that increase in RD and ADV increases NX.

Considering MKT of the current period, it can be seen that MKT has U-relationship with NX. The positive effect of MKT can be obtained beyond the critical level of MKT. The marginal effect of MKT is negative as mean MKT is lesser than the critical level of MKT.

Another factor affecting NX is DIVIND. It has negative effect on ITE. As the market share gets concentrated, NX of the firms increases.

5.4.1.e Metal Industry

The estimated ITE of Indian metal firms and also the other endogenous variables explaining the ITE corresponding to ITE block can be visualized from Table 5.9.1 to Table 5.9.5.

Table 5.9.1 Factors explaining ITE from a Simultaneous Equation Panel Model: The ITE Block

Endogenous Variable: ITE

Independent Variable	Coefficient	z-value	p>|z|
ADV	-.0012831	-4.15	0.000
$(ADV)^2$	2.03e-06	5.25	0.000
ADV*MKT	4.25e-07	6.77	0.000
RD	.0014052	6.21	0.000
$(RD)^2$	8.00e-07	6.78	0.000
NX	.0146098	6.87	0.000
DIVIND	.2555148	5.79	0.000
Wald chi2 = 49.36 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
ADV		0.1129	
MKT		0.0170	
RD		0.0076	
NX		0.0146	

The first equation of ITE Block: The estimated ITE relation

The estimated ITE relation as presented in Table 5.9.1 shows that ITE is positively related to NX of the current period. The increase in NX in the current period increases ITE of the firms in the current period.

Considering ADV of the current period, it can be seen that it can be seen that ADV has U-relationship with ITE. The sole effect of ADV is negative and the effect of the square term is positive. This means that initially with the increase in ADV will not initiate ITE but beyond the critical level of ADV, increase in ADV will lead the increase in ITE.

There exists a joint interaction term of ADV and MKT. It has positive effect on ITE. The effect of ADV on ITE depends on MKT and vice-versa. All these effects taken into account, the marginal effects of both ADV and MKT are positive.

Considering RD of the current period, it can be seen that RD has non-linear relationship with ITE. The sole effect and the effect of the square term are positive. The marginal effect of RD is positive, meaning that increase in RD increases ITE.

Another factor positively affecting ITE is DIVIND. As the market share gets diversified, ITE of the firms increases.

Table 5.9.2 Factors explaining ADV behaviour from a Simultaneous Equation Panel Model: The ITE Block

Endogenous Variable: ADV

Independent Variable	Coefficient	z-value	p>|z|
ITE	-3.560777	-1.47	0.141
$(ITE)^2$	.027919	1.46	0.145
MKT	.1810649	6.34	0.000
$(MKT)^2$	-5.78e-06	-4.88	0.000
MKTlag	.1385589	7.72	0.000
$(MKTlag)^2$	-3.64e-06	-4.03	0.000
RD	-.1260557	-2.93	0.003
$(RD)^2$	.0000104	0.78	0.434
NXlag	3.199889	4.70	0.000
Wald chi2 = 682.84 Prob > chi2 = 0.0000			

Determinants	Marginal effects
ITE	-3.5060
MKT	0.0593
MKTlag	0.0781
RD	-0.1199
NXlag	3.1999

The second equation of ITE Block: The estimated ADV relation

The estimated ADV relation as presented in Table 5.9.2 shows that ADV is positively related to NX of the previous period. Increase in NX of the previous period increases the ADV of the current period.

Considering ITE of the current period, it can be seen that ITE has U-relationship with ADV. Initially the increase in ITE will not increase ADV but beyond the critical level of ADV, the increase in ITE will increase ADV. The marginal effect of ADV is negative as the mean level of ITE is lesser than the critical level of ITE.

Considering MKT of the current period as well as the previous period, it can be seen that both have inverted U-relationship with ADV. Initially increase in MKT both in the current period and the previous period increases ADV but beyond their critical levels, their negative effect on ADV will be felt. Considering all these effects, the marginal effects of MKT of current period as well as of the previous period come out to be positive.

Considering RD of the current period, it can be seen that RD has U-relationship with ADV. The positive effect of RD on ADV will be realised beyond the critical level of RD. The marginal effect of RD is negative as the mean level of RD is lesser than critical level of RD.

Table 5.9.3 Factors explaining MKT behaviour from a Simultaneous Equation Panel Model: The ITE Block

Endogenous Variable: MKT

Independent Variable	Coefficient	z-value	p>|z|
ITE*ADV	.0190271	4.81	0.000
ADV	2.620612	1.84	0.066
$(ADV)^2$	-.0015761	-2.36	0.018
RD	-1.924777	-12.16	0.000
$(RD)^2$	.0014027	4.58	0.000
Wald chi2 = 11748.31 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
ITE		0.0878	
ADV		2.6292	
RD		-1.9191	

The third equation of ITE Block: The estimated MKT relation

The estimated MKT relation as presented in Table 5.9.3 shows that RD of the current period has U-relationship with MKT. The positive effect of RD on MKT will be realised beyond the critical level of RD. The marginal effect of RD is negative as the mean level of RD is lesser than the critical level of RD.

Considering ADV of the current period, it can be seen that ADV has inverted U-relationship with MKT. Initially increase in ADV will lead to a rise in MKT but beyond the critical level of ADV, its negative effect on MKT will be felt.

There exists a composite effect of ITE and ADV. This joint interaction term of ITE and ADV has positive effect on MKT. All these effects taken into account, the marginal effect of both ITE and ADV are positive.

Table 5.9.4 Factors explaining RD behaviour from a Simultaneous Equation Panel Model: The ITE Block

Endogenous Variable: RD

Independent Variable	Coefficient	z-value	p>|z|
ITE	4.351799	1.34	0.179
$(ITE)^2$	-.0347489	-1.36	0.175
ADV	.6903395	3.78	0.000
MKT	.0892778	2.57	0.010
MKTlag	.1903673	14.07	0.000
ITE*NX	.0189431	9.26	0.000
Wald chi2 = 2222.92 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
ITE		3.8682	
ADV		0.6903	
MKT		0.0893	
NX		0.0180	

The fourth equation of ITE Block: The estimated RD relation

The estimated RD relation as presented in Table 5.9.4 shows that RD is positive related to ADV of the current period and the MKT of the previous period as well as current period. Increase in both these factors increases RD of the current period.

Considering ITE of the current period, it can be seen that ITE has inverted U-relationship with RD. Initially increase in ITE increases RD but beyond the critical level, the increase in ITE will lead to a fall in RD.

There exists a composite effect of ITE and NX. The effect of this joint interaction term of ITE and NX is positive. The effect of ITE on RD depends on NX and vice-versa. All these effects taken into consideration, the marginal effects of ITE and NX come out to be positive.

Table 5.9.5 Factors explaining NX behaviour from a Simultaneous Equation Panel Model: The ITE Block

Endogenous Variable: NX

Independent Variable	Coefficient	z-value	p>|z|
ITE	2.663375	3.15	0.002
$(ITE)^2$	-.0207661	-3.14	0.002
ADV	.1084396	2.80	0.005
$(ADV)^2$	.0000503	3.07	0.002
MKTlag	-.0175203	-4.35	0.000
$(MKTlag)^2$	1.11e-06	6.09	0.000
ITE*RD	-.0007632	-2.80	0.005
$(ITE*RD)^2$	1.16e-09	2.55	0.011
Wald chi2 = 9109.16 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
ITE		2.6237	
ADV		0.1109	
MKTlag		2.4345	
RD		0.0098	
ITE*RD		1.1488	

The fifth equation of ITE Block: The estimated NX relation

The estimated NX relation as presented in Table 5.9.5 shows that ITE has inverted U-relationship with NX. Initially the increase in ITE increases NX but beyond the critical level of ITE, the increase in ITE will lead to a fall in NX.

There exists a joint interaction term of ITE and RD. Its marginal effect on NX is positive. The effect of ITE on NX depends on RD and vice-versa. All these effects taken into account, the marginal effects of both ITE and RD come out to be positive.

Considering ADV of the current period, it can be seen that ADV has non-linear positive relationship with NX. The marginal effect of ADV is positive, meaning that increase in ADV increases NX.

Considering MKT of the previous period, it can be seen that it has U-relationship with NX. The positive effect of MKT of the previous period on NX can be obtained beyond the critical level of MKT of the previous period. The marginal effect of MKT of the previous period is positive.

5.4.1.f Non-metallic mineral products Industry

The estimated ITE of Indian non-metallic mineral products firms and also the other endogenous variables explaining the ITE corresponding to ITE block can be visualized from Table 5.10.1 to Table 5.10.5.

Table 5.10.1 Factors explaining ITE from a Simultaneous Equation Panel Model: The ITE Block

Endogenous Variable: ITE

Independent Variable	Coefficient	z-value	p>|z|
ADV	.0072358	1.02	0.309
$(ADV)^2$	.0000911	2.30	0.022
MKT	.0036416	1.76	0.078
MKTlag	.0019932	2.21	0.027
RD	.0053197	1.44	0.150
NX	.0012384	2.02	0.044
NXlag	.000844	2.17	0.030
DIVIND	-1.381907	-2.07	0.039
Agedum	-4.217179	-1.83	0.067
Wald chi2 = 6.34 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
ADV		0.0071	
MKT		0.0036	
RD		0.0053	
NX		0.0012	
NXLAG		0.0008	

The first equation of ITE Block: The estimated ITE relation

The estimated ITE relation as presented in Table 5.10.1 shows that ITE is positively related to MKT of the current period as well as the previous period, RD of the current period and NX of the current period as well as previous period.

Considering ADV of the current period, it can be seen that ADV has positive non-linear relationship with ITE. The marginal effect of ADV is positive. The increase in ADV increases ITE.

Another factor affecting ITE is DIVIND. It has negative effect on ITE. This means that as the market share gets concentrated, ITE of the firms rises.

Another factor affecting ITE is Agedum. It has negative effect on ITE. This means that the older firms are having higher level of ITE than the younger firms.

Table 5.10.2 Factors explaining ADV behaviour from a Simultaneous Equation Panel Model: The ITE Block

Endogenous Variable: ADV

Independent Variable	Coefficient	z-value	p>|z|
ITE	-4.446589	-5.14	0.000
$(ITE)^2$	.0262601	4.93	0.000
MKT	-.0937222	-4.91	0.000
$(MKT)^2$	.0000171	14.58	0.000
MKTlag	-.0145951	-2.29	0.022
$(MKTlag)^2$	2.61e-06	4.10	0.000
ITE*MKT	.0005225	2.14	0.032
RD	.9196624	18.56	0.000
$(RD)^2$	-.0004591	-8.98	0.000
NX	-.0684365	-13.04	0.000
$(NX)^2$	6.42e-07	1.38	0.166
NXlag	-.0084998	-4.93	0.000
$(NXlag)^2$	8.13e-07	4.35	0.000
NX*RD	.0000214	2.52	0.012
ITE*NX	.0007082	13.95	0.000
Wald chi2 = 14435.90 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
ITE		-4.3936	
MKT		-0.0890	
MKTlag		1.8403	
RD		0.9196	
NX		-0.0484	
NXlag		0.0105	

The second equation of ITE Block: The estimated ADV relation

The estimated ADV relation as presented in Table 5.10.2 shows that ITE has U-relationship with ADV. The positive effect of ITE on ADV can be felt beyond its critical level.

There exists a composite effect of ITE and NX. It has positive effect on ADV. The effect of ITE on ADV depends on NX and vice-versa.

There exists another composite effect of ITE and MKT. It also has positive effect on ADV. The effect of ITE on ADV also depends on MKT and vice-versa. Considering all these effects, the marginal effect of ITE comes out to be negative as the mean level of ITE is lesser that critical level of ITE.

Considering MKT of the current period as well as the previous period, it can be seen that both have U-relationship with ADV. Their positive effects on ADV will be realised beyond their critical levels. Considering theses effects, the positive marginal effect of MKT of the previous period can be obtained but the marginal effect of MKT in the current period is negative as the mean level of MKT in the current period is lesser than the critical level of MKT.

Considering RD of the current period, it can be seen that RD has inverted U-relationship with ADV. Initially increase in RD increases ADV but the critical level of RD, its negative effect on ADV can be felt.

There exists a composite effect of NX and RD. This joint interaction term of NX and RD has positive effect on ADV. The effect of NX on ADV depends on RD and vice-versa. All these effects taken into account, the marginal effect of RD comes out to be positive.

Considering NX of the current period as well as previous period, it can be seen that both have U-relationship with ADV. Their positive effect on ADV will be realised beyond their critical levels. Taking into account all these effects, the marginal effect of NX of the previous period comes out to positive but the effect of NX of the previous period is negative as the imports dominate over the exports in the current period.

Table 5.10.3 Factors explaining MKT behaviour from a Simultaneous Equation Panel Model: The ITE Block

Endogenous Variable: MKT

Independent Variable	Coefficient	z-value	p>|z|
ITE	.7553921	1.02	0.308
ADV	-1.633841	-1.83	0.068
$(ADV)^2$	.0016507	2.48	0.013
ITE*ADV	5.032709	3.92	0.000
RD	6.918028	5.44	0.000
$(RD)^2$	-.0044741	-7.62	0.000
RD*ADV	.0062071	3.24	0.001
NX*RD	-.0002295	-3.20	0.001
$(NX*RD)^2$	3.31e-11	6.22	0.000
Wald chi2 = 7979.15 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
ITE		3.0189	
ADV		2.9019	
RD		6.9185	
NX		-0.0001	
NX*RD		0.0017	

The third equation of ITE Block: The estimated MKT relation

The estimated MKT relation as presented in Table 5.10.3 shows that sole effect of ITE is positive. There exists a joint interaction term of ITE and ADV. It has positive effect on MKT. The effect of ITE on MKT depends on ADV and vice-versa. The marginal effect of ITE is positive.

Considering ADV of the current period, it can be seen that ADV has U-relationship with MKT. The positive effect of ADV on MKT can be obtained beyond the critical level of ADV.

There exists a joint interaction term of RD and ADV. It has positive effect on MKT. Considering all these effects, the marginal effect of ADV comes out to be positive.

Considering RD of the current period, it can be seen that RD has inverted U-relationship with MKT. Initially increase in RD increases MKT but beyond the critical level of RD, its increase will lead to a fall in MKT.

There exists a joint interaction term of NX and RD. The marginal effect of this joint interaction term of NX and RD is positive. This means that effect of RD on MKT depends on the mean level of NX and vice-versa.

Considering all these effects, the marginal effect of RD comes out to be positive but that of NX in the current period is negative as the imports dominate over exports.

Table 5.10.4 Factors explaining RD behaviour from a Simultaneous Equation Panel Model: The ITE Block

Endogenous Variable: RD

Independent Variable	Coefficient	z-value	p>|z|
ADV	1.444971	10.40	0.000
$(ADV)^2$	.0011441	4.26	0.000
MKT	.1229728	3.86	0.000
$(MKT)^2$	-.0000512	-7.76	0.000
MKTlag	.0342182	2.83	0.005
NX	.1772385	22.25	0.000
$(NX)^2$	-6.44e-06	-5.56	0.000
NXlag	.0108104	3.19	0.001
ITE*NX	-.0020039	-13.81	0.000
$(ITE*NX)^2$	8.05e-10	4.09	0.000
Wald chi2 = 1693.01 Prob > chi2 = 0.0000			

Determinants	Marginal effects
ITE	5.2904
ADV	1.4409
MKT	0.1199
NX	0.1697
ITE*NX	0.1116

The fourth equation of ITE Block: The estimated RD relation

The estimated RD relation as presented in Table 5.10.4 shows that RD is positively related to MKT of the previous period and NX of the previous period. The increase in MKT and NX in the previous period increases RD of the current period.

Considering ADV of the current period, it can be seen that ADV has positive non-linear relationship with RD. The marginal effect of ADV is positive, meaning that the increase in ADV in the current period increases RD.

Considering MKT and NX of the current period, it can be seen that both have inverted U-relationship with RD. Initially their increase will lead to the rise in RD. But beyond their critical levels, their negative effect on RD will be felt. MKT is having positive marginal effect on RD.

There exists a joint interaction term of ITE and NX. Its marginal effect on RD is positive. The effect of ITE on RD depends on NX and vice-versa. Considering all these effects, the positive marginal effects of ITE and NX can be obtained.

Table 5.10.5 Factors explaining NX behaviour from a Simultaneous Equation Panel Model: The ITE Block

Endogenous Variable: NX

Independent Variable	Coefficient	z-value	p>|z|
ITE	.50989	3.14	0.002
$(ITE)^2$	-.0030773	-3.05	0.002
ADVlag	.035556	4.34	0.000
MKT	.0098713	5.01	0.000
$(MKT)^2$	6.08e-07	2.77	0.006
RD	-.1475585	-5.93	0.000
$(RD)^2$	.0001126	8.23	0.000
RDlag	.0107492	1.80	0.072
ITE*RD	.0021374	6.37	0.000
DIVIND	-1.349904	-1.75	0.079
REER	-.1326212	-2.21	0.027
Wald chi2 = 712.18 Prob > chi2 = 0.0000			

Determinants	Marginal effects
ITE	0.5056
ADVlag	0.0356
MKT	0.0265
RD	-0.1481

The fifth equation of ITE Block: The estimated NX relation

The estimated NX relation as presented in Table 5.10.5 shows that NX is positively related to ADV of the previous period and RD of the previous period and NX is negatively related to REER.

Considering ITE of the current period, it can be seen that ITE has inverted U-relationship with NX. Initially increase in ITE increases NX but beyond the critical level of ITE, the increase in ITE will lead to the fall in NX.

Considering RD of the current period, it can be seen that RD has U-relationship with NX. The positive effect on RD on NX can be achieved beyond the critical level of RD.

There exists a joint interaction term of ITE and RD. It has positive effect on NX. The effect of ITE on NX depends on RD and vice-versa. All these effects taken into account, the positive marginal effect of ITE can be obtained but the marginal effect of RD is negative as the mean level of RD is lesser than critical level of RD.

Considering MKT of the current period, it can be seen that MKT has positive non-linear relationship with NX. The marginal effect of MKT is positive. The increase in MKT increases NX in the current period.

Another factor affecting NX is DIVIND. It has negative effect on NX. As the market share gets concentrated, NX of the firms increases.

5.4.1.g Paper Industry

The estimated ITE of Indian paper firms and also the other endogenous variables explaining the ITE corresponding to ITE block can be visualized from Table 5.11.1 to Table 5.11.5.

Table 5.11.1 Factors explaining ITE from a Simultaneous Equation Panel Model: The ITE Block

Endogenous Variable: ITE

Independent Variable	Coefficient	z-value	p>|z|
ADV	.2003526	9.81	0.000
$(ADV)^2$	-.0049467	-8.13	0.000
MKT	.0045648	3.99	0.000
ADV*MKT	-.0013059	-3.33	0.001
$(ADV*MKT)^2$	1.87e-07	3.05	0.002
RD	.0044527	0.97	0.334
$(RD)^2$	.0000167	1.19	0.236
NX	-.0227177	-1.76	0.078
$(NX)^2$	-.0000435	-1.91	0.056
NX*RD	.0079056	2.10	0.035
DIVIND	.1144374	16.84	0.000
Agedum	.1621026	2.60	0.009
Wald chi2 = 1266.24 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
ADV		3.2412	
MKT		3.1173	
ADV*MKT		0.6248	
RD		0.0716	
NX		0.0498	

The first equation of ITE Block: The estimated ITE relation

The estimated ITE relation as presented in Table 5.11.1 shows that ADV has inverted U-relationship with ITE. Initially increase in ADV increases ITE but beyond ITS critical level increase in ADV will reduce ITE as too much ADV is costly for the firms.

Considering MKT of the current period, it can be seen that sole effect of MKT is positive. There exists a joint interaction term of ADV and MKT. Its marginal effect is positive. The effect of ADV on ITE depends on MKT and vice-versa. Considering all these effects, the positive marginal effects of ADV and MKT can be achieved.

Considering RD of the current period, it can be seen that RD has positive non-linear relationship with ITE. Considering NX of the current period, it can be seen that NX has negative non-linear relationship with ITE. There exists a joint interaction term of NX and

RD. It has positive effect on ITE. The effect of NX on ITE depends on RD and vice-versa. All these effects taken into account, the positive marginal effects of RD and NX can be obtained.

Another factor positively affecting ITE is DIVIND. This means that as the market share gets diversified, ITE of the firms increases.

The last factor positively affecting ITE is Agedum. This means that the younger firms have higher level of ITE than the older firms.

Table 5.11.2 Factors explaining ADV behaviour from a Simultaneous Equation Panel Model: The ITE Block

Endogenous Variable: ADV

Independent Variable	Coefficient	z-value	p>|z|
ITE	.270449	2.43	0.015
$(ITE)^2$	-.0020311	-2.44	0.015
RD	.2854453	1.68	0.093
$(RD)^2$	-.000871	-2.21	0.027
Smalldum	11.4782	6.11	0.000
Wald chi2 = 95.00 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
ITE		0.2964	
RD		0.2888	

The second equation of ITE Block: The estimated ADV relation

Considering both ITE and RD of the current period, it can be seen from Table 5.11.2 that both have inverted U-relationship with ADV. Initially their increase will lead to the rise in ADV but beyond their critical levels, their increase will lead to the fall in ADV. Considering all these effects, the positive marginal effects of both ITE and RD on ADV can be obtained.

Another factor positively affecting ADV is Smalldum, indirectly affecting ITE. The smaller sized firms are having higher level of ADV than the larger sized firms.

Table 5.11.3 Factors explaining MKT behaviour from a Simultaneous Equation Panel Model: The ITE Block

Endogenous Variable: MKT

Independent Variable	Coefficient	z-value	p>|z|
ITE	3.983969	1.93	0.053
$(ITE)^2$	-.0302525	-1.98	0.048
ADVlag	11.948	1.61	0.108
$(ADVlag)^2$	-.3468152	-1.35	0.176
RD	2.473915	2.65	0.008
$(RD)^2$	-.0032055	-3.03	0.002
NX	-5.795184	-2.20	0.028
$(NX)^2$	.0031162	2.31	0.021
Wald chi2 = 56.44 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
ITE		3.9260	
ADVlag		9.1300	
RD		2.4278	
NX		-5.7596	

The third equation of ITE Block: The estimated MKT relation

The estimated MKT relation as presented in Table 5.11.3 shows that ITE of the current period, RD of the current period and ADV of the previous period have inverted U-relationship with MKT. Initially increase in these factors increases MKT but beyond their critical levels, their increase will lead to a fall in MKT. The marginal effects of these factors are positive, implying that their increase will result in the rise in MKT.

Considering NX of current period, it can be seen that NX has U-relationship with MKT. The positive effect of NX on MKT can be obtained beyond its critical level. The marginal effect is negative, implying that the imports dominate over the exports.

Table 5.11.4 Factors explaining RD behaviour from a Simultaneous Equation Panel Model: The ITE Block

Endogenous Variable: RD

Independent Variable	Coefficient	z-value	p>|z|
ITE	-.2919439	-2.43	0.015
ITE*NX	.4219347	3.76	0.000
ADV	-1.73898	-1.38	0.167
$(ADV)^2$	.0701136	1.40	0.163
MKT	.2656012	2.08	0.038
$(MKT)^2$	-.000228	-1.85	0.065
NXlag	3.988431	1.56	0.119
DIVIND	4.513062	1.28	0.201
Agedum	11.21574	1.69	0.092
Wald chi2 = 22.72 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
ITE		2.5282	
ADV		-1.0202	
MKT		0.2999	
NX		0.3570	

The fourth equation of ITE Block: The estimated RD relation

The estimated RD relation as presented in Table 5.11.4 shows that RD is positively related to NX of the previous period. The NX in the previous period increase RD in the current period.

Considering ITE of the current period, it can be seen that the sole effect of ITE is negative. There exists a composite effect of ITE and NX. It has positive effect on ITE. The effect of ITE on RD depends on NX and vice-versa. The marginal effect of both ITE and NX are positive.

Considering ADV of the current period, it can be seen that ADV has U-relationship with RD. The positive effect of ADV on RD can be felt beyond the critical level of ADV. The marginal effect of ADV is negative as the mean level of ADV is lesser than critical level of ADV.

Considering MKT of the current period, it can be seen that MKT has inverted U-relationship with RD. Initially increase in MKT increases RD but beyond the critical level of MKT, its negative effect of MKT on RD can be obtained. Considering all these effects, the positive marginal effect of MKT can be obtained.

Table 5.11.5 Factors explaining NX behaviour from a Simultaneous Equation Panel Model: The ITE Block

Endogenous Variable: NX

Independent Variable	Coefficient	z-value	p>|z|
ITE	-2.978985	-1.45	0.146
$(ITE)^2$	.021059	1.38	0.167
ADV	1.05807	0.26	0.797
ADVlag	3.526198	1.17	0.241
MKT	-.6032152	-2.30	0.022
$(MKT)^2$	.0003495	1.47	0.142
MKTlag	.2441355	1.92	0.055
RD	-1.551724	-0.50	0.619
$(RD)^2$	.0249916	3.43	0.001
RDlag	-5.119186	-2.38	0.017
$(RDlag)^2$	.0058723	2.22	0.027
ITE*RD	.1239145	2.91	0.004
$(ITE*RD)^2$	-9.00e-06	-3.85	0.000
Wald chi2 = 28.27 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
ITE		-4.0749	
ADV		1.0581	
MKT		-0.5787	
RD		-1.2688	
RDLAG		-5.0309	
ITE*RD		0.1178	

The fifth equation of ITE Block: The estimated NX relation

The estimated NX relation as presented in Table 5.11.5 shows that NX is positively related to ADV of the current period as well as previous period and MKT of the previous period.

Considering ITE, MKT of the current period and RD of the current period as well as previous period, it can be seen that all these factors have U-relationship with NX. Their positive effects on NX can be realised beyond their critical levels.

There exists a composite effect of ITE and RD of the current period. The marginal effect of this joint interaction term on NX is positive. The effect of ITE on NX depends on RD and vice-versa.

Considering all these effects, the marginal effects of all the said factors come out to be negative as their mean values are lesser than their critical levels.

5.4.1.h Textile Industry

The estimated ITE of Indian textile firms and also the other endogenous variables explaining the ITE corresponding to ITE block can be visualized from Table 5.12.1 to Table 5.12.5.

Table 5.12.1 Factors explaining ITE from a Simultaneous Equation Panel Model: The ITE Block

Endogenous Variable: ITE

Independent Variable	Coefficient	z-value	p>|z|
ADV*MKT	.0040353	1.69	0.091
MKT	.0195448	3.14	0.002
$(MKT)^2$	-.0004704	-3.20	0.001
RD	-.0537817	-2.03	0.043
$(RD)^2$	.0068143	2.35	0.019
RDlag	.0452688	2.81	0.005
NX	-.0015283	-2.91	0.004
$(NX)^2$	3.48e-06	0.89	0.373
NXlag	-.0007802	-1.61	0.107
$(NXlag)^2$	1.54e-07	0.04	0.968
NX*RD	.0007068	2.50	0.013
Agedum	.0527361	2.05	0.041
Largedum	-.0552546	-2.05	0.040
Wald chi2 = 121.06 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
ADV		0.0214	
MKT		0.0191	
RD		-0.0124	
NX		0.6391	
NXlag		0.0996	

The first equation of ITE Block: The estimated ITE relation

The estimated ITE relation as presented in Table 5.12.1 shows that ITE is positively related to RD of the previous period.

Considering MKT of the current period, it can be seen that MKT is inverted U-relationship with ITE. Initially increase in MKT increases ITE but too much MKT is costly for the firms.

There exists a joint interaction term of ADV and MKT. It has positive effect on ITE. The effect of MKT on ITE depends on ADV and vice-versa. Considering all these effects, the positive effects of ADV and MKT can be achieved.

Considering RD of the current period and NX of the current period as well as previous period, it can be seen that both have U-relationship with ITE. Their positive effect on ITE can be achieved beyond their critical levels.

There exists a composite effect of NX and RD. This joint interaction term has positive effect on ITE. The effect of NX on ITE depends on RD and vice-versa. Considering all these effects, the positive marginal effects of NX of the current period as well as previous period can be obtained but the marginal effect of RD is negative as the mean level of RD is lesser than the critical level of RD beyond which the positive effect of RD can be achieved.

Another factor positively affecting ITE is Agedum. The younger firms are having higher level of ITE than older firms.

The last factor affecting ITE is Largedum. It has negative effect on ITE. The smaller firms are having higher level of ITE than the larger firms.

Table 5.12.2 Factors explaining ADV behaviour from a Simultaneous Equation Panel Model: The ITE Block

Endogenous Variable: ADV

Independent Variable	Coefficient	z-value	p>|z|
ITE*MKT	.9497749	4.11	0.000
MKTlag	.2596744	3.65	0.000
RD	-.5547842	-2.77	0.006
NX	-.0133726	-3.88	0.000
$(NX)^2$	.0000808	2.97	0.003
NX*RD	.0032354	1.21	0.228
$(NX*RD)^2$	8.48e-08	1.11	0.265
DIVIND	.2352113	4.31	0.000
Agedum	.3192698	1.22	0.222
Wald chi2 = 363.28 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
ITE		5.0730	
MKT		0.7695	
RD		6.0504	
NX		0.1437	
NX*RD		0.7043	

The second equation of ITE Block: The estimated ADV relation

The estimated ADV relation as presented in Table 5.12.2 shows that ADV is positively related to MKT of the previous period.

There exists a joint interaction term of ITE and MKT. It has positive effect on ADV. The effect of ITE on ADV depends on MKT and vice-versa. Considering all these effects, the positive marginal effects of both ITE and MKT can be obtained.

Considering RD of the current period, it can be seen that the sole effect of RD is negative.

Considering NX of the current period, it can be seen that NX has U-relationship with ADV. The positive effect of NX on ADV can be obtained beyond the critical level of NX.

There exists a joint interaction term of NX and RD. The marginal effect of this joint interaction term is positive. The effect of NX on ADV depends on RD and vice-versa. Considering all these effects, the positive marginal effects of NX and RD can be achieved.

Another factor positively affecting ADV is DIVIND, indirectly affecting ITE. As the market share gets diversified, the firms will have higher level of ADV.

The last factor positively affecting ADV is Agedum. The younger firms are having higher level of ADV than older firms.

Table 5.12.3 Factors explaining MKT behaviour from a Simultaneous Equation Panel Model: The ITE Block

Endogenous Variable: MKT

Independent Variable	Coefficient	z-value	p>|z|
ITE	3.829243	2.28	0.023
RD	.7051172	1.91	0.056
NX	.0190459	3.17	0.002
$(NX)^2$	-.0001174	-2.23	0.025
Smalldum	1.282626	1.74	0.082
Wald chi2 = 151.50 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
ITE		3.8292	
RD		0.7051	
NX		0.0126	

The third equation of ITE Block: The estimated MKT relation

The estimated MKT relation as presented in Table 5.12.3 shows that MKT is positively related to ITE and RD of the current period. Increase in ITE and RD increases MKT of the current period.

Considering NX of the current period, it can be seen that NX has inverted U-relationship with MKT. Initially increase in NX increases MKT but beyond the critical level of NX, its negative effect on MKT will be realised. All these effects taken into account, the positive marginal effect of NX can be obtained.

Another factor positively affecting MKT is Smalldum, meaning that the smaller firms are having higher level of MKT than the larger firms.

Table 5.12.4 Factors explaining RD behaviour from a Simultaneous Equation Panel Model: The ITE Block

Endogenous Variable: RD

Independent Variable	Coefficient	z-value	p>|z|
ADV	-.1308419	-1.92	0.055
$(ADV)^2$	.0065761	1.16	0.247
MKT	.0764546	1.69	0.092
$(MKT)^2$	-.0011457	-1.34	0.180
MKTlag	.2227078	3.09	0.002
$(MKTlag)^2$	-.0152123	-3.33	0.001
NX	-.0879998	-10.99	0.000
$(NX)^2$	.000344	8.86	0.000
NXlag	.0011187	1.12	0.264
ITE*NX	.0898965	9.37	0.000
$(ITE*NX)^2$	-.0002988	-4.79	0.000
DIVIND	.0918938	3.34	0.001
Agedum	.3826794	2.96	0.003
Wald chi2 = 8732.84 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
ITE		2.8911	
ADV		-0.1145	
MKT		0.0693	
MKTlag		0.0968	
NX		0.0054	
ITE*NX		0.0792	

The fourth equation of ITE Block: The estimated RD relation

The estimated RD relation as presented in Table 5.12.4 shows that RD is positively related to NX of the previous period.

Considering ADV and NX of the current period, it can be seen that both have U-relationship with RD. The positive effect of these factors on RD will be realised beyond their critical levels.

There exists a joint interaction term of ITE and NX. The marginal effect of this joint interaction term is positive. The effect of ITE on RD depends on NX and vice-versa.

Considering all these effects, the positive marginal effects of ITE and NX can be obtained but the marginal effect of ADV is negative as the mean value of ADV is lesser than the critical value of ADV beyond which its positive effect on RD will be realised.

Considering MKT of the current period as well as the previous period, it can be seen that both have inverted U-relationship with positive marginal effects. Increase in MKT in the current period and previous period increases RD.

Another factor positively affecting RD is DIVIND, indirectly affecting ITE. As the market share gets diversified, the RD of the firms increases.

The last factor positively affecting RD is Agedum. The younger firms are having higher level of RD than the older firms.

Table 5.12.5 Factors explaining NX behaviour from a Simultaneous Equation Panel Model: The ITE Block

Endogenous Variable: NX

Independent Variable	Coefficient	z-value	p>|z|
ITE	-2.122433	-1.38	0.167
$(ITE)^2$	.0105486	1.21	0.225
ITE*RD	.5616706	2.41	0.016
MKT	1.808371	2.95	0.003
MKTlag	1.627859	3.94	0.000
ITE*MKT	-.1697789	-2.73	0.006
$(ITE*MKT)^2$	4.73e-06	1.28	0.199
Smalldum	10.8929	1.23	0.219
Wald chi2 = 442.14 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
ITE		-2.4004	
RD		0.4860	
MKT		1.7626	
ITE*MKT		0.0051	

The fifth equation of ITE Block: The estimated NX relation

The estimated NX relation as presented in Table 5.12.5 shows that NX is positively related to MKT of the previous period.

Considering ITE of the current period, it can be seen that ITE has U-relationship with NX. The positive effect of ITE on NX will be obtained beyond the critical level of ITE.

Considering MKT of the current period, it can be seen that the sole effect of MKT is positive.

There are two joint interaction terms of (ITE and RD) and (ITE and MKT). Both of these joint interaction terms have positive effects on NX.

Considering all these effects, the marginal effects of RD and MKT come out to be positive but the marginal effect of ITE is negative as the mean ITE is lesser than the critical level of ITE beyond which its positive effect can be obtained.

Another factor positively affecting NX is Smalldum, indirectly affecting ITE. The smaller firms are having higher level of ITE than the larger firms.

5.4.1.i Transport Industry

The estimated ITE of Indian transport firms and also the other endogenous variables explaining the ITE corresponding to ITE block can be visualized from Table 5.13.1 to Table 5.13.5.

Table 5.13.1 Factors explaining ITE from a Simultaneous Equation Panel Model: The ITE Block

Endogenous Variable: ITE

Independent Variable	Coefficient	z-value	p>|z|
ADV*MKT	3.97e-07	1.68	0.092
MKT	-.0001367	-2.36	0.018
$(MKT)^2$	1.60e-08	3.13	0.002
RD	.0025731	4.28	0.000
RDlag	.0016111	2.79	0.005
NX	7.74e-06	0.63	0.527
DIVIND	-.0588657	-6.78	0.000
Wald chi2 = 466.11 Prob > chi2 = 0.0000			
Determinants	Marginal effects		
ADV	0.0046		
MKT	0.0024		
RD	0.0026		
NX	7.74e-06		

The first equation of ITE Block: The estimated ITE relation

The estimated ITE relation as presented in Table 5.13.1 shows that ITE is positively related to RD of the current period as well as of the previous period and NX of the current period. Increase in RD in the current period as well as in the previous period and NX in the current period increases ITE of the firms.

Considering MKT of the current period, it can be seen that MKT has U-relationship with ITE. The sole effect of MKT is negative but the effect of the square term is positive. Initially the increase in MKT will not initiate ITE but beyond the critical level of ITE, its positive effect on ITE will be achieved.

There exists a joint interaction term of ADV and MKT which has positive effect on ITE. The effect of MKT on ITE depends on ADV and vice-versa. Considering all these effects, the positive marginal effects of ADV and MKT can be achieved.

Another factor affecting ITE is DIVIND. It has negative effect on ITE. As the market share gets concentrated, the ITE of the firms rises.

Table 5.13.2 Factors explaining ADV behaviour from a Simultaneous Equation Panel Model: The ITE Block

Endogenous Variable: ADV

Independent Variable	Coefficient	z-value	p>|z|
ITE	-1.218344	-2.28	0.022
$(ITE)^2$	.0065412	2.24	0.025
MKT	-.2100781	-13.35	0.000
$(MKT)^2$	.0000416	22.94	0.000
MKTlag	.0400495	2.85	0.004
ITE*MKT	.0013421	8.82	0.000
RD	.5867467	9.03	0.000
$(RD)^2$	-.0006265	-8.51	0.000
NX	.0263682	7.94	0.000
$(NX)^2$	-6.70e-07	-7.89	0.000
NXlag	.0047609	2.13	0.033
DIVIND	-2.614153	-2.88	0.004
Wald chi2 = 8041.93 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
ITE		-1.1960	
MKT		-0.2090	
RD		0.5898	
NX		0.0389	

The second equation of ITE Block: The estimated ADV relation

The estimated ADV relation as presented in Table 5.13.2 shows that ADV is positively related to MKT of the previous period and NX of the previous period.

Considering ITE and MKT of the current period, it can be seen that both have U-relationship with ADV. Their sole effects are negative but the effects of their square terms are positive. Their positive effect on ADV can be achieved beyond their critical levels.

There exists a joint interaction term of ITE and MKT which has positive effect on ADV. The effect of ITE on ADV depends on MKT and vice-versa. All these effects taken into account, the marginal effects of both ITE and MKT come to be negative as their mean levels are lesser than their critical levels.

Considering RD and NX of the current period, it can be seen that both have inverted U-relationship with ADV. Initially their increase will lead to the rise in ADV but beyond their critical levels, their increase will lead to the fall in ADV. Considering all these effects, the positive marginal effects of both RD and NX can be achieved.

Another factor affecting ADV is DIVIND. It has negative effect on ADV, meaning that as the market share gets concentrated, ADV of the firms rises.

Table 5.13.3 Factors explaining MKT behaviour from a Simultaneous Equation Panel Model: The ITE Block

Endogenous Variable: MKT

Independent Variable	Coefficient	z-value	p>|z|
ITE	1.056689	6.00	0.000
ADV	9.202651	8.28	0.000
$(ADV)^2$	-.004645	-3.96	0.000
RD	11.82123	9.64	0.000
$(RD)^2$	-.008286	-23.48	0.000
NX	-.172345	-12.78	0.000
$(NX)^2$	7.73e-06	24.42	0.000
Agedum	-14.06056	-2.06	0.040
Wald chi2 = 846151.30 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
ITE		1.0567	
ADV		9.1994	
RD		11.8171	
NX		-0.1980	

The third equation of ITE Block: The estimated MKT relation

The estimated MKT relation as presented in Table 5.13.3 shows that MKT is positively related to ITE of the current period. As the ITE of the firms increases, MKT of the firms increases.

Considering ADV and RD of the current period, it can be seen that both have inverted U-relationship with MKT. Initially the increase in these factors increases MKT but beyond the critical levels, their increase will lead to the fall in MKT. Considering all these effects, the positive marginal effects of both ADV and RD can be obtained.

Considering NX of the current period, it can be seen that NX has U-relationship with MKT. The positive effects of NX on MKT can be achieved beyond the critical level of NX. Considering all these effects, the negative marginal effect of NX can be achieved, implying that imports dominate exports.

Table 5.13.4 Factors explaining RD behaviour from a Simultaneous Equation Panel Model: The ITE Block

Endogenous Variable: RD

Independent Variable	Coefficient	z-value	p>|z|
ITE	.8306778	1.91	0.056
$(ITE)^2$	-.0047139	-1.99	0.047
ADV	.136479	1.73	0.084
$(ADV)^2$	-.0005187	-3.21	0.001
ADVlag	.2251219	2.06	0.040
$(ADVlag)^2$	-.000335	-0.50	0.620
MKT	.014126	0.99	0.323
$(MKT)^2$	5.63e-06	2.14	0.032
MKTlag	.0545482	5.74	0.000
NX	.0174572	3.32	0.001
$(NX)^2$	-2.74e-07	-1.18	0.238
DIVIND	-.7343391	-1.18	0.237
Wald chi2 = 27373.56 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
ITE		0.8227	
ADV		0.1399	
MKT		0.0457	
NX		0.0218	

The fourth equation of ITE Block: The estimated RD relation

The estimated RD relation as presented in Table 5.13.4 shows that RD is positively related to MKT of the current period.

Considering ITE, NX of the current period and ADV of the current period as well as the previous period, it can be seen that all have inverted U-relationship with RD. Initially their increase will increase RD but beyond their critical levels, the negative effect on RD will be felt. Considering all these effects, the positive marginal effects of all these factors can be achieved.

Considering MKT of the current period, it can be seen that MKT has non-linear positive relationship with RD. The marginal effect of MKT is positive.

Another factor affecting RD is DIVIND. It has negative effect on RD. As the market share gets concentrated, RD of the firms increases.

Table 5.13.5 Factors explaining NX behaviour from a Simultaneous Equation Panel Model: The ITE Block

Endogenous Variable: NX

Independent Variable	Coefficient	z-value	p>|z|
ITE	2.33725	1.03	0.301
ADV	.4006593	0.16	0.871
$(ADV)^2$	-.0212762	-4.72	0.000
MKT	3.293024	11.75	0.000
$(MKT)^2$	-.0003479	-19.62	0.000
MKTlag	1.29249	8.60	0.000
RD	1.632312	3.85	0.000
Wald chi2 = 76105.86 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
ITE		2.3373	
ADV		0.3968	
MKT		3.2892	
RD		1.6323	

The fifth equation of ITE Block: The estimated NX relation

The estimated NX relation as presented in Table 5.13.5 shows that NX is positively related to ITE and RD of the current period and MKT of the previous period. Increase in these factors increases NX.

Considering ADV and MKT of the current period, it can be seen that both have inverted U-relationship with NX. Initially their increase will increase NX but beyond their critical levels, the negative effect on NX will be felt. Considering all these effects, their marginal effects come out to be positive.

5.5 Estimated results of Output Oriented Technical Efficiency of Firms

The output oriented efficiency score of the companies is obtained on the basis of a computer program DEAP Version 2.1, developed by Tim Coelli.

Table 5.14 Mean Output Oriented Technical Efficiency

Year	Chemical	Food Products	Leather	Machinery	Metal	Non-metallic mineral products	Paper	Textile	Transport	Grand Mean
1995	0.764	0.828	0.886	0.917	0.709	0.951	0.928	0.746	0.938	0.852
1996	0.798	0.879	0.910	0.909	0.895	0.94	0.948	0.887	0.944	0.901
1997	0.755	0.901	0.959	0.918	0.938	0.945	0.894	0.868	0.935	0.901
1998	0.743	0.871	0.965	0.936	0.942	0.925	0.898	0.901	0.948	0.903
1999	0.839	0.893	0.928	0.910	0.947	0.963	0.877	0.906	0.921	0.909
2000	0.919	0.893	0.952	0.941	0.935	0.949	0.871	0.919	0.938	0.924
2001	0.918	0.886	0.965	0.899	0.934	0.971	0.858	0.766	0.931	0.903
2002	0.867	0.837	0.953	0.911	0.928	0.973	0.887	0.841	0.910	0.901
2003	0.866	0.839	0.93	0.850	0.893	0.954	0.880	0.881	0.914	0.890
2004	0.814	0.867	0.999	0.903	0.914	0.840	0.877	0.901	0.934	0.894
2005	0.807	0.874	0.991	0.936	0.931	0.830	0.928	0.877	0.940	0.902
2006	0.843	0.877	0.926	0.940	0.947	0.716	0.918	0.916	0.923	0.890
2007	0.881	0.874	0.981	0.939	0.909	0.748	0.900	0.883	0.934	0.894
2008	0.867	0.873	0.968	0.940	0.805	0.841	0.923	0.878	0.957	0.895
2009	0.877	0.882	0.925	0.862	0.832	0.911	0.922	0.872	0.962	0.894
2010	0.863	0.881	0.922	0.915	0.919	0.926	0.940	0.860	0.952	0.909
2011	0.820	0.860	0.97	0.913	0.904	0.900	0.894	0.860	0.953	0.897
2012	0.886	0.845	0.977	0.914	0.904	0.838	0.901	0.856	0.951	0.897
2013	0.924	0.891	0.976	0.926	0.889	0.933	0.919	0.871	0.952	0.920
2014	0.866	0.887	0.966	0.846	0.905	0.922	0.899	0.890	0.885	0.896
2015	0.729	0.892	0.97	0.920	0.889	0.896	0.888	0.841	0.915	0.882
2016	0.719	0.832	0.959	0.886	0.932	0.896	0.907	0.783	0.950	0.874

Source: Compiled by the Author

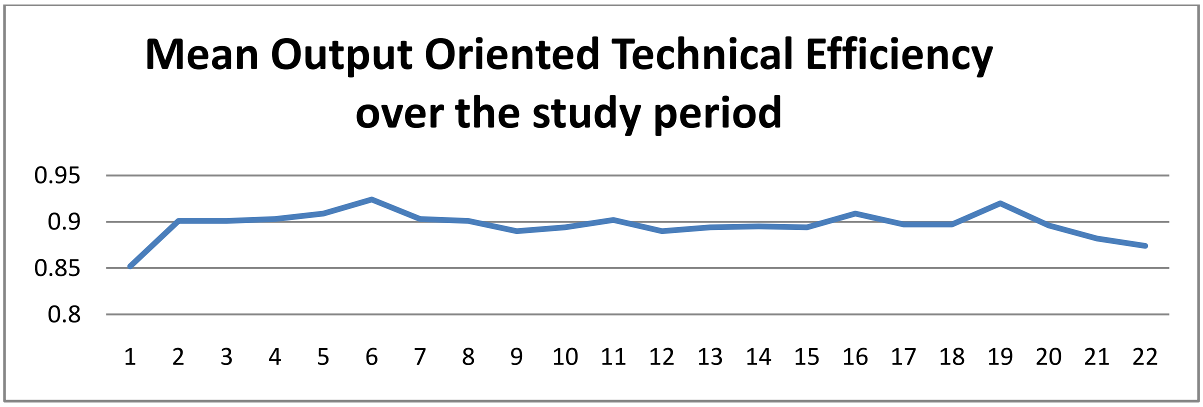

Figure 5.8. Mean Output Oriented Technical Efficiency (year-wise analysis)

Table 5.14 and Figure 5.8. show 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 & 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.

Table 5.15 Mean Output Oriented Technical Efficiency (all the years taken together)

Industry	Mean Output Oriented Technical Efficiency
Chemical	0.835
Food Products	0.871
Leather	0.954
Machinery	0.911
Metal	0.900
Non-metallic mineral products	0.899
Paper	0.903
Textile	0.864
Transport	0.936
Grand Mean	0.897

Source: Compiled by the Author

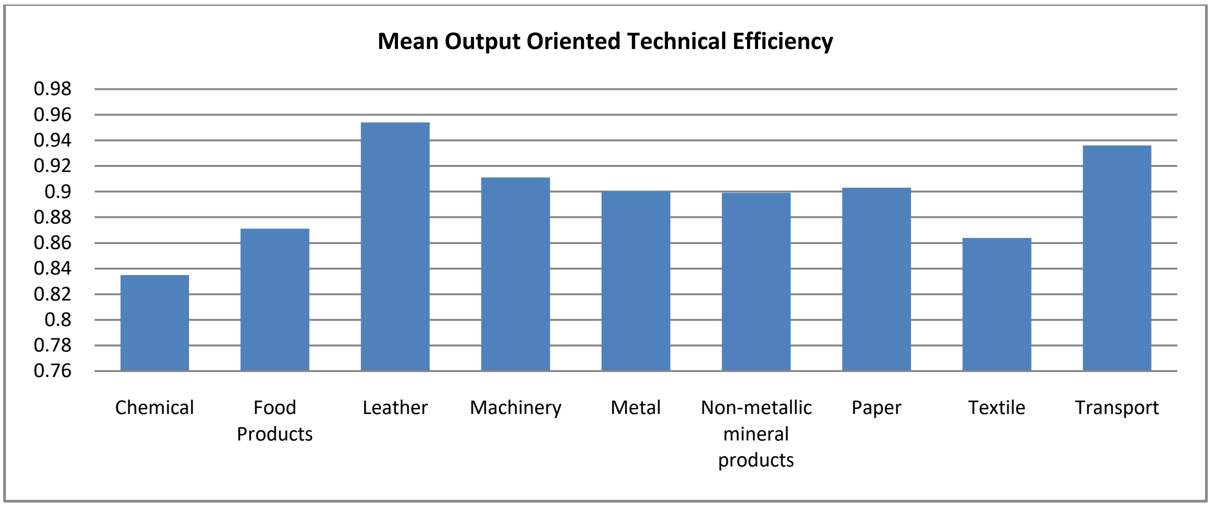

Figure 5.9. Mean Output Oriented Technical Efficiency (industry-wise analysis)

Table 5.15 shows 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. Figure 5.9. also shows that 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.

Table 5.16 Percentage of Efficient firms for all industry groups (OTE)

Industry	% of Efficient firms
Chemical	14
Food Products	28
Leather	64
Machinery	18
Metal	23
Non-metallic mineral products	32
Paper	55
Textile	18
Transport	23
Grand Mean	31

Source: Compiled by the Author

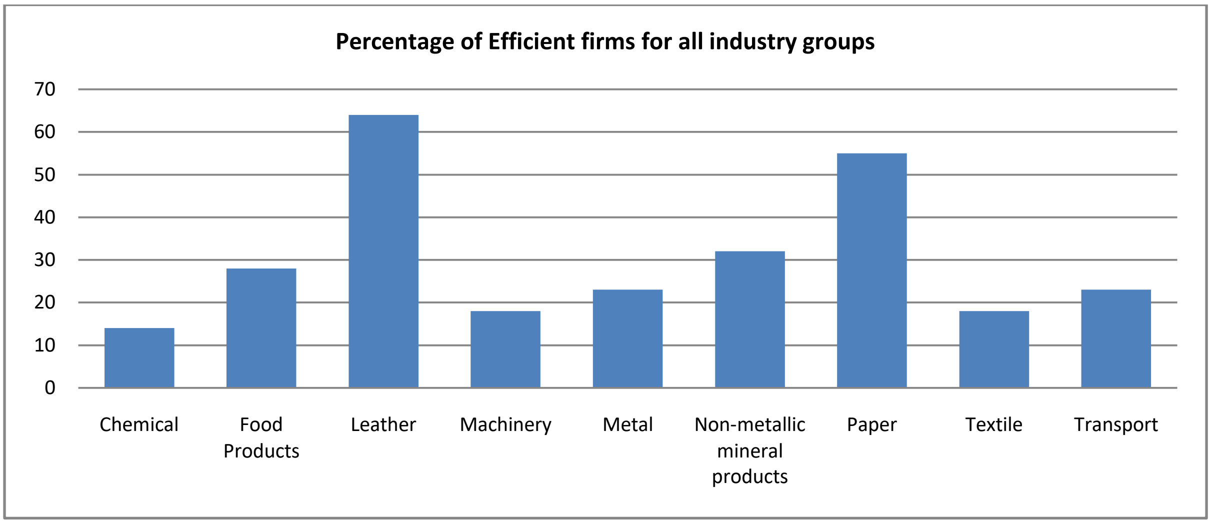

Figure 5.10. Percentage of Efficient firms for all industry groups (OTE)

Table 5.16 shows that about 31% of sample manufacturing firms are output efficient on an average. They are having the efficiency score of one. Figure 5.10. shows that 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.

5.6 Determinants of Output Oriented Technical Efficiency (OTE)

A second stage panel regression has been carried out to relate the output oriented technical efficiency of the Indian manufacturing firms with the strategic variables perused by firms as well as firms' characteristics namely R&D Intensity, Net Export Intensity, Advertising Intensity, Marketing Intensity, Age, Diversification Index and Size of the company. The explanations for the inclusion of different explanatory variables can be summarized as follows:

Advertising Intensity (ADV):

Advertising is used as the instrument to lower the scope and effectiveness of price competition by creating product differentiation among different firms in the consumer goods industries. Syverson (2004) explores the effect of product substitutability in an industry on the disparity of productivity level. When consumers can easily switch between producers, relatively more inefficient (high-cost) producers cannot be able to operate profitably. Thus the high-substitutability industries should exhibit less productivity dispersion and have higher average efficiency and or productivity levels. Syverson (2004) demonstrated this mechanism in a simple industry equilibrium model and tested it empirically using producer-level data from 443 U.S. manufacturing industries and tested for the effect of higher advertising intensity on substitutability. Advertising expenditure can also affect output oriented efficiency of the industry. Goldar et al. (2004) and Carod and Blasco (2004) pointed out the relationship between advertising intensity and technical efficiency for the Indian Engineering goods industries and Spanish manufacturing firms respectively. Ray (2006) did not find any effect of product differentiation on technical efficiency in the Indian manufacturing industry.

This chapter considers product differentiation by differences in advertisement activity and tries to find out a relation between advertisement activity and output oriented efficiency of the companies. The basic question is to what extent advertising expenditures foster output oriented technical efficiency? At the same time advertising expenditure can in turn get affected by the efficiency of the company and also by the other economic and strategic variables like market share, marketing and R&D behavior. Further advertisement activity can be influenced by age and size of the company. Thus in order to determine the major factors influencing advertisement expenditure one need to formulate and estimate a simultaneous kind of relation between all these variables.

Marketing Intensity (MKT):

This variable is measured by marketing expenditure as a ratio to total sales. It can be as a proxy for product differentiation. Sheth and Sisodia (2002) pointed out that low productivity or efficiency occurs due to the fall in marketing effectiveness. Their study suggests some changes which are needed at the corporate level. The most fundamental point is that the corporations must treat marketing as an investment rather than an expense. Kao et al. (2006) evaluates technical efficiency and allocative efficiency in marketing and gets a direct relationship between return and marketing expenditure. The return can be in the form of increased sales or increased customers or some forms of infrastructure which makes acquiring these items easier.

As in the case of advertising expenditure, this chapter tries to find out a relation between marketing activity and output oriented efficiency of the companies and other economic and strategic variables like market share, advertisement and R&D behavior, the age and size of the company. The basic question is to what extent marketing expenditures foster efficiency and in turn gets affected by strategic variables, age and size of the company. The answer to the question will be dependent on the estimation of a simultaneous kind of model where marketing expenditure is determined jointly by the other endogenous variables of the model.

R&D Intensity (RD):

While determining the factors explaining output oriented efficiency of Indian manufacturing firms, the role of R&D is relevant.

R&D basically includes the search for various novel pathways and the development of expertise which facilitate faster product development. On one hand, it makes new technologies and, on the other hand, it increases a firm's ability to employ existing technology. R&D leads to expansion in output. Here the idea is that as the firm undertakes more R&D, its technical knowledge gradually increases and thus the firm is more capable of producing increased amount of output. Thus one can expect a positive relationship between outputs oriented TE and R&D.

Thus it is really important to obverse whether R&D activities leads to expansion of output and thereby enhancing output oriented technical efficiency of the companies.

According to the recent theoretical models of endogenous growth R&D expenditures of individual firms are contributing to sustained long run growth of an economy through their industry-wide spillover effect (Grossman and Helpman, 1990a, Grossman and Helpman, 1990b, Romer, 1986). This view points out that individual firm invests in R&D to acquire private knowledge which increases their productivity and profit. Private knowledge of individual firms then spreads over the rest of the industry and it becomes social knowledge that acts as the external impacts in raising the efficiency and or productivity of the firms. A constant or decreasing return to scale, aggregate production function with positive spill-over effect of R&D may exhibit increasing returns to scale and thus may result in the sustained long run growth (Romer, 1986; Raut and Srinivasan, 1993). In a second line of thought Cohen and Levinthal (1989) argued that while knowledge from private R&D capital spills over to create social or public domain knowledge, a firm must invest in R&D to acquire the technical capability required to make use of the public domain knowledge to increase its productivity and or efficiency.

Many studies in the international literature tested R&D as the one of the determinants of efficiency at an aggregate country level, or by sector, although some studies have taken the firm as a unit of analysis. To mention a few, Yang et al. (2009), Kumbhakar et al. (2009), Scannell et al. (2012). Some studies are available which are showing the linkage between the R&D activities and efficiency of the firm for Indian industry, for instance, Ferrantino, (1992), Driffield and Kambhampti (2003), Mazumder et al. (2010). The studies vary with respect to the specific industries that they are considering and also with respect to the effect of R&D activity.

This type of argument represents only one aspect of the story. An alternative view is that the R&D decision of the firms is guided by output efficiency of the firms. The idea is that the efficient firms are able to undertake R&D decision because R&D requires some extra enpenditure, such as costs of establishing the research laboratory, spending related to training of research personnel. This in turn implies that only the better-off are firms expect to be able to cover this extra cost and will rationally choose to undertake R&D decision. Hence, ther is a correlation between R&D and efficiency of firms which may arise as a result of the self-selection of better firms into the R&D decision.

At the same time R&D can be influenced by other economic variables like market share of the company, and also by the companies' strategic variables like advertisement and marketing behavior. Age and size of the company can also be a significant determinant of R&D expenditure. It is expected that R&D decision of the company will be determined by the joint interactions of all these variables.

Thus the question can be asked to what extent the increase in R&D helps to increase the output efficiency of the firms belonging to the Indian manufacturing sector? At the same time one may be interested in knowing to what extent R&D decision of the companies is influenced by output efficiency, market share as well as other strategic variables and firms' characteristics. Hence one has to formulate a simultaneous kind of relation between these variables showing the joint interactions of each other.

Net Export Intensity (NX):

Apart from R&D activities the role of export behavior is also relevant while determining the factors explaining efficiency and or productivity of Indian manufacturing firms. Here the idea is that as the firms participate more and more in export activities they acquire better technologies by various ways which enable them in producing more output with same inputs, thus making them more efficient in output production.

An enormous amount of literature is available which supports the role of exports in increasing the efficiency both at the theoretical as well as empirical level. On the theoretical front, there is a common opinion that international trade in general and export in particular improves the efficiency of the firms (Balassa, 1988). The economic policies under export-led growth strategy support the argument that the exposure to the international market through the channel of export helps to increase the efficiency of exporters. Similarly, advocates of endogenous growth theory believe that export is playing a significant role by increasing efficiency through innovation (Grossman and Helpman, 1991) and technology transfer (Barro and Sala-i-Martin, 1995). One of the key factors in favor of the export-led hypothesis is the effect of the economic openness on the efficiency with which resources are utilised in an economy. In theories, there are four explanations regarding how the export expansion improves the efficiency of industry. (i) Export expansion *can lead to economies of scale*. A rise in exports represents an expansion of markets. International demand determines higher capacity utilization and allows the exploitation of economies of scale which tends to facilitate the expansion of the scale of production and the achievement of economies of scale. Outward orientation may result in efficiency gains for firms, due to the exploitation of economies of scale (Clerides et al, 1998; World Bank, 1993).(ii) *Exporters do learn from their presence in international markets associated with knowledge spillovers from international contacts* (Clerides et al, 1998; World Bank, 1993). International connections with buyers and customers are likely to improve the knowledge and technology spillovers, for example the access to technical expertise, including new product designs and new production methods. (iii) *Export intensifies the market competition in both overseas and domestic markets and* *tends to force firms to be more efficient through the rationalization of management and by adopting new technologies* (Balassa, 1988; Kwon, 1986; Greenaway, 1986; Chen and Tang, 1990; Greenaway and Sapsford, 1994). (iv) *There are spill-over effects, for instance, the technology diffusion, from the export-oriented industries to the non-export-oriented industries, and from the foreign-invested enterprises to the domestic firms* (Feder, 1983; Huallachain**,** 1984).

The empirical evidence showing that firms which will become exporters have some prior benefits is very rich and unambiguous. Mention may be made of studies by Chen and Tang (1987), Sun et al. (1999), Walujadi (2004), Mok et al. (2010) among many others. However, the studies vary with respect to the effect of export performance on efficiency of the firms.

World Bank Report (1993, 1997) discussed about the import of foreign technology by the firm and its positive effect on its efficiency. Such activity enables the firms to develop their internal production capabilities and competency. The abolition of the quantitative restrictions on imports and reduction of the customs duties in the post liberalization era in India must have improved the access to imported raw materials and capital goods to enter into the domestic economy. The imports of raw materials embodying latest technologies should increase the efficiency of the firms. In the context of India, a direct relationship between technical efficiency and imports has beem reported by Goldar et al. (2004) and Mazumder et al. (2010).

The above discussion reveals that the exports and imports both will improve efficiency. Since both exports and imports influence the efficiency, it may be interesting to find out the relative strength of exports vis á vis imports in enhancing efficiency. In order to find out this relative role the present chapter takes net export intensity **(NX)** as an explanatory variable while determining efficiency. The question is to what extent the net exports matter?

Thus question can be raised to what extent net export activities help to foster the output efficiency of the firms belonging to the Indian manufacturing sector and reciprocally get affected by the output efficiency of the firms? The present chapter tests these hypotheses empirically. Thus to test for the existence of the link between efficiency and net export one needs to model net export behavior of the firm taking efficiency as a determinant of net export in a simultaneous kind of set up.

In fact net exports will be determined by the simultaneous interactions with other economic and strategic variables like market share, advertising expenditures, marketing expenditures, age and size of the company.

Diversification Index (DIVIND):

DIVIND of a particular industry groups captures the effect of market structure on efficiency of the firms. DIVIND is the reciprocal of concentration ratio. The Herfindahl Index or Concentration Index is calculated as follows: $H = \Sigma s_i^2$; where s_i is the market share of the i^{th} firm in the market and N is the number of firms.

A negative relation between CR and efficiency is expected by some researchers because competition may lead to cost-consciousness and drive for technological advancement. Others point out the benefits of large size, secured market and expect a direct association between CR and efficiency. The conclusion from the empirical literature also varies and does not provide us a uniform answer [(Katz, 1969); (Kendrick, 1973)].

Age: There are counter arguments regarding the effect of age on firm's performances. One argument is that older firms are displaying superior performances since they are more experienced. They are having the advantages of learning earlier; as a result they do not experience the problems that the newcomers usually face (Stinchcombe, 1965). On the other hand, the counter argument is that older firms do lack enough flexibility to adopt quickly to the changing economic circumstances which the younger firms can do much more rapidly and efficiently (Marshall, 1920)

The present study has divided the sample companies into two groups:

Agedum = 1, if Mean Age of the firm < Grand Mean Age (considering all the firms and all time Points taken together)

= 0, Otherwise

Size: The efficiency differs due to difference in relative size. A larger sized firm may have an easier access to cheaper and superior quality inputs. It is easier for such firms to exploit economies of scale. They can widen scope of production by making its operation more effective which allows then to perform better compared to smaller firms (Penrose,1959). 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. rupees

= 0, otherwise

Mediumdum = 1, if mean investment < 10 Cr. rupees

= 0, otherwise

Largedum = 1, if mean investment > 10 Cr. rupees

= 0, otherwise

In order to avoid dummy variable trap, Mediumdum has been dropped.

It may be possible that the effect of different explanatory variables may be non-linear in nature. To get this effect, the sole effect of different variables, their square terms and the joint effect of different variables will be incorporated. The effects of the lag value (one year lag) of different strategic variables (i.e. the effects of different strategic variable in the previous period) have also been considered.

Since we are dealing with simultaneous equation model one important problem is the problem of Identification of the model, we have solved the problem of Identification by taking into account exclusion restriction. We have checked that the rank and order condition of Identification under exclusion restriction have got satisfied for the model. We make sure that at least one variable is specific to one particular equation and appears only in that equation. The model is identified.

5.6.1 Explaining the Factors Influencing OTE of the Firms: The Results from a Two Stage Least Square Type Approach in a Simultaneous Panel Model.

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

Since we are doing with simultaneous equation model in a panel setup, for purpose of estimation we have used two stage procedures.

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.

Significant Factors explaining OTE from a Simultaneous Equation Panel Model: The OTE Block

The estimated OTE of Indian manufacturing firms and also the other endogenous variables explaining the OTE corresponding to OTE block can be visualized below.

5.6.1.a Chemical Industry

The estimated OTE of Indian chemical firms and also the other endogenous variables explaining the OTE corresponding to OTE block can be visualized from Table 5.17.1 to Table 5.17.5.

Table 5.17.1 Factors explaining OTE from a Simultaneous Equation Panel Model: The OTE Block

Endogenous Variable: OTE

Independent Variable	Coefficient	z-value	p>|z|
ADV	.0002484	0.69	0.488
MKT	-.000625	-1.67	0.094
$(MKT)^2$	1.08e-06	1.38	0.167
RD	.0002352	1.26	0.208
$(RD)^2$	-1.82e-07	-2.10	0.035
RDlag	.0001228	1.93	0.053
RD*NXlag	1.82e-08	1.41	0.158
NX	-6.96e-06	-0.99	0.323
$(NX)^2$	4.78e-10	1.13	0.259
DIVIND	-.008573	-11.57	0.000
Agedum	.0327192	1.35	0.177
Wald chi2 = 162.52 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
ADV		0.0002	
MKT		0.0439	
RD		0.0274	
NX		0.0213	
NXlag		0.0005	

The first equation of OTE Block: The estimated OTE relation

The estimated OTE relation as presented in Table 5.17.1 shows that OTE is positively related to ADV of the current period and RD of the previous period. Higher levels of ADV in the current period and RD in the previous period increase OTE in the current period.

Considering MKT and NX of the current period, it can be seen that both have U-relationship with OTE. Their initial sole effect on OTE is negative and beyond their critical levels, their positive effects on OTE can be realised. When the net impacts are calculated, the marginal effects of MKT and NX come out to be positive.

Considering RD of the current period, it can be seen that RD has inverted U-relationship with OTE. Its initial sole effect on OTE is positive and the effect of its square term is negative.

There exists a joint interaction term of RD of the current period and NX of the previous period. The effect of RD on OTE depends on NX of the previous period.

Considering all these effects, the positive marginal effects of RD of the current period and NX of the previous period can be obtained.

DIVIND has negative effect on OTE. This means that as the market share gets concentrated, OTE of the firms increases.

Another factor positively influencing OTE is Agedum. This implies that the younger firms are having higher level of OTE than the older firms.

Table 5.17.2 Factors explaining ADV behaviour from a Simultaneous Equation Panel Model: The OTE Block

Endogenous Variable: ADV

Independent Variable	Coefficient	z-value	p>|z|
OTE*MKT	.0599315	2.19	0.028
MKT	.0521222	1.71	0.087
RD	.0323572	2.32	0.020
$(RD)^2$	-.0000238	-2.29	0.022
NX	-.0006246	-2.47	0.014
NX*RD	1.35e-06	2.64	0.008
Wald chi2 = 144.41 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
OTE		0.4986	
MKT		0.0998	
RD		0.0296	
NX		0.0266	

The second equation of OTE Block: The estimated ADV relation

The estimated ADV relation as presented in Table 5.17.2 shows that the sole effect of MKT is positive. There exists a composite effect of OTE and MKT. Its effect on ADV is positive. The effect of OTE on ADV depends on the mean level of MKT and vice-versa.

Considering all these effects, the positive marginal effects of OTE and MKT can be obtained.

Considering RD and NX of the current period, it can be seen that RD has inverted U-relationship with ADV. The sole effect of RD is positive while the effect of the square term is negative. Beyond its critical level, its negative effect on ADV will be felt. The sole effect of NX is negative.

There exists a composite effect of NX and RD on ADV. The joint interaction term of NX and RD has positive impact on ADV. Considering all these effects, the positive marginal effects of RD and NX can be obtained.

Table 5.17.3 Factors explaining MKT behaviour from a Simultaneous Equation Panel Model: The OTE Block

Endogenous Variable: MKT

Independent Variable	Coefficient	z-value	p>|z|
OTE	.9011746	0.27	0.785
ADV	.6137475	6.38	0.000
$(ADV)^2$	-.0023381	-6.42	0.000
RD	.3588477	20.69	0.000
$(RD)^2$	-.0002983	-27.91	0.000
RD*ADV	.0171538	30.33	0.000
NX	-.0021128	-2.25	0.024
$(NX)^2$	5.36e-07	10.68	0.000
NXlag	-.0006406	-0.66	0.512
$(NXlag)^2$	5.29e-07	9.42	0.000
Wald chi2 = 2592.54 Prob > chi2 = 0.0000			

Determinants	Marginal effects
OTE	0.9012
ADV	0.5870
RD	0.5117
NX	0.8660
NXlag	0.6127

The third equation of OTE Block: The estimated MKT relation

The estimated MKT relation as presented in Table 5.17.3 shows that MKT is positively related to OTE. Higher level of OTE increases MKT.

Considering ADV and RD of the current period, it can be seen that both have inverted U-relationship with MKT. Their initial sole effects are positive and beyond their critical levels, their negative effects on MKT will be felt.

There exists a composite effect of RD and ADV on MKT. This effect is positive. The effect of RD on MKT depends on ADV and vice-versa.

Considering all these effects, the positive marginal effects of RD and ADV on MKT can be obtained.

Considering NX of the current period as well as previous period, it can be seen that both are having U-relationship with MKT. Their initial sole effects are negative. Beyond their critical levels, their positive effects on MKT will be realised.

Considering all these effects, the positive marginal effects of NX of the current period as well as previous period can be obtained.

Table 5.17.4 Factors explaining RD behaviour from a Simultaneous Equation Panel Model: The OTE Block

Endogenous Variable: RD

Independent Variable	Coefficient	z-value	p>|z|
OTE	-.2463379	-1.93	0.054
$(OTE)^2$	.0003945	2.11	0.035
MKT	1.459307	7.02	0.000
$(MKT)^2$	-.0058896	-10.66	0.000
ADV*MKT	.0087996	1.23	0.220
$(ADV*MKT)^2$	6.89e-07	4.09	0.000
NX	-.0148321	-4.03	0.000
$(NX)^2$	2.70e-06	18.45	0.000
NXlag	.0115074	4.61	0.000
Largedum	9.781226	1.07	0.283
Wald chi2 = 1350.87 Prob > chi2 = 0.0000			

Determinants	Marginal effects
OTE	-0.2393
ADV	5.0643
MKT	4.9211
ADV*MKT	1.2129
NX	1.1785

The fourth equation of OTE Block: The estimated RD relation

The estimated RD relation as presented in Table 5.17.4 shows that RD is positively related to NX of the previous period.

Considering OTE of the current period, it can be seen that it has U-relationship with RD. Its initial sole effect is negative. Beyond its critical level, its positive effect on RD can be obtained. Considering these effects, the marginal effect of OTE comes out to be negative as the mean level of OTE is lesser than the critical level of OTE, beyond which its positive effect on RD can be achieved.

Considering MKT of the current period, it can be seen that it has inverted U-relationship with RD. Its initial sole effect is positive. Beyond its critical level, its negative effect on RD will be felt.

There exists a joint interaction term of ADV and MKT on RD. The marginal effect of this joint interaction term is positive. All these effects taken into account, the positive marginal effects of ADV and MKT will be obtained.

Considering NX of the current period, it can be seen that NX has U-relationship with RD. Its initial sole effect is negative. Beyond its critical level, its positive effect on RD will be felt. Considering all these effects, the positive marginal effect of NX on RD will be obtained.

Another factor positively affecting RD is Largedum. It has indirect impact on OTE. This means that larger sized firms are having higher level of RD than the smaller sized firms.

Table 5.17.5 Factors explaining NX behaviour from a Simultaneous Equation Panel Model: The OTE Block

Endogenous Variable: NX

Independent Variable	Coefficient	z-value	p>|z|
OTE	4.255648	3.56	0.000
$(OTE)^2$	-.011837	-6.22	0.000
ADVlag	4.093703	1.11	0.267
MKT	9.386084	6.17	0.000
MKTlag	6.310448	3.80	0.000
RD	1.952152	24.63	0.000
RDlag	5.401884	5.07	0.000
DIVIND	-10.79461	-1.79	0.073
Wald chi2 = 1845.76 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
OTE		4.2434	
MKT		9.3861	
RD		1.9522	

The fifth equation of OTE Block: The estimated NX relation

The estimated NX relation as presented in Table 5.17.5 shows that NX is positively related to ADV of the previous period, MKT of the current period as well as previous period, RD of the current period as well as previous period. Increase in all these factors increase NX.

Considering OTE of the current period, it can be seen that OTE has inverted U-relationship with NX. Its sole effect is positive but the effect of the square term is negative. Initially the increase in OTE increases NX but beyond its critical level, its negative effect on NX can be felt.

Another factor influencing NX is DIVIND. It has negative impact on NX. As the market share gets concentrated, NX of the firms increases.

5.6.1.b Food Products Industry

The estimated OTE of Indian food product firms and also the other endogenous variables explaining the OTE corresponding to OTE block can be visualized from Table 5.18.1 to Table 5.18.5.

Table 5.18.1 Factors explaining OTE from a Simultaneous Equation Panel Model: The OTE Block

Endogenous Variable: OTE

Independent Variable	Coefficient	z-value	p>|z|
ADV*MKT	.0003729	2.37	0.018
MKT	.006928	1.95	0.051
$(MKT)^2$	-.0004841	-2.34	0.019
RD	-.0644132	-2.80	0.005
$(RD)^2$	.0063814	1.79	0.074
NX	-.0003233	-2.20	0.028
NX*RD	.0002183	1.08	0.280
$(NX*RD)^2$	4.29e-07	1.77	0.076
Wald chi2 = 55.78 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
ADV		0.0002	
MKT		0.0006	
RD		5.7184	
NX		0.1242	
NX*RD		0.1044	

The first equation of OTE Block: The estimated OTE relation

The estimated OTE relation as presented in Table 5.18.1 shows that MKT has inverted U-relationship with OTE. Initially with the increase in MKT increases OTE but too much MKT will be costly for the firms.

There exists a composite effect of ADV and MKT. The joint interaction term of ADV and MKT has positive effect on OTE. Considering all these effects, the marginal effects of ADV and MKT are positive.

Considering RD of the current period, RD has U-relationship with OTE. The sole effect is negative while the effect of the square term is positive. The positive effect of RD on OTE will be realised beyond the critical level of RD.

Considering NX of the current period, the sole effect is negative. There exists a joint interaction term of NX and RD. The marginal effect of this joint interaction term on OTE is positive. Considering all these effects, the marginal effects of NX and RD are positive.

Table 5.18.2 Factors explaining ADV behaviour from a Simultaneous Equation Panel Model: The OTE Block

Endogenous Variable: ADV

Independent Variable	Coefficient	z-value	p>|z|
OTE	1.224395	1.68	0.092
OTE*RD	.1612667	2.93	0.003
NX	-.0564022	-0.49	0.623
$(NX)^2$	.0003201	1.74	0.082
DIVIND	-4.167383	-3.79	0.000
Smalldum	-6.019565	-2.96	0.003
Wald chi2 = 313.49 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
OTE		1.2211	
RD		0.1820	
NX		-0.0305	

The second equation of OTE Block: The estimated ADV relation

The estimated ADV relation as presented in Table 5.18.2 shows that the sole effect of OTE is positive. There exists a joint interaction term of OTE and RD. It has positive effect on ADV.

The effect of OTE depends on RD and vice-versa. Considering all these effects, the marginal effects of OTE and RD on ADV are positive.

Considering NX of the current period, NX has U-relationship with ADV. The sole effect of NX is negative and the effect of the square term is positive. This means that the positive effect of NX on ADV will be realised beyond the critical value of NX.

Another factor affecting ADV is DIVIND, indirectly affecting OTE. It has negative effect on ADV, meaning that as the market share gets concentrated, the ADV of the firms increase.

Other factor affecting ADV is Smalldum, indirectly affecting OTE. It has negative effect on ADV, meaning that the larger sized firms are having higher level of ADV than the smaller sized firms.

Table 5.18.3 Factors explaining MKT behaviour from a Simultaneous Equation Panel Model: The OTE Block

Endogenous Variable: MKT

Independent Variable	Coefficient	z-value	p>|z|
OTE	.4086468	2.34	0.019
$(OTE)^2$	-.0024987	-2.60	0.009
ADV	-.1813414	-2.20	0.028
$(ADV)^2$	.0057625	1.45	0.148
RD	2.61666	3.10	0.002
$(RD)^2$	-.170925	-1.46	0.144
RDlag	1.435757	1.64	0.100
$(RDlag)^2$	-.1385803	-1.12	0.263
RD*ADV	.0383915	1.47	0.142
NX	-.0397961	-4.81	0.000
$(NX)^2$	.0002621	7.03	0.000
NX*RD	.0212631	8.26	0.000
DIVIND	-1.139594	-2.00	0.046
Smalldum	-8.749674	-9.32	0.000
Wald chi2 = 1128.60 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
OTE		0.3964	
ADV		-0.0654	
RD		3.3196	
RDlag		1.3200	
NX		0.0035	

The third equation of OTE Block: The estimated MKT relation

The estimated MKT relation as presented in Table 5.18.3 shows that OTE has inverted U-relationship with MKT. Initially with the increase in OTE, MKT increases but beyond the critical level of OTE, increase in OTE reduces MKT as too much MKT is costly for the firms. The marginal effect of OTE on MKT is positive.

Considering ADV of the current period, it can be seen that ADV has U-relationship with MKT. The sole effect is negative but the effect of the square term is positive. The positive effect of ADV on MKT will be realised beyond the critical level of ADV.

There exists a joint interaction term of RD and ADV. Its effect on MKT is positive. These effects taken into account, the marginal effect of ADV is negative as the mean level of ADV is lesser than the critical level of ADV.

Considering RD of the current period and the previous period, it can be seen that both have inverted U-relationship with MKT. Initially with the increase in RD both in the current period as well as in the previous period increases MKT but beyond their critical levels, their increase reduces MKT.

There exists another joint interaction term of NX and RD. It has positive effect on MKT.

All these effects taken into account, the marginal effects of RD in the current period and in previous period are positive.

Considering NX of the current period, it can be seen that NX has U-relationship with MKT. The positive effect of NX on MKT can be felt beyond the critical level of NX. All the effects taken under consideration, the marginal effect of NX on MKT is positive.

Another factor affecting MKT is DIVIND, indirectly affecting OTE. It has negative effect on MKT, meaning that as the market share gets concentrated, the MKT of the firms increase.

Other factor affecting MKT is Smalldum, indirectly affecting OTE. It has negative effect on MKT, meaning that larger sized firms are having higher level of MKT than the smaller sized firms.

Table 5.18.4 Factors explaining RD behaviour from a Simultaneous Equation Panel Model: The OTE Block

Endogenous Variable: RD

Independent Variable	Coefficient	z-value	p>|z|
OTE	-.0127863	-2.76	0.006
OTE*NX	-.0001801	-1.04	0.300
$(OTE*NX)^2$	1.17e-09	0.33	0.741
ADV	-.0647405	-5.26	0.000
$(ADV)^2$	.0016717	4.75	0.000
MKT	.0864187	6.50	0.000
MKTlag	.1412815	4.30	0.000
DIVIND	-.1531963	-1.16	0.248
Wald chi2 = 423.03 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
OTE		0.2633	
ADV		-0.0311	
MKT		0.0864	
NX		0.0077	
OTE*NX		0.9961	

The fourth equation of OTE Block: The estimated RD relation

The estimated RD relation as presented in Table 5.18.4 shows that RD is positively related to MKT of the current period as well as of the previous period. The increase in MKT in the current period as well as in the previous period increases OTE.

Considering OTE of the current period, it can be seen that the sole effect of OTE on RD is negative. There exists a joint interaction term of OTE and NX. The marginal effect of this joint interaction term is positive. Considering all these effects, the marginal effects of OTE and NX on RD are positive.

Considering ADV of the current period, it can be seen that ADV has U-relationship with RD. The sole effect of RD is negative but beyond the critical level the positive effect of ADV on RD will be felt. These effects taken into account, the marginal effect of ADV is negative as the mean ADV is lesser than the critical level of ADV.

Another factor affecting RD is DIVIND, indirectly affecting OTE. It has negative effect on RD, meaning that as the market share gets concentrated, RD of the firms increases.

Table 5.18.5 Factors explaining NX behaviour from a Simultaneous Equation Panel Model: The OTE Block

Endogenous Variable: NX

Independent Variable	Coefficient	z-value	p>|z|
OTE	.423823	2.20	0.028
OTE*RD	.091442	3.24	0.001
ADV	3.70157	4.09	0.000
$(ADV)^2$	-.060014	-3.62	0.000
MKTlag	1.576943	2.49	0.013
REER	-.4357115	-1.03	0.303
Wald chi2 = 50.73 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
OTE		0.4830	
RD		0.0819	
ADV		2.8336	

The fifth equation of OTE Block: The estimated NX relation

The estimated NX relation as presented in Table 5.18.5 shows that NX is positively related to MKT of the previous period and negatively related to REER.

Considering OTE of the current period, it can be seen that the sole effect of OTE is positive. There exists a joint interaction term of OTE and RD. It has positive effect on NX. The effect of OTE on NX depends on RD and vice-versa. Considering all these effects, the marginal effects of OTE on NX is positive.

Considering ADV of the current period, it can be seen that ADV has inverted U-relationship with NX. Initially with the increase in ADV, NX increases but beyond the critical level of ADV, increase in ADV reduces NX. Considering all these effects, the marginal effect of ADV on NX is positive.

5.6.1.c Leather Industry

The estimated OTE of Indian leather firms and also the other endogenous variables explaining the OTE corresponding to OTE block can be visualized from Table 6.19.1 to Table 6.19.5.

Table 5.19.1 Factors explaining OTE from a Simultaneous Equation Panel Model: The OTE Block

Endogenous Variable: OTE

Independent Variable	Coefficient	z-value	p>|z|
ADV	-.003962	-2.23	0.026
$(ADV)^2$	.0000643	2.05	0.040
MKT	-.0001017	-0.45	0.652
$(MKT)^2$	7.04e-07	2.60	0.009
RD*NXlag	.0000429	3.28	0.001
NX	-.0000111	-0.84	0.403
$(NX)^2$	-1.57e-08	-5.22	0.000
NXlag	.0000187	1.34	0.179
DIVIND	.0228531	2.09	0.037
Wald chi2 = 210.07 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
ADV		-0.0020	
MKT		0.4486	
RD		0.0001	
NX		-0.0026	
NXLAG		0.0001	

The first equation of OTE Block: The estimated OTE relation

The estimated OTE relation as presented in Table 5.19.1 shows that ADV and MKT both have U-relationship with OTE. Their sole effects are negative and the effects of the square terms are positive. Initially with the increase in ADV and MKT will not initiate OTE but beyond their critical levels, their positive effects on OTE can be achieved. All these effects taken into consideration, the marginal effect of MKT is positive but the marginal effect of ADV is negative as the mean ADV is lesser than critical level of ADV.

Considering NX of the current period, it can be observed that NX has non-linear negative relationship with OTE. The marginal effect of NX is negative, implying that imports dominate over exports.

Considering NX of the previous period, it can be seen that the sole effect of NX of the previous period is positive. There exists a composite effect of NX of the previous period and RD of the current period. It has positive effect on OTE. Through the imports of capital goods, store and spare parts in the previous period will lead to rise in RD in the current period, as a result the OTE increases.

Another factor positively affecting OTE is DIVIND. As the market share gets diversified, OTE of the firms increases.

Table 5.19.2 Factors explaining ADV behaviour from a Simultaneous Equation Panel Model: The OTE Block

Endogenous Variable: ADV

Independent Variable	Coefficient	z-value	p>|z|
OTE	.1814232	1.61	0.108
MKT	.0272742	1.89	0.059
MKTlag	.0254679	2.78	0.005
RD	10.23307	1.50	0.133
$(RD)^2$	-.2583464	-1.80	0.072
NX	-.3194663	-2.13	0.034
$(NX)^2$	.0020011	0.87	0.382
Agedum	-3.539275	-1.87	0.061
Largedum	-7.099628	-2.83	0.005
Wald chi2 = 75.75 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
OTE		0.1814	
MKT		0.0273	
RD		9.7050	
NX		-0.3002	

The second equation of OTE Block: The estimated ADV relation

The estimated ADV relation as presented in the Table 5.19.2 shows that ADV is positively related to OTE of the current period and MKT of the current period as well as of the previous period. Increase in these factors increases ADV of the current period.

Considering RD of the current period, it can be seen that RD has inverted U-relationship with ADV. The sole effect of RD is positive but the effect of the square term is negative. Initially with the increase in RD, ADV increases but beyond the critical level of RD, increase in RD will lead to a fall in ADV. All these effects taken into consideration, the marginal effect of RD is positive.

Considering NX of the current period, it can be seen that NX has U-relationship with ADV. The sole effect of NX is negative but the effect of the square term is positive. The positive effect of NX on ADV can be realised beyond its critical level. The marginal effect of NX is negative, implying that imports dominate over exports.

Another factor affecting ADV is Agedum, indirectly influencing OTE. It has negative effect on ADV, meaning that older firms are having higher level of ADV than the younger firms.

Other factor affecting ADV is Largedum, indirectly influencing OTE. It has negative effect on ADV, meaning that the smaller sized firms are having higher level of ADV than the larger sized firms.

Table 5.19.3 Factors explaining MKT behaviour from a Simultaneous Equation Panel Model: The OTE Block

Endogenous Variable: MKT

Independent Variable	Coefficient	z-value	p>|z|
OTE	7.806762	2.02	0.043
$(OTE)^2$	-.0490303	-2.03	0.042
ADV	4.304541	2.27	0.023
$(ADV)^2$	-.0636093	-1.89	0.058
NX	3.094789	3.56	0.000
$(NX)^2$	.1064226	8.29	0.000
NXlag	1.119171	1.81	0.071
Wald chi2 = 1004.54 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
OTE		7.7332	
ADV		3.2956	
NX		3.5780	

The third equation of OTE Block: The estimated MKT relation

The estimated MKT relation as presented in Table 5.19.3 shows that MKT is positively related to NX of the previous period. The increase in NX in the previous period will lead to the rise in MKT in the current period.

Considering OTE and ADV of the current period, it can be seen that both have inverted U-relationship with MKT. Initially with the increase in OTE and ADV will initiate MKT but beyond their threshold levels, the increase in OTE and ADV will reduce MKT. After attaining the critical levels of output efficiency and ADV, the firms reduce their expenditures on MKT.

Considering NX of the current period, it can be seen that NX has positive non-linear relationship with MKT. The marginal effect of NX is positive.

Table 5.19.4 Factors explaining RD behaviour from a Simultaneous Equation Panel Model: The OTE Block

Endogenous Variable: RD

Independent Variable	Coefficient	z-value	p>|z|
OTE	.0326835	2.06	0.039
ADV	-.0817312	-1.60	0.109
$(ADV)^2$	.0018253	2.04	0.041
MKTlag	-.0119559	-1.48	0.140
$(MKTlag)^2$	.0000127	1.38	0.167
NX	.2201109	1.39	0.164
$(NX)^2$	-.0019805	-1.68	0.093
NXlag	.0678126	1.45	0.147
$(NXlag)^2$	-.0013142	-1.50	0.133
OTE*NX	-.0030727	-1.59	0.112
$(OTE*NX)^2$	2.52e-07	1.05	0.292
Agedum	-1.280585	-4.59	0.000
Smalldum	.9900111	3.07	0.002
Wald chi2 = 66.90 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
OTE		0.0487	
ADV		-0.0465	
MKTlag		-0.0093	
NX		0.2226	
NXlag		0.0655	
OTE*NX		0.7943	

The fourth equation of OTE Block: The estimated RD relation

The estimated RD relation as presented in Table 5.19.4 shows that the sole effect of OTE is positive.

There exists a composite effect of OTE and NX. The marginal effect of this joint interaction term is positive. Increase in NX will lead to the rise in OTE, as a result RD will be increased. Considering all these effects, the marginal effect of OTE on RD is positive.

Considering ADV of the current period and MKT of previous period, it can be seen that both have U-relationship with OTE. Their sole effects are negative and the effects of the square terms are positive, meaning that their positive effects can be realised beyond their critical levels. All these effects taken into account, the marginal effects of both on RD are negative as their mean values are lesser than the critical levels beyond which their positive effects on RD can be felt.

Considering NX of the current period and the previous period, it can be seen that both have inverted U-relationship with RD. Initially the increase in both NX of the current period and previous period will initiate RD but beyond their critical levels, their negative effect on RD will be felt. The marginal effects of NX of the current period and the previous period on RD are positive.

Another factor affecting RD is Agedum, indirectly affecting OTE. It has negative effect on RD, meaning that older firms are having higher level of RD than the younger firms.

Other factor positively influencing RD is Smalldum, indirectly affecting OTE. This means that smaller sized firms are having higher level of RD than the larger sized firms.

Table 5.19.5 Factors explaining NX behaviour from a Simultaneous Equation Panel Model: The OTE Block

Endogenous Variable: NX

Independent Variable	Coefficient	z-value	p>|z|
OTE	.0863767	1.70	0.089
ADV	-.3217927	-1.97	0.049
$(ADV)^2$	.0053093	1.83	0.067
ADVlag	.2310374	1.25	0.212
MKT	.0093802	0.95	0.341
$(MKT)^2$	.0000441	5.26	0.000
MKTlag	.0138256	3.17	0.002
RDlag	4.243086	1.70	0.090
Agedum	-2.025886	-2.45	0.014
Wald chi2 = 769.55 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
OTE		0.0864	
ADV		-0.2363	
MKT		0.0118	

The fifth equation of OTE Block: The estimated NX relation

The estimated NX relation as presented in Table 5.19.5 shows that NX is positively related to OTE, ADV of the previous period, MKT of the previous period and RD of the previous period. Increase in all these factors increases NX of the current period.

Considering ADV of the previous period, it can be seen that ADV has U-relationship with NX. The positive effect of ADV on NX can be realised beyond the critical level of ADV. The marginal effect of ADV is negative as the mean level of ADV is lesser than the critical level of ADV.

Considering MKT of the current period, it can be seen that MKT has non-linear positive relationship with NX. The marginal effect of MKT is positive. Increase in MKT in the current period increases the NX of the current period.

Another factor affecting NX is Agedum, indirectly affecting OTE. It has negative effect on NX, meaning that older firms are having higher level of NX.

5.6.1.d Machinery Industry

The estimated OTE of Indian machinery firms and also the other endogenous variables explaining the OTE corresponding to OTE block can be visualized from Table 5.20.1 to Table 5.20.5.

Table 5.20.1 Factors explaining OTE from a Simultaneous Equation Panel Model: The OTE Block

Endogenous Variable: OTE

Independent Variable	Coefficient	z-value	p>|z|
RD*ADV	.0000518	1.21	0.224
MKT	-.0493388	-2.42	0.015
$(MKT)^2$	.0000748	3.68	0.000
MKTlag	.0393132	3.05	0.002
NX	.0002458	1.02	0.309
DIVIND	-.2837272	-3.78	0.000
Wald chi2 = 49.32 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
ADV		0.0007	
MKT		-0.0377	
RD		0.0004	
NX		0.0002	

The first equation of OTE Block: The estimated OTE relation

The estimated OTE relation as presented in Table 5.20.1 shows that OTE is positively related to MKT of the previous period and NX of current period. Increase in MKT of the previous period and NX of current period increases OTE.

Considering MKT of the current period, it can be seen that MKT has U-relationship with OTE. The sole effect of MKT is negative and the effect of the square term is positive. The positive effect of MKT of OTE will be obtained beyond the critical level of MKT. The marginal effect of MKT on OTE is negative as the mean MKT is lesser than the critical level of MKT.

There exists a joint interaction term of RD and ADV. It has positive effect on OTE. The joint effect on RD and ADV increases OTE. The marginal effects of both RD and ADV are positive.

Another factor affecting OTE is DIVIND. It has negative effect on OTE. As the market share gets concentrated, OTE of the firms increases.

Table 5.20.2 Factors explaining ADV behaviour from a Simultaneous Equation Panel Model: The OTE Block

Endogenous Variable: ADV

Independent Variable	Coefficient	z-value	p>|z|
OTE	-2.138047	-6.23	0.000
$(OTE)^2$	.0102466	6.14	0.000
MKT	.3876298	4.75	0.000
$(MKT)^2$	-.0000904	-3.05	0.002
RD	.0816578	3.31	0.001
$(RD)^2$	-.0000684	-10.25	0.000
NX	.0063702	4.80	0.000
$(NX)^2$	-9.81e-08	-7.96	0.000
NXlag	.0010779	2.91	0.004
$(NXlag)^2$	-4.04e-09	-2.97	0.003
OTE*MKT	-.0013494	-1.68	0.094
$(OTE*MKT)^2$	3.23e-08	8.55	0.000
OTE*NX	5.72e-06	0.42	0.677
$(OTE*NX)^2$	8.04e-12	7.49	0.000
Largedum	2.534428	1.25	0.213
Wald chi2 = 3109.15 Prob > chi2 = 0.0000			

Determinants	Marginal effects
OTE	-1.5145
MKT	4.3201
OTE*MKT	0.0257
RD	0.0883
NX	-0.0177
NXlag	-0.0046
OTE*NX	0.0147

The second equation of OTE Block: The estimated ADV relation

The estimated ADV relation as presented in Table 5.20.2 shows that OTE has U-relationship with ADV. The sole effect of OTE is negative and the effect of the square term is positive, meaning that the positive effect of OTE on ADV will be realised beyond the critical level of OTE.

There exists a joint interaction term of OTE and MKT. It has positive effect on ADV. Increase in MKT increases OTE, as a result ADV will be increased.

There exists a joint interaction term of OTE of the current period and the NX of the current period. Increase in NX increases OTE; again that will lead to an increase in ADV.

All these effects taken into consideration, the marginal effect of OTE comes out to be negative as the mean OTE is lesser than the critical level of OTE.

Considering MKT of the current period, RD of the current period and NX of the current period and previous period, it can be seen that all have inverted U-relationship with ADV. Their respective sole effects on ADV are positive but the effects of the square terms are negative. Initially the increase in these factors increases ADV but beyond their critical levels, their negative effects on ADV will be felt. Considering all these effects, the marginal effects of MKT and RD are positive, implying that increase in MKT and RD increases ADV. But the marginal effects of NX of the current period and the previous period are negative, implying that imports dominate over exports.

Another factor positively influencing ADV is Largedum, indirectly affecting OTE. This means that the larger sized firms are having higher level of ADV than the smaller sized firms.

Table 5.20.3 Factors explaining MKT behaviour from a Simultaneous Equation Panel Model: The OTE Block

Endogenous Variable: MKT

Independent Variable	Coefficient	z-value	p>|z|
OTE	2.217096	5.26	0.000
$(OTE)^2$	-.0110148	-5.38	0.000
ADV	.3687172	3.85	0.000
$(ADV)^2$	-.0002122	-3.64	0.000
ADVlag	.4925038	20.39	0.000
RD	.1586765	15.68	0.000
RDlag	.4405705	24.26	0.000
NX*RD	5.18e-06	29.71	0.000
OTE*ADV	.0052342	5.43	0.000
Wald chi2 = 21835.07 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
OTE		2.2353	
ADV		0.3711	
RD		0.2323	
NX		0.1812	

The third equation of OTE Block: The estimated MKT relation

The estimated MKT relation as presented in Table 5.20.2 shows that MKT is positively related to ADV of the previous period and RD of the previous period. Increase in ADV and RD in the previous period increases MKT in the current period.

Considering OTE and ADV of the current period, it can be seen that both have inverted U-relationship with MKT. Their sole effects on MKT are positive but beyond their critical levels, their increase will lead to a fall in MKT. There exists a composite effect of OTE and ADV on MKT. This effect is positive. All these effects taken into consideration, the marginal effects of OTE and ADV are positive.

Considering RD of the current period, it can be seen that the sole effect of RD is positive. There exists a composite effect of NX and RD. This joint interaction term has positive effect on MKT. Considering all these effects, the marginal effects of RD and NX are positive.

Table 5.20.4 Factors explaining RD behaviour from a Simultaneous Equation Panel Model: The OTE Block

Endogenous Variable: RD

Independent Variable	Coefficient	z-value	p>|z|
OTE	-2.584138	-2.78	0.005
$(OTE)^2$	.0119945	2.67	0.008
MKT	1.242222	27.29	0.000
$(MKT)^2$	.0002507	12.51	0.000
NX	.004249	0.92	0.358
$(NX)^2$	-4.38e-07	-11.08	0.000
NXlag	.0518038	9.05	0.000
OTE*NX	.0001319	2.65	0.008
$(OTE*NX)^2$	3.80e-11	10.98	0.000
DIVIND	-.3986563	-1.30	0.195
Wald chi2 = 11216.05 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
OTE		-2.5576	
MKT		1.2498	
NX		-0.0403	
OTE*NX		0.0007	

The fourth equation of OTE Block: The estimated RD relation

The estimated RD relation as presented in Table 5.20.4 shows that RD is positively related to NX of the previous period. The NX of the previous period increases the RD of the current period.

Considering OTE of the current period, it is seen that OTE has U-relationship with RD. The sole effect of OTE is negative but the effect of the square term is positive. This means that initially the increase in OTE will not initiate RD but beyond the critical level of OTE, its positive effect on RD will be felt.

There exists a joint interaction term of OTE and NX. The marginal effect of this joint interaction term is positive. Through NX, OTE will be increased; as a result, RD will be increased. All these effects taken into consideration, the marginal effect of OTE is negative as mean OTE is lesser than the critical level of OTE.

Considering MKT of the current period, it can be seen that MKT has non-linear positive relationship with RD. The marginal effect of MKT on RD is positive, meaning that increase in MKT increases RD.

Considering NX of the current period, it can be seen that NX has inverted U-relationship with RD. The marginal effect of NX is negative, implying that imports dominate over exports.

Another factor affecting RD is DIVIND. It has negative effect on RD, meaning that as the market share gets concentrated, RD of the firms increases.

Table 5.20.5 Factors explaining NX behaviour from a Simultaneous Equation Panel Model: The OTE Block

Endogenous Variable: NX

Independent Variable	Coefficient	z-value	p>|z|
OTE	1.08476	2.82	0.005
$(OTE)^2$	-.0054131	-2.90	0.004
ADV	.3478556	6.11	0.000
$(ADV)^2$	.0009876	19.85	0.000
ADVlag	.6178425	10.09	0.000
MKTlag	.1737778	4.16	0.000
$(MKTlag)^2$	-.0001158	-9.48	0.000
RD	.0462312	1.32	0.188
$(RD)^2$	.0000703	7.14	0.000
RDlag	.0996169	8.04	0.000
REER	-.1872353	-1.33	0.185
Wald chi2 = 11732.08 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
OTE		1.0709	
ADV		0.3656	
MKTlag		0.1968	
RD		0.0520	

The fifth equation of OTE Block: The estimated NX relation

The estimated NX relation as presented in Table 5.20.5 shows that NX is positively related to ADV of the previous period and RD of the previous period. Increase in ADV and RD of the previous period increases the NX of the current period. NX is negatively related to REER.

Considering OTE of the current period, it can be seen that OTE has inverted U-relationship with NX. Initially increase in OTE will increase NX but beyond the critical level of OTE, increase in OTE will lead to fall in NX. All these effects taken into account, the marginal effect of OTE comes out to be positive.

Considering ADV and RD of the current period, it can be seen that both have non-linear positive relationship with NX. The sole effect and the effect of the square term are positive. The marginal effects of both ADV and RD are positive.

Considering MKT of the previous period, it can be seen that MKT of the previous period has inverted U-relationship with NX. Initially increase MKT in the previous period increases the NX in the current period but beyond the critical level of MKT of the previous period, its negative effect on NX will be realised. The marginal effect of MKT of the previous period is positive.

5.6.1.e Metal Industry

The estimated OTE of Indian metal firms and also the other endogenous variables explaining the OTE corresponding to OTE block can be visualized from Table 5.21.1 to Table 5.21.5.

Table 5.21.1 Factors explaining OTE from a Simultaneous Equation Panel Model: The OTE Block

Endogenous Variable: OTE

Independent Variable	Coefficient	z-value	p>|z|
ADV	-.0000533	-0.46	0.644
$(ADV)^2$	1.77e-07	1.94	0.052
MKT	-.0000938	-3.49	0.000
$(MKT)^2$	2.14e-09	2.49	0.013
RD	-.0006843	-3.11	0.002
$(RD)^2$	4.04e-08	1.43	0.153
NX	.002168	3.92	0.000
Agedum	-.0202601	-1.00	0.318
Wald chi2 = 22.09 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
ADV		0.0141	
MKT		0.0025	
RD		0.0006	
NX		0.0022	

The first equation of OTE Block: The estimated OTE relation

The estimated OTE relation as presented in Table 5.21.1 shows that OTE is positively related to NX of the current period, implying that exports dominate over imports.

Considering ADV, MKT and RD of the current period, it can be seen that all have U-relationship with OTE. Their sole effects are negative and the effects of their square terms are positive. This means that the positive effects of these factors on OTE can be obtained beyond their critical levels. Considering all these effects, the positive marginal of ADV, MKT and RD can be obtained.

Another factor affecting OTE is Agedum. It has negative effect on OTE, meaning that the older firms are having higher level of OTE than the younger firms.

Table 5.21.2 Factors explaining ADV behaviour from a Simultaneous Equation Panel Model: The OTE Block

Endogenous Variable: ADV

Independent Variable	Coefficient	z-value	p>|z|
OTE	-12.41683	-1.76	0.078
$(OTE)^2$	.0656472	1.73	0.084
MKT	.046447	2.54	0.011
MKTlag	.039178	3.89	0.000
OTE*MKT	.0002993	1.97	0.049
RDlag	.6159902	4.67	0.000
NXlag	2.387302	5.23	0.000
DIVIND	11.92381	1.75	0.080
Wald chi2 = 382.74 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
OTE		-12.2911	
MKT		0.0503	

The second equation of OTE Block: The estimated ADV relation

The estimated ADV relation as presented in Table 5.21.2 shows that ADV is positively related to MKT of previous period, RD of the current period and NX of the previous period. Increase in MKT, RD and NX in the previous period increases ADV in the current period.

Considering OTE of the current period, it can be seen that OTE has U-relationship with ADV. The sole effect of ADV is negative and the effect of the square term is positive, meaning that the positive effect of OTE on ADV can be achieved beyond the critical level of OTE.

Considering MKT of the current period, it can be seen that the sole effect of MKT is positive. There exists a composite effect of OTE and MKT. This joint interaction term has positive effect on ADV. The effect of OTE on ADV depends on MKT and vice-versa. All these effects taken under consideration, the marginal effect of MKT is positive but the marginal effect of OTE is negative as the mean level of OTE is lesser than the critical level of OTE.

Another factor positively affecting ADV is DIVIND, indirectly influencing OTE. This means that as the market shares of the firms get diversified, the firms are having level of ADV.

Table 5.21.3 Factors explaining MKT behaviour from a Simultaneous Equation Panel Model: The OTE Block

Endogenous Variable: MKT

Independent Variable	Coefficient	z-value	p>|z|
OTE*RD	.0234277	2.33	0.020
ADV	-7.600611	-7.81	0.000
$(ADV)^2$	.0026601	10.38	0.000
ADVlag	7.265555	7.25	0.000
RD	5.820388	5.52	0.000
$(RD)^2$	-.0014135	-6.61	0.000
NX	8.75395	3.80	0.000
$(NX)^2$	.0085016	4.13	0.000
Wald chi2 = 20383.53 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
OTE		0.0090	
ADV		-7.5737	
RD		5.8373	
NX		8.3650	

The third equation of OTE Block: The estimated MKT relation

The estimated MKT relation as presented in Table 5.21.3 shows that MKT is positively related to ADV of the previous period.

Considering ADV of the current period, it can be seen that ADV has U-relationship with MKT. The positive effect of ADV on MKT can be obtained beyond the critical level of ADV.

The marginal effect of ADV is negative as the mean ADV is lesser than the critical level of ADV.

Considering RD of the current period, it can be seen that RD has inverted U-relationship with MKT. Initially increase in RD increases MKT but beyond the critical level of RD, the increase in RD will lead to a fall in MKT.

There exists a joint interaction term of OTE and RD. This joint interaction term has positive effect on MKT. The effect of OTE on MKT depends on RD and vice-versa. All these effects taken into consideration, the marginal effect of both OTE and RD come out to be positive.

Considering NX of the current period, it can be seen that NX has non-linear positive relationship with MKT. Both the sole effect and the effect of the square term are positive. The marginal effect of NX on MKT is positive.

Table 5.21.4 Factors explaining RD behaviour from a Simultaneous Equation Panel Model: The OTE Block

Endogenous Variable: RD

Independent Variable	Coefficient	z-value	p>|z|
OTE	.0397046	2.71	0.007
$(OTE)^2$	-.0001961	-2.65	0.008
ADV	.0015254	4.24	0.000
$(ADV)^2$	-2.14e-06	-6.61	0.000
MKT	.1099826	9.56	0.000
$(MKT)^2$	-.0005199	-13.67	0.000
MKTlag	.0000435	2.11	0.035
NX	.0006885	0.39	0.698
$(NX)^2$	.0000187	20.67	0.000
Wald chi2 = 15072.36 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
OTE		0.0398	
ADV		-0.0446	
MKT		0.1051	
NX		-0.0002	

The fourth equation of OTE Block: The estimated RD relation

The estimated RD relation as presented in Table 5.21.4 shows that RD is positively related to MKT of the previous period.

Considering OTE of the current period, it can be seen that OTE has inverted U-relationship with RD. Initially increase in OTE increases RD, but beyond the critical level of OTE, increase in OTE will lead to a fall in RD. The marginal effect of OTE on RD is positive.

Considering ADV and MKT of the current period, it can be seen that both have inverted U-relationship with RD. Initially increase in ADV and MKT increases RD but beyond their critical levels, their negative impacts on RD will be realised. The marginal effect of MKT is positive but that of ADV is negative as too much ADV is costly for the firms.

Considering NX of the current period, it can be seen that NX has positive non-linear relationship with RD. Both the sole effect and the effect of the square term are positive. The marginal effect of NX is positive, meaning that increase in NX increases RD of the current period.

Table 5.21.5 Factors explaining NX behaviour from a Simultaneous Equation Panel Model: The OTE Block

Endogenous Variable: NX

Independent Variable	Coefficient	z-value	p>|z|
OTE	.0322769	0.69	0.491
ADV	.3378215	19.72	0.000
MKT	-.0293457	-12.14	0.000
$(MKT)^2$	6.46e-07	6.69	0.000
RD	-.2846056	-18.01	0.000
$(RD)^2$	2.35e-06	0.74	0.458
RDlag	.0142752	4.86	0.000
DIVIND	1.318016	1.29	0.196
Wald chi2 = 20086.18 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
OTE		0.0323	
ADV		0.3378	
MKT		0.0378	
RD		-0.2748	

The fifth equation of OTE Block: The estimated NX relation

The estimated NX relation as presented in Table 5.21.5 shows that NX is positively related to OTE and ADV of the current period and RD of the previous period.

Considering MKT and RD of the current period, it can be seen that both have U-relationship with NX. Their positive effects on NX will be felt beyond their critical levels. The marginal effect of MKT is positive but the marginal effect of the RD is negative as mean level of RD is lesser than critical level of RD.

Another factor positively influencing NX is DIVIND, indirectly affecting OTE. This means that as the market share gets diversified, The NX of the firms increases during the current period.

5.6.1.f Non-metallic mineral products Industry

The estimated OTE of Indian non-metallic mineral products firms and also the other endogenous variables explaining the OTE corresponding to OTE block can be visualized from Table 5.22.1 to Table 5.22.5.

Table 5.22.1 Factors explaining OTE from a Simultaneous Equation Panel Model: The OTE Block

Endogenous Variable: OTE

Independent Variable	Coefficient	z-value	p>|z|
ADV	.0026698	3.77	0.000
ADVlag	.0005034	3.34	0.001
MKT	.0004077	4.49	0.000
RD	-.0047078	-6.47	0.000
$(RD)^2$	5.13e-06	7.47	0.000
NX	.0003066	7.12	0.000
DIVIND	-.1554657	-4.15	0.000
Wald chi2 = 88.57 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
ADV		0.0027	
MKT		0.0004	
RD		0.0092	
NX		0.0003	

The first equation of OTE Block: The estimated OTE relation

The estimated OTE relation as presented in Table 5.22.1 shows that OTE is positively related to ADV of the previous period as well as current period, MKT and NX of the current period. The increase in all these factors increases OTE of the firms.

Considering RD of the current period, it can be seen that RD has U-relationship with OTE. The sole effect of RD is negative and the effect of the square term is positive, implying that the positive effect of RD on OTE will be realised beyond the critical level of RD. Considering all these effects, the positive marginal effect of RD can be obtained.

Another factor affecting OTE is DIVIND. It has negative effect on OTE, meaning that as the market share gets concentrated, the OTE of the firms increase.

Table 5.22.2 Factors explaining ADV behaviour from a Simultaneous Equation Panel Model: The OTE Block

Endogenous Variable: ADV

Independent Variable	Coefficient	z-value	p>|z|
OTE*NX	.1020342	13.42	0.000
MKT	.0444835	3.03	0.002
$(MKT)^2$	.0000138	9.31	0.000
RD	1.140101	20.59	0.000
$(RD)^2$	-.0005031	-15.55	0.000
RD*MKT	-.0002319	-6.81	0.000
$(RD*MKT)^2$	1.30e-11	1.78	0.075
NX	-.0775887	-13.87	0.000
$(NX)^2$	8.10e-06	23.99	0.000
NXlag	-.016948	-11.48	0.000
$(NXlag)^2$	1.71e-06	10.29	0.000
Wald chi2 = 8181.62 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
OTE		0.0910	
MKT		0.0399	
RD		1.1392	
RD*MKT		0.0001	
NX		0.0465	
NXlag		0.0006	

The second equation of OTE Block: The estimated ADV relation

The estimated ADV relation as presented in Table 5.22.2 shows that MKT has positive non-linear relationship with ADV.

Considering RD of the current period, it can be seen that RD has inverted U-relationship with ADV. Initially increase in RD increases ADV. But beyond the critical level of RD, the increase in RD will lead to the fall in ADV.

There exists a joint interaction term of RD and MKT. It has positive marginal effect on ADV. The effect of RD on ADV depends on MKT and vice-versa. Taking into account all these effects, the positive marginal effects of MKT and RD on ADV can be obtained.

Considering NX of the current period as well as previous period, it can be seen that both have U-relationship with ADV. Their positive effects on ADV can be achieved beyond their critical levels.

There exists a joint interaction term of OTE and NX. Its effect on ADV is positive. The effect of OTE on ADV depends on mean level of NX and vice-versa.

Considering all these effects, the positive marginal effects of OTE, NX of both current period and previous period can be obtained.

Table 5.22.3 Factors explaining MKT behaviour from a Simultaneous Equation Panel Model: The OTE Block

Endogenous Variable: MKT

Independent Variable	Coefficient	z-value	p>|z|
OTE	.8932498	1.12	0.262
ADV	-2.242719	-2.37	0.018
$(ADV)^2$	.0016507	2.67	0.008
ADVlag	1.92709	8.54	0.000
RD	4.335059	7.34	0.000
$(RD)^2$	-.0052248	-12.90	0.000
RD*ADV	.0035852	1.93	0.053
$(RD*ADV)^2$	9.20e-09	5.78	0.000
NXlag	.007838	0.39	0.697
$(NXlag)^2$	-.0000163	-6.54	0.000
Wald chi2 = 1661.81 Prob > chi2 = 0.0000			

Determinants	Marginal effects
OTE	0.8932
ADV	-2.2358
RD	4.3369
RD*ADV	0.0094
NXlag	0.0080

The third equation of OTE Block: The estimated MKT relation

The estimated MKT relation as presented in Table 5.22.3 shows that MKT is positively related to OTE of the current period and ADV of the previous period. Increase in OTE in the current period and ADV in the previous period increases MKT of the current period.

Considering ADV of the current period, it can be seen that ADV has U-relationship with MKT. The positive effect of ADV on MKT can be obtained beyond the critical level of ADV.

Considering RD of the current period, it can be seen that RD has inverted U-relationship with MKT. Initially increase in RD will bring about a rise in MKT but beyond the critical level of RD, its negative effect on MKT can be felt.

There exists a joint interaction term of RD and ADV. Its marginal effect is positive. The effect of RD on MKT depends on ADV and vice-versa. All these effects taken into account, the marginal effect of RD is positive but the marginal effect of ADV is negative as the mean level of ADV is lesser than critical level of ADV beyond which its positive effect can be felt.

Considering NX of the previous period, it can be seen that it has inverted U-relationship with MKT. Initially the increase in NX of the previous period increases MKT of the current period but beyond the critical level of NX of the previous period, its negative effect on MKT can be felt.

Table 5.22.4 Factors explaining RD behaviour from a Simultaneous Equation Panel Model: The OTE Block

Endogenous Variable: RD

Independent Variable	Coefficient	z-value	p>|z|
OTE	.2969799	1.64	0.100
ADV	1.889222	15.25	0.000
$(ADV)^2$	-.0012156	-5.08	0.000
ADV*MKT	.0000918	2.36	0.018
NX	.2160836	19.54	0.000
$(NX)^2$	-.000013	-13.63	0.000
NXlag	.0118501	3.78	0.000
Wald chi2 = 1574.15 Prob > chi2 = 0.0000			

Determinants	Marginal effects
OTE	0.2670
ADV	1.8792
MKT	0.0001
NX	0.2200

The fourth equation of OTE Block: The estimated RD relation

The estimated RD relation as presented in Table 5.22.4 shows that RD is positively related to OTE of the current period and NX of the previous period.

Considering ADV of the current period, it can be seen that ADV has inverted U-relationship with RD. Initially increase in ADV increases RD but beyond the critical level of ADV, its negative effect on RD can be felt.

There exists a joint interaction term of ADV and MKT. It has positive effect on RD. Considering all these effects, the marginal effects of OTE, ADV and MKT of the current period come out to be positive.

Considering NX of the current period, it can be seen that NX has inverted U-relationship with RD. Initially increase in NX increases RD but beyond the critical level of NX, its negative effect on RD can be felt. All these effects taken into account, the positive marginal effect of NX on RD can be achieved.

Table 5.22.5 Factors explaining NX behaviour from a Simultaneous Equation Panel Model: The OTE Block

Endogenous Variable: NX

Independent Variable	Coefficient	z-value	p>|z|
OTE	.3277335	2.17	0.030
$(OTE)^2$	-.0015335	-2.25	0.024
MKT	.0040803	1.74	0.081
$(MKT)^2$	4.42e-07	1.72	0.085
RD	.0588101	7.44	0.000
RDlag	.0223938	3.57	0.000
REER	-.1185879	-1.86	0.063
Wald chi2 = 513.63 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
OTE		0.3282	
MKT		0.0160	
RD		0.0588	

The fifth equation of OTE Block: The estimated NX relation

The estimated NX relation as presented in Table 5.22.5 shows that NX is positively related to RD of the current period as well as previous period and negatively related to REER.

Considering OTE of the current period, it can be seen that OTE has inverted U-relationship with NX. Initially increase in OTE increases NX but beyond the critical level of OTE, the increase in OTE will lead to a fall in NX. All these effects taken into account, the marginal effect of OTE comes out to be positive.

Considering MKT of the current period, it can be seen that MKT has non-linear positive relationship with NX. The marginal effect of MKT is positive. This means that increase in MKT increases NX of the firms.

5.6.1.g Paper Industry

The estimated OTE of Indian paper firms and also the other endogenous variables explaining the OTE corresponding to OTE block can be visualized from Table 5.23.1 to Table 5.23.5.

Table 5.23.1 Factors explaining OTE from a Simultaneous Equation Panel Model: The OTE Block

Endogenous Variable: OTE

Independent Variable	Coefficient	z-value	p>|z|
RD*ADV	.0028824	2.07	0.039
RD*MKT	.0001833	1.73	0.084
RD	-.0189663	-2.61	0.009
$(RD)^2$	.0001064	2.87	0.004
NX	-.0750577	-2.80	0.005
$(NX)^2$	.0025798	2.87	0.004
NX*RD	.0100262	2.63	0.009
$(NX*RD)^2$	-.0000151	-2.87	0.004
NXlag	.0196306	1.46	0.144
DIVIND	.0482114	1.99	0.046
Wald chi2 = 20.12 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
ADV		0.0002	
MKT		0.00001	
RD		0.0725	
NX		-0.0289	
NX*RD		0.0083	

The first equation of OTE Block: The estimated OTE relation

The OTE relation as presented in Table 5.23.1 shows that OTE is positively related to NX of the previous period. The increase in NX in the previous period increase OTE of the current period.

Considering RD and NX of the current period, it can be seen that both have U-relationship with OTE. Their sole effects are negative and the effects of their square term are positive, implying that the positive effects of RD and NX on OTE can be achieved beyond their critical levels.

There exists two joint interaction terms of (RD and ADV) and (RD and MKT). Both have positive effect on OTE. There exists another joint interaction term of NX and RD which also has positive marginal effect on OTE. Considering all these effects, the positive marginal effects of ADV, MKT and RD can be achieved but the marginal effect of NX is negative, implying the imports dominate over exports.

Another positively affecting OTE is DIVIND. As the market share gets diversified, OTE of the firms increases.

Table 5.23.2 Factors explaining ADV behaviour from a Simultaneous Equation Panel Model: The OTE Block

Endogenous Variable: ADV

Independent Variable	Coefficient	z-value	p>|z|
OTE	.2233037	1.40	0.162
$(OTE)^2$	-.0017018	-1.39	0.166
MKT	-.0179286	-1.75	0.080
$(MKT)^2$	.0000133	1.05	0.295
RD	-.0356614	-0.74	0.459
$(RD)^2$	.0002698	1.23	0.219
NX	-.268053	-1.48	0.138
$(NX)^2$	.0057829	1.05	0.295
NX*RD	.0293436	1.24	0.216
Smalldum	11.5522	5.97	0.000
Wald chi2 = 88.29 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
OTE		0.2182	
MKT		-0.0099	
RD		0.1719	
NX		-0.1771	

The second equation of OTE Block: The estimated ADV relation

The estimated ADV relation as presented in Table 5.23.2 shows that OTE has inverted U-relationship with ADV. The sole effect of OTE is positive and the effect of the square term is negative. Initially the increase in OTE increases ADV but the beyond the critical level of OTE, increase in OTE will lead to the fall in ADV. The marginal effect of OTE is positive, meaning that increase in OTE increases ADV.

Considering MKT, RD and NX of the current period, it can be seen that all have U-relationship with ADV. Their positive effects on ADV will be obtained beyond their critical levels.

There exists a joint interaction term of NX and RD. It has positive marginal effect on ADV. The effect of NX on ADV depends on RD and vice-versa.

Considering all these effects, the marginal effect of RD is positive but the marginal effects of MKT & NX are negative as their mean values are lesser than their critical values.

Another factor positively influencing ADV is Smalldum, indirectly affecting OTE. The smaller sized firms are having higher level of ADV than the larger firms.

Table 5.23.3 Factors explaining MKT behaviour from a Simultaneous Equation Panel Model: The OTE Block

Endogenous Variable: MKT

Independent Variable	Coefficient	z-value	p>|z|
OTE	4.831693	2.04	0.042
$(OTE)^2$	-.0342877	-1.88	0.061
RD	8.459394	3.19	0.001
$(RD)^2$	-.0157641	-5.14	0.000
NX	1.722081	0.73	0.468
$(NX)^2$	.0160683	10.66	0.000
Wald chi2 = 360.47 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
OTE		4.7760	
RD		8.4586	
NX		1.9892	

The third equation of OTE Block: The estimated MKT relation

The estimated MKT relation as presented in Table 5.23.3 shows that both OTE and RD have inverted U-relationship with MKT. Initially their increase increases MKT but beyond their critical levels, their negative on MKT will be felt. All these effects taken into account, the marginal effects of both come out to be positive.

Considering NX of the current period, it can be seen that NX has positive non-linear relationship with MKT. The marginal effect of NX on MKT is positive.

Table 5.23.4 Factors explaining RD behaviour from a Simultaneous Equation Panel Model: The OTE Block

Endogenous Variable: RD

Independent Variable	Coefficient	z-value	p>|z|
OTE	-6.208593	-4.34	0.000
$(OTE)^2$	.0427371	3.89	0.000
OTE*NX	.7858261	6.25	0.000
MKT	.3081363	2.23	0.026
$(MKT)^2$	-.0002718	-2.01	0.044
Wald chi2 = 68.80 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
OTE		-0.8229	
MKT		0.3099	
NX		0.6952	

The fourth equation of OTE Block: The estimated RD relation

The estimated RD relation as presented in Table 5.23.4 shows that OTE has U-relationship with ADV. The sole effect of OTE is negative and the effect of the square term is positive, implying that the positive effect of OTE on RD can be achieved beyond the critical level of OTE.

There exists a composite effect of OTE and NX. It has positive effect on RD. The effect of OTE on RD depends on NX and vice-versa. Taking into account these effects, the positive marginal effect of NX can be obtained but the marginal effect of OTE is negative as the mean level of OTE is lesser than the critical level of OTE.

Considering MKT of the current period, it can be seen that MKT has inverted U-relationship with RD. Initially increase in MKT increases RD but beyond the critical level of MKT, its increase will lead to the fall in RD. The marginal effect of MKT on RD is positive.

Table 5.23.5 Factors explaining NX behaviour from a Simultaneous Equation Panel Model: The OTE Block

Endogenous Variable: NX

<table>
<tr><td>Independent Variable</td><td>Coefficient</td><td>z-value</td><td>p>|z|</td></tr>
<tr><td>OTE</td><td>-5.458313</td><td>-1.65</td><td>0.100</td></tr>
<tr><td>$(OTE)^2$</td><td>.0429983</td><td>1.71</td><td>0.086</td></tr>
<tr><td>MKT</td><td>-1.173387</td><td>-3.34</td><td>0.001</td></tr>
<tr><td>$(MKT)^2$</td><td>.0007639</td><td>2.47</td><td>0.013</td></tr>
<tr><td>MKTlag</td><td>.6845012</td><td>1.99</td><td>0.046</td></tr>
<tr><td>RD</td><td>10.84347</td><td>2.69</td><td>0.007</td></tr>
<tr><td>$(RD)^2$</td><td>-.0115496</td><td>-2.71</td><td>0.007</td></tr>
<tr><td>OTE*RD</td><td>.0515353</td><td>1.50</td><td>0.134</td></tr>
<tr><td>$(OTE*RD)^2$</td><td>-8.15e-06</td><td>-4.52</td><td>0.000</td></tr>
<tr><td colspan="4">Wald chi2 = 44.02
Prob > chi2 = 0.0000</td></tr>
<tr><td colspan="2">Determinants</td><td colspan="2">Marginal effects</td></tr>
<tr><td colspan="2">OTE</td><td colspan="2">-5.3763</td></tr>
<tr><td colspan="2">MKT</td><td colspan="2">-1.1694</td></tr>
<tr><td colspan="2">RD</td><td colspan="2">10.8800</td></tr>
<tr><td colspan="2">OTE*RD</td><td colspan="2">0.0484</td></tr>
</table>

The fifth equation of OTE Block: The estimated NX relation

The estimated NX relation as presented in Table 5.23.5 shows that NX is positively related to MKT of the previous period.

Considering OTE and MKT of the current period, it can be seen that both have U-relationship with NX. Their positive effects on NX can be achieved beyond their critical levels.

Considering RD of the current period, it can be seen that RD has inverted U-relationship with NX. Initially increase in RD increases NX but beyond its critical level, its negative effect on NX will be felt.

There exists a joint interaction term of OTE and RD. Its marginal effect on NX is positive. The effect of OTE on NX depends on RD and vice-versa.

All these effects taken into account, the positive marginal effect of RD can be achieved but the effect of the marginal effects of OTE and MKT are negative as their mean levels are lesser than their critical levels beyond which their positive effect on NX can be felt.

5.6.1.h Textile Industry

The estimated OTE of Indian textile firms and also the other endogenous variables explaining the OTE corresponding to OTE block can be visualized from Table 5.24.1 to Table 5.24.5.

Table 5.24.1 Factors explaining OTE from a Simultaneous Equation Panel Model: The OTE Block

Endogenous Variable: OTE

Independent Variable	Coefficient	z-value	p>|z|
ADV	.0246719	1.72	0.085
MKT	-.0241685	-4.30	0.000
$(MKT)^2$	.0003976	3.19	0.001
RD	.0826389	1.71	0.088
$(RD)^2$	-.0285072	-1.77	0.077
NX*RD	.0008584	3.39	0.001
Agedum	.0720825	2.98	0.003
DIVIND	.0058798	1.21	0.226
Largedum	-.0624188	-2.47	0.014
Wald chi2 = 149.07 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
ADV		0.0247	
MKT		-0.0157	
RD		0.0468	
NX		0.0007	

The first equation of OTE Block: The estimated OTE relation

The estimated OTE relation as presented in Table 5.24.1 shows that ADV is positively related to OTE. Increase in ADV increases OTE.

Considering MKT of the current period, it can be seen that MKT has U-relationship with OTE. The positive effect of MKT can be obtained beyond the critical level of MKT. Considering these effects, the marginal effect of MKT comes out to be negative as the mean level of MKT is lesser than critical level of MKT beyond which its positive effect can be obtained.

Considering RD of the current period, it can be seen that RD has inverted U-relationship with OTE. Initially increase in RD increases OTE but too much RD is costly for the firms.

There exists a joint interaction term of NX and RD. It has positive effect on OTE. The effect of RD on OTE depends on NX and vice-versa. All these effects taken into account, the positive marginal effects of NX and RD can be obtained.

Agedum positively affects OTE, implying that younger firms are having higher level of OTE than the older firms.

Another factor positively affecting OTE is DIVIND. As the market share gets diversified, OTE of the firms increases.

The final factor affecting OTE is Largedum. It has negative effect on OTE, meaning that the smaller firms have higher level of OTE than the larger firms.

Table 5.24.2 Factors explaining ADV behaviour from a Simultaneous Equation Panel Model: The OTE Block

Endogenous Variable: ADV

Independent Variable	Coefficient	z-value	p>|z|
OTE*MKT	1.014742	4.73	0.000
MKTlag	.2233625	3.25	0.001
RDlag	.3253012	3.14	0.002
NX	-.0137309	-3.53	0.000
$(NX)^2$	.0001166	4.23	0.000
NXlag	.0041559	1.29	0.198
DIVIND	.2204152	4.35	0.000
Wald chi2 = 431.18 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
OTE		5.3934	
MKT		0.7777	
NX		-0.0026	

The second equation of OTE Block: The estimated ADV relation

The estimated ADV relation as presented in Table 5.24.2 shows that ADV is positively related to MKT of the previous period, RD of the previous period and NX of the previous period. The increase in MKT, RD and NX of previous period increases the ADV of the current period.

There exists a joint interaction term of OTE and MKT. This joint interaction term has positive effect on ADV. The effect of OTE on ADV depends on MKT and vice-versa. Considering all these effects, the positive marginal effects of OTE and MKT can be obtained.

Considering NX of the current period, it can be seen that NX has U-relationship with ADV. Its positive effect on ADV can be obtained beyond the critical level of NX. Considering all these effects, the marginal effect of NX comes out to be negative as the imports dominate over the exports.

Another factor positively affecting ADV is DIVIND. As the market share gets diversified, the firms will have higher level of ADV.

Table 5.24.3 Factors explaining MKT behaviour from a Simultaneous Equation Panel Model: The OTE Block

Endogenous Variable: MKT

Independent Variable	Coefficient	z-value	p>|z|
OTE*ADV	2.141462	1.94	0.052
ADV	.3654183	0.40	0.692
$(ADV)^2$	-.138731	-4.40	0.000
RD	.6788464	1.55	0.120
NX	.0211022	2.99	0.003
$(NX)^2$	-.0001602	-2.50	0.012
Wald chi2 = 177.22 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
OTE		2.3754	
ADV		1.7070	
RD		0.6788	
NX		0.0126	

The third equation of OTE Block: The estimated MKT relation

The estimated MKT relation as presented in Table 5.24.3 shows that MKT is positively related to RD. Increase in RD increases MKT.

Considering ADV and NX of the current period, it can be seen that both have inverted U-relationship with MKT. Initially their increase increases MKT. But beyond their critical levels, their increase will lead to the fall in MKT.

There exists a composite effect of OTE and ADV. It has positive effect on MKT. The effect of OTE on MKT depends on ADV and vice-versa. All these effects taken into account, the positive marginal effects of OTE, ADV and NX on MKT in the current period can be obtained.

Table 5.24.4 Factors explaining RD behaviour from a Simultaneous Equation Panel Model: The OTE Block

Endogenous Variable: RD

Independent Variable	Coefficient	z-value	p>|z|
OTE*NX	.0939509	9.93	0.000
$(OTE*NX)^2$	-.0003095	-4.92	0.000
ADV	-.0934825	-1.49	0.136
$(ADV)^2$	.0059764	1.15	0.251
MKTlag	.2611246	3.87	0.000
$(MKTlag)^2$	-.0173856	-3.96	0.000
NX	-.0853015	-11.72	0.000
$(NX)^2$	.000322	9.66	0.000
NXlag	.0010258	1.11	0.266
Agedum	.1978495	1.65	0.099
DIVIND	.0644838	2.61	0.009
Wald chi2 = 10251.45 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
OTE		2.7014	
ADV		-0.0767	
MKTLAG		0.1968	
NX		-0.0016	
OTE*NX		0.0750	

The fourth equation of OTE Block: The estimated RD relation

The estimated RD relation as presented in Table 5.24.4 shows that RD is positively related to NX of the previous period.

Considering ADV and NX of the current period, it can be seen that both have U-relationship with RD. The positive effect of these factors on RD can be realised beyond their critical levels.

There exists a joint interaction term of OTE and NX. The marginal effect of this joint interaction term is positive. The effect of OTE on MKT depends on NX and vice-versa. Taking into account all these effects, the positive marginal effect of OTE can be obtained but the marginal effects of ADV and NX come out to be negative as their mean values are lesser than their critical levels beyond which their positive effects can be obtained.

Considering MKT of the previous period, it can be seen that it has inverted U-relationship with RD. Initially the increase in MKT in the previous period increases RD but beyond its critical level its increase will lead to the fall in RD. The marginal effect of MKT of the previous period is positive.

Another factor positively affecting RD is Agedum, indirectly affecting OTE. The younger firms are having higher level of RD than the older firms.

The last factor affecting RD is DIVIND. As the market share gets diversified, RD of the firms increases.

Table 5.24.5 Factors explaining NX behaviour from a Simultaneous Equation Panel Model: The OTE Block

Endogenous Variable: NX

Independent Variable	Coefficient	z-value	p>|z|
OTE	1.019801	5.25	0.000
ADV*MKT	1.402281	1.85	0.064
MKT	1.124092	0.37	0.710
$(MKT)^2$	-.0675249	-1.30	0.194
MKTlag	2.292876	4.98	0.000
RDlag	8.398112	1.92	0.055
$(RDlag)^2$	-.1426117	-2.07	0.039
Wald chi2 = 437.14 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
OTE		1.0198	
ADV		7.4760	
MKT		2.0332	
MKTlag		2.2929	
RDlag		8.1620	

The fifth equation of OTE Block: The estimated NX relation

The estimated NX relation as presented in Table 5.24.5 shows that NX is positively related to OTE of the current period and MKT of the previous period.

Considering MKT of current period and RD of the previous period, it can be seen that both have inverted U-relationship with NX. Initially their increase increases NX but beyond their critical levels, their increase will lead to fall in NX.

There exists a joint interaction term of ADV and MKT which has positive effect on NX. The effect of ADV on NX depends on MKT and vice-versa.

Considering all these effects, the positive marginal effects of ADV, MKT of current period as well as previous period and RD of the previous period can be realised.

5.6.1.i Transport Industry

The estimated OTE of Indian transport firms and also the other endogenous variables explaining the OTE corresponding to OTE block can be visualized from Table 5.25.1 to Table 5.25.5.

Table 5.25.1 Factors explaining OTE from a Simultaneous Equation Panel Model: The OTE Block

Endogenous Variable: OTE

Independent Variable	Coefficient	z-value	p>|z|
ADV	.0006718	2.57	0.010
ADVlag	.0006684	1.67	0.095
MKT	.0001058	2.18	0.030
RD	-.0033853	-2.76	0.006
$(RD)^2$	1.63e-06	2.73	0.006
RDlag	.0042552	3.22	0.001
NX	.0000558	2.65	0.008
$(NX)^2$	-1.04e-09	-2.42	0.015
DIVIND	-.0474668	-6.08	0.000
Wald chi2 = 51.72 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
ADV		0.0007	
MKT		0.0001	
RD		-0.0015	
NX		0.0002	

The first equation of OTE Block: The estimated OTE relation

The estimated OTE relation as presented in Table 5.25.1 shows that OTE is related to ADV of the current period as well as previous period, MKT of the current period and RD of the previous period. Increase in ADV in the current period as well as in the previous period, MKT in the current period and RD in the previous period increases OTE of the current period.

Considering RD of the current period, it can be seen that RD has U-relationship with OTE. Its sole effect is negative but the effect of the square term is positive. The positive effect of RD on OTE can be felt beyond its critical level. Considering all these effects, the marginal effect of RD comes out to be negative as the mean level of RD is lesser than the critical level of RD beyond which its positive effect on OTE can be felt.

Considering NX of the current period, it can be seen that NX has inverted U-relationship with OTE. Initially increase in OTE increases NX but beyond its critical level, its negative effect on OTE can be felt. All these effects taken into account, the positive marginal effect of NX can be obtained.

Another factor affecting OTE is DIVIND. It has negative effect on OTE. As the market share gets concentrated, OTE of the firms increases.

Table 5.25.3 Factors explaining ADV behaviour from a Simultaneous Equation Panel Model: The OTE Block

Endogenous Variable: ADV

Independent Variable	Coefficient	z-value	p>|z|
OTE*RD	.0502354	4.68	0.000
MKT	.1406129	15.27	0.000
NX	-.0821006	-10.52	0.000
$(NX)^2$	2.15e-06	7.46	0.000
NXlag	.0282964	16.17	0.000
DIVIND	-3.836863	-2.09	0.036
Wald chi2 = 1610.60 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
OTE		0.0090	
MKT		0.1406	
RD		0.0460	
NX		-0.0878	

The second equation of OTE Block: The estimated ADV relation

The estimated ADV relation as presented in Table 5.25.3 shows that ADV is positively related to MKT of the current period and NX of the previous period.

Considering NX of the current period, it can be seen that NX has U-relationship with ADV. The positive effect of NX on ADV can be obtained beyond the critical level of NX.

Considering all these effects, the marginal effect of NX comes out to be negative, implying the imports dominate over exports.

There exists a composite effect of OTE and RD. This joint interaction term has positive effect on ADV. The effect of OTE on ADV depends on RD and vice-versa. All these effects taken into account, the positive marginal effect of OTE and RD can be achieved.

Another factor affecting ADV is DIVIND. As the market share gets concentrated, the firms will have higher level of ADV.

Table 5.25.3 Factors explaining MKT behaviour from a Simultaneous Equation Panel Model: The OTE Block

Endogenous Variable: MKT

Independent Variable	Coefficient	z-value	p>|z|
OTE	-8.516632	-2.65	0.008
$(OTE)^2$	.0444638	2.68	0.007
ADV	-.642769	-2.93	0.003
$(ADV)^2$	.0027705	7.40	0.000
RD	2.40633	5.01	0.000
$(RD)^2$	.0309837	33.76	0.000
NX	2.267194	32.48	0.000
$(NX)^2$	-.0000232	-35.97	0.000
Wald chi2 = 1.04e+06 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
OTE		-8.4364	
ADV		-0.6395	
RD		2.4208	
NX		2.2700	

The third equation of OTE Block: The estimated MKT relation

The estimated MKT relation as presented in Table 5.25.3 shows that both OTE and ADV have U-relationship with MKT. Their positive effects on MKT can be realised beyond their critical levels. All these effects taken into account, the marginal effects of both OTE and ADV come out to be negative as their mean levels are lesser than their critical levels beyond which their positive effects on MKT can be felt.

Considering RD of the current period, it can be seen that RD has non-linear positive relationship with MKT. The marginal effect of RD is positive. Increase in RD increases MKT in the current period.

Considering NX of the current period, it can be seen that NX has inverted U-relationship with MKT. Initially the increase in NX increases MKT but beyond the critical level of NX, its negative effect on MKT will be felt. Considering all these effects, the positive marginal effect of NX can be achieved.

Table 5.25.4 Factors explaining RD behaviour from a Simultaneous Equation Panel Model: The OTE Block

Endogenous Variable: RD

Independent Variable	Coefficient	z-value	p>|z|
OTE	.5596313	1.12	0.261
$(OTE)^2$	-.0033066	-1.28	0.202
MKT	-.1907382	-5.01	0.000
$(MKT)^2$	8.06e-06	3.76	0.000
MKTlag	.073885	8.86	0.000
NX	.0083397	3.99	0.000
$(NX)^2$	1.80e-07	2.88	0.004
OTE*MKT	.0017547	6.07	0.000
OTE*ADV	.014594	5.49	0.000
DIVIND	-.5944977	-1.02	0.308
Wald chi2 = 18719.20 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
OTE		0.5979	
ADV		0.0090	
MKT		-0.1374	
NX		0.0056	

The fourth equation of OTE Block: The estimated RD relation

The estimated OTE relation as presented in Table 5.25.4 shows that OTE is positively related to MKT of the previous period.

Considering OTE of the current period, it can be seen that OTE has inverted U-relationship with RD. Increase in OTE initially increases RD but beyond the critical level of OTE, its increase will lead to the fall in RD.

Considering MKT of the current period, it can be seen that MKT has U-relationship with RD. The positive effect of MKT on RD can be obtained beyond the critical level of MKT.

There exists two joint interaction terms of (OTE and MKT) and (OTE and ADV). Both of these joint interaction terms have positive effects on RD. The effect of OTE on RD depends on the mean levels of MKT and ADV. Considering all these effects, the positive effects of OTE and ADV can be obtained but the marginal effect of MKT comes out to be negative as the mean level of MKT is lesser than the critical level of MKT beyond which its positive effect can be felt.

Considering NX of the current period, it can be seen that both have positive non-linear relationship with RD. The marginal effect of NX is positive, implying that the exports dominate over imports.

Another factor affecting RD is DIVIND. It has negative effect on RD, meaning that as the market share gets concentrated, RD of the firms increases.

Table 5.25.5 Factors explaining NX behaviour from a Simultaneous Equation Panel Model: The OTE Block

Endogenous Variable: NX

Independent Variable	Coefficient	z-value	p>|z|
OTE	3.454772	1.75	0.081
ADV	6.481058	3.45	0.001
$(ADV)^2$	-.0255849	-7.72	0.000
MKT	4.74295	27.24	0.000
$(MKT)^2$	-.0003366	-32.76	0.000
RD	6.14456	2.74	0.006
Wald chi2 = 133536.49 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
OTE		3.4548	
ADV		6.4768	
MKT		4.7392	
RD		6.1446	

The fifth equation of OTE Block: The estimated NX relation

The estimated NX relation as presented in Table 5.25.5 shows that NX is positively related to OTE and RD of the current period.

Considering ADV and MKT of the current period, it can be seen that both have inverted U-relationship with NX. Initially their increase increases NX but beyond their critical levels their negative effects on NX will be felt. Considering all these effects, the positive marginal effects of ADV and MKT on NX can be obtained.

5.7 Conclusion

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 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 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 & 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 of the current in the machinery industry. Increase in ADV in the previous period increases ITE of 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 increase ITE in the current period in all these industries.

MKT of the previous period has positive effect with 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 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 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 and MKT in chemical industry, ADV and MKT in food products industry, 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, increases; 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.

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 have become costlier and its imports have become 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 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. Increase in ITE increases MKT, RD and NX of the sample firms 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 & 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. 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. 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 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 import; 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 lead to the rise in OTE of 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 these industries as a result their OTE 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 influenced.

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 increases; 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 have become costlier and its imports have become 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.

Chapter 6

Analysis of Productivity

6.1 Introduction

There are two concepts of productivity. One is the concept of Partial Productivity of any input which can be defined as the relationship between the output and single input which is used in the production and the other one is Total factor productivity growth (TFPG) which basically denotes the changes in output which is not accounted by the growth of inputs used in the production process. This present study uses the concept of total factor productivity growth (TFPG).

TFPG is a measure of productivity that relates output to all the inputs of production utilised in the production process. It is a broader concept encircling the impact not only of technical progress but also of better employment of capabilities, learning by doing and improved skills of workers etc. (Denison, 1962, 1967, 1985). So TFPG is a composite measure of technical change and change in efficiency with which known technology is applied to production. TFPG basically measures the changes in output which is not accounted by growth in inputs.

The perusal of the literature relating to studies on productivity as discussed in Chapter 3 suggests that there is dearth in studies dealing with the measurement total factor productivity growth and its determinants for Indian manufacturing firms in a simultaneous panel set up considering other endogenous variables like ADV, MKT, RD and NX. This chapter finds out the determinants of productivity in a simultaneous panel set up as developed by Baltagi (EC2SLS random-effects IV regression) for all the nine industry groups. The present chapter adds the literature to this direction.

This chapter uses nonparametric DEA and measures total factor productivity growth of manufacturing firms in India over the period 1995–2016 by using Malmquist Productivity Index (MPI) introduced by Caves, Christensen and Diewert (1982) . Since the extent of productivity growth embedded itself the extent of technical change, efficiency change and scale efficiency change, one may be interested to know about the movement about these respective components. As an answer to this article, MPI is decomposed into these three components following the methods suggested by Ray and Desli (1997). The chapter uses two stage approaches. In the first stage, MPI score and its decomposition are obtained. Based on the estimated MPI score, in the second stage panel regression is run to find out the determinants of TFPG in a simultaneous panel set up.

The chapter unfolds as follows. Section 6.2 reports methodology and data source. The estimated results of productivity are presented in Section 6.3. Section 6.4 finds out the determinants of TFPG in a simultaneous panel equation model comprising of the following endogenous variables like TFPG, ADV, MKT, RD and NX under TFPG Block for the nine industry groups. Finally Section 6.5 concludes the study.

6.2 Methodology and Data Source

6.2.1 Measurement and Decomposition of Multifactor Productivity Growth

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

In the 1-output-1 input case, the rate of productivity growth is measured by the difference in growth rates of output and input quantities respectively. In parametric analysis, the specification of some explicit functional form of a production, cost or profit function is needed. In non-parametric analysis, the exact technological relationship is unspecified. The relevant assumptions are — (i) Both inputs and output are freely disposable and the production possibility *set is* convex. (ii) All input-output combinations, actually observed, are by definition feasible. (iii) Variable Returns to Scale prevails.

6.2.1.A Methodology

Consider, for simplicity, a single input – single output industry consists of n firms. Let x_k^t and y_k^t represent the input and output quantities of firm k at time t. The average productivity of this firm at time t is $AP_k^t = \frac{y_k^t}{x_k^t}$ …6.1

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

$$\Pi_{k(t+1)} = \frac{AP_k^{t+1}}{AP_k^t} = \frac{y_k^{t+1}/x_k^{t+1}}{y_k^t/x_k^t} \qquad ...6.2$$

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

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

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

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

$$\Pi_{a1} = \frac{a_1 x_1 / ox_1}{a_0 x_0 / ox_0} \qquad \text{...6.3}$$

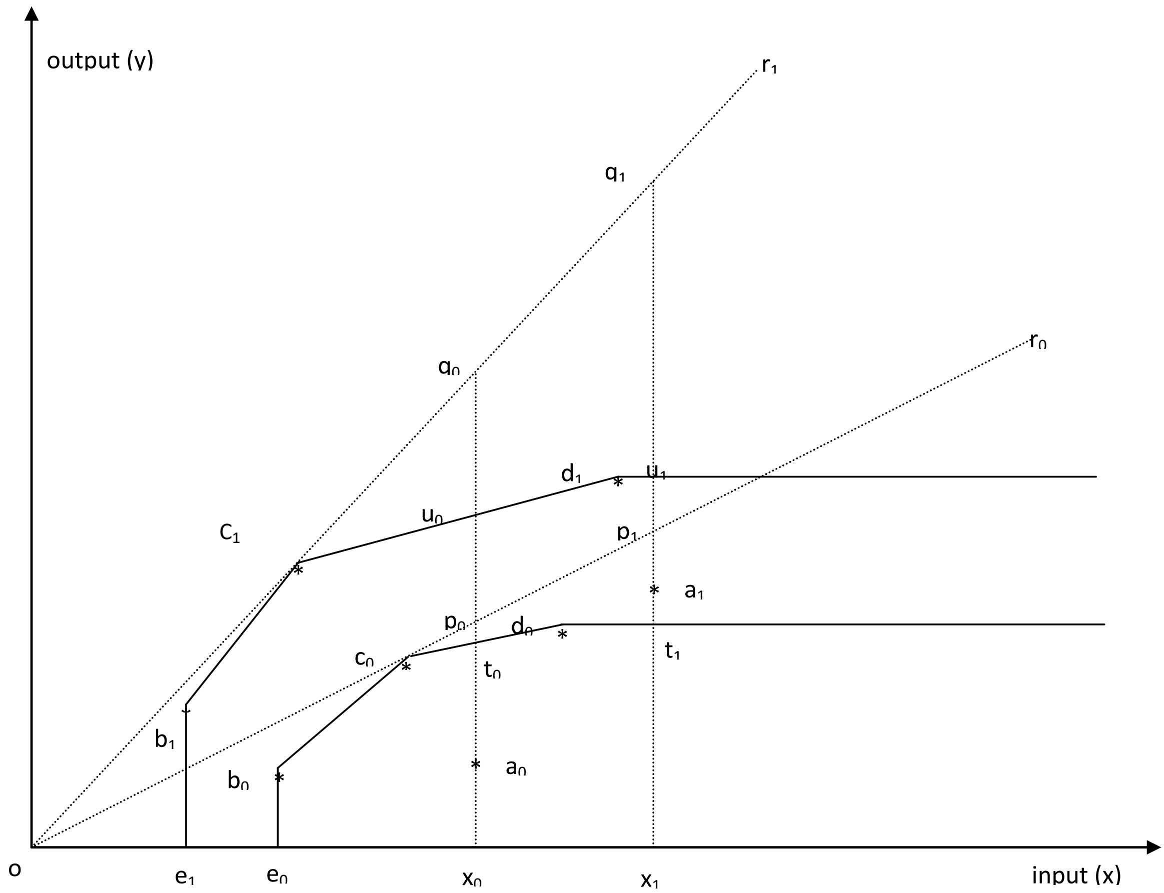

Figure 6.1. Measurement and Decomposition of Productivity Index

By convexity, all the points in the convex hull of the points a_0, b_0, c_0 and d_0 (i.e., the convex combinations of these points) represent feasible input-output combinations in period 0.

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

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

$$S^t = \{(x, y): y \text{ can be produced from x} \in \text{period } t\} \text{...6.4}$$

The output distance functioni is

$$D^t(x, y) = \min \theta : \left(x, \frac{1}{\theta} y\right) \in S^t \text{ ....6.5}$$

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

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

The productivity index for firm 'a' is

$$\Pi_{a0} = \frac{a_1 x_1 / ox_1}{a_0 x_0 / ox_0} = \frac{a_1 x_1 / p_1 x_1 \,.\, p_1 x_1 / ox_1}{a_0 x_0 / p_0 x_0 \,.\, p_0 x_0 / ox_0} = \frac{D_c^0(x_1, y_1)}{D_c^0(x_0, y_0)} \text{ ....6.6}$$

Analogously, $$\Pi_{a1} = \frac{a_1 x_1 / ox_1}{a_0 x_0 / ox_0} = \frac{D_c^1(x_1, y_1)}{D_c^1(x_0, y_0)} \text{ ....6.7}$$

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

Thus, $$SE^0(x_0, y_0) = \frac{AP(t_0)}{AP(c_0)} = \frac{t_0 x_0}{p_0 x_0} = \frac{D_c^0(x_0, y_0)}{D_v^0(x_0, y_0)} \quad \text{...6.8}$$

Also, $$SE^0(x_1, y_1) = \frac{AP(t_1)}{AP(c_0)} = \frac{D_c^0(x_1, y_1)}{D_v^0(x_1, y_1)} \quad \text{..6.9}$$

Now equation (6) can be written as

$$\Pi_{a0} = \frac{D_v^0(x_1, y_1) \cdot \dfrac{D_c^0(x_1, y_1)}{D_v^0(x_1, y_1)}}{D_v^0(x_0, y_0) \cdot \dfrac{D_c^0(x_0, y_0)}{D_v^0(x_0, y_0)}} = \frac{D_v^0(x_1, y_1)}{D_v^0(x_0, y_0)} \cdot \frac{SE^0(x_1, y_1)}{SE^0(x_0, y_0)} \quad \text{..6.10}$$

In a perfectly analogous manner, $\Pi_{a1} = \dfrac{D_v^1(x_1, y_1)}{D_v^1(x_0, y_0)} \cdot \dfrac{SE^1(x_1, y_1)}{SE^1(x_0, y_0)}$ 6.11

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

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

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

$$= \frac{D_v^1(x_1, y_1)}{D_v^0(x_0, y_0)} \times \left[\frac{D_v^0(x_0, y_0)}{D_v^1(x_0, y_0)} \cdot \frac{D_v^0(x_1, y_1)}{D_v^1(x_1, y_1)} \right]^{\frac{1}{2}} \times \left[\frac{SE^0(x_1, y_1)}{SE^0(x_0, y_0)} \cdot \frac{SE^1(x_1, y_1)}{SE^1(x_0, y_0)} \right]^{\frac{1}{2}} \quad \text{.................. 6.12}$$

= peffch . techch . sch

where peffch = $\dfrac{D_v^1(x_1, y_1)}{D_v^0(x_0, y_0)}$ measures pure technical efficiency change,

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

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

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

6.2.1.B Non-parametric Methodology

The decomposition of MPI into technical efficiency change, technical change and scale efficiency change can be applied in practical sense if the reference technology set is constructed from sample data in the following way — Let, y_j^t and x_j^t represent the output and input vectors respectively of firm j (j =1, 2, 3 …N) in period t. Following Varian (1984), an inner approximation to the underlying production possibility set in period t will be

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

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

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

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

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

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

subject to

$$;\ \sum_{j=1}^{N}\lambda_j x_t^j \le x_k^t\ ; \quad \sum_{j=1}^{N}\lambda_j = 1; \quad \lambda_j \ge 0, \left(j = 1,2,3.....N\right)$$

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

The rate of productivity growth can be measured easily by the difference in the growth rates of output and input quantities respectively when only one output and one input case is considered. In case of multiple inputs the rate of multi-factor productivity growth (MFPG) is given by the difference in the growth rate of output and the growth rate of total input.

In parametric analysis the form of a production, cost or profit function is explicitly specified. But in non-parametric analysis, the exact technological relationship need not be specified. Only few general assumptions about the production technology are made. They are as follows.

All actually observed input-output combinations are feasible. Both inputs and outputs are freely disposable. The production possibility set is convex.

In this thesis variable return to scale (VRS) is assumed to hold throughout the analysis.

6.2.2 Data Source

Data regarding the Input-Output variables and factors determining the productivity have been collected from CMIE Prowess Database for the time period March, 1995 – March, 2016.

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) deflated by WPI (base 1993-94 = 100), and (v) Capital (measured in terms of value of the net fixed assets) deflated by WPI of machinery (base: 1993-94 =100).

After estimating productivity, this chapter tries explain the variation of productivity in term of other economic and strategic variables like R&D, Marketing, advertisement, net export, diversification index, size and age of the companies. The data for all these are also collected from CMIE Prowess data. Productivity, ADV, MKT, RD and NX are assumed to be jointly determined in a simultaneous equation frame. ADV, MKT, RD and NX affect the productivity of the firms and in turn get reciprocally affected by productivity. In order to explain net export behavior, we have used real effective exchange rate, the data of which are collected from Reserve Bank of India.

6.3 Estimated Results of Productivity

The computer program DEAP by T. Coelli is used to calculate the Malmquist Productivity Index (MPI). The details of the estimated results are discussed in the following section.

6.3.1 Estimated Results of MPI

Table 6.1.1 Malmquist Index Summary of Annual Means (Year wise analysis including all industries)

Year	Mean Efficiency Change	Mean Technical Change	Mean Scale Change	Mean TFPG
1995-96	1.159	0.881	1.101	0.997
1996-97	0.981	0.940	0.989	0.928
1997-98	0.960	0.950	1.004	0.908
1998-99	1.024	0.959	1.016	0.980
1999-2000	1.016	0.975	1.021	0.983
2000-01	0.987	1.012	0.976	0.986
2001-02	1.000	0.979	0.996	0.975
2002-03	0.935	0.968	0.979	0.902
2003-04	1.025	0.957	1.014	0.979
2004-05	1.048	0.948	1.020	0.992
2005-06	1.006	0.959	0.981	0.960
2006-07	0.941	1.051	1.005	0.983
2007-08	0.954	0.998	0.997	0.930
2008-09	1.025	0.902	1.011	0.920
2009-10	1.039	0.900	1.013	0.919
2010-11	0.995	0.959	0.990	0.947
2011-12	0.973	0.986	1.000	0.952
2012-13	1.045	0.944	1.033	0.981
2013-14	0.936	0.995	0.974	0.930
2014-15	0.960	1.042	0.970	0.992
2015-16	0.985	0.993	0.995	0.962
Mean	1.000	0.967	1.004	0.958

Source: Author's Calculation

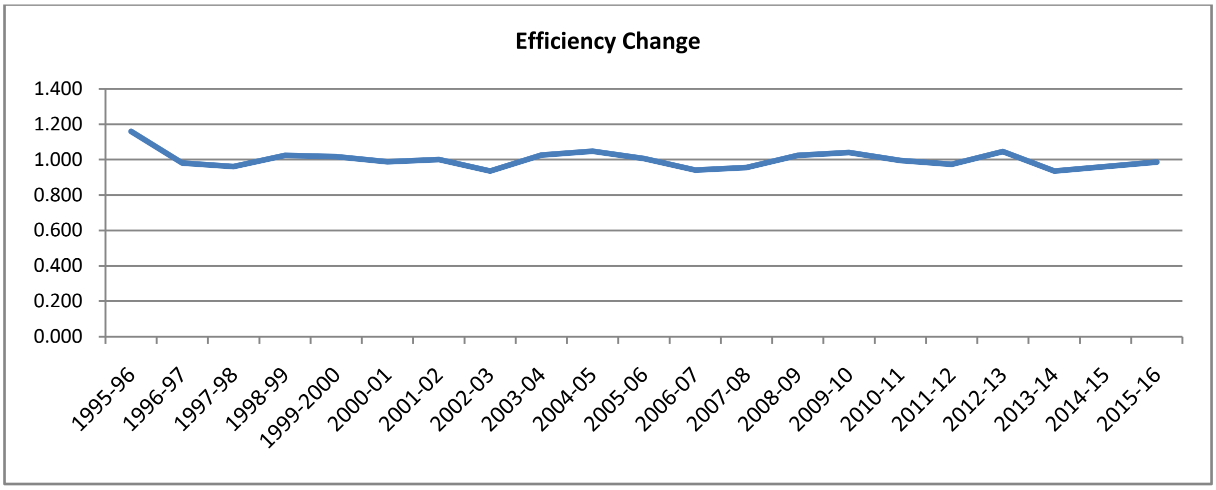

Figure 6.2. Efficiency Change over the study period (Year wise analysis including all industries)

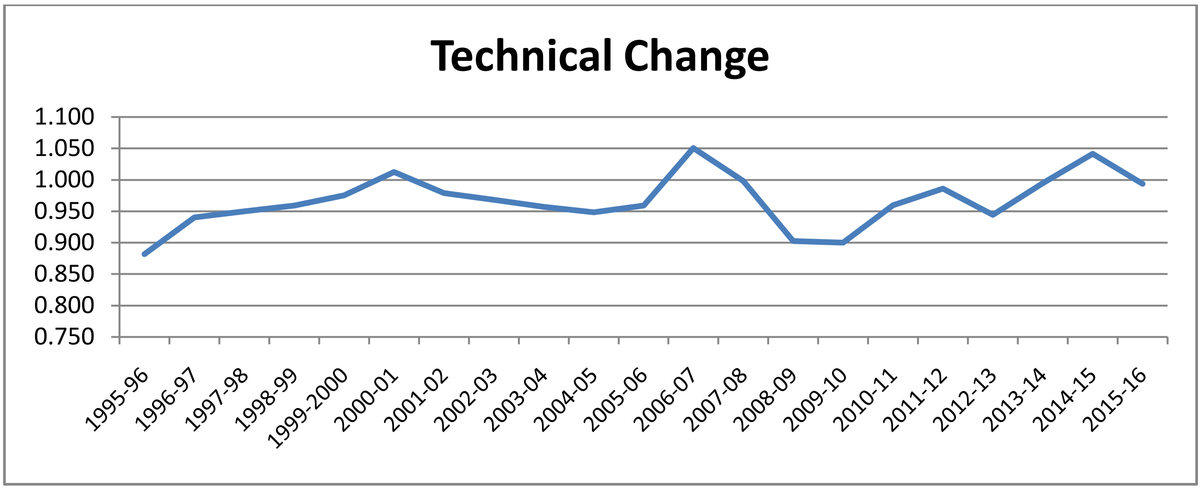

Figure 6.3. Technical Change over the study period (Year wise analysis including all industries)

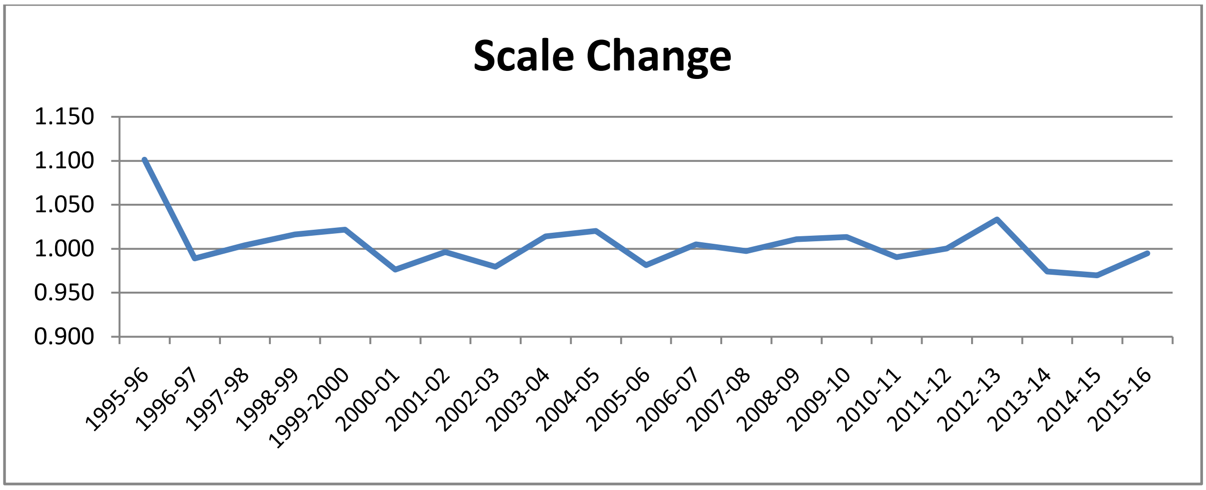

Figure 6.4. Scale Change over the study period (Year wise analysis including all industries)

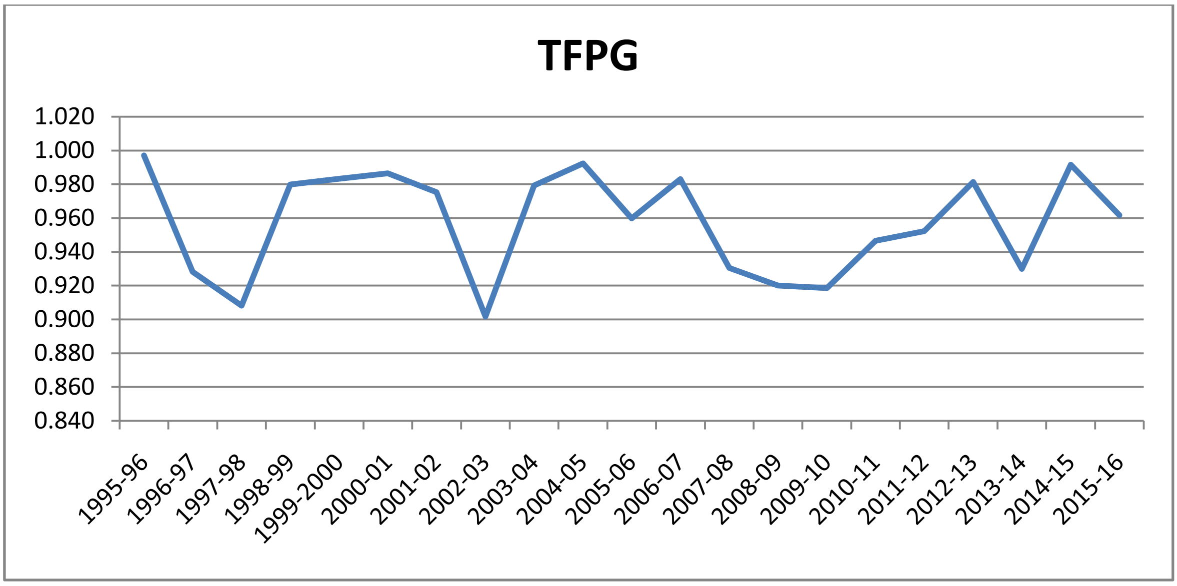

Figure 6.5. TFPG over the study period (Year wise analysis including all industries)

By analysing Table 6.1 and Figure 6.2. to Figure 6.5., it can be seen that the efficiency change remains more or less constant and the technical change, the scale change and total factor productivity change remain fluctuating during 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. In the study period, the efficiency change falls from 1.159 in 1995-96 to 0.985 in 2015-16. On an average, the mean efficiency change is 1.000, 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. Over the study period, the technical change rises from 0.88 in 1995-96 to 0.993 in the 2015-16. On an average, the mean technical change is 0.967, 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. Over the study period, the scale change falls from 1.101 in 1995-96 to 0.995 in 2015-16. On an average, the mean scale change is 1.004, meaning that the scale change has increased by 0.4% over the study period. 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. Over the study period, the total factor productivity growth falls from 0.997 in 1995-96 to 0.962 in 2015-16. On an average, mean TFPG is 0.958, 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.

Table 6.1.2 Malmquist Index Summary of Annual Means (at disaggregated level)

Year	Industry	Efficiency Change	Technical Change	Scale Change	TFP Change (TFPG)
1995-96	Chemical	1.064	0.943	1.081	1.004
	Food Products	1.123	0.903	1.079	1.014
	Leather	1.131	0.910	1.131	1.029
	Machinery	1.044	0.941	0.993	0.983
	Metal	1.590	0.571	1.357	0.908
	Non-Metallic mineral products	1.032	0.975	0.992	1.006
	Paper	1.028	1.038	1.020	1.067
	Textile	1.371	0.710	1.247	0.973
	Transport	1.051	0.942	1.009	0.990
	Mean	1.159	0.881	1.101	0.997
1996-97	Chemical	0.875	1.042	0.936	0.912
	Food Products	1.024	0.957	1.036	0.980
	Leather	0.993	0.913	1.036	0.980
	Machinery	1.021	0.947	1.012	0.967
	Metal	1.091	0.857	1.055	0.935
	Non-Metallic mineral products	1.048	0.865	1.005	0.907
	Paper	0.855	0.886	0.859	0.758
	Textile	0.943	1.007	0.980	0.949
	Transport	0.980	0.985	0.979	0.966
	Mean	0.981	0.940	0.989	0.928
1997-98	Chemical	0.990	0.902	0.974	0.893
	Food Products	0.912	1.065	0.960	0.971
	Leather	0.910	1.068	1.008	0.971
	Machinery	0.991	0.915	1.022	0.906
	Metal	1.026	0.982	1.005	1.008
	Non-Metallic mineral products	0.959	0.934	0.962	0.895
	Paper	0.767	0.919	1.035	0.705
	Textile	1.116	0.826	1.041	0.921
	Transport	0.967	0.935	1.025	0.904
	Mean	0.960	0.950	1.004	0.908
1998-99	Chemical	1.093	0.911	1.145	0.995
	Food Products	0.977	0.954	1.022	0.932
	Leather	0.991	0.967	0.957	0.958
	Machinery	0.962	1.015	0.967	0.977
	Metal	0.942	1.001	1.008	0.943
	Non-Metallic mineral products	1.150	0.954	1.065	1.097
	Paper	1.054	0.953	0.987	1.004
	Textile	1.019	0.935	1.005	0.953
	Transport	1.024	0.938	0.987	0.960
	Mean	1.024	0.959	1.016	0.980

Year	Industry	Efficiency Change	Technical Change	Scale Change	TFP Change (TFPG)
1999-2000	Chemical	1.262	0.744	1.109	0.939
	Food Products	0.919	0.862	1.012	0.792
	Leather	0.961	1.017	1.030	0.978
	Machinery	1.045	0.900	1.030	0.940
	Metal	0.979	1.015	0.985	0.994
	Non-Metallic mineral products	0.997	1.025	0.984	1.022
	Paper	1.065	1.059	1.039	1.128
	Textile	1.012	1.006	1.009	1.018
	Transport	0.903	1.149	0.994	1.038
	Mean	1.016	0.975	1.021	0.983
2000-01	Chemical	0.972	0.983	1.000	0.955
	Food Products	1.059	0.984	0.997	1.042
	Leather	1.057	0.801	1.016	0.847
	Machinery	0.897	1.126	0.958	1.009
	Metal	1.003	0.991	0.998	0.993
	Non-Metallic mineral products	0.978	0.943	1.026	0.923
	Paper	1.004	1.112	0.981	1.116
	Textile	0.786	1.337	0.810	1.051
	Transport	1.130	0.834	0.998	0.942
	Mean	0.987	1.012	0.976	0.986
2001-02	Chemical	0.933	1.075	0.930	1.003
	Food Products	0.919	1.072	0.926	0.985
	Leather	1.036	0.900	0.975	0.933
	Machinery	1.032	0.933	1.016	0.962
	Metal	0.953	0.964	0.991	0.919
	Non-Metallic mineral products	1.023	1.023	1.002	1.047
	Paper	1.049	0.908	1.028	0.953
	Textile	1.097	0.882	1.119	0.968
	Transport	0.959	1.052	0.978	1.009
	Mean	1.000	0.979	0.996	0.975
2002-03	Chemical	0.984	0.960	1.007	0.945
	Food Products	0.986	0.944	1.006	0.931
	Leather	0.997	0.862	0.958	0.860
	Machinery	0.872	1.080	0.920	0.942
	Metal	0.889	1.033	0.942	0.919
	Non-Metallic mineral products	0.711	1.017	0.975	0.723
	Paper	1.019	0.944	0.973	0.962
	Textile	1.027	0.923	1.049	0.948
	Transport	0.931	0.952	0.984	0.886
	Mean	0.935	0.968	0.979	0.902

Year	Industry	Efficiency Change	Technical Change	Scale Change	TFP Change (TFPG)
2003-04	Chemical	0.977	1.015	0.936	0.992
	Food Products	1.062	0.893	1.020	0.948
	Leather	1.097	0.954	1.110	1.046
	Machinery	0.974	0.968	1.064	0.943
	Metal	1.115	0.973	1.040	1.085
	Non-Metallic mineral products	0.939	1.102	0.866	1.035
	Paper	0.990	0.888	1.016	0.879
	Textile	1.035	0.884	1.032	0.914
	Transport	1.038	0.936	1.042	0.972
	Mean	1.025	0.957	1.014	0.979
2004-05	Chemical	0.966	1.069	0.986	1.033
	Food Products	1.071	0.980	1.040	1.049
	Leather	0.997	0.865	0.991	0.863
	Machinery	1.105	0.907	1.049	1.002
	Metal	1.077	0.936	1.024	1.008
	Non-Metallic mineral products	1.019	0.920	0.981	0.937
	Paper	1.071	0.919	1.076	0.985
	Textile	1.077	0.936	1.024	1.008
	Transport	1.045	1.001	1.009	1.046
	Mean	1.048	0.948	1.020	0.992
2005-06	Chemical	1.147	0.835	1.054	0.958
	Food Products	1.027	0.973	1.006	0.999
	Leather	0.903	1.039	0.930	0.939
	Machinery	1.066	0.916	1.008	0.976
	Metal	1.011	0.921	1.018	0.931
	Non-Metallic mineral products	0.908	1.099	0.833	0.998
	Paper	1.010	0.943	0.984	0.953
	Textile	1.011	0.921	1.018	0.931
	Transport	0.968	0.985	0.981	0.954
	Mean	1.006	0.959	0.981	0.960
2006-07	Chemical	0.923	1.050	1.047	0.969
	Food Products	0.948	0.972	0.990	0.922
	Leather	1.032	1.137	1.064	1.173
	Machinery	1.000	0.985	0.997	0.985
	Metal	0.837	1.202	0.946	1.005
	Non-Metallic mineral products	0.858	1.042	1.052	0.894
	Paper	0.996	0.937	0.989	0.933
	Textile	0.837	1.202	0.946	1.005
	Transport	1.036	0.929	1.012	0.962
	Mean	0.941	1.051	1.005	0.983

Year	Industry	Efficiency Change	Technical Change	Scale Change	TFP Change (TFPG)
2007-08	Chemical	0.922	1.003	0.977	0.925
	Food Products	1.021	0.911	0.993	0.930
	Leather	0.998	0.984	0.986	0.983
	Machinery	0.918	0.981	0.992	0.900
	Metal	0.636	1.450	0.858	0.922
	Non-Metallic mineral products	1.170	0.800	1.161	0.936
	Paper	0.976	0.961	0.993	0.938
	Textile	0.932	0.983	0.994	0.916
	Transport	1.015	0.910	1.021	0.924
	Mean	0.954	0.998	0.997	0.930
2008-09	Chemical	0.997	0.971	1.017	0.968
	Food Products	0.829	1.003	1.021	0.831
	Leather	0.952	0.737	0.907	0.701
	Machinery	0.994	0.989	0.981	0.983
	Metal	1.234	0.788	1.041	0.973
	Non-Metallic mineral products	1.109	0.859	1.100	0.953
	Paper	1.073	0.940	1.029	1.008
	Textile	1.013	0.914	0.991	0.926
	Transport	1.020	0.920	1.008	0.938
	Mean	1.025	0.902	1.011	0.920
2009-10	Chemical	1.108	0.818	0.989	0.907
	Food Products	1.018	0.918	0.996	0.935
	Leather	0.938	0.961	0.988	0.902
	Machinery	0.995	0.900	0.990	0.896
	Metal	1.424	0.619	1.146	0.881
	Non-Metallic mineral products	1.051	0.922	1.016	0.969
	Paper	0.990	0.919	1.022	0.910
	Textile	0.908	1.104	0.980	1.003
	Transport	0.921	0.939	0.991	0.865
	Mean	1.039	0.900	1.013	0.919
2010-11	Chemical	0.906	1.047	0.940	0.949
	Food Products	0.823	0.976	0.971	0.803
	Leather	1.249	0.909	1.117	1.135
	Machinery	1.056	0.922	1.004	0.973
	Metal	0.907	1.015	0.977	0.921
	Non-Metallic mineral products	1.151	0.754	0.964	0.868
	Paper	0.916	1.059	0.937	0.970
	Textile	0.954	0.976	1.003	0.932
	Transport	0.992	0.976	0.999	0.969
	Mean	0.995	0.959	0.990	0.947

Year	Industry	Efficiency Change	Technical Change	Scale Change	TFP Change (TFPG)
2011-12	Chemical	1.113	0.812	1.096	0.904
	Food Products	0.914	1.022	0.976	0.934
	Leather	0.973	1.179	1.009	1.146
	Machinery	0.903	1.035	0.990	0.934
	Metal	0.904	0.954	0.998	0.862
	Non-Metallic mineral products	0.908	1.100	0.919	0.999
	Paper	0.994	0.955	1.017	0.949
	Textile	1.098	0.807	0.999	0.885
	Transport	0.948	1.010	0.995	0.957
	Mean	0.973	0.986	1.000	0.952
2012-13	Chemical	1.125	0.839	1.044	0.944
	Food Products	1.070	0.886	1.073	0.948
	Leather	1.056	1.023	1.000	1.080
	Machinery	0.884	1.051	1.013	0.928
	Metal	0.977	1.005	0.977	0.981
	Non-Metallic mineral products	1.167	0.907	1.141	1.058
	Paper	1.017	0.952	1.028	0.968
	Textile	1.019	1.015	1.015	1.035
	Transport	1.086	0.820	1.006	0.890
	Mean	1.045	0.944	1.033	0.981
2013-14	Chemical	0.900	1.098	0.936	0.988
	Food Products	0.993	0.967	0.993	0.959
	Leather	0.959	1.060	0.994	1.017
	Machinery	0.914	1.022	0.966	0.934
	Metal	1.003	0.918	1.021	0.921
	Non-Metallic mineral products	0.982	0.946	0.981	0.929
	Paper	0.874	0.944	0.982	0.825
	Textile	0.874	0.944	0.982	0.825
	Transport	0.924	1.052	0.911	0.972
	Mean	0.936	0.995	0.974	0.930
2014-15	Chemical	0.760	1.307	0.818	0.993
	Food Products	1.051	0.997	1.000	1.048
	Leather	0.965	0.989	0.997	0.955
	Machinery	1.089	0.901	1.044	0.981
	Metal	0.988	1.127	0.983	1.114
	Non-Metallic mineral products	0.951	1.021	0.951	0.971
	Paper	0.873	1.004	0.940	0.877
	Textile	0.939	1.049	0.940	0.985
	Transport	1.021	0.980	1.053	1.001
	Mean	0.960	1.042	0.970	0.992

Year	Industry	Efficiency Change	Technical Change	Scale Change	TFP Change (TFPG)
2015-16	Chemical	0.957	0.917	0.961	0.877
	Food Products	0.780	1.031	0.855	0.804
	Leather	0.982	1.035	0.989	1.017
	Machinery	0.779	1.175	0.946	0.915
	Metal	1.134	0.794	1.056	0.900
	Non-Metallic mineral products	0.951	0.960	0.987	0.913
	Paper	1.197	1.033	1.070	1.143
	Textile	1.107	1.033	1.070	1.143
	Transport	0.981	0.962	1.019	0.943
	Mean	0.985	0.993	0.995	0.962

Source: Author's Calculation

Table 6.1.2 represents Malmquist Index Summary of Annual Means at disaggregated level. The estimated result suggest 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 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 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.

Table 6.2.1 Malmquist Index Summary of Annual Means (Industry wise analysis)

Industry	Mean Efficiency Change	Mean Technical Change	Mean Scale Change	Mean TFPG
Chemical	0.993	0.961	0.996	0.954
Food Products	0.973	0.964	0.998	0.938
Leather	1.006	0.962	1.009	0.967
Machinery	0.975	0.979	0.998	0.954
Metal	1.017	0.940	1.017	0.956
Non-metallic mineral products	0.997	0.956	0.995	0.953
Paper	0.983	0.964	0.999	0.947
Textile	0.992	0.965	1.003	0.956
Transport	0.996	0.960	1.000	0.956

Source: Author's Calculations

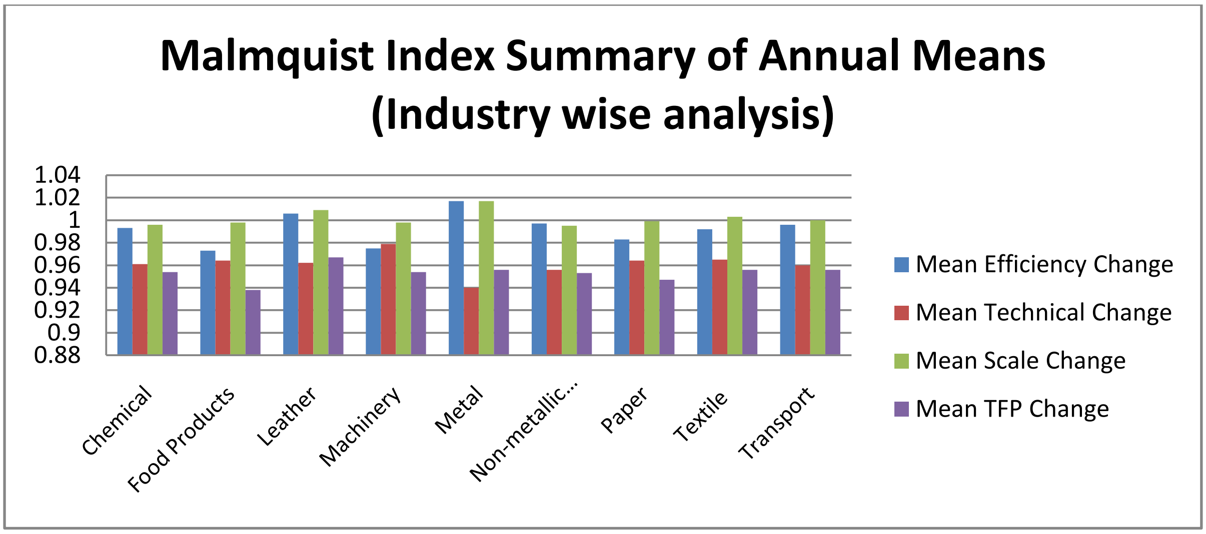

Figure 6.6. Malmquist Index Summary of Annual Means (Industry wise analysis)

Table 6.2.1 and Figure 6.6. suggest 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 Scale change is the highest (1.017) for metal industry and the lowest (0.995) for non-metallic mineral product industry. The TFPG is the highest (0.967) for leather industry and the lowest (0.938) for food product industry.

Table 6.2.2 The Malmquist Productivity Index (Annual Average)

Industry	Range of MPI	Grand mean of MPI (GRM)	Standard deviation of MPI	Percentage of firms below or equal to the GRM	Percentage of firms above the GRM	CV of MPI
Chemical	0.63 to 1.069	0.954	0.048	42.60%	57.40%	0.050
Food Products	0.767 to 1.029	0.938	0.058	29.41%	70.59%	0.062
Leather	0.919 to 1.101	0.967	0.050	72.73%	27.27%	0.051
Machinery	0.729 to 1.138	0.954	0.050	36%	64%	0.052
Metal	0.741 to 1.05	0.956	0.047	39.47%	60.53%	0.049
Non-metallic mineral products	0.755 to 1.184	0.953	0.069	39.13%	60.87%	0.073
Paper	0.823 to 1.066	0.947	0.058	20%	80%	0.061
Textile	0.625 to 1.046	0.956	0.052	42.40%	57.60%	0.054
Transport	0.691 to 1.093	0.956	0.047	40.22%	59.78%	0.049

Source: Author's Calculations

The Table 6.2.2 reveals that the annual average Malmquist Productivity Index of chemical industry varies over the range 0.63 to 1.069. The mean of the annual average MPI or the grand mean (GRM) is 0.954, the standard deviation is 0.048 and coefficient of variation (CV) is 0.050. The percentage of companies/firms having average MPI above the grand mean is 57.40. The average MPI of the rest 42.60% of companies is below or equal to the grand mean of MPI. So the majority of the chemical companies have their MPI above the GRM of MPI.

The annual average Malmquist Productivity Index of food products industry varies over the range 0.767 to 1.029. The mean of the annual average MPI or the grand mean (GRM) is 0.938, the standard deviation is 0.058 and coefficient of variation (CV) is 0.062. The percentage of companies having average MPI above the grand mean is 70.59. The average MPI of the rest 29.41% of companies is below or equal to the grand mean of MPI. So the majority of the chemical companies have their MPI above the GRM of MPI.

The annual average Malmquist Productivity Index of leather industry varies over the range 0.919 to 1.101. The mean of the annual average MPI or the grand mean (GRM) is 0.967, the standard deviation is 0.050 and coefficient of variation (CV) is 0.051. The percentage of companies having average MPI above the grand mean is 27.27. The average MPI of the rest 72.73% of companies is below or equal to the grand mean of MPI. So the majority of the chemical companies has their MPI below or equal to the GRM of MPI.

The annual average Malmquist Productivity Index of machinery industry varies over the range 0.729 to 1.138. The mean of the annual average MPI or the grand mean (GRM) is 0.954, the standard deviation is 0.050 and coefficient of variation (CV) is 0.052. The percentage of companies having average MPI above the grand mean is 64. The average MPI of the rest 36% of companies is below or equal to the grand mean of MPI. So the majority of the chemical companies have their MPI above the GRM of MPI.

The annual average Malmquist Productivity Index of metal industry varies over the range 0.741 to 1.05. The mean of the annual average MPI or the grand mean (GRM) is 0.956, the standard deviation is 0.047 and coefficient of variation (CV) is 0.049. The percentage of companies having average MPI above the grand mean is 60.53. The average MPI of the rest 39.47% of companies is below or equal to the grand mean of MPI. So the majority of the chemical companies have their MPI above the GRM of MPI.

The annual average Malmquist Productivity Index of non-metallic mineral products industry varies over the range 0.755 to 1.184. The mean of the annual average MPI or the grand mean (GRM) is 0.953, the standard deviation is 0.069 and coefficient of variation (CV) is 0.073. The percentage of companies having average MPI above the grand mean is 39.13. The average MPI of the rest 60.87% of companies is below or equal to the grand mean of MPI. So the majority of the chemical companies have their MPI above the GRM of MPI.

The annual average Malmquist Productivity Index of paper industry varies over the range 0.823 to 1.066. The mean of the annual average MPI or the grand mean (GRM) is 0.947, the standard deviation is 0.058 and coefficient of variation (CV) is 0.061. The percentage of companies having average MPI above the grand mean is 80. The average MPI of the rest 20% of companies is below or equal to the grand mean of MPI. So the majority of the chemical companies have their MPI above the GRM of MPI.

The annual average Malmquist Productivity Index of textile industry varies over the range 0.625 to 1.046. The mean of the annual average MPI or the grand mean (GRM) is 0.956, the standard deviation is 0.052 and coefficient of variation (CV) is 0.054. The percentage of companies having average MPI above the grand mean is 57.60. The average MPI of the rest 42.40% of companies is below or equal to the grand mean of MPI. So the majority of the chemical companies have their MPI above the GRM of MPI.

The annual average Malmquist Productivity Index of transport industry varies over the range 0.691 to 1.093. The mean of the annual average MPI or the grand mean (GRM) is 0.956, the standard deviation is 0.047 and coefficient of variation (CV) is 0.049. The percentage of companies having average MPI above the grand mean is 59.78. The average MPI of the rest 40.22% of companies is below or equal to the grand mean of MPI. So the majority of the chemical companies have their MPI above the GRM of MPI.

Table 6.2.3 Level of efficiency change (Annual Average)

Industry	Range of level efficiency change	Grand mean of level eff. change (GRM)	SD of level of eff. change	Percentage of firms below or equal to the GRM	Percentage of firms above the GRM	CV of Level of efficiency change
Chemical	0.642 to 1.123	0.993	0.051	43.50%	56.50%	0.051
Food Products	0.783 to 1.058	0.973	0.058	29.41%	70.59%	0.060
Leather	0.981 to 1.108	1.006	0.034	90.91%	9.09%	0.034
Machinery	0.758 to 1.175	0.975	0.046	42%	58%	0.047
Metal	0.78 to 1.111	1.017	0.045	48.25%	51.75%	0.044
Non-metallic mineral products	0.783 to 1.212	0.997	0.064	32.61%	67.39%	0.064
Paper	0.87 to 1.119	0.983	0.055	88%	12%	0.056
Textile	0.674 to 1.096	0.992	0.050	43.20%	56.80%	0.051
Transport	0.721 to 1.135	0.996	0.047	41.30%	58.70%	0.047

Source: Author’s Calculations

It is apparent from the table 6.2.3 that the level of average efficiency change of the companies varies over the range of 0.642 to 1.123 for chemical industry. The grand mean of average level of efficiency change is 0.993, the standard deviation is 0.051 and the coefficient of variation (CV) is 0.051**.** Now among the companies under study, 56.50% of the companies have their average level of efficiency change above the grand mean. The rest 43.50% of the companies have their average level of efficiency change below or equal to the grand mean of average level of efficiency change.

The level of average efficiency change of the companies varies over the range of 0.783 to 1.058 for food products industry. The grand mean of average level of efficiency change is 0.973, the standard deviation is 0.058 and the coefficient of variation (CV) is 0.060**.** Now among the companies under study, 70.59% of the companies have their average level of efficiency change above the grand mean. The rest 29.41% of the companies have their average level of efficiency change below or equal to the grand mean of average level of efficiency change.

The level of average efficiency change of the companies varies over the range of 0.981 to 1.108 for leather industry. The grand mean of average level of efficiency change is 1.006, the standard deviation is 0.034 and the coefficient of variation (CV) is 0.034**.** Now among the companies under study, 9.09% of the companies have their average level of efficiency change above the grand mean. The rest 90.91% of the companies have their average level of efficiency change below or equal to the grand mean of average level of efficiency change.

The level of average efficiency change of the companies varies over the range of 0.758 to 1.175 for machinery industry. The grand mean of average level of efficiency change is 0.975, the standard deviation is 0.046 and the coefficient of variation (CV) is 0.047**.** Now among the companies under study, 58% of the companies have their average level of efficiency change above the grand mean. The rest 42% of the companies have their average level of efficiency change below or equal to the grand mean of average level of efficiency change.

The level of average efficiency change of the companies varies over the range of 0.78 to 1.111 for metal industry. The grand mean of average level of efficiency change is 1.017, the standard deviation is 0.045 and the coefficient of variation (CV) is 0.044**.** Now among the companies under study, 51.75% of the companies have their average level of efficiency change above the grand mean. The rest 48.25% of the companies have their average level of efficiency change below or equal to the grand mean of average level of efficiency change.

The level of average efficiency change of the companies varies over the range of 0.783 to 1.212

for non-metallic mineral products industry. The grand mean of average level of efficiency change is 0.997, the standard deviation is 0.064 and the coefficient of variation (CV) is 0.064. Now among the companies under study, 67.39% of the companies have their average level of efficiency change above the grand mean. The rest 32.61% of the companies have their average level of efficiency change below or equal to the grand mean of average level of efficiency change.

The level of average efficiency change of the companies varies over the range of 0.87 to 1.119 for paper industry. The grand mean of average level of efficiency change is 0.983, the standard deviation is 0.055 and the coefficient of variation (CV) is 0.056. Now among the companies under study, 12% of the companies have their average level of efficiency change above the grand mean. The rest 88% of the companies have their average level of efficiency change below or equal to the grand mean of average level of efficiency change.

The level of average efficiency change of the companies varies over the range of 0.674 to 1.096 for textile industry. The grand mean of average level of efficiency change is 0.992, the standard deviation is 0.050 and the coefficient of variation (CV) is 0.051. Now among the companies under study, 56.80% of the companies have their average level of efficiency change above the grand mean. The rest 43.20% of the companies have their average level of efficiency change below or equal to the grand mean of average level of efficiency change.

The level of average efficiency change of the companies varies over the range of 0.721 to 1.135 for transport industry. The grand mean of average level of efficiency change is 0.996, the standard deviation is 0.047 and the coefficient of variation (CV) is 0.047. Now among the companies under study, 58.70% of the companies have their average level of efficiency change above the grand mean. The rest 41.30% of the companies have their average level of efficiency change below or equal to the grand mean of average level of efficiency change.

Table 6.2.4 Level of technical change (Annual Average)

Industry	Range of level tech. change	Grand mean of level tech. change (GRM)	SD of level of tech. change	Percentage of firms below or equal to the GRM	Percentage of firms above the GRM	CV of Level of Tech. change
Chemical	0.906 to1.012	0.961	0.018	46.64%	53.36%	0.019
Food Products	0.924 to 0.998	0.964	0.017	47.06%	52.94%	0.018
Leather	0.919 to 1.002	0.962	0.026	54.55%	45.45%	0.027
Machinery	0.925 to 1.048	0.979	0.021	56.67%	43.33%	0.022
Metal	0.846 to 1.009	0.940	0.025	46.49%	53.51%	0.027
Non-metallic mineral products	0.838 to 1.007	0.956	0.026	43.48%	56.52%	0.027
Paper	0.94 to 1.004	0.964	0.014	4%	96%	0.015
Textile	0.853 to 1.04	0.965	0.028	43.20%	56.80%	0.030
Transport	0.915 to 0.983	0.960	0.012	46.74%	53.26%	0.012

Source: Author's Calculations

It is apparent from the table 6.2.4 that the level of average technical change of the companies varies over the range of 0.906 to1.012 for chemical industry. The grand mean of average level of technical change is 0.961, the standard deviation is 0.018 and the coefficient of variation (CV) is 0.019**.** Now among the companies under study, 53.36% of the companies have their average level of technical change above the grand mean. The rest 46.64% of the companies have their average level of technical change below or equal to the grand mean of average level of technical change.

The level of average technical change of the companies varies over the range of 0.924 to 0.998 for food products industry. The grand mean of average level of technical change is 0.964, the standard deviation is 0.017 and the coefficient of variation (CV) is 0.018**.** Now among the companies under study, 52.94% of the companies have their average level of technical change above the grand mean. The rest 47.06% of the companies have their average level of technical change below or equal to the grand mean of average level of technical change.

The level of average technical change of the companies varies over the range of 0.919 to 1.002 for leather industry. The grand mean of average level of technical change is 0.962, the standard deviation is 0.026 and the coefficient of variation (CV) is 0.027**.** Now among the companies under study, 45.45% of the companies have their average level of technical change above the grand mean. The rest 54.55% of the companies have their average level of technical change below or equal to the grand mean of average level of technical change.

The level of average technical change of the companies varies over the range of 0.925 to 1.048 for machinery industry. The grand mean of average level of technical change is 0.979, the standard deviation is 0.021 and the coefficient of variation (CV) is 0.022**.** Now among the companies under study, 43.33% of the companies have their average level of technical change above the grand mean. The rest 56.67% of the companies have their average level of technical change below or equal to the grand mean of average level of technical change.

The level of average technical change of the companies varies over the range of 0.846 to 1.009 for metal industry. The grand mean of average level of technical change is 0.940, the standard deviation is 0.025 and the coefficient of variation (CV) is 0.027**.** Now among the companies under study, 53.51% of the companies have their average level of technical change above the grand mean. The rest 46.49% of the companies have their average level of technical change below or equal to the grand mean of average level of technical change.

The level of average technical change of the companies varies over the range of 0.838 to 1.007 for non-metallic mineral products industry. The grand mean of average level of technical change is 0.956, the standard deviation is 0.026 and the coefficient of variation (CV) is 0.027**.** Now among the companies under study, 56.52% of the companies have their average level of technical change above the grand mean. The rest 43.48% of the companies have their average level of technical change below or equal to the grand mean of average level of technical change.

The level of average technical change of the companies varies over the range of 0.94 to 1.004 for paper industry. The grand mean of average level of technical change is 0.964, the standard deviation is 0.014 and the coefficient of variation (CV) is 0.015**.** Now among the companies under study, 96% of the companies have their average level of technical change above the grand mean. The rest 4% of the companies have their average level of technical change below or equal to the grand mean of average level of technical change.

The level of average technical change of the companies varies over the range of 0.853 to 1.04

for textile industry. The grand mean of average level of technical change is 0.965, the standard deviation is 0.028 and the coefficient of variation (CV) is 0.030**.** Now among the companies under study, 56.80% of the companies have their average level of technical change above the grand mean. The rest 43.20% of the companies have their average level of technical change below or equal to the grand mean of average level of technical change.

The level of average technical change of the companies varies over the range of 0.915 to 0.983 for transport industry. The grand mean of average level of technical change is 0.960, the standard deviation is 0.012 and the coefficient of variation (CV) is 0.012**.** Now among the companies under study, 53.26% of the companies have their average level of technical change above the grand mean. The rest 46.74% of the companies have their average level of technical change below or equal to the grand mean of average level of technical change.

Table 6.2.5 Level of scale change (Annual Average)

Industry	Range of level of scale change	Grand mean of level of scale Change (GRM)	SD of level of scale change	Percentage of firms below or equal to the GRM	Percentage of firms above the GRM	CV of Level of Scale change
Chemical	0.774 to 1.158	0.996	0.028	46.64%	53.36%	0.028
Food Products	0.834 to 1.081	0.998	0.037	41.18%	58.82%	0.037
Leather	0.987 to 1.108	1.009	0.034	90.91%	9.09%	0.033
Machinery	0.876 to 1.07	0.998	0.017	36.67%	63.33%	0.018
Metal	0.974 to 1.108	1.017	0.021	61.40%	38.60%	0.020
Non-metallic mineral products	0.875 to 1.043	0.995	0.020	28.26%	71.74%	0.020
Paper	0.915 to 1.093	0.999	0.026	32%	68%	0.026
Textile	0.953 to 1.107	1.003	0.022	51.20%	48.80%	0.022
Transport	0.881 to 1.019	1.000	0.013	28.26%	71.74%	0.013

Source: Author’s Calculations

It is apparent from the table 6.2.5 that the level of average scale change of the companies varies over the range of 0.774 to 1.158 for chemical industry. The grand mean of average level of scale change is 0.996, the standard deviation is 0.028 and the coefficient of variation (CV) is 0.028**.** Now among the companies under study, 53.36% of the companies have their average level of scale change above the grand mean. The rest 46.64% of the companies have their average level of scale change below or equal to the grand mean of average level of scale change.

The level of average scale change of the companies varies over the range of 0.834 to 1.081 for food products industry. The grand mean of average level of scale change is 0.998, the standard deviation is 0.037 and the coefficient of variation (CV) is 0.037**.** Now among the companies under study, 58.82% of the companies have their average level of scale change above the grand mean. The rest 41.18% of the companies have their average level of scale change below or equal to the grand mean of average level of scale change.

The level of average scale change of the companies varies over the range of 0.987 to 1.108 for leather industry. The grand mean of average level of scale change is 1.009, the standard deviation is 0.034 and the coefficient of variation (CV) is 0.033**.** Now among the companies under study, 9.09% of the companies have their average level of scale change above the grand mean. The rest 90.91% of the companies have their average level of scale change below or equal to the grand mean of average level of scale change.

The level of average scale change of the companies varies over the range of 0.876 to 1.07 for machinery industry. The grand mean of average level of scale change is 0.998, the standard deviation is 0.017 and the coefficient of variation (CV) is 0.018**.** Now among the companies under study, 63.33% of the companies have their average level of scale change above the grand mean. The rest 36.67% of the companies have their average level of scale change below or equal to the grand mean of average level of scale change.

The level of average scale change of the companies varies over the range of 0.974 to 1.108 for metal industry. The grand mean of average level of scale change is 1.017, the standard deviation is 0.021 and the coefficient of variation (CV) is 0.020**.** Now among the companies under study, 38.60% of the companies have their average level of scale change above the grand mean. The rest 61.40% of the companies have their average level of scale change below or equal to the grand mean of average level of scale change.

The level of average scale change of the companies varies over the range of 0.875 to 1.043 for non-metallic mineral products industry. The grand mean of average level of scale change is 0.995, the standard deviation is 0.020 and the coefficient of variation (CV) is 0.020**.** Now among the companies under study, 71.74% of the companies have their average level of scale change above the grand mean. The rest 28.26% of the companies have their average level of scale change below or equal to the grand mean of average level of scale change.

The level of average scale change of the companies varies over the range of 0.915 to 1.093 for paper industry. The grand mean of average level of scale change is 0.999, the standard deviation is 0.026 and the coefficient of variation (CV) is 0.026**.** Now among the companies under study, 68% of the companies have their average level of scale change above the grand mean. The rest 32% of the companies have their average level of scale change below or equal to the grand mean of average level of scale change.

The level of average scale change of the companies varies over the range of 0.953 to 1.107

for textile industry. The grand mean of average level of scale change is 1.000, the standard deviation is 0.013 and the coefficient of variation (CV) is 0.013**.** Now among the companies under study, 48.80% of the companies have their average level of scale change above the grand mean. The rest 51.20% of the companies have their average level of scale change below or equal to the grand mean of average level of scale change.

The level of average scale change of the companies varies over the range of 0.881 to 1.019 transport industry. The grand mean of average level of scale change is 0.960, the standard deviation is 0.012 and the coefficient of variation (CV) is 0.012**.** Now among the companies under study, 71.74% of the companies have their average level of scale change above the grand mean. The rest 28.26% of the companies have their average level of scale change below or equal to the grand mean of average level of scale change.

Table 6.3.1 Distribution of Firms on the basis of annual average MPI (in %)

Industry	**Range of Average MPI**		
	Below 0.900	**0.900-1.000**	**Above 1.000**
Chemical	7	83	10
Food Products	18	76	6
Leather	00	82	18
Machinery	7	82	11
Metal	7	84	9
Non-metallic mineral products	13	76	11
Paper	20	68	12
Textile	6	83	11
Transport	5	88	7
Grand Mean	9	80	11

Source: Author’s Calculations

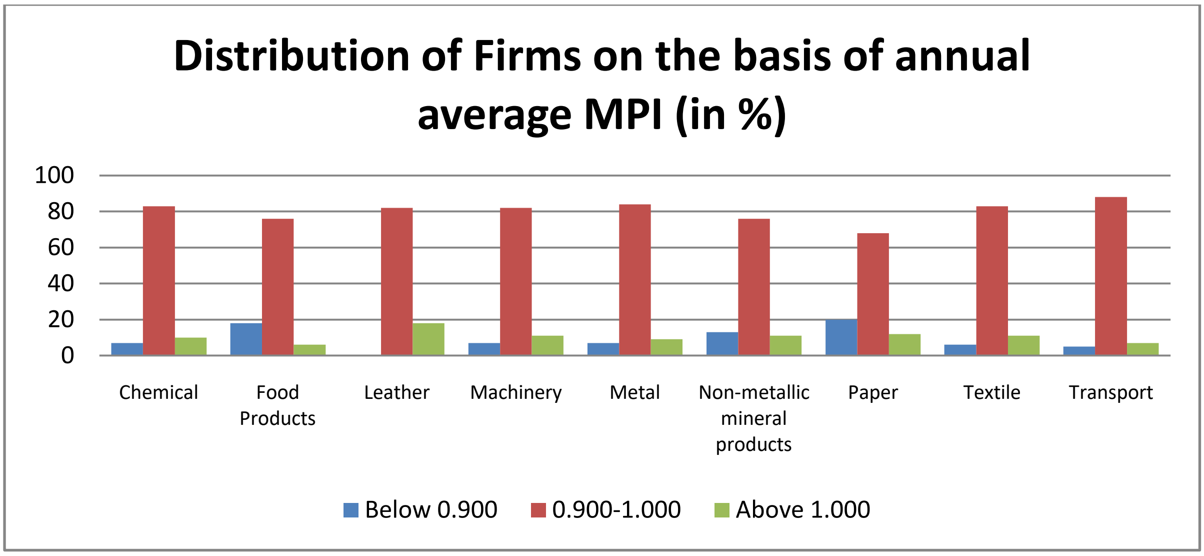

Figure 6.7. Distribution of Firms on the basis of annual average MPI (in %)

Table 6.3.1 suggests that 80% of sample firms are having the average MPI ranging between 0.900 to 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. Figure 6.7. represents the distribution of firms on the basis of annual average MPI.

Table 6.3.2 Distribution of Firms on the basis of annual average efficiency change (in %)

Industry	**Range of Average efficiency change**		
	Below 0.900	**0.900-1.000**	**Above 1.000**
Chemical	4	49	47
Food Products	12	53	35
Leather	0	91	9
Machinery	6	71	23
Metal	2	25	73
Non-metallic mineral products	7	41	52
Paper	16	52	32
Textile	2	52	46
Transport	4	48	48
Grand Mean	6	54	40

Source: Author's Calculations

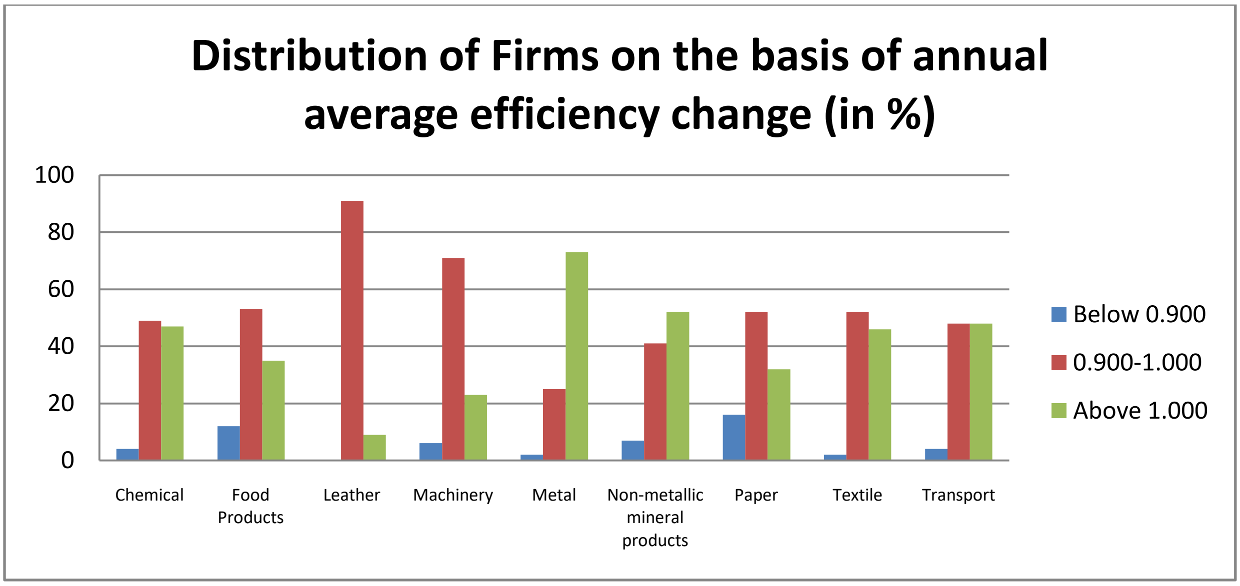

Figure 6.8. Distribution of Firms on the basis of annual average efficiency change (in %)

Table 6.3.2 suggests that 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. Figure 6.8. represents the distribution of firms on the basis of annual average efficiency change.

Table 6.3.3 Distribution of Firms on the basis of annual average technical change (in %)

Industry	**Range of Average technical change**		
	Below 0.900	**0.900-1.000**	**Above 1.000**
Chemical	0	99	1
Food Products	0	100	0
Leather	0	91	9
Machinery	0	85	15
Metal	6	91	3
Non-metallic mineral products	4	91	5
Paper	0	96	4
Textile	3	89	8
Transport	0	100	0
Grand Mean	1	94	5

Source: Author’s Calculations

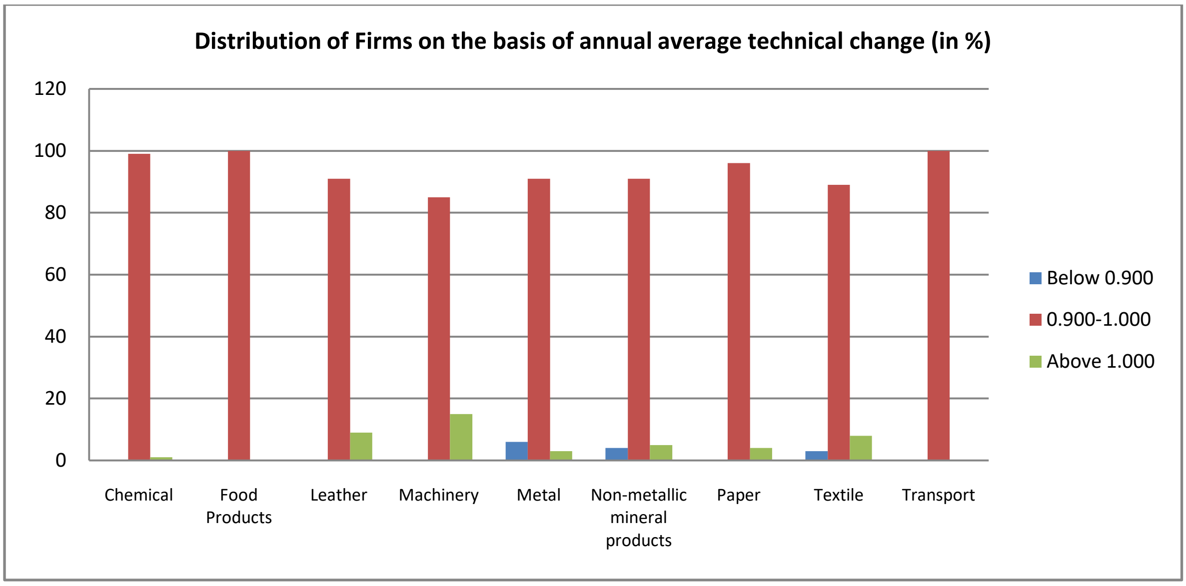

Figure 6.9. Distribution of Firms on the basis of annual average technical change

Table 6.3.3 suggests that 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. Figure 6.9. represents the distribution of firms on the basis of annual average technical change.

Table 6.3.4 Distribution of Firms on the basis of annual average scale change (in %)

Industry	Range of Average scale change		
	Below 0.900	**0.900-1.000**	**Above 1.000**
Chemical	7	83	10
Food Products	3	47	50
Leather	0	82	18
Machinery	1	59	40
Metal	0	23	77
Non-metallic mineral products	2	76	22
Paper	0	80	20
Textile	0	45	55
Transport	7	86	7
Grand Mean	2	65	33

Source: Author's Calculations

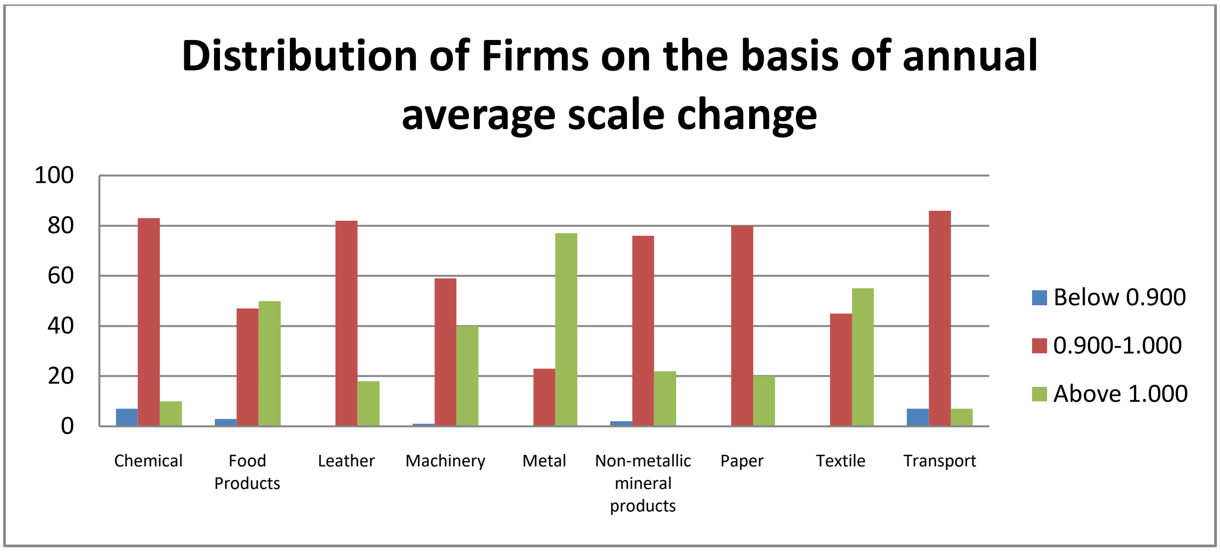

Figure 6.10. Distribution of Firms on the basis of annual average scale change (in %)

Table 6.3.4 suggests that 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. Figure 6.10. represents the distribution of firms on the basis of annual average scale change.

Table 6.4 Mean Growth rate of Efficiency Change, Technical Change, Scale Change and TFPG (Industry wise analysis)

Industry	Mean Growth rate (%) of Efficiency Change	Mean Growth rate(%) of Technical Change	Mean Growth rate(%) of Scale Change	Mean Growth rate(%) of TFPG
Chemical	33.71	4.62	5.35	29.89
Food Products	261.27	2.49	2.95	276.04
Leather	5.4	7.13	3.34	20.29
Machinery	178.51	4.77	5.77	191.55
Metal	132.1	8.09	6.69	121.21
Non-metallic mineral product	47.22	8.16	4.29	73.16
Paper	271.98	2.56	43.79	287.53
Textile	86.02	6.61	5.96	82.68
Transport	46.26	2.71	17.55	44.79
Mean	118.05	5.24	10.63	125.24

Source: Author’s Calculations

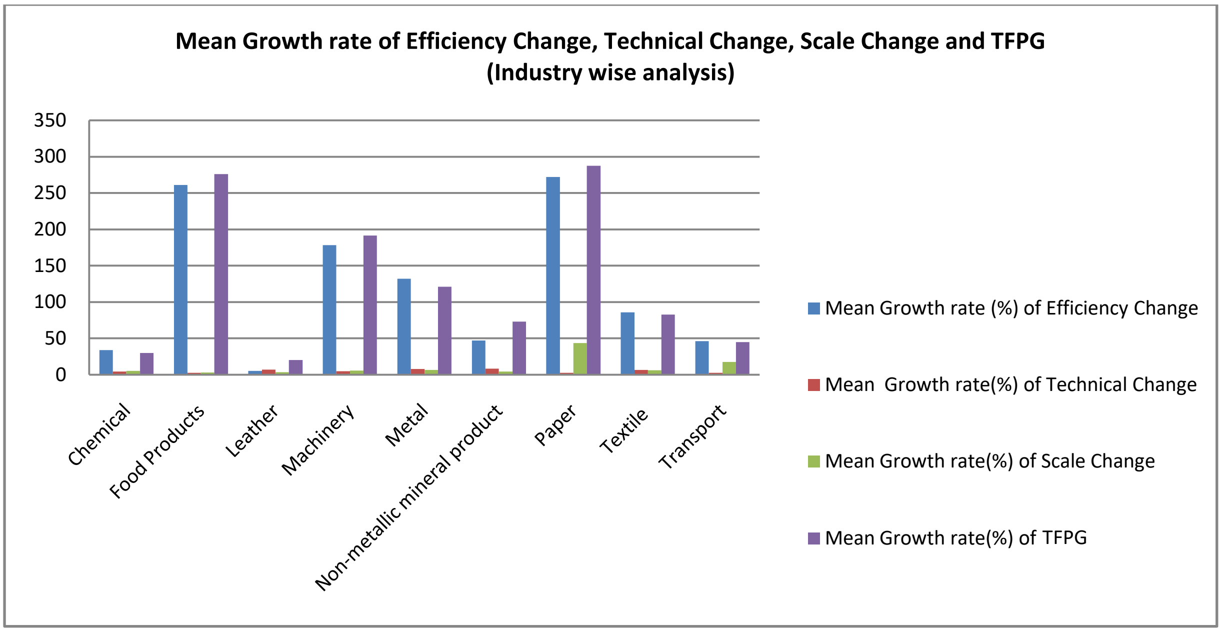

Figure 6.11. Mean Growth rate of Efficiency Change, Technical Change, Scale Change and TFPG (Industry wise analysis)

Table 6.4 shows that 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 over the study period. This result suggests that efficiency change is contributing the most towards TFPG, implying 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. Figure 6.11. graphically represents the mean growth rate of efficiency change, technical change, scale change and TFPG (TFP Change) of different industries.

6.4 Determinants of Productivity

A second stage panel regression has been carried out to relate the productivity (TFPG) of Indian manufacturing firms with the strategic variables perused by firms as well as firms' characteristics namely ADV Intensity, MKT Intensity, RD Intensity, Net Export Intensity, Age, Diversification Index, Size and Age of the firm. The explanations for the inclusion of different explanatory variables can be summarized as follows:

Advertising Intensity (ADV):

Advertising, which initiates the scope of product substitutability on the part of consumers, has a definite influence on the productivity of the firms. Thus high-substitutability industries should exhibit less productivity dispersion and have higher average productivity levels .The literature review shows that there are studies estimating the effect of advertising expenditure productivity level. Mention may be made of studies by Luo and Donthu (2005), Tucker (2008) among many others.

As advertising activity effect productivity, on the other hand, advertising expenditure can in turn get affected by the productivity of the firm and also by the other economic and strategic variables like market share, marketing and R&D behavior. Further advertisement activity can be influenced by age and size of the firm. The basic question thus is to what extent advertising expenditures foster productivity and at the same time get affected by the same and other economic and strategic variables? Thus, in order to determine the major factors influencing advertisement expenditure, one needs to formulate and estimate a simultaneous kind of relation between all these variables.

Marketing Intensity (MKT):

This variable also serves as a proxy for product differentiation. The average growth trend of marketing activity is increasing and it has started taking important role in determining productivity of firms. The article by Rust et al. (2004) proposes a broad framework for examining marketing productivity, cataloging what is an already known and suggesting area for further research. Their study also emphasizes on the increasing marketing's vitality in the firm and towards raising the performance of the firm itself. There has been much research in the area of marketing performance measurement (MPM) and several conceptual and empirical research papers .Mention may be made of studies by Donthu et al. (2005) and Lukas et al. (2005) among many others.

As in the case of advertising expenditure, this chapter tries to find out a relation between marketing activity and productivity of the Indian manufacturing firms and other economic and strategic variables like market share, advertisement and R&D behavior, the age and size of the company. The basic question is to what extent marketing expenditures foster productivity and in turn gets affected by the productivity and other strategic variables and age of the company. The answer to the question will be dependent on the estimation of a simultaneous kind of model where marketing expenditure is determined jointly by the other endogenous variables of the model.

R&D Intensity (RD):

The recent theoretical models of endogenous growth emphasize that R&D expenditures of individual firms are contributing to the sustained long run growth of an economy through their industry-wide spillover effect. According to this view, individual firm invest in R&D to private knowledge that enhances their productivity and profit.

The companies engaged in R&D activities are capable of developing improved technologies which enhances their productivity. Here the idea is that the increased technical knowledge helps them to improve their level of output production. Thus one can expect a positive relationship between productivity of companies and their R&D activity.

Empirical literature relating productivity and R&D is vast. To mention a few, Clark and Griliche (1982), Dietmar (1994), Kwon and Inui (2003)**,** Higon (2003), Mate-Garcia and Rodriguez- Fernandez (2008), Goedhuys et al. (2008), Johansson and Lööf (2008), Moen and Burchardt (2009) and others.

Some studies are available showing the linkage between the R&D activities and productivity of the firm for Indian industry. For example, Raut (1995), Hasan (2000), Kathuria (2001), Patibandla and Sanyal (2005), Sharma (2011) and Reikard (2011). The studies vary with respect to the specific industries that they are considering and also with respect to the impact of R&D activity.

The R&D decision of the firm is guided by productivity of the firms. Here the logic is that productive firms undertake R&D decision, because R&D requires some additional cost. Hence, correlation between R&D and productivity of firms may arise as a result of the self-selection of better companies into the R&D decision.

At the same time R&D can be influenced by other economic variables like market share of the companies, and also by the companies' strategic variables like advertisement and marketing behavior. Age and size of the company can also be a significant determinant of R&D expenditure. It is expected that R&D decision of the company will be determined by the joint interactions of all these variables.

Thus question can be asked to what extent increase in R&D helps to increase the productivity of the firms belonging to the Indian manufacturing sector? At the same time one may be interested to know to what extent R&D decision of the companies is influenced by productivity, market share as well as other strategic variables. Hence one has to formulate a simultaneous kind of relation between these variables showing the joint interactions of each other.

Net Export Intensity (NX):

While detecting the factors determining productivity of Indian manufacturing firms, the role of export and the role of import behavior are relevant. An enormous amount of literature is available supporting the role of exports in improving productivity both at the theoretical as well as empirical level. The theoretical literature suggests that international trade in general and export in particular improves the productivity of involved firms. There exists also a vast empirical literature relating the export activity and productivity. The empirical evidence showing that firms which will become exporters have some prior benefit is very rich and unambiguous. The studies vary with respect to the impact of export performance on productivity of the firms. Mention may be made of the studies by Roberts and Tybout (1997), Clerides et al. (1998), Bernard and Jensen (1999), Biesebroeck (2005), Alvarez and Lopez (2005) among others.

Loecker (2007) finds that the export entrants will become more productive when they start exporting. The productivity gap between exporters and their domestic counter- parts increases further over time. These results also hold at the industry level.

Mukim (2011) identifies two separate effects – that of exporting on productivity across manufacturing firms in India. The findings show that exporting is associated with a jump in productivity, both within industries and within firms, but that this effect tapers over time. Entry into export markets has a positive effect on firm performance in the very beginning, but there is no evidence of sustained learning-by exporting.

For the Indian manufacturing firms import is important. This is mainly essential to carry out the R&D activities. The literature review shows that many studies have been focused relating both to the theoretical aspect and empirical aspect concerning import and productivity of firms. The World Bank Report (1993, 1997) discussing about the firm’s import for foreign technology and it has positive impact on its productivity. Such activities enable firms to build up their internal production capabilities and competency. The empirical literature shows that there have been studies showing that improved access to foreign inputs has increased firm productivity. Lawrence and Weinstein (2001) argue that imports, not exports, contribute importantly to productivity growth of Japan and Korea. To examine the effect of import on productivity, Halpern et al. (2005) estimate a structural model of producers using product-level import data for a panel of Hungarian manufacturing firms from 1992 to 2001. Imports have an effect on firm productivity by expanding variety as well as improved input quality. The results suggest that the role of imports is both statistically and economically significant. Imports are responsible for 30% of the growth in aggregate total factor productivity in Hungary during the 1990s. About 50% of this effect is through imports advancing firm level productivity, while the remaining 50% comes from the reallocation of capital and labor to importers. Study by Amiti and Konings (2007) show that improved access to foreign inputs has increased firm productivity in Indonesia. Vogel and Wagner (2010) uses a newly available comprehensive panel data set for manufacturing enterprises from 2001 to 2005 to represent the first empirical results on the relationship between imports and productivity for Germany. They find a positive link between importing and productivity. Among many other studies mention may be made studies by Kasahara and Rodrigue (2008), Topalova and Khandelwal (2011).

The above discussion shows that both import and export has a role to play in determining productivity. So it is important to find out the relative strength of exports vis á vis imports in increasing productivity. In order to find out this relative role the present chapter takes net exports **(NX)** as an explanatory variable while determining productivity. The question is to what extent the net exports matter?

Many empirical studies have been conducted where focus is given either on export or on import and they are unable to separate the impact of exports and imports. Mention may be made of studies by Kim et al. (2009), where they investigate the relationship between trade and economic growth in Korea during 1980–2003. The results indicate that imports have a significant positive effect on TFP growth, but exports do not. Arvas and Uyar (2014) in their study while explaining firm Productivity in Turkish Manufacturing sector, estimated the relationship between productivity and net-export by fixed-effects panel data method. Results show that, productivity level for net-exporters is lesser than the level for net-importers indicating that industries are more prone to import and more competitive on import markets.

This type of argument represents only one aspect of the story. An alternative view is that the net export decision of the firm is guided by productivity of the firms.

At the same time net export can be influenced by other economic variables like market share of the firm, and also by the firm's strategic variables like R&D activity, advertisement and marketing behavior. Age and size of the firm can also be a significant determinant of net export. NX can also be influenced by Real effective exchange rate (REER). It is expected that net export decision of the firm will be determined by the joint interactions of all these variables.

Thus question can be raised to what extent net export activities help to foster the productivity of the companies belonging to the Indian manufacturing sector and reciprocally get affected by the productivity of the companies and by other economic and strategic variables like market share, R&D activity, advertising expenditures, marketing expenditures and age of the company? The present chapter tests these hypotheses empirically formulating a simultaneous kind of relation between these variables showing the joint interactions of each other.

Diversification Index (DIVIND): DIVIND of a particular industry groups captures the effect of market structure on productivity of the firms. DIVIND is the reciprocal of concentration ratio. The Herfindal Index or Concentration Index is calculated as follows: $H = \Sigma s_i^2$;where s_i is the market share of the i^{th} firm in the market and N is the number of firms.

A negative relation between CR and TFPG is expected by some researchers because competition may lead to cost-consciousness and drive for technological advancement. Others may point out the benefits of large size, secured market and expect a positive association between CR and TFPG. The conclusion from the empirical literature also varies and does not provide us a single answer [(Katz, 1969); (Kendrick, 1973)].

Age: There are counter arguments regarding the effect of age on firm's performances. One argument is that older firms are displaying superior performances since they are more experienced. They are having the advantages of learning earlier and they do not experience the problems that the newcomers usually face (Stinchcombe, 1965). On the other hand, the counter argument is that older firms do lack adequate flexibility to adopt quickly to the changing economic circumstances which the younger firms can do much more rapidly and efficiently (Marshall, 1920)

The present study has divided the sample companies into two groups:

Agedum = 1, if Mean Age of the firm < Grand Mean Age (considering all the

firms and all time Points taken together)

= 0, Otherwise

Size: The productivity differs due to difference in relative size. A larger sized firm may have an easier access to the cheaper and superior quality inputs which helps to increase its productivity. It is easier for such firms to exploit economies of scale. They can widen scope of production by making its operation more effective and allowing them to perform better compared to smaller firms (Penrose, 1959). 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. rupees

= 0, otherwise

Mediumdum = 1, if mean investment < 10 Cr. rupees

= 0, otherwise

Largedum = 1, if mean investment > 10 Cr. rupees

= 0, otherwise

In order to avoid dummy variable trap, Mediumdum has been dropped.

It may be possible that the effect of different explanatory variables may be non-linear in nature. To get this effect, the sole effect of different variables, their square terms and the joint effect of different variables will be incorporated. The effects of the lag value (one year lag) of different strategic variables (i.e. the effects of different strategic variable in the previous period) have also been considered.

Since we are dealing with simultaneous equation model one important problem is the problem of Identification of the model, we have solved the problem of Identification by

taking into account exclusion restriction. We have checked that the rank and order condition of Identification under exclusion restriction have got satisfied for the model. We make sure that at least one variable is specific to one particular equation and appears only in that equation. The model is identified.

6.4.1 Explaining the Factors Influencing TFPG of the Firms: The Results from a Two Stage Least Square Type Approach in a Simultaneous Panel Model.

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

Since we are doing with simultaneous equation model in a panel setup, for purpose of estimation we have used two stage procedures.

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.

Significant Factors explaining the total factor productivity growth from a Simultaneous Equation Panel Model: The TFPG Block

The estimated TFPG of Indian manufacturing firms and also the other endogenous variables explaining TFPG corresponding to TFPG block can be visualized below.

6.4.1.a Chemical Industry

The estimated TFPG of Indian chemical firms and also the other endogenous variables explaining the TFPG corresponding to TFPG block can be visualized from Table 6.4.1 to Table 6.4.5.

Table 6.4.1 Factors explaining the total factor productivity growth from a Simultaneous Equation Panel Model: The TFPG Block

Endogenous Variable: TFPG

Independent Variable	Coefficient	z-value	p>|z|
ADV	-.0115817	-3.33	0.001
$(ADV)^2$	.0000248	2.36	0.018
ADVlag	.011994	3.48	0.000
MKT	-.00347	-3.47	0.001
$(MKT)^2$	2.28e-06	1.42	0.154
MKTlag	.0032243	4.85	0.000
NX	8.28e-06	0.52	0.604
$(NX)^2$	-1.17e-09	-1.19	0.233
NX*RD	7.84e-09	0.36	0.719
DIVIND	-.0044082	-2.41	0.016
Agedum	.0230011	1.40	0.163
Wald chi2 = 72.49 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
ADV		-0.0098	
MKT		-0.0021	
RD		0.0859	
NX		0.0028	

The first equation of TFPG Block: The estimated TFPG relation

The estimated TFPG relation as presented in Table 6.4.1 shows that TFPG of the firms is positively related to both ADV and MKT of the previous period, meaning that the increase in ADV and MKT in the previous period increases the TFPG of the current period.

Considering ADV and MKT of the current period, it can be observed that the initial impacts of increase in both ADV and MKT are negative, but there exist the critical values of ADV & MKT beyond which their effects on TFPG are positive. Both ADV and MKT have U-relationship with TFPG. This in turn implies that initially spending on ADV and MKT seems costly to the firms as these are the sunk costs but beyond their critical levels their positive impacts on TFPG can be realised. As the mean levels of ADV and MKT are lesser than their critical levels for the sample firms, their negative marginal effects on TFPG have been obtained as the Indian chemical firms are not doing enough ADV & MKT.

Next, considering NX of the current period, one can find that NX has inverted U-relationship with TFPG with positive marginal effect. The initial impact of its increase on TFPG is positive, suggesting that there exists a critical level beyond which its effect on TFPG is negative.

There exists another composite effect of NX and RD on TFPG is positive. The effect of NX on TFPG depends RD and vice-versa. Adequate RD improves product quality and that increases NX which enhances TFPG. On the other hand, through the imports of capital goods, spare parts, RD practices will be enhanced; as a result, TFPG will be increased. Taken all these effects into account, the respective marginal effects of NX and RD on TFPG are positive.

Another factor which has negative impact on TFPG is DIVIND, meaning that as the market share gets concentrated, TFPG of the firms rises.

Next, another factor positively influencing TFPG is Agedum. Younger firms are more productive than the older ones.

Table 6.4.2 Factors explaining ADV behaviour from a Simultaneous Equation Panel Model: The TFPG Block

Endogenous Variable: ADV

<table>
<tr><td>Independent Variable</td><td>Coefficient</td><td>z-value</td><td>p>|z|</td></tr>
<tr><td>TFPG</td><td>6.787432</td><td>1.82</td><td>0.068</td></tr>
<tr><td>MKT</td><td>.1058917</td><td>3.96</td><td>0.000</td></tr>
<tr><td>$(MKT)^2$</td><td>-.0001244</td><td>-1.97</td><td>0.048</td></tr>
<tr><td>RD</td><td>.0291127</td><td>2.58</td><td>0.010</td></tr>
<tr><td>$(RD)^2$</td><td>-.0000317</td><td>-3.68</td><td>0.000</td></tr>
<tr><td>RDlag</td><td>.0052767</td><td>1.41</td><td>0.159</td></tr>
<tr><td>RD*MKT</td><td>.0001997</td><td>4.21</td><td>0.000</td></tr>
<tr><td>NXlag</td><td>-.0007402</td><td>-1.57</td><td>0.117</td></tr>
<tr><td>$(NXlag)^2$</td><td>3.11e-08</td><td>1.11</td><td>0.268</td></tr>
<tr><td colspan="4">Wald chi2 = 151.31
Prob > chi2 = 0.0000</td></tr>
<tr><td colspan="2">Determinants</td><td colspan="2">Marginal effects</td></tr>
<tr><td colspan="2">TFPG</td><td colspan="2">6.7874</td></tr>
<tr><td colspan="2">MKT</td><td colspan="2">0.1099</td></tr>
<tr><td colspan="2">RD</td><td colspan="2">0.0312</td></tr>
<tr><td colspan="2">NXlag</td><td colspan="2">0.0006</td></tr>
</table>

The second equation of TFPG Block: The estimated ADV relation

The estimated ADV relation as presented in Table 6.4.2 shows that ADV of the firms is positively related to TFPG of the current period and RD of previous period. Increase in TFPG in the current period as well as RD practices in the previous period boost up ADV in the current period.

Considering MKT and RD of the current period, both have inverted U-relationship with ADV with positive marginal effects. Their initial sole effects are positive but beyond their critical level their impacts on ADV will be negative.

There exists a joint effect of RD and MKT on ADV. The effect of the joint interaction term is positive. The effect of MKT on ADV depends on RD and vice-versa. All these effects taken into account, the marginal effects of RD and MKT on ADV are positive.

Next, considering NX of the previous period, it can be seen that it is having U-relationship with ADV. Its initial sole effect is negative but beyond its critical level, its positive effect on ADV can be realised. When the net effect of NX of the previous period is calculated by considering its marginal effect, it will be positive.

Table 6.4.3 Factors explaining MKT behaviour from a Simultaneous Equation Panel Model: The TFPG Block

Endogenous Variable: MKT

Independent Variable	Coefficient	z-value	p>|z|
TFPG	8.750437	1.07	0.284
ADV	.5795459	5.40	0.000
$(ADV)^2$	-.002213	-5.90	0.000
RD	.7338134	5.31	0.000
$(RD)^2$	-.0006669	-13.84	0.000
RDlag	.0310864	4.39	0.000
RD*ADV	.0196586	26.96	0.000
NX	-.0033287	-3.70	0.000
$(NX)^2$	6.44e-07	13.07	0.000
NXlag	-.0005862	-0.62	0.532
$(NXlag)^2$	5.08e-07	9.57	0.000
Wald chi2 = 3158.57 Prob > chi2 = 0.0000			

Determinants	Marginal effects
TFPG	8.7504
ADV	0.5770
RD	0.6902
NX	0.0075
NXlag	0.0054

The third equation of TFPG Block: The estimated MKT relation

The estimated MKT relation as presented in Table 6.4.3shows that MKT of the firms is positively related to TFPG of the current period and RD of the previous period. Increase in TFPG in the current period and RD in the previous period boost up MKT.

Considering ADV and RD of the current period, it can be seen that both have inverted U-relationship with MKT. Their initial sole effects on MKT are positive but beyond the critical levels, their negative effect on MKT will be felt.

There exists a composite effect of RD and ADV on MKT. The effect of this joint interaction term is positive. The effect of RD on MKT depends on ADV and vice-versa.

Considering NX of the current period as well as previous period, both are having U-relationship with ADV with positive marginal effects. Their initial sole effects are negative, beyond their critical levels, their positive effects on MKT can be felt.

Table 6.4.4 Factors explaining RD behaviour from a Simultaneous Equation Panel Model: The TFPG Block

Endogenous Variable: RD

Independent Variable	Coefficient	z-value	p>|z|
TFPG	1.679948	0.28	0.778
MKT	1.46275	7.14	0.000
$(MKT)^2$	-.0057302	-10.49	0.000
ADV*MKT	.0064799	0.91	0.361
$(ADV*MKT)^2$	7.10e-07	4.19	0.000
NX	-.0159259	-4.23	0.000
$(NX)^2$	2.74e-06	18.41	0.000
NXlag	.0111813	4.48	0.000
Largedum	10.99895	1.21	0.228
Wald chi2 = 1346.12 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
TFPG		1.6799	
ADV		5.1914	
MKT		4.9691	
ADV*MKT		1.2466	
NX		0.0021	

The fourth equation of TFPG Block: The estimated RD relation

The estimated RD relation as presented in Table 6.4.4 shows that RD is positively related to TFPG of the current period and NX of the previous period. Increase in current period TFPG and previous period NX increases RD practices of the current period.

Considering MKT of the current period, it can be seen that it has inverted U-relationship with RD. Its initial sole effect is positive and the effect of the square term is negative, meaning that beyond the critical level of MKT, its impact on RD is negative.

There exists a composite effect of ADV and MKT on RD. The marginal effect of this joint interaction term is positive, implying that positive effect of MKT on RD depends on ADV and vice-versa. Considering all these effects, the marginal effects of ADV and MKT on RD are positive.

Considering NX of the current period, it has U-relationship with RD. Its initial sole effect on RD is negative but beyond the critical level, its effect on RD is positive. To get the net impact of NX, the marginal effect of NX on RD has been calculated and this effect comes out to be positive.

Another factor positively influencing RD is Largedum, indirectly affecting TFP. The larger sized firms are practicing higher level of RD than the smaller sized firms.

Table 6.4.5 Factors explaining NX behaviour from a Simultaneous Equation Panel Model: The TFPG Block

Endogenous Variable: NX

Independent Variable	Coefficient	z-value	p>|z|
TFPG	4.690333	3.11	0.002
$(TFPG)^2$	-.0060303	-2.48	0.013
MKT	11.9363	16.69	0.000
RD	6.372078	10.58	0.000
DIVIND	-13.37001	-2.04	0.041
Wald chi2 = 1062.97 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
TFPG		4.6781	
MKT		11.9363	
RD		6.3721	

The fifth equation of TFPG Block: The estimated NX relation

The estimated NX relation as presented in Table 6.4.5 shows that NX of the firms is positively related to MKT and RD. Higher level of MKT and RD boost up NX of the current period.

Considering TFPG of the current period, it can be seen that it has inverted U-relationship with positive marginal effects. It initial sole effect on NX is positive. Beyond the critical level, its effect on NX will be negative. Significant rise in TFPG may increase imports, as a result, NX starts falling when the critical level of TFPG will be reached.

Considering DIVIND, it has negative effect TFPG, meaning that as the market share gets concentrated, NX of the firms rises.

6.4.1.b Food Product Industry

The estimated TFPG of Indian food product firms and also the other endogenous variables explaining the TFPG corresponding to TFPG block can be visualized from Table 6.5.1 to Table 6.5.5.

Table 6.5.1 Factors explaining the total factor productivity growth from a Simultaneous Equation Panel Model: The TFPG Block

Endogenous Variable: TFPG

Independent Variable	Coefficient	z-value	p>|z|
ADV	-.0243586	-2.94	0.003
$(ADV)^2$	.000851	3.07	0.002
ADVlag	.0166142	2.58	0.010
MKT	.0072897	1.37	0.170
RD	.1958008	2.47	0.013
RDlag	.1170961	4.86	0.000
NX	-.0006648	-0.82	0.409
$(NX)^2$	-4.08e-06	-1.39	0.163
NXlag	.0015719	2.18	0.029
Wald chi2 = 122.37 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
ADV		-0.0056	
MKT		0.0073	
RD		0.1958	
NX		-0.6568	

The first equation of TFPG Block: The estimated TFPG relation

The estimated TFP relation as presented in Table 6.5.1 shows that TFPG is positively related to ADV of the previous period, MKT of the current period, RD of the current period as well as previous period and NX of the previous period. Increase in all these factors lead to an increase in TFP.

Considering ADV of the current period, it can be observed that it has U-relationship with TFPG. Initially with the increase in ADV will not lead to a rise in TFPG but beyond the critical level, the positive effect of ADV on TFPG will be realised. As the mean level of ADV is lesser than the critical level of ADV for the sample firms, the positive marginal effect of ADV on TFPG has not been obtained.

Considering NX of the current period, it can be observed that it has non-linear relationship with TFP. Its marginal effect is negative, meaning that imports dominate over exports.

Table 6.5.2 Factors explaining ADV behaviour from a Simultaneous Equation Panel Model: The TFPG Block

Endogenous Variable: ADV

Independent Variable	Coefficient	z-value	p>|z|
TFPG	-.07898	-6.05	0.000
$(TFPG)^2$	3.863723	3.73	0.000
MKT	-.1530595	-0.69	0.488
$(MKT)^2$	.0083523	1.86	0.063
MKTlag	1.50202	4.06	0.000
RD	9.790227	3.68	0.000
NX	-.0497723	-3.40	0.001
$(NX)^2$	.0001183	1.68	0.093
TFPG*RD	-7.07956	-2.86	0.004
$(TFPG*RD)^2$	.3291307	1.46	0.145
DIVIND	-4.29284	-4.30	0.000
Largedum	3.72809	1.95	0.051
Agedum	1.809769	2.29	0.022
Wald chi2 = 400.77 Prob > chi2 = 0.0000			

Determinants	Marginal effects
TFPG	2.7831
MKT	-0.1058
RD	3.3668
TFPG*RD	32.3320
NX	-0.0399

The second equation of TFPG Block: The estimated ADV relation

The estimated ADV relation as presented in Table 6.5.2 shows that ADV is positively related to MKT of the previous period. The increase in MKT in the previous year leads to a rise in ADV in the current year.

Considering TFPG of the current year, it can be observed that it has U-relationship with ADV. Initially increase in TFPG will not result in the rise in ADV but beyond the critical level of TFPG, its positive effect on ADV will be felt. After reaching at the critical level of TFPG, increase in TFPG will lead to a rise in ADV.

The sole effect of RD on ADV is positive. There exists a composite effect of TFPG and RD on ADV. The marginal effect of this joint interaction term is positive. Increase in RD enhances TFPG, as a result ADV gets increased. Considering all these effects, the marginal effects of both RD and TFPG will be positive.

Considering MKT and NX of the current period, it can be seen that both have U-relationship with ADV. Their sole effects are negative and the effects of their square terms are positive. This means that the positive effects of MKT and NX on ADV will be obtained beyond their critical levels. But the negative marginal effects of MKT and NX have been obtained as the mean values of MKT and NX of the sample firms are lesser than their critical levels beyond which their positive effects on ADV will be achieved.

Another factor affecting ADV is DIVIND, indirectly influencing TFPG. It has negative effect on ADV, meaning that as the market share gets concentrated, ADV of the firms rises.

Other factor positively affecting ADV is Largedum, indirectly affecting TFPG. The larger sized firms are doing higher level of ADV than the smaller sized firms.

The last factor affecting ADV is Agedum, indirectly affecting TFPG. It has positive effect on ADV, implying that the younger firms are having higher level of ADV than the older firms.

Table 6.5.3 Factors explaining MKT behaviour from a Simultaneous Equation Panel Model: The TFPG Block

Endogenous Variable: MKT

Independent Variable	Coefficient	z-value	p>|z|
TFPG	-.0088793	-1.44	0.151
ADV	-.2232196	-2.41	0.016
$(ADV)^2$	.0067329	1.59	0.113
RD	2.334803	2.61	0.009
$(RD)^2$	-.1542366	-1.25	0.211
RDlag	1.427317	1.56	0.118
$(RDlag)^2$	-.1507718	-1.17	0.242
NX	-.0532533	-2.47	0.013
$(NX)^2$	.0002888	7.34	0.000
RD*ADV	.0364328	1.34	0.179
NX*RD	.0223129	6.21	0.000
TFPG*NX	.0160999	0.88	0.379
DIVIND	-1.123727	-1.93	0.054
Wald chi2 = 1086.20 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
TFPG		0.6488	
ADV		-0.0756	
RD		3.0576	
RDlag		1.2440	
NX		0.0029	

The third equation of TFPG Block: The estimated MKT relation

The MKT relation as presented in Table 6.5.3 shows that it can be observed that the sole effect of TFPG on MKT is negative. There exists a joint interaction term of TFPG and NX which has positive effect on MKT. Considering these two effects, the marginal effect of TFPG is positive.

Considering ADV of the current year, it can be seen that ADV has U-relationship with MKT. Initially, an increase in ADV will not result in the increase in MKT but beyond the critical level its positive effect on MKT can be obtained.

There exists a composite effect of RD and ADV. It has a positive effect on MKT. All these effects taken into account, the marginal effect of ADV is negative as the mean ADV is lesser than critical level of ADV for the sample firms.

Considering RD of the current year as well as the previous year, both have inverted U-relationship with MKT. Initially the increase in these factors increase MKT but beyond their critical levels their effects on MKT will be negative.

There exists another composite effect of NX and RD. It has a positive effect on MKT. Through imports of capital goods, RD will be increased and that will result in increase in MKT. All these effects taken under consideration, the marginal effects of RD of both current year and previous year will be positive.

Considering NX of the current year, it can be seen that it has U-relationship with MKT. Its positive effect on MKT can be realised beyond its critical level. After considering the sole effect, effect of the square term and the effects of the joint interaction terms, the marginal effect of NX comes out to be positive.

Another factor affecting MKT is DIVIND, indirectly affecting TFPG. As the market share gets concentrated, MKT of the firms increases.

Table 6.5.4 Factors explaining RD behaviour from a Simultaneous Equation Panel Model: The TFPG Block

Endogenous Variable: RD

Independent Variable	Coefficient	z-value	p>|z|
TFPG	-.0106345	-6.34	0.000
$(TFPG)^2$	.4398229	4.16	0.000
ADV	-.0919467	-4.60	0.000
$(ADV)^2$	.0031036	4.01	0.000
MKT	.0673908	2.53	0.011
$(MKT)^2$	.0011904	2.52	0.012
MKTlag	.1236562	2.88	0.004
ADV*MKT	-.0048679	-2.24	0.025
$(ADV*MKT)^2$	6.90e-07	1.66	0.097
NX	-.0049164	-6.32	0.000
DIVIND	-.3393286	-2.66	0.008
Largedum	1.041486	4.56	0.000
Wald chi2 = 507.47 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
TFPG		0.8436	
ADV		1.8909	
MKT		3.1242	
NX		-0.0049	
ADV*MKT		0.5711	

The fourth equation of TFPG Block: The estimated RD relation

The estimated RD relation as presented in Table 6.5.4 shows that RD is positively related to MKT of the previous period, meaning that the increase in MKT in the previous period increases the RD of the current period. RD is negatively related to NX of the current year, implying that the imports dominate over exports.

Considering TFPG of the current period, it can be observed that it has U-relationship with RD. Initially increase in TFPG will not result in increase in RD but beyond its critical level the positive effect of TFPG on RD will be obtained. The marginal effect of TFPG is positive when all these effects will be considered.

Considering ADV of the current period, it can be observed that it has U-relationship with RD. Initially with the rise in ADV will reduce RD but beyond the critical level of ADV, its positive effect on RD can be felt.

Considering MKT of the current period, it can be seen that it has non-linear positive relationship with RD. Increase in MKT increases RD.

There exists a composite effect of ADV and MKT. Its marginal effect on RD is positive. Considering all these effects, the marginal effects of both ADV and MKT are positive.

Another factor affecting RD is DIVIND, indirectly affecting TFPG. It has negative impact, meaning that the market share gets concentrated, the RD of the firms increase.

Other factor positively affecting RD is Largedum, meaning that the larger sized firms are doing higher level of RD than the smaller sized firms.

Table 6.5.5 Factors explaining NX behaviour from a Simultaneous Equation Panel Model: The TFPG Block

Endogenous Variable: NX

Independent Variable	Coefficient	z-value	p>|z|
TFPG	-.0940725	-1.60	0.110
ADV	.8422395	0.73	0.465
$(ADV)^2$	-.038967	-2.30	0.021
ADVlag	2.860464	2.05	0.041
$(ADVlag)^2$	-.0757614	-2.07	0.038
MKT	-3.066836	-1.90	0.058
$(MKT)^2$	.0860941	4.44	0.000
MKTlag	2.959909	1.68	0.092
TFPG*MKT	2.774316	2.13	0.033
DIVIND	-7.717285	-1.57	0.116
REER	-.6834311	-1.86	0.063
Wald chi2 = 191.59 Prob > chi2 = 0.0000			

Determinants	Marginal effects
TFPG	14.3924
ADV	0.2224
ADVlag	1.9192
MKT	0.4621

The fifth equation of TFPG Block: The estimated NX relation

The estimated NX relation as presented in Table 6.5.5 shows that NX is positively related to MKT of the previous period. Increase in MKT of the previous period increases the NX of the current period.

Considering TFPG of the current period, it can be seen that its sole effect is negative. There exists a composite effect of TFPG and MKT on NX. This effect is positive. All these effects taken into account, the marginal effect of TFPG is positive.

Considering ADV of the current period as well as of previous period, it can be observed that both have inverted U-relationship with NX. Initially increase in ADV of the current period and previous period increases NX but beyond their critical levels their negative effects on NX will be felt. Their marginal effects on NX are positive.

Considering MKT of the current period, it can be observed that it has U-relationship with NX. Initially with increase in MKT does not increase NX but its critical level, the positive effect of MKT on NX can be realised. After considering the sole effect, the effect of the square term and the effect of the joint interaction term of TFP & MKT, the marginal effect of MKT comes out to be positive.

Another factor affecting NX is DIVIND, indirectly affecting TFPG. It has negative effect on NX. As the market share gets concentrated, NX of the firms gets increased.

Last factor affecting NX is REER, indirectly affecting TFPG. It has negative effect on NX.

6.4.1.c Leather Industry

The estimated TFPG of Indian leather firms and also the other endogenous variables explaining the TFPG corresponding to TFPG block can be visualized from Table 6.6.1 to Table 6.6.5.

Table 6.6.1 Factors explaining the total factor productivity growth from a Simultaneous Equation Panel Model: The TFPG Block

Endogenous Variable: TFPG

Independent Variable	Coefficient	z-value	p>|z|
ADV	-.0173345	-1.67	0.094
$(ADV)^2$	.0002231	1.22	0.221
ADVlag	.0166115	1.44	0.151
MKT	.0020642	4.05	0.000
RD	.0044778	0.13	0.895
NX	-.0002539	-5.90	0.000
NXlag	.0001448	2.93	0.003
DIVIND	.0646792	1.32	0.187
Wald chi2 = 68.37 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
ADV		-0.0067	
MKT		0.0021	
RD		0.0045	
NX		-0.0003	

The first equation of TFPG block: The estimated TFPG relation

The estimated TFPG relation as presented as Table 6.6.1 shows that TFPG is positively related to ADV of the previous period, MKT and RD of the current period and NX of the previous period. Increase in these factors increase the TFPG. TFPG is negatively related to NX of the current period, implying that the imports dominate over the exports.

Considering ADV of the current period, ADV has U-relationship with TFPG. Initially with the increase in ADV will not initiate increase in TFPG but the beyond the critical level of ADV, its positive effect on TFPG can be realised. The marginal effect of ADV is negative as the mean ADV is lesser than critical level of ADV.

Another factor positively affecting TFPG is DIVIND. As the market share gets diversified, TFPG of the firms increases.

Table 6.6.2 Factors explaining ADV behaviour from a Simultaneous Equation Panel Model: The TFPG Block

Endogenous Variable: ADV

Independent Variable	Coefficient	z-value	p>|z|
TFPG	-.2314788	-6.17	0.000
$(TFPG)^2$	.0002584	5.16	0.000
TFP*RD	.0384009	2.05	0.040
NX*RD	.0054572	3.84	0.000
NXlag	.0024628	2.41	0.016
MKT	.105544	8.66	0.000
Agedum	-10.728	-5.79	0.000
Wald chi2 = 116.89 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
TFPG		-0.1874	
MKT		0.1055	
RD		0.0648	
NX		0.0105	

The second equation of TFPG Block: The estimated ADV relation

The estimated ADV relation as presented in Table 6.6.2 shows that ADV is positively related to MKT of the current period and NX of the previous period. Increase in MKT of the current period and NX of the previous period increase the ADV of the current period.

Considering TFPG of the current period, it can be seen that TFPG has U-relationship with ADV. The sole effect of TFPG is negative and the effect of the square term is positive. This means that the positive effect of TFPG on ADV can be obtained beyond the critical level of TFPG.

There exists a joint interaction term of TFPG and RD. It has positive effect on ADV. Through RD, TFPG will be enhanced. As a result, ADV will be increased. All these effects taken into consideration, the marginal effect of TFPG is negative as the mean level of TFPG is lesser than critical level of TFPG.

There exists another composite effect of NX and RD on ADV. This effect is also positive. Through RD, the product quality will be enhanced. As a result, NX of the firms gets increased. The firms will be able to start spending more on ADV. Considering these effects, the marginal effects of both RD and ADV are positive.

Another factor affecting ADV is Agedum, indirectly affecting TFPG. The effect of Agedum is negative, meaning that the older firms are having higher level of ADV than the younger firms.

Table 6.6.3 Factors explaining MKT behaviour from a Simultaneous Equation Panel Model: The TFPG Block

Endogenous Variable: MKT

Independent Variable	Coefficient	z-value	p>|z|
TFPG	-.3347713	-5.65	0.000
TFPG*ADV	.0925545	9.13	0.000
NX	.1122469	11.33	0.000
$(NX)^2$	1.95e-06	1.96	0.049
NX*RD	-.060498	-6.98	0.000
$(NX*RD)^2$	7.80e-06	8.12	0.000
Wald chi2 = 1627.04 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
TFPG		0.4233	
ADV		0.0909	
RD		0.0934	
NX		0.3533	
NX*RD		0.0003	

The third equation of TFPG Block: The estimated MKT relation

The estimated MKT relation as presented in Table 6.6.3 shows that the sole effect of TFPG is negative. There exists a joint interaction term of TFPG and ADV. It has positive effect on MKT. Through ADV, TFPG will be enhanced, as a result MKT will be increased. Considering these effects, the marginal effects of TFPG and ADV are positive.

Considering NX of the current period, it can be seen that NX has non-linear relationship with MKT. Both the sole effect and the effect of the square term are positive.

There exists a composite effect of NX and RD. The marginal effect of this joint interaction term is positive. Through RD, the product quality will be enhanced. As a result, NX will be increased and the firms will start spending more on MKT.

Table 6.6.4 Factors explaining RD behaviour from a Simultaneous Equation Panel Model: The TFPG Block

Endogenous Variable: RD

<table>
<tr><td>Independent Variable</td><td>Coefficient</td><td>z-value</td><td>p>|z|</td></tr>
<tr><td>TFPG</td><td>.0047815</td><td>1.14</td><td>0.253</td></tr>
<tr><td>ADV</td><td>-.0320381</td><td>-0.70</td><td>0.487</td></tr>
<tr><td>$(ADV)^2$</td><td>.001013</td><td>1.26</td><td>0.207</td></tr>
<tr><td>MKT</td><td>-.0084111</td><td>-1.69</td><td>0.091</td></tr>
<tr><td>$(MKT)^2$</td><td>.0000101</td><td>1.70</td><td>0.089</td></tr>
<tr><td>NX</td><td>.0007833</td><td>1.72</td><td>0.086</td></tr>
<tr><td>$(NX)^2$</td><td>-1.19e-07</td><td>-1.84</td><td>0.066</td></tr>
<tr><td>TFPG*NX</td><td>-3.96e-06</td><td>-1.70</td><td>0.090</td></tr>
<tr><td>$(TFPG*NX)^2$</td><td>3.60e-12</td><td>1.39</td><td>0.164</td></tr>
<tr><td colspan="4">Wald chi2 = 115.28
Prob > chi2 = 0.0000</td></tr>
<tr><td colspan="2">Determinants</td><td colspan="2">Marginal effects</td></tr>
<tr><td colspan="2">TFPG</td><td colspan="2">0.0124</td></tr>
<tr><td colspan="2">ADV</td><td colspan="2">-0.0133</td></tr>
<tr><td colspan="2">MKT</td><td colspan="2">-0.0073</td></tr>
<tr><td colspan="2">NX</td><td colspan="2">0.0300</td></tr>
<tr><td colspan="2">TFPG*NX</td><td colspan="2">0.0253</td></tr>
</table>

The fourth equation of TFPG Block: The estimated RD relation

The estimated RD relation as presented in Table 6.6.4 shows that the sole effect of TFPG is positive. There exists a composite effect of TFPG and NX. This effect is positive. Increase in NX increases TFPG, as a result RD gets increased. Considering these effects, the marginal effect of TFPG is positive.

Considering ADV and MKT of the current period, it can be observed that both have U-relationship with RD. Their sole effects are negative but the effects of the square terms are positive. The positive effect of ADV and MKT on RD can be felt beyond their critical levels. Considering these effects, the marginal effects of ADV and MKT on RD are negative as the mean levels of ADV and MKT are lesser than the critical levels of ADV and MKT.

Considering NX of the current period, it can be observed that NX has inverted U-relationship with RD. Initially with the increase in NX, RD increases but beyond the critical level of NX, its negative effect on RD will be realised. All these effects taken into consideration, the marginal effect of NX on RD is positive, implying that exports dominate over imports.

Table 6.6.5 Factors explaining NX behaviour from a Simultaneous Equation Panel Model: The TFPG Block

Endogenous Variable: NX

Independent Variable	Coefficient	z-value	p>|z|
TFPG	-4.005333	-2.64	0.008
$(TFPG)^2$	.0050923	2.21	0.027
MKT	2.933077	3.24	0.001
$(MKT)^2$	.0034521	4.41	0.000
MKTlag	.8631291	1.83	0.067
Wald chi2 = 664.48 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
TFPG		-3.9848	
MKT		3.1397	

The fifth equation of TFPG Block: The estimated NX relation

The estimated NX relation as presented in Table 6.6.5 shows that NX is positively related to MKT of the previous period. Increase in MKT in the previous period increases NX in the current period.

Considering TFPG of the current period, it can be seen that TFPG has U-relationship with NX. The sole effect of TFPG is negative but the effect of the square term is positive. The positive effect of TFPG on NX will be felt beyond the critical level of TFPG. Considering these effects, the marginal effect of TFPG is negative as mean level of TFPG is lesser than the critical level of TFPG.

Considering MKT of the current period, it can be seen that non-linear positive relationship with NX. The sole effect and the effect of the square term are positive. When these effects are taken under consideration, the marginal effect of MKT on NX comes out to be positive.

6.4.1.d Machinery Industry

The estimated TFPG of Indian machinery firms and also the other endogenous variables explaining the TFPG corresponding to TFPG block can be visualized from Table 6.7.1 to Table 6.7.5.

Table 6.7.1 Factors explaining the total factor productivity growth from a Simultaneous Equation Panel Model: The TFPG Block

Endogenous Variable: TFPG

Independent Variable	Coefficient	z-value	p>|z|
ADV*MKT	7.45e-06	5.40	0.000
ADVlag	.004381	4.47	0.000
MKTlag	.0034989	5.27	0.000
RD	-.0017876	-2.79	0.005
$(RD)^2$	7.73e-07	3.66	0.000
RDlag	.0006089	2.69	0.007
NX	-.0000101	-1.35	0.176
$(NX)^2$	2.57e-11	0.92	0.359
NXlag	.0000268	5.91	0.000
Largedum	.0399298	1.28	0.201
Wald chi2 = 352.88 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
ADV		0.3030	
MKT		0.1605	
RD		0.1979	
NX		0.0005	

The first equation of TFPG Block: The estimated TFPG relation

The estimated TFPG relation as presented in Table 6.7.1 shows that TFPG is positively related to ADV of the previous period, MKT of the previous period, RD of the previous period and NX of the previous period. The increase in ADV, MKT, RD and NX of previous period will lead to a rise in TFPG of the current period.

Considering RD and NX of the current period, it can be seen that both have U-relationship with TFPG. Their sole effects are negative and the effects of the square terms are positive. This means that their positive effects are realised beyond their critical levels. Considering all these effects, the marginal effects of RD and NX come out to be positive.

There exists a joint interaction term of ADV and MKT. This joint interaction term has a positive effect on TFPG. The joint spending on ADV and MKT increases TFPG. The marginal effects of both ADV and MKT are positive.

Another factor positive influencing TFPG is Largedum. This means that the larger sized firms are having higher level of TFPG than the smaller sized firms.

Table 6.7.2 Factors explaining ADV behaviour from a Simultaneous Equation Panel Model: The TFPG Block

Endogenous Variable: ADV

Independent Variable	Coefficient	z-value	p>|z|
TFPG	-1.986805	-2.08	0.038
RD	.1887954	5.43	0.000
$(RD)^2$	-.0003135	-13.68	0.000
MKT	.2754451	6.84	0.000
$(MKT)^2$	-.0002313	-3.19	0.001
RD*MKT	.00128	12.74	0.000
NX	.0079582	35.55	0.000
$(NX)^2$	5.60e-08	20.84	0.000
TFPG*MKT	-.0287027	-0.78	0.437
$(TFPG*MKT)^2$	.0000231	1.78	0.076
TFPG*RD	.2671448	7.23	0.000
DIVIND	-.1194186	-1.49	0.136
Largedum	3.496578	2.09	0.036
Wald chi2 = 9188.19 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
TFPG		1.9357	
MKT		0.2880	
RD		0.5109	
NX		0.0312	
TFPG*MKT		0.0458	

The second equation of TFPG Block: The estimated ADV relation

The estimated ADV relation as presented in Table 6.7.2 shows that the sole effect of TFPG on ADV is positive. There exists a joint interaction term of TFPG and RD. It is also having positive effect on ADV. Increase in RD increases TFPG, as a result ADV will be increased.

There exists another joint interaction term of TFPG and MKT. The marginal effect of this joint interaction term is positive. The increase in MKT increases TFPG; as a result ADV will be increased. All these effects taken into consideration, the marginal effect of TFPG is positive.

Considering RD and MKT of current period, it can be seen that both have inverted U-relationship with TFPG. Initially the increase in RD and MKT will lead to the rise in ADV. But beyond their critical levels, their negative effect on ADV will be felt.

There exists a joint interaction term of RD and MKT. It has positive effect on ADV. Considering all these effects, the marginal effects of RD and MKT come out to be positive.

Considering NX of the current period, it can be seen that NX has non-linear positive relationship with ADV. The marginal effect of NX is positive.

Another factor affecting ADV is DIVIND, indirectly affecting TFPG. It has negative effect on ADV, meaning that as the market share gets concentrated, ADV of the firms rises.

Another factor positively affecting ADV is Largedum, meaning that the larger sized firms have higher level of ADV than the smaller sized firms.

Table 6.7.3 Factors explaining MKT behaviour from a Simultaneous Equation Panel Model: The TFPG Block

Endogenous Variable: MKT

Independent Variable	Coefficient	z-value	p>|z|
TFPG	5.019993	3.91	0.000
RD	.0672858	2.02	0.043
$(RD)^2$	.0000523	5.66	0.000
RDlag	.464922	16.75	0.000
ADV	.5739973	8.96	0.000
ADVlag	.4320969	14.13	0.000
RD*ADV	.0002468	7.86	0.000
NX	-.0033561	-9.39	0.000
$(NX)^2$	1.27e-08	5.66	0.000
TFPG*ADV	.1137741	2.10	0.036
TFPG*NXlag	.0004909	1.57	0.117
$(TFPG*NXlag)^2$	6.11e-10	3.14	0.002
Wald chi2 = 25949.45 Prob > chi2 = 0.0000			

Determinants	Marginal effects
TFPG	5.9863
ADV	0.7139
RD	0.1046
NX	0.0018
NXlag	0.0037
TFPG*NXlag	66.132

The third equation of TFPG Block: The estimated MKT relation

The estimated MKT relation as presented in Table 6.7.3 shows that MKT is positively related to RD of the previous period and ADV of the previous period. Increase in RD and ADV in the previous period increases TFPG of the current period.

Considering TFPG of the current period, it can be seen that the sole effect of TFPG is positive. There exists a joint interaction term of TFPG and ADV. It has positive effect on MKT. Increase in ADV increases TFPG, as a result MKT will be increased.

There exists another joint interaction term of TFPG and NX of the previous period. It has positive effect on MKT. Increase in NX of previous period increases the TFPG in the current period, as a result MKT of the current period increases. All these effects taken into consideration, the marginal effects of TFPG of the current period and NX of the previous period are positive.

Considering RD of the current period, it can be seen that RD has non-linear positive relationship with MKT. The sole effect of ADV of the current period is positive. There exists a joint interaction term of RD and ADV which has positive effect on MKT. Considering all these effects, the marginal effects of RD and ADV come out to be positive.

Considering NX of the current period, it has U-relationship with MKT. The positive effect of NX on MKT can be achieved beyond the critical level of NX. The marginal effect of NX is positive.

Table 6.7.4 Factors explaining RD behaviour from a Simultaneous Equation Panel Model: The TFPG Block

Endogenous Variable: RD

Independent Variable	Coefficient	z-value	p>|z|
MKT	1.243891	33.51	0.000
$(MKT)^2$	.000195	13.42	0.000
NX	.0092124	23.14	0.000
TFPG*NX	.0004255	2.02	0.044
Agedum	6.369883	2.08	0.038
Largedum	6.292889	1.48	0.140
Wald chi2 = 9713.15 Prob > chi2 = 0.0000			

Determinants	Marginal effects
TFPG	0.0023
MKT	1.2466
NX	0.0104

The fourth equation of TFPG Block: The estimated RD relation

The estimated RD relation as presented in Table 6.7.4 shows that MKT has non-linear positive relationship with MKT. The marginal effect of MKT on RD is positive.

Considering NX of the current period, it can be seen that the sole effect of NX is positive. There exists a joint interaction term of TFPG and NX. It has a positive effect on RD. Increase in NX of the current period increases TFPG, as a result RD increases.

Another factor positively influencing RD is Agedum, indirectly affecting TFPG. This means that the younger firms have higher level of RD than the older firms.

Other factor affecting RD is Largedum, implying that the larger sized firms have higher level of RD than the smaller sized firms.

Table 6.7.5 Factors explaining NX behaviour from a Simultaneous Equation Panel Model: The TFPG Block

Endogenous Variable: NX

Independent Variable	Coefficient	z-value	p>|z|
TFPG	.0354206	2.71	0.007
ADV	.2154429	4.50	0.000
$(ADV)^2$	.0009765	22.36	0.000
ADVlag	.4757745	22.18	0.000
MKTlag	.1070083	3.87	0.000
RD	.5775345	34.09	0.000
RDlag	.3072038	19.01	0.000
TFPG*RD	-.0066282	-18.17	0.000
$(TFPG*RD)^2$	3.10e-09	5.13	0.000
REER	-.1580403	-1.25	0.213
Wald chi2 = 14219.78 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
TFPG		0.1092	
ADV		0.2374	
RD		0.6050	
TFPG*RD		1.0521	

The fifth equation of TFPG Block: The estimated NX relation

The estimated NX relation as presented in Table 6.7.5 shows that NX is positively related to ADV of the previous period, MKT of the previous period and RD of the previous period. NX is negatively related to REER, indirectly affecting TFPG.

Considering TFPG and RD of the current period, it can be seen that their sole effects on NX is positive. There exists a joint interaction term of TFPG and RD. It also has positive effect on NX. Through RD, TFPG increases, as a result the NX of the current period will be increased.

Considering ADV of the current period, it can be seen that ADV has non-linear positive relationship with NX. Increase in ADV in the current period increases the NX of the current period. The marginal effect of ADV on TFPG is positive.

6.4.1.e Metal Industry

The estimated TFPG of Indian metal firms and also the other endogenous variables explaining the TFPG corresponding to TFPG block can be visualized from Table 6.8.1 to Table 6.8.5.

Table 6.8.1 Factors explaining the total factor productivity growth from a Simultaneous Equation Panel Model: The TFPG Block

Endogenous Variable: TFPG

Independent Variable	Coefficient	z-value	p>|z|
ADV	-.0076674	-3.62	0.000
$(ADV)^2$	.0000139	4.22	0.000
MKT	-.0016757	-2.42	0.016
$(MKT)^2$	4.76e-08	1.88	0.060
MKTlag	.0041755	6.96	0.000
RD	-.0149537	-3.63	0.000
$(RD)^2$	.0000189	6.19	0.000
RDlag	.0037861	3.78	0.000
NX	.019302	2.39	0.017
DIVIND	.3453629	2.33	0.020
Smalldum	.4281591	1.35	0.176
Agedum	-.4712616	-2.46	0.014
Wald chi2 = 78.33 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
ADV		-0.0069	
MKT		0.0147	
RD		-0.0099	
NX		0.0193	

The first equation of TFPG Block: The estimated TFPG relation

The estimated TFPG relation as presented in Table 6.8.1 shows that TFPG is positively related to MKT of the previous period, RD of the previous period and NX of the current period. Increase in these factors increases TFPG of the current period.

Considering ADV, MKT and RD of the current period, it can be seen that all have U-relationship with TFPG. Their sole effects are negative and the effects of the square terms are positive. This means that the positive effects of ADV, MKT and RD on TFPG will be realised beyond their critical levels. The marginal effect of MKT is positive. But the marginal effects of ADV and RD are negative as the mean levels of ADV and RD are lesser than their critical levels.

Another factor positively affecting TFPG is DIVIND. The market share gets diversified, TFPG of the firms increases.

Another factor positively affecting TFPG is Smalldum, meaning that the smaller firms are having higher level of TFPG than the larger sized firms.

Another factor affecting TFPG is Agedum. It has negative effect of TFPG, meaning that older firms are having higher level of TFPG than the younger firms.

Table 6.8.2 Factors explaining ADV behaviour from a Simultaneous Equation Panel Model: The TFPG Block

Endogenous Variable: ADV

Independent Variable	Coefficient	z-value	p>|z|
TFPG	.2739716	1.33	0.184
$(TFPG)^2$	-.0002483	-1.65	0.098
MKT	.2266305	6.59	0.000
$(MKT)^2$	-4.23e-06	-3.29	0.001
MKTlag	.2703652	8.43	0.000
$(MKTlag)^2$	-8.43e-06	-7.91	0.000
TFPG*MKT	-.0011197	-2.68	0.007
$(TFPG*MKT)^2$	1.18e-10	1.69	0.092
NX	2.119122	2.57	0.010
NXlag	1.832079	1.47	0.142
Wald chi2 = 771.11 Prob > chi2 = 0.0000			

Determinants	Marginal effects
TFPG	0.2996
MKT	0.1270
MKTlag	0.1267
NX	2.1191
TFPG*MKT	0.0566

The second equation of TFPG Block: The estimated ADV relation

The estimated ADV relation as presented in Table 6.8.2 shows that ADV is positively related to NX of both current period and previous period.

Considering TFPG of the current period and MKT of the current period as well as previous period, it can be seen that all have inverted U-relationship with ADV. Initially the increase in these factors increases ADV but their negative effects on ADV will be felt beyond their critical levels.

There exists a joint interaction term of TFPG and MKT. The marginal effect of this joint interaction is positive. The effect of TFPG on ADV depends on MKT and vice-versa. All these effects taken into account, the marginal effects of TFPG of the current period, MKT of the current period and the previous period come out to be positive.

Table 6.8.3 Factors explaining MKT behaviour from a Simultaneous Equation Panel Model: The TFPG Block

Endogenous Variable: MKT

Independent Variable	Coefficient	z-value	p>|z|
TFPG	-4.094236	-3.06	0.002
$(TFPG)^2$	.0027496	2.72	0.007
TFPG*RD	.1003976	12.62	0.000
RDlag	1.512752	1.42	0.157
ADV	-13.06977	-4.60	0.000
$(ADV)^2$	.0105972	8.18	0.000
NX	3.962738	0.95	0.341
$(NX)^2$	.048283	10.07	0.000
Wald chi2 = 4200.92 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
TFPG		-4.0383	
RD		0.1120	
ADV		-12.9822	
NX		2.2488	

The third equation of TFPG Block: The estimated MKT relation

The estimated MKT relation as presented in Table 6.8.3 shows that MKT is positively related to RD of the previous period.

Considering RD of the current period, it can be seen that TFPG has U-relationship with MKT. Its sole effect is negative but the effect of the square term is positive. The positive effect of TFPG on MKT will be obtained beyond the critical level of TFPG.

There exists a joint interaction term of TFPG and RD. It has positive effect on MKT. Considering all these effects, the marginal effect of TFPG is negative as the mean level of TFPG is lesser than the critical level of TFP but the marginal effect of RD is positive.

Considering ADV of the current period, it can be seen that ADV has U-relationship with MKT. The positive effect of ADV on MKT can be obtained beyond the critical level of ADV. The marginal effect of ADV is negative as the mean level of MKT is lesser than critical level of MKT.

Considering NX of the current period, it can be seen that NX has positive non-linear effect on ADV. The marginal effect of NX on ADV is positive.

Table 6.8.4 Factors explaining RD behaviour from a Simultaneous Equation Panel Model: The TFPG Block

Endogenous Variable: RD

Independent Variable	Coefficient	z-value	p>|z|
TFPG	.170714	1.89	0.058
$(TFPG)^2$	-.0001274	-1.87	0.062
ADV	.9713755	12.12	0.000
$(ADV)^2$	-.0001747	-5.60	0.000
MKTlag	.0065853	1.40	0.161
TFPG*NX	.006872	2.80	0.005
Wald chi2 = 16922.73 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
TFPG		0.0738	
ADV		0.9691	
NX		0.0078	

The fourth equation of TFPG Block: The estimated RD relation

The estimated RD relation as presented in Table 6.8.4 shows that RD is positively related to MKT of the previous period.

Considering TFPG and ADV of the current period, it can be seen that both have inverted U-relationship with RD. Initially the increase in TFPG and ADV increases RD but beyond their critical levels, their negative effect on RD can be felt.

There exists a joint interaction term of TFPG and NX. It has positive effect on RD. The effect of TFPG on RD depends on NX and vice-versa.

Considering all these effects, the marginal effects of TFPG, ADV and NX in the current period come out to be positive.

Table 6.8.5 Factors explaining NX behaviour from a Simultaneous Equation Panel Model: The TFPG Block

Endogenous Variable: NX

Independent Variable	Coefficient	z-value	p>|z|
TFPG	.0453275	1.34	0.179
$(TFPG)^2$	-.0000382	-1.51	0.131
ADV	.1125754	2.06	0.039
$(ADV)^2$	.0001059	4.34	0.000
MKT	-.0332127	-10.59	0.000
$(MKT)^2$	8.75e-07	6.84	0.000
RDlag	.0245485	3.62	0.000
Wald chi2 = 17923.34 Prob > chi2 = 0.0000			

Determinants	Marginal effects
TFPG	0.0499
ADV	0.1009
MKT	0.0484

The fifth equation of TFPG Block: The estimated NX relation

The estimated NX relation as presented in Table 6.8.5 shows that NX is positively related to RD of the previous period.

Considering TFPG of the current period, it can be seen that TFPG has inverted U-relationship with NX. Initially increase in TFPG increases NX. But beyond the critical level of TFPG, its negative effect on NX will be felt. The marginal effect of TFPG is positive.

Considering ADV of the current period, it can be seen that ADV has positive non-linear relationship with NX. The marginal effect of ADV on NX is positive, meaning that increase in ADV increases NX.

Considering MKT of the current period, it can be seen that MKT has U-relationship with ADV. The positive effect of MKT on NX can be obtained beyond its critical level. The marginal effect of MKT on NX is positive.

6.4.1. f Non-metallic mineral products Industry

The estimated TFPG of Indian non-metallic mineral products firms and also the other endogenous variables explaining the TFPG corresponding to TFPG block can be visualized from Table 6.9.1 to Table 6.9.5.

Table 6.9.1 Factors explaining the total factor productivity growth from a Simultaneous Equation Panel Model: The TFPG Block

Endogenous Variable: TFPG

Independent Variable	Coefficient	z-value	p>|z|
ADV*MKT	.0008477	2.55	0.011
$(ADV*MKT)^2$	3.28e-11	4.74	0.000
MKT	.3199409	3.05	0.002
$(MKT)^2$	-.000209	-4.02	0.000
MKTlag	.2780071	6.29	0.000
RD	-1.511735	-2.16	0.031
$(RD)^2$	.0013154	2.68	0.007
RDlag	.751878	1.62	0.105
NX	-.1569394	-4.63	0.000
$(NX)^2$	1.47e-06	0.33	0.740
NXlag	.173874	11.78	0.000
NX*RD	.000069	1.07	0.285
Wald chi2 = 1873.18 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
ADV		0.0016	
MKT		0.3199	
RD		-1.5089	
NX		-0.1433	
ADV*MKT		0.0022	

The first equation of TFPG Block: The estimated TFPG relation

The estimated TFPG relation as presented in Table 6.9.1 shows that TFPG is positively related to MKT of the previous period, RD of the previous period and NX of previous period. The increase in MKT, RD and NX in the previous period increases the TFPG of the current period.

Considering MKT of the current period, it can be seen that MKT has inverted U-relationship with TFPG. The sole effect of MKT is positive and the effect of the square term is negative. Initially the increase in MKT leads to the increase in TFPG but beyond the critical level of MKT, the increase in MKT will be too much costly for the firms; as a result, TFPG of the firms falls.

There exists a joint interaction term of ADV and MKT. The marginal effect of this joint interaction term is positive. The joint increase in ADV and MKT increases TFPG of the firms. Considering all these effects, the positive marginal effects of both ADV and MKT can be achieved.

Considering RD and NX of the current period, it can be seen that both have U-relationship with TFP. Their sole effects are negative and the effects of the square terms are positive. This means that the positive effect of RD as well as NX on TFPG can be obtained beyond their critical levels.

There exists a composite effect of NX and RD. This joint interaction term has positive effect on TFPG. Considering all these effects, the marginal effects of both RD and NX come out to be negative as the mean levels of RD and NX are lesser than their critical levels beyond which their positive effects can be obtained.

Table 6.9.2 Factors explaining ADV behaviour from a Simultaneous Equation Panel Model: The TFP Block

Endogenous Variable: ADV

Independent Variable	Coefficient	z-value	p>|z|
TFPG	.0478223	1.72	0.085
$(TFPG)^2$	-.0000245	-3.82	0.000
MKT	-.1147767	-9.30	0.000
$(MKT)^2$	.0000199	19.68	0.000
MKTlag	.0441082	9.47	0.000
RD	1.14319	12.79	0.000
$(RD)^2$	-.0006351	-7.87	0.000
NX	-.0680178	-11.81	0.000
$(NX)^2$	2.72e-06	5.35	0.000
NXlag	-.0068672	-1.28	0.201
$(NXlag)^2$	4.17e-06	7.39	0.000
NX*RD	.0000576	5.49	0.000
TFPG*NX	.0002422	5.08	0.000
Wald chi2 = 9606.11 Prob > chi2 = 0.0000			

Determinants	Marginal effects
TFPG	0.0501
MKT	-0.1099
RD	1.1394
NX	-0.0474
NXlag	0.0198

The second equation of TFPG Block: The estimated ADV relation

The estimated ADV relation as presented in Table 6.9.2 shows that ADV is positively related to MKT of the previous period. The increase MKT in the previous period increases the ADV of the current period.

Considering TFPG and RD of the current period, it can be seen that they have inverted U-relationship with ADV. Their sole effects are positive but the effects of the square terms are negative. Initially increase in TFPG and RD will increase ADV but beyond their critical levels, their negative effect on ADV will be felt.

There exists a joint interaction term of TFPG and NX which has positive effect on ADV. There exists composite effects of NX and RD which is also having positive effect on ADV. Considering all these effects, the positive marginal effects of TFPG and RD on ADV can be obtained.

Considering MKT of the current period, it can be seen that MKT has U-relationship with ADV. The positive effect of MKT on ADV will be realised beyond the critical level of MKT. Taken into account these effects, the negative marginal effect of MKT can be obtained as the mean level of MKT is lesser than the critical level of MKT.

Considering NX of the current period as well as the previous period, it can be seen that both have U-relationship with ADV. Their positive effects on ADV can be obtained beyond their critical levels. Considering these effects together, the marginal effect of NX of the previous period come out to be positive but the marginal effect of NX of the current period is negative as the imports dominate over the exports in the current period.

Table 6.9.3 Factors explaining MKT behaviour from a Simultaneous Equation Panel Model: The TFPG Block

Endogenous Variable: MKT

Independent Variable	Coefficient	z-value	p>|z|
TFPG	-.1857748	-1.18	0.239
$(TFPG)^2$	.0001351	4.41	0.000
ADV	5.350901	5.90	0.000
$(ADV)^2$	.0018087	3.19	0.001
ADVlag	7.248453	7.21	0.000
RD	2.613573	2.58	0.010
$(RD)^2$	-.0011639	-2.20	0.028
NX	.1202116	3.82	0.000
$(NX)^2$	-.0000812	-10.45	0.000
NXlag	.0460804	1.53	0.127
$(NXlag)^2$	-.0000426	-14.13	0.000
NX*RD	-.0005312	-9.01	0.000
$(NX*RD)^2$	9.66e-11	13.17	0.000
TFPG*RD	.0093668	1.45	0.147
$(TFPG*RD)^2$	-8.57e-08	-2.48	0.013
Wald chi2 = 3382.72 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
TFPG		-0.0965	
ADV		5.3518	
RD		2.6168	
NX		0.1197	
NXlag		0.0499	
NX*RD		0.0052	
TFPG*RD		0.0070	

The third equation of TFPG Block: The estimated MKT relation

The estimated MKT relation as presented in Table 6.9.3 shows that MKT is positively related to ADV of the previous period. The increase in ADV in the previous period increases the MKT of the current period.

Considering TFPG of the current period, it can be seen that TFPG has U-relationship with MKT. The sole effect of TFPG is negative but the effect of the square term is positive, implying that the positive effect of TFPG can be obtained beyond the critical level of TFPG.

There exists a composite effect of TFPG and RD. This join interaction term has positive marginal effect on MKT, meaning that the effect of TFPG on MKT depends on RD and vice-versa. When these effects will be considered together, a negative marginal effect of TFPG will be obtained as the mean level of TFPG is lesser than the critical level of TFPG.

Considering ADV of the current period, it can be seen that ADV has positive non-linear relationship with MKT. The marginal effect of ADV is positive, meaning that increase in ADV increases MKT of the current period.

Considering RD of the current period and NX of the current period as well as previous period, it can be seen that all have inverted U-relationship with MKT. Initially increase in these factors increases MKT. But beyond their critical levels, the increase in these factors will lead to a fall in MKT.

There exists a joint interaction term of NX and RD. The marginal effect of this joint interaction is positive. The effect of NX on MKT depends on RD and vice-versa. Considering all these effects, the positive marginal effects of RD of the current period, NX of the current period as well as the previous period have been obtained.

Table 6.9.4 Factors explaining RD behaviour from a Simultaneous Equation Panel Model: The TFPG Block

Endogenous Variable: RD

Independent Variable	Coefficient	z-value	p>|z|
TFPG	.118859	0.75	0.454
$(TFPG)^2$	-.0000483	-0.67	0.506
ADV	2.21861	9.50	0.000
$(ADV)^2$	-.0015735	-5.28	0.000
MKT	-.0719361	-2.42	0.016
$(MKT)^2$	.0000152	2.59	0.010
MKTlag	.0606808	2.85	0.004
NX	.0553671	8.64	0.000
NXlag	.0205436	2.42	0.015
Wald chi2 = 1154.12 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
TFPG		0.1199	
ADV		2.2191	
MKT		-0.0699	
NX		0.0554	

The fourth equation of TFPG Block: The estimated RD relation

The estimated RD relation as presented in Table 6.9.4 shows that RD is positively related NX of the current period as well as previous period and MKT of the previous period.

Considering TFPG and ADV of the current period, it can be seen that both have inverted U-relationship with RD. Initially their increase will result in a rise in RD but beyond their critical levels the increase in TFPG and RD will lead to a fall in RD. Considering all these effects, the positive marginal effects of TFPG and ADV can be obtained.

Considering MKT of the current period, it can be seen that MKT has U-relationship with RD. The positive effect of MKT on RD can be achieved beyond the critical level of MKT. The marginal effect of MKT is negative as the mean level of MKT is lesser than the critical level of MKT.

Table 6.9.5 Factors explaining NX behaviour from a Simultaneous Equation Panel Model: The TFPG Block

Endogenous Variable: NX

Independent Variable	Coefficient	z-value	p>|z|
TFPG	-.0119974	-2.28	0.022
$(TFPG)^2$	1.71e-06	1.94	0.052
ADV	-.1592346	-11.38	0.000
$(ADV)^2$	.0000639	4.32	0.000
MKT	.0052561	2.55	0.011
RD	.1081992	7.04	0.000
$(RD)^2$	-.0000292	-2.90	0.004
RDlag	.0369817	5.71	0.000
Wald chi2 = 966.46 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
TFPG		0.0007	
ADV		-0.1499	
MKT		0.0053	
RD		0.1099	

The fifth equation of TFPG Block: The estimated NX relation

The estimated NX relation as presented in Table 6.9.5 shows that NX is positively related to MKT of the current period and RD of previous period.

Considering TFPG and ADV of the current period, it can be seen that both have U-relationship with NX. Their positive effects on NX can be achieved beyond their critical levels. Considering all these effects, the positive marginal effect of TFPG can be achieved but the marginal effect of ADV is negative as the mean level of ADV is lesser than the critical level of ADV.

Considering RD of the current period, it can be seen that RD has inverted U-relationship with NX. Initially the increase in RD increases NX but the beyond the critical of RD, its negative effect on NX will be felt. The marginal effect of RD is positive when all these effects are considered.

6.4.1.g Paper Industry

The estimated TFPG of Indian paper firms and also the other endogenous variables explaining the TFPG corresponding to TFPG block can be visualized from Table 6.10.1 to Table 6.10.5.

Table 6.10.1 Factors explaining the total factor productivity growth from a Simultaneous Equation Panel Model: The TFPG Block

Endogenous Variable: TFPG

Independent Variable	Coefficient	z-value	p>|z|
ADV	.1693422	3.17	0.002
$(ADV)^2$	-.0045177	-2.79	0.005
MKT	.0102923	1.66	0.098
RD	.0139639	1.40	0.162
NX	.0108769	0.36	0.721
ADV*MKT	-.0006996	-1.02	0.306
$(ADV*MKT)^2$	1.79e-07	1.32	0.187
RD*MKT	-.000657	-1.86	0.063
$(RD*MKT)^2$	1.40e-08	0.97	0.332
Agedum	.2471369	1.79	0.074
Wald chi2 = 26.48 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
ADV		0.1613	
MKT		0.0363	
ADV*MKT		0.5985	
RD		0.0098	
RD*MKT		0.5545	
NX		0.0109	

The first equation of TFPG Block: The estimated TFPG relation

The estimated TFPG relation as presented in Table 6.10.1 shows that TFPG is positively related to NX. The increase in NX in the current period increases the TFPG in the current period.

Considering ADV of the current period, it can be seen that ADV has inverted U-relationship with TFPG. Initially increase in ADV increases TFPG but too much ADV is costly for the firms so the effect of its square term is negative.

Considering MKT of the current period, it can be seen that the sole effect of MKT is positive. There exists a joint interaction term of ADV and MKT. Its marginal effect is positive. The effect of MKT on TFPG depends on ADV and vice-versa.

Considering RD of the current period, it can be seen that the sole effect is positive. There exists a joint interaction term of RD and MKT. Its marginal effect is positive. The effect of MKT on TFPG depends on RD and vice-versa.

Considering all these effects, the positive marginal effects of ADV, MKT and RD on TFPG can be achieved.

Another factor positive influencing TFPG is Agedum. The younger firms have higher level of TFPG than the older firms.

Table 6.10.2 Factors explaining ADV behaviour from a Simultaneous Equation Panel Model: The TFPG Block

Endogenous Variable: ADV

Independent Variable	Coefficient	z-value	p>|z|
TFPG	.0118782	7.54	0.000
$(TFPG)^2$	-1.75e-06	-4.30	0.000
RD	-.2344437	-2.10	0.036
$(RD)^2$	.0003812	1.92	0.055
NX	-.4507243	-2.10	0.035
$(NX)^2$	.0090214	1.78	0.074
TFPG*RD	.0019853	2.00	0.046
NX*RD	.0239721	1.06	0.290
$(NX*RD)^2$	-.0000519	-1.78	0.076
Wald chi2 = 211.82 Prob > chi2 = 0.0000			

Determinants	Marginal effects
TFPG	0.0010
RD	-0.0936
NX	-0.3275
NX*RD	0.0117

The second equation of TFPG Block: The estimated ADV relation

The estimated ADV relation as presented in Table 6.10.2 shows that TFPG has inverted U-relationship with ADV. Initially the increase in TFPG increases ADV but beyond the critical level of TFPG, the increase in TFPG will reduce ADV.

Considering RD and NX of the current period, it can be seen that both have U-relationship with ADV. Their positive effect on ADV can be achieved beyond their critical levels.

There exists a composite effect of TFPG and RD. Its effect on ADV is positive. The effect of TFPG on ADV depends on RD and vice-versa.

There exists another composite effect of NX and RD. Its marginal effect on ADV is positive. The effect of NX on ADV depends on RD and vice-versa.

Considering all these effects, the positive marginal effect of TFPG can be obtained but the marginal effect of RD and NX are negative as their mean levels are lesser than their critical levels.

Table 6.10.3 Factors explaining MKT behaviour from a Simultaneous Equation Panel Model: The TFPG Block

Endogenous Variable: MKT

Independent Variable	Coefficient	z-value	p>|z|
TFPG*ADV	.0051582	2.70	0.007
ADVlag	11.10152	3.33	0.001
RD	1.745575	2.34	0.019
$(RD)^2$	-.0121481	-9.84	0.000
RD*ADV	1.02766	3.25	0.001
NX	4.686362	1.98	0.048
Wald chi2 = 382.53 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
TFPG		0.0105	
ADV		1.7486	
RD		6.9614	
NX		4.6864	

The third equation of TFPG Block: The estimated MKT relation

The estimated MKT relation as presented in Table 6.10.3 shows that MKT is positively related to ADV of the previous period and NX of the current period.

Considering RD of the current period, it can be seen that RD has inverted U-relationship with MKT. Initially the increase in RD increases MKT but beyond the critical level of RD, its negative effect on MKT will be felt.

There exists a joint interaction term of RD and ADV. Its effect on MKT is positive. The effect of RD on MKT depends on ADV and vice-versa.

There exists another joint interaction term of TFPG and ADV. Its effect on MKT is positive. The effect of TFPG on MKT depends on ADV and vice-versa.

Considering all these effects, the marginal effects of ADV, RD and NX has positive marginal effects on MKT.

Table 6.10.4 Factors explaining RD behaviour from a Simultaneous Equation Panel Model: The TFPG Block

Endogenous Variable: RD

Independent Variable	Coefficient	z-value	p>|z|
TFPG	.0143508	0.48	0.633
ADV	-2.090526	-1.04	0.298
$(ADV)^2$	.0667323	1.09	0.274
MKT	.3901113	1.51	0.132
$(MKT)^2$	-.0003	-1.85	0.064
Agedum	8.561927	1.27	0.204
Wald chi2 = 8.81 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
TFPG		0.0144	
ADV		-1.0760	
MKT		0.3998	

The fourth equation of TFPG Block: The estimated RD relation

The estimated RD relation as presented in Table 6.10.4 shows that RD is positively related to TFPG of the current period.

Considering ADV of the current period, it can be seen that ADV has U-relationship with RD. Its positive effect on RD will be realised beyond its critical level. The marginal effect of ADV is negative as the mean level of ADV is lesser than the critical level of ADV.

Considering MKT of the current period, it can be seen that MKT has inverted U-relationship with RD. Initially increase in MKT increases RD but beyond the critical level of MKT, its negative effect on RD will be achieved. The marginal effect of MKT is positive.

Table 6.10.5 Factors explaining NX behaviour from a Simultaneous Equation Panel Model: The TFPG Block

Endogenous Variable: NX

Independent Variable	Coefficient	z-value	p>|z|
TFPG	.0078995	0.50	0.614
ADVlag	4.435405	1.42	0.157
RD	1.523861	1.59	0.113
$(RD)^2$	-.001646	-1.51	0.131
Wald chi2 = 11.78 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
TFPG		0.0079	
RD		1.5199	

The fifth equation of TFPG Block: The estimated NX relation

The estimated NX relation as presented in Table 6.10.5 shows that NX is positively related to TFPG of the current period, ADV of the previous period.

Considering RD of the current period, it can be seen that RD has inverted U-relationship with NX. Initially increase in RD increases NX but beyond the critical level of RD, its negative effect on NX will be felt. The marginal effect of RD on NX is positive.

6.4.1.h Textile Industry

The estimated TFPG of Indian textile firms and also the other endogenous variables explaining the TFPG corresponding to TFPG block can be visualized from Table 6.11.1 to Table 6.11.5.

Table 6.11.1 Factors explaining the total factor productivity growth from a Simultaneous Equation Panel Model: The TFPG Block

Endogenous Variable: TFPG

Independent Variable	Coefficient	z-value	p>|z|
ADV	-.1019871	-2.06	0.039
$(ADV)^2$	.0085218	1.62	0.105
ADV*MKT	.0104585	2.48	0.013
$(ADV*MKT)^2$	-.0000594	-2.36	0.018
RD	-.0177749	-0.30	0.762
$(RD)^2$	.0051422	0.26	0.792
NX	.0011766	2.01	0.044
DIVIND	.0096902	-1.68	0.094
Wald chi2 = 3274.68 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
ADV		-0.0276	
MKT		0.0104	
RD		0.0066	
NX		0.0012	
ADV*MKT		0.0089	

The first equation of TFPG Block: The estimated TFPG relation

The estimated TFPG relation as presented in Table 6.11.1 shows that TFPG is positively related to NX, meaning that exports dominate over imports,

Considering ADV and RD of the current period, it can be seen that both have U-relationship with TFP. Their sole effects are negative and the effects of their square terms are positive.

There exists a joint interaction term of ADV and MKT which has positive effect on TFPG. The effect of ADV on TFPG depends on MKT and vice-versa.

All these effects taken into account, the positive marginal effects of MKT and RD can be obtained but the marginal effect of ADV is negative as the mean level of ADV is lesser than critical level of ADV beyond which its positive effect will be realised.

Another factor positively affecting TFPG is DIVIND. As the market share gets diversified, TFPG of the firms increases.

Table 6.11.2 Factors explaining ADV behaviour from a Simultaneous Equation Panel Model: The TFPG Block

Endogenous Variable: ADV

Independent Variable	Coefficient	z-value	p>|z|
TFPG	.8542675	0.94	0.347
$(TFPG)^2$	-.3029783	-2.09	0.036
MKT	.9711444	13.64	0.000
$(MKT)^2$	-.0152771	-10.99	0.000
RD	.7541604	2.10	0.036
$(RD)^2$	-.0174041	-3.33	0.001
RDlag	.3345275	2.61	0.009
NX	-.0222994	-5.07	0.000
$(NX)^2$	.0001249	4.36	0.000
Agedum	1.044595	3.69	0.000
Wald chi2 = 341.48 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
TFPG		0.3060	
MKT		0.8632	
RD		0.7834	
NX		-0.0126	

The second equation of TFPG Block: The estimated ADV relation

The estimated ADV relation as presented in Table 6.11.2 shows that ADV is positively related to RD of the previous period.

Considering TFPG of the current period, MKT and RD of the current period, it can be seen that all have inverted U-relationship with ADV. Initially their increase will increase ADV but beyond their critical levels, their increase will lead to the fall in ADV. All these effects taken into account, the positive marginal effects of TFPG, MKT and RD on ADV will be realised.

Considering NX of the current period, it can be seen that NX has U-relationship with ADV. The positive effect of NX on ADV will be realised beyond the critical level of ADV. The marginal effect of NX is negative as the imports dominate over the exports.

Table 6.11.3 Factors explaining MKT behaviour from a Simultaneous Equation Panel Model: The TFPG Block

Endogenous Variable: MKT

<table>
<tr><td>Independent Variable</td><td>Coefficient</td><td>z-value</td><td>p>|z|</td></tr>
<tr><td>TFPG</td><td>-3.041849</td><td>-1.54</td><td>0.124</td></tr>
<tr><td>$(TFPG)^2$</td><td>.282973</td><td>1.43</td><td>0.152</td></tr>
<tr><td>ADV</td><td>2.065516</td><td>6.33</td><td>0.000</td></tr>
<tr><td>$(ADV)^2$</td><td>-.107524</td><td>-3.86</td><td>0.000</td></tr>
<tr><td>RD</td><td>.8908273</td><td>2.30</td><td>0.021</td></tr>
<tr><td>NX</td><td>.0114241</td><td>1.66</td><td>0.097</td></tr>
<tr><td>$(NX)^2$</td><td>-.0000948</td><td>-1.54</td><td>0.123</td></tr>
<tr><td colspan="4">Wald chi2 = 171.07
Prob > chi2 = 0.0000</td></tr>
<tr><td colspan="2">Determinants</td><td colspan="2">Marginal effects</td></tr>
<tr><td colspan="2">TFPG</td><td colspan="2">-2.4460</td></tr>
<tr><td colspan="2">ADV</td><td colspan="2">1.8380</td></tr>
<tr><td colspan="2">RD</td><td colspan="2">0.8908</td></tr>
<tr><td colspan="2">NX</td><td colspan="2">0.0033</td></tr>
</table>

The third equation of TFPG Block: The estimated MKT relation

The estimated MKT relation as presented in Table 6.11.3 shows that MKT is positively related to RD.

Considering TFPG of the current period, it can be seen that TFP has U-relationship with MKT. The positive effect of TFPG on MKT can be obtained beyond the critical level of TFPG. The marginal level of TFPG is positive as the mean TFPG is lesser than the critical level of TFPG beyond which positive effect of TFPG will be realised.

Considering ADV and NX of the current period, it can be seen that both have inverted U-relationship with MKT. Initially increase in these factors increases MKT but beyond their critical levels, their negative effect on MKT will be felt. Considering all these effects, the positive marginal effects of ADV and NX can be obtained.

Table 6.11.4 Factors explaining RD behaviour from a Simultaneous Equation Panel Model: The TFPG Block

Endogenous Variable: RD

Independent Variable	Coefficient	z-value	p>|z|
TFPG	-2.4094	-4.60	0.000
$(TFPG)^2$	.5626421	8.09	0.000
ADV	-1.0742	-1.98	0.048
$(ADV)^2$	.0498905	1.66	0.098
MKT	.1402734	3.91	0.000
$(MKT)^2$	-.0027242	-3.65	0.000
NX	-.0310799	-5.40	0.000
$(NX)^2$	.0001334	14.50	0.000
TFPG*NX	.0296008	4.56	0.000
$(TFPG*NX)^2$	-.0001058	-9.53	0.000
TFPG*ADV	.9908524	1.74	0.081
$(TFPG*ADV)^2$	-.0540941	-1.52	0.127
Agedum	.3751281	3.67	0.000
Wald chi2 = 12437.75 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
TFPG		0.6049	
ADV		0.6893	
MKT		0.1186	
NX		-0.0002	
TFPG*NX		0.0227	
TFPG*ADV		0.8820	

The fourth equation of TFPG Block: The estimated RD relation

The estimated RD relation as presented in Table 6.11.4 shows that TFPG, ADV and NX of the current period have U-relationship with RD. Their positive effect on RD can be obtained beyond their critical levels.

There are two joint interaction terms of (TFPG and ADV) and (TFPG and NX) which have positive marginal effects on RD. The effect of TFPG on RD depends on ADV and NX. Considering all these effects, the positive marginal effects of TFPG and ADV can be obtained but the marginal effect of NX is negative as the imports dominate over exports.

Considering MKT of the current period, it can be seen that MKT has inverted U-relationship with RD. Initially increase in MKT increases RD but beyond the critical level of MKT, its negative effect on RD can be felt. Taking under consideration all these effects, the positive marginal effect of MKT on RD can be obtained.

Another factor positively affecting RD is Agedum, indirectly affecting TFPG. This means that younger firms are doing more RD than the older firms.

Table 6.11.5 Factors explaining NX behaviour from a Simultaneous Equation Panel Model: The TFPG Block

Endogenous Variable: NX

Independent Variable	Coefficient	z-value	p>|z|
TFPG	.4505514	1.75	0.080
$(TFPG)^2$	-.0011399	-2.05	0.040
TFPG*RD	.1680068	2.29	0.022
RDlag	6.012558	1.41	0.159
ADV*MKT	.7851421	0.44	0.657
$(ADV*MKT)^2$	.0212747	2.77	0.006
Wald chi2 = 336.67 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
TFPG		0.6640	
ADV		5.5381	
MKT		1.1512	
ADV*MKT		1.2368	
RD		0.1980	

The fifth equation of TFPG Block: The estimated NX relation

The estimated NX relation as presented in Table 6.11.5 shows that NX is positively related to RD of the previous period.

Considering TFPG of the current period, it can be seen that TFPG has inverted U-relationship with NX. Initially the increase in TFPG increases NX but beyond the critical level of TFPG, its negative effect on NX can be felt.

There exists a composite effect of TFPG and RD. This joint interaction term has positive effect on NX. Considering all these effects, the positive marginal effects of TFPG and RD can be obtained.

There exists another joint interaction term of ADV and MKT which also has positive effect on NX. The effect of ADV on NX depends on MKT and vice-versa. Considering all these effects, the positive marginal effects of ADV and MKT can be obtained.

6.4.1.i Transport Industry

The estimated TFPG of Indian transport firms and also the other endogenous variables explaining the TFPG corresponding to TFPG block can be visualized from Table 6.12.1 to Table 6.12.5.

Table 6.12.1 Factors explaining the total factor productivity growth from a Simultaneous Equation Panel Model: The TFPG Block

Endogenous Variable: TFPG

Independent Variable	Coefficient	z-value	p>|z|
ADV	-.0094697	-2.01	0.044
$(ADV)^2$	.0000318	1.64	0.102
ADVlag	.0233385	3.06	0.002
MKT	-.0020723	-3.08	0.002
$(MKT)^2$	6.50e-07	3.70	0.000
RD	-.014138	-3.03	0.002
$(RD)^2$	.0000295	2.39	0.017
RDlag	.0210494	3.56	0.000
NX	.00116	3.57	0.000
$(NX)^2$	-4.95e-08	-2.88	0.004
Wald chi2 = 40.80 Prob > chi2 = 0.0026			
Determinants		Marginal effects	
ADV		-0.0085	
MKT		-0.0020	
RD		-0.0099	
NX		0.0034	

The first equation of TFPG Block: The estimated TFPG relation

The estimated TFPG relation as presented in Table 6.12.1 shows that TFPG is positively related to ADV of the previous period and RD of the previous period. The increase in ADV and RD in the previous period increases TFPG of the current period.

Considering ADV, MKT and RD of the current period, it can be seen that all have U-relationship with TFPG. Their sole effects are negative and the effects of their square term are positive. Initially their increase will not initiate TFPG of the firms but beyond their critical levels, their positive effects on TFPG will be obtained. Considering all these effects, the marginal effects of these factors come out to be negative as their mean levels are lesser than critical levels beyond which their positive levels can be achieved.

Considering NX of the current period, it can be seen that NX has inverted U-relationship with TFPG. Initially increase in NX increases TFPG but beyond the critical level of NX, its negative effects on TFPG can be achieved. Considering all these effects, the positive marginal effects of NX can be obtained.

Table 6.12.2 Factors explaining ADV behaviour from a Simultaneous Equation Panel Model: The TFPG Block

Endogenous Variable: ADV

Independent Variable	Coefficient	z-value	p>|z|
TFPG	8.674512	1.29	0.197
$(TFPG)^2$	-1.336976	-1.19	0.234
MKT	.1634008	9.37	0.000
$(MKT)^2$	.0000344	15.95	0.000
RD	.7372677	9.90	0.000
NX	-.0390326	-10.97	0.000
$(NX)^2$	6.47e-07	5.97	0.000
NXlag	.0294968	32.84	0.000
RD*MKT	-.0005095	-12.63	0.000
$(RD*MKT)^2$	7.81e-13	5.32	0.000
DIVIND	-2.791855	-2.80	0.005
Wald chi2 = 5970.53 Prob > chi2 = 0.0000			

Determinants	Marginal effects
TFPG	6.0632
MKT	0.1999
RD	0.7394
RD*MKT	0.0007
NX	-0.0214

The second equation of TFPG Block: The estimated ADV relation

The estimated ADV relation as presented in Table 6.12.2 shows that ADV is positively related to NX of the previous period.

Considering TFPG of the current period, it can be seen that TFPG has inverted U-relationship with ADV. Initially the increase in TFPG will increase ADV. But beyond the critical level of

TFPG, the increases in TFPG will lead to the fall in ADV. Considering all these effects, the positive marginal effect of TFPG can be obtained.

Considering RD and MKT of the current period, it can be seen that the sole effect of RD on ADV is positive while MKT has non-linear positive relationship with ADV.

There exists a joint interaction term of RD and MKT. The marginal effect of this joint interaction term is positive. The effect of RD on ADV depends on MKT and vice-versa. Considering all these effects, the positive marginal effects of both MKT and RD can be achieved.

Considering NX of the current period, it can be seen that NX has U-relationship with ADV. The positive effect of NX on ADV can be achieved beyond the critical level of NX. Taking into account all these effects, the marginal effect of NX comes out to be negative as the imports dominate over exports.

Another factor influencing is DIVIND, indirectly affecting TFPG. It has negative effect on ADV, implying that as the market share gets concentrated, ADV of the firms increases.

Table 6.12.3 Factors explaining MKT behaviour from a Simultaneous Equation Panel Model: The TFPG Block

Endogenous Variable: MKT

Independent Variable	Coefficient	z-value	p>|z|
TFPG	1.870468	3.63	0.000
$(TFPG)^2$	-.0047334	-3.47	0.001
ADV	2.291125	3.19	0.001
$(ADV)^2$	.0177519	26.43	0.000
ADVlag	5.66722	19.93	0.000
RD	3.052153	5.13	0.000
$(RD)^2$	.0011971	8.22	0.000
RDlag	3.110807	4.54	0.000
NX	.1279121	14.35	0.000
Wald chi2 = 266848.49 Prob > chi2 = 0.0000			

Determinants	Marginal effects
TFPG	1.8622
ADV	2.2932
RD	3.0504
NX	0.1279

The third equation of TFPG Block: The estimated MKT relation

The estimated MKT relation as presented in Table 6.12.3 shows that MKT is positively related to ADV of the previous period, RD of the previous period and NX of the current period. Increase in these factors increases MKT in the current period.

Considering TFPG of the current period, it can be seen that TFPG has inverted U-relationship with MKT. Initially the increase in TFPG increases MKT but beyond the critical level of TFPG, its negative effect on MKT will be felt. Considering all these effects, the positive marginal effect of TFPG on MKT can be obtained.

Considering ADV and RD of the current period, it can be seen that both have positive non-linear relationship with MKT. Their marginal effects on MKT are positive, meaning that increase in ADV and RD in the current period increases MKT.

Table 6.12.4 Factors explaining RD behaviour from a Simultaneous Equation Panel Model: The TFPG Block

Endogenous Variable: RD

Independent Variable	Coefficient	z-value	p>|z|
TFPG	.3763193	5.33	0.000
$(TFPG)^2$	-.0009683	-5.27	0.000
ADV	.1518523	1.87	0.061
$(ADV)^2$	-.0011317	-6.48	0.000
ADVlag	.3720007	3.39	0.001
$(ADVlag)^2$	-.0019202	-4.32	0.000
MKT	.0378853	3.24	0.001
$(MKT)^2$	3.65e-06	1.57	0.118
MKTlag	.105941	7.61	0.000
NX	.0096584	4.43	0.000
Wald chi2 = 16395.05 Prob > chi2 = 0.0000			

Determinants	Marginal effects
TFPG	0.3982
ADV	0.1999
ADVlag	0.3452
MKT	0.0632
NX	0.0097

The fourth equation of TFPG Block: The estimated RD relation

The estimated RD relation as presented in Table 6.12.4 shows that RD is positively related to MKT of the previous period and NX of the current period. Increase in MKT in the previous period and NX of the current period increases RD in the current period.

Considering TFPG of the current period and ADV of the current period as well as of the previous period, it can be seen that all have inverted U-relationship with RD. Initially their increase will lead to the rise in RD but beyond their critical levels, their negative effects on RD will be felt. Considering all these effects, the positive marginal effects of TFPG of the current period and ADV of the previous period as well as current period can be obtained.

Considering MKT of the current period, it can be seen that MKT has positive non-linear relationship with RD. The marginal effect of MKT on RD is positive. Increase in MKT increases RD and vice-versa.

Table 6.12.5 Factors explaining NX behaviour from a Simultaneous Equation Panel Model: The TFPG Block

Endogenous Variable: NX

Independent Variable	Coefficient	z-value	p>|z|
ADV	.8970833	0.24	0.809
$(ADV)^2$	-.0265234	-4.27	0.000
MKT	4.363194	19.88	0.000
$(MKT)^2$	-.0003185	-17.63	0.000
TFPG*MKTlag	.0087122	7.59	0.000
RD	4.742865	1.19	0.234
Wald chi2 = 68935.98 Prob > chi2 = 0.0000			
Determinants		Marginal effects	
TFPG		0.5237	
ADV		0.8972	
MKT		4.3592	
MKTlag		0.0088	
RD		4.7429	

The fifth equation of TFPG Block: The estimated NX relation

The estimated NX relation as presented in Table 6.12.5 shows that NX is positively related to RD in the current period. The increase in RD in the current period increases NX of the current period.

Considering ADV and MKT of the current period, it can be seen that both have inverted U-relationship with NX. Initially the increase in these factors increases NX but beyond their critical level their negative effects on NX will be felt. Considering all these effects, the positive marginal effects of ADV and MKT can be achieved.

There exists a joint interaction term of TFPG of the current period and MKT of the previous period which has positive effect on NX. The effect of TFPG on NX depends on MKT of the previous period. Considering all these effects, the positive marginal effects of both TFPG of the current period and MKT of the previous period can be obtained.

6.5 Conclusion

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 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 Scale change is the highest (1.017) for metal industry and the lowest (0.995) for non-metallic mineral product industry. The 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, implying 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. 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 of the current period has positive marginal effect on TFPG in machinery, non-metallic mineral products and paper industries. 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 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 of the current period on TFPG is positive in food products, leather, machinery, metal, non-metallic mineral products, paper and textile industries. 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 the current period in these industries.

RD of the current period has positive marginal effect on TFPG in chemical, food products, leather, machinery, paper and textile industries. Increase in RD increases TFPG in these said industries. 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 effects 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 of the current period in these industries.

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 increase TFPG as ADV in leather industry is the significant determinant of TFPG.

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 determinant 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 have become more expensive and its imports have become 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 felt yet. Further increase in TFPG is needed to realise its positive effect on MKT in these industries which will further boost up TFPG.

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i Let the production possibility set: *T= {(x, y): x* can produce *y}. Let* (x, y) be any input-output bundle, (not necessarily feasible), then the output- oriented distance function is $D(x,y) = \min \theta : \left(x, \frac{1}{\theta} y \right) \in T$. Thus, $(x, y) \in T$ implies $D(x, y) \leq 1$.

ii The terminologies peffch, techch and sch are borrowed from FGNZ (1994).

iii Let 1-input 1-output technology be represented by the production function $y = f(x)$.

Average productivity of $x = \frac{f(x)}{x}$. Let it be maximized at $x = x^*$ where, $f'(x) = \frac{f(x)}{x}$. Taking $f'(x^*) = w$, the pseudo production function be defined as *R(x) =wx* which exhibits CRS and is a ray through the origin.

A part of this Chapter has been published in an edited book.

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Chapter 7

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

7.1 Introduction

In the present chapter, it will be examined whether the highly growing firms are highly productive or highly efficient. To do the exercise, the sample firms are divided into two groups for all the industries, one group consisting of all those firms which are operating above the mean growth rate of output and another group consisting of all those firms which are operating below the mean growth rate of output. The mean productivity and efficiency have calculated for both the groups and finally the conclusion has been derived. This chapter also finds out the figure of mean percentage of firms working above mean TFPG, mean input oriented technical efficiency and mean output oriented technical efficiency. It will also be examined whether the highly productive firms are highly technically efficient or not.

7.2 Estimated Results

Table 7.1 Comparative analysis between Growth and Input Oriented Technical Efficiency

Industry	ITE of the firms operating above Mean Growth Rate of output(ITE_1)	ITE of the firms operating below Mean Growth Rate of output(ITE_2)	Remarks
Chemical	0.84	0.85	$ITE_1<ITE_2$
Food Products	0.88	0.94	$ITE_1<ITE_2$
Leather	0.93	0.97	$ITE_1<ITE_2$
Machinery	0.87	0.91	$ITE_1<ITE_2$
Metal	0.86	0.87	$ITE_1<ITE_2$
Non-metallic mineral products	0.89	0.88	$ITE_1>ITE_2$
Paper	0.84	0.86	$ITE_1<ITE_2$
Textile	0.80	0.81	$ITE_1<ITE_2$
Transport	0.92	0.90	$ITE_1>ITE_2$
Grand Mean	0.87	0.89	$ITE_1<ITE_2$

Source: Author’s Calculation

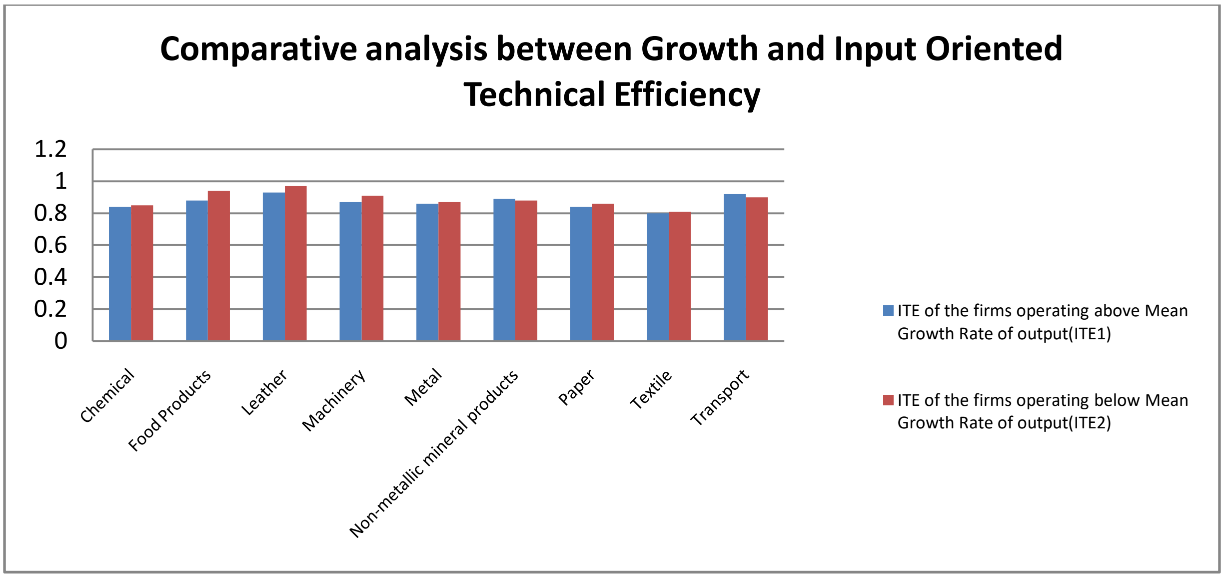

Figure 7.1. Comparative analysis between Growth and Input Oriented Technical Efficiency

Table 7.1 suggests that the grand mean ITE of the firms operating above mean growth rate of output is lesser than the grand mean ITE of the firms operating below mean growth rate of output taking all the sample firms under consideration. This result shows that high level of growth does not always imply high level of input efficiency. Figure 7.1. graphically represents the comparative analysis between growth and ITE for different industry groups. For all the industries except non-metallic mineral products and transport industries, $ITE_1<ITE_2$.

Table 7.2 Comparative analysis between Growth and Output Oriented Technical Efficiency

Industry	OTE of the firms operating above Mean Growth Rate of output(OTE_1)	OTE of the firms operating below Mean Growth Rate of output(OTE_2)	Remarks
Chemical	0.80	0.84	$OTE_1<OTE_2$
Food Products	0.87	0.96	$OTE_1<OTE_2$
Leather	0.95	0.96	$OTE_1<OTE_2$
Machinery	0.88	0.92	$OTE_1<OTE_2$
Metal	0.91	0.91	$OTE_1>OTE_2$
Non-metallic mineral products	0.73	0.89	$OTE_1<OTE_2$
Paper	0.86	0.89	$OTE_1<OTE_2$
Textile	0.74	0.78	$OTE_1<OTE_2$
Transport	0.93	0.91	$OTE_1>OTE_2$
Grand Mean	0.85	0.90	$OTE_1<OTE_2$

Source: Author's Calculation

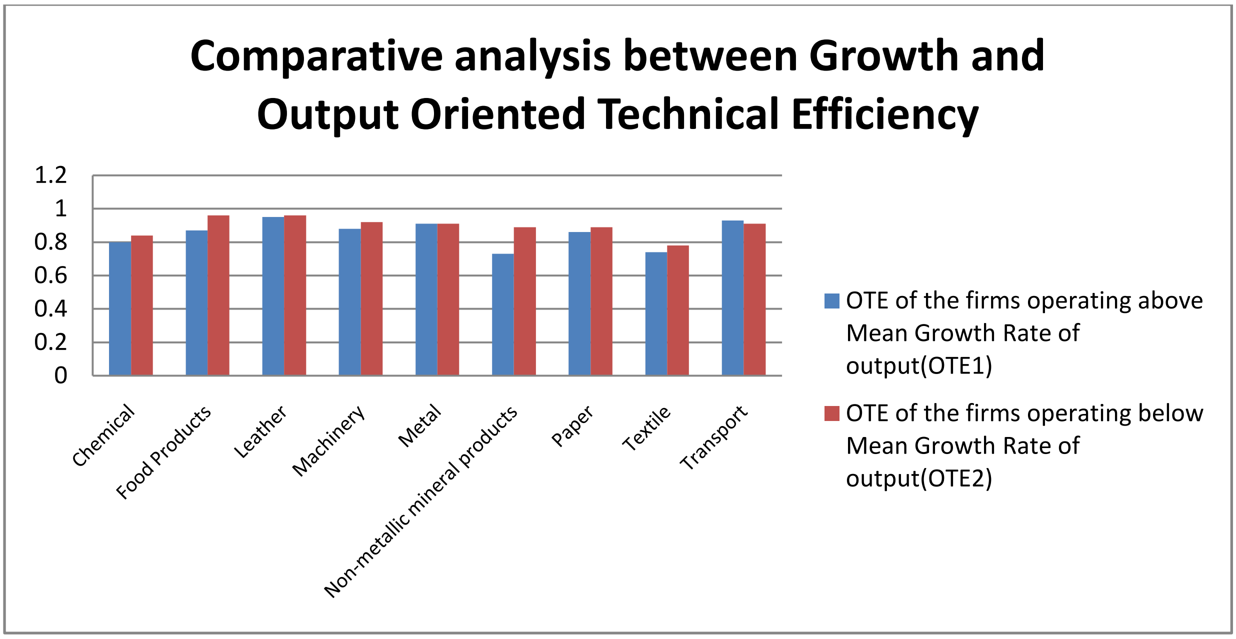

Figure 7.2. Comparative analysis between Growth and Output Oriented Technical Efficiency

Table 7.2 suggests that the grand mean OTE of the firms operating above mean growth rate of output is lesser than the grand mean OTE of the firms operating below mean growth rate of output taking all the sample firms under consideration. This result shows that high level of growth does not always imply high level of output efficiency. Figure 7.2. graphically represents comparative analysis between growth and OTE. For all industries except metal and transport industries, $OTE_1<OTE_2$.

Table 7.3 Comparative analysis between Growth and Productivity

Industry	TFPG of the firms operating above Mean Growth Rate of output($TFPG_1$)	TFPG of the firms operating below Mean Growth Rate of output($TFPG_2$)	Remarks
Chemical	1.02	0.96	$TFPG_1>TFPG_2$
Food Products	0.99	0.96	$TFPG_1>TFPG_2$
Leather	1.03	0.99	$TFPG_1>TFPG_2$
Machinery	1.08	0.98	$TFPG_1>TFPG_2$
Metal	1.32	0.98	$TFPG_1>TFPG_2$
Non-metallic mineral products	2.86	0.96	$TFPG_1>TFPG_2$
Paper	0.99	1.07	$TFPG_1<TFPG_2$
Textile	1.06	0.97	$TFPG_1>TFPG_2$
Transport	0.99	0.95	$TFPG_1>TFPG_2$
Grand Mean	1.26	0.98	$TFPG_1>TFPG_2$

Source: Author's Calculation

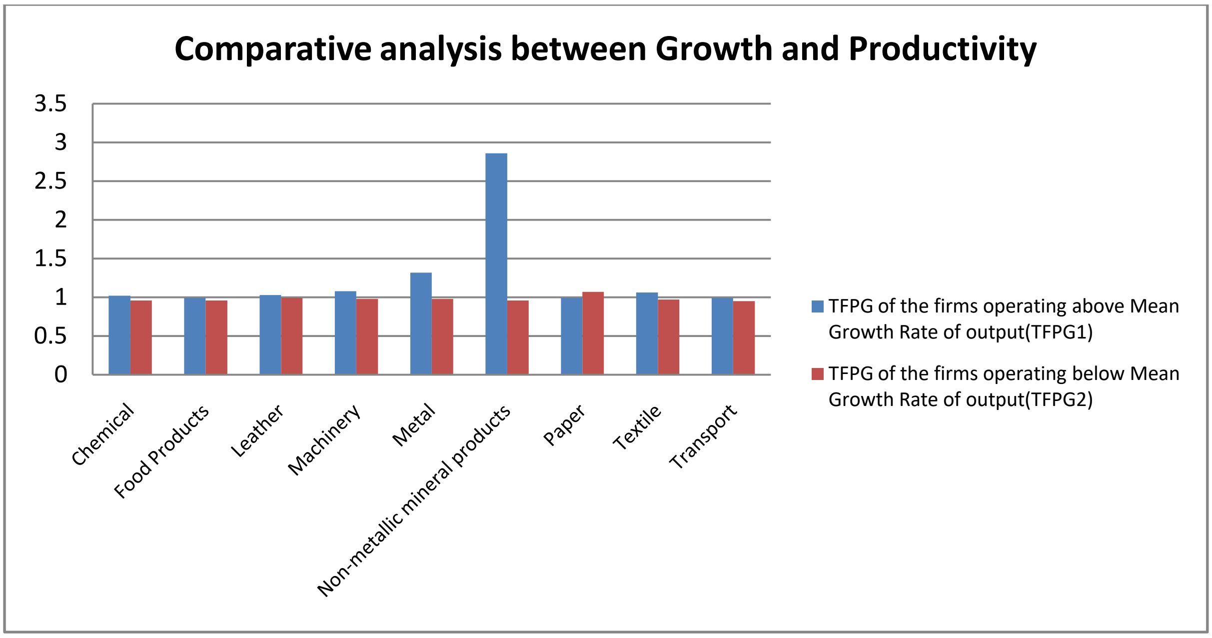

Figure 7.3. Comparative analysis between Growth and Productivity

Table 7.3 suggests that the grand mean TFPG of the firms operating above mean growth rate of output is higher than the grand mean TFPG of the firms operating below mean growth rate of output taking all the firms under consideration. This result shows that high level of growth implies high level of productivity. Figure 7.3. represents comparative analysis between growth and productivity. For all the industries except paper industry, $TFPG_1 > TFPG_2$.

Table 7.4 Comparative analysis between Productivity, Input Oriented Technical Efficiency and Output Oriented Technical Efficiency

Industry	% of firms working above Mean TFPG	% of firms working above Mean Input Oriented Technical Efficiency	% of firms working above Mean Output Oriented Technical Efficiency	% of firms working above Mean TFPG, Mean Input Oriented Technical Efficiency and Mean Output Oriented Technical Efficiency
Chemical	53	63	60	30
Food Products	57	65	66	34
Leather	54	76	78	43
Machinery	51	72	69	34
Metal	54	71	68	36
Non-metallic mineral products	55	72	70	37
Paper	58	79	77	43
Textile	53	66	62	31
Transport	53	71	67	34
Grand Mean	54	71	69	36

Source: Author's Calculation

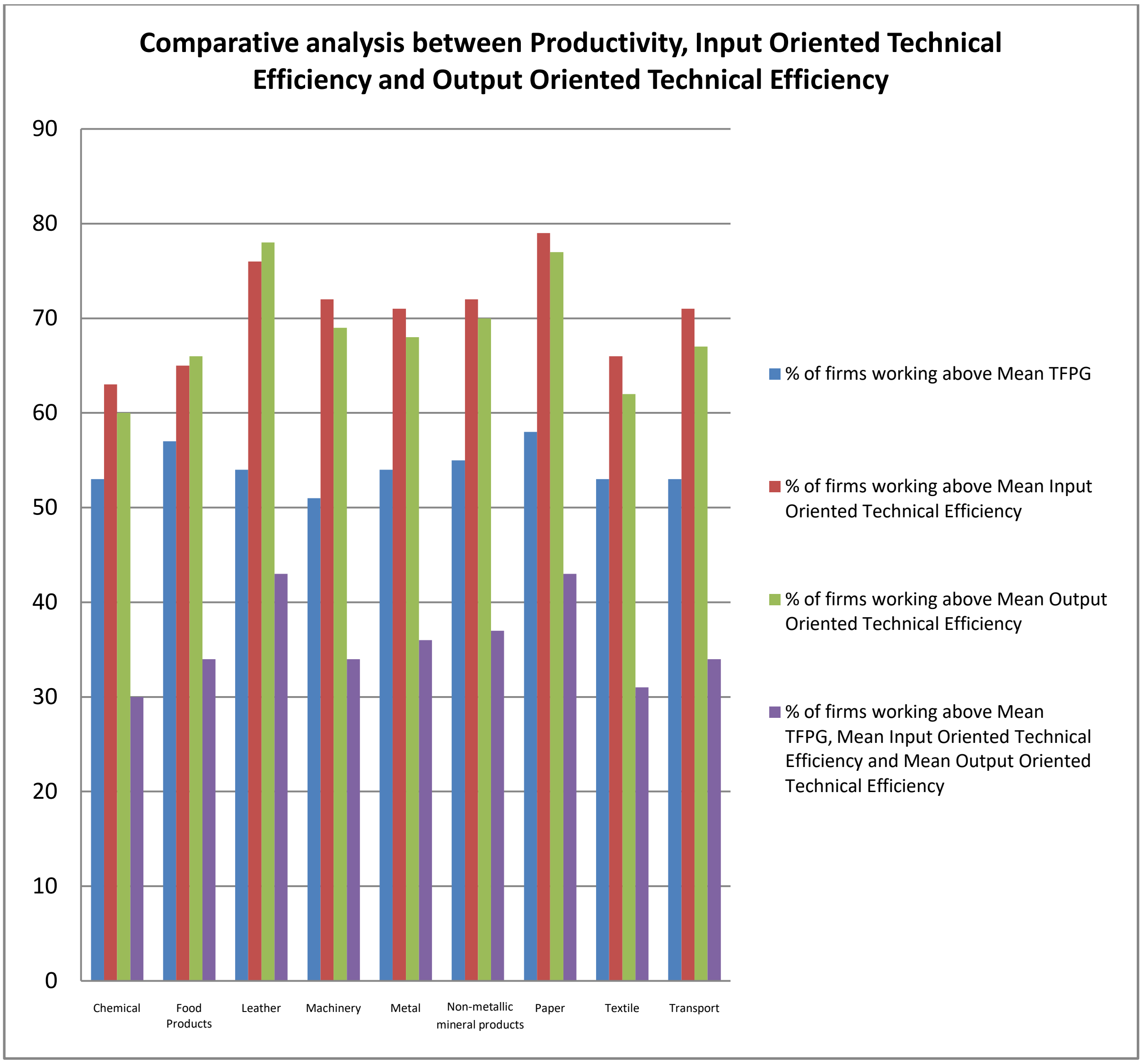

Figure 7.4. Comparative analysis between Productivity, Input Oriented Technical Efficiency and Output Oriented Technical Efficiency

Table 7.4 suggests that 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 are operating above mean TFPG, mean input oriented technical efficiency and mean output oriented technical efficiency in leather and paper industries and the lowest i.e. only 30% of sample firms operating above mean TFPG, mean input oriented technical efficiency and mean output oriented technical efficiency in Chemical industry. Figure 7.4. graphically represents the comparative analysis between productivity, input Oriented technical efficiency and output oriented technical efficiency.

Table 7.5 Technical Efficiency analysis of Highly Productive Firms

Industry	High ITE & Low OTE	Low ITE & High OTE	High ITE & High OTE	Low ITE & Low OTE
Chemical	10.16	5.47	57.03	27.34
Food Products	4.17	0.00	66.66	29.17
Leather	0	33.33	66.67	0
Machinery	8.96	7.46	59.70	22.39
Metal	0	50	18.75	31.25
Non-metallic mineral products	0	8.33	50	41.67
Paper	8.33	8.33	0	83.33
Textile	28.57	0	28.57	42.86
Transport	35.29	0.00	0.00	64.71
Grand Mean	10.61	12.55	38.60	38.08

Source: Author's Calculation

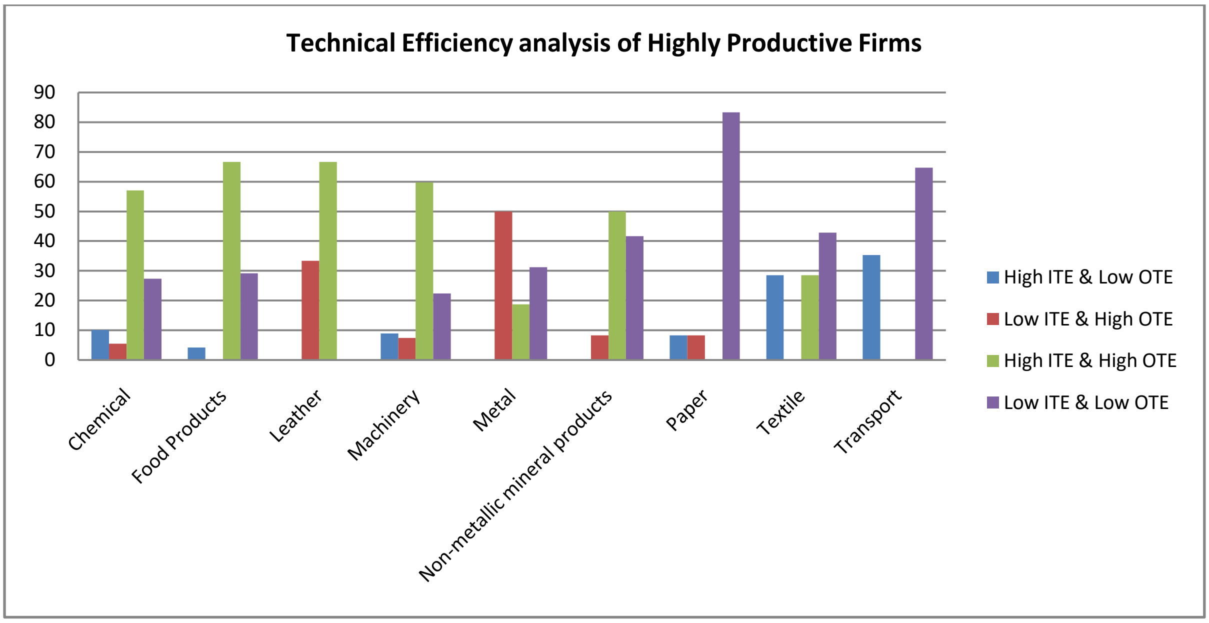

Figure 7.5. Technical Efficiency analysis of Highly Productive Firms

Table 7.3 suggests that high growth implies high productivity. Therefore, for highly productive firms included in the industry groups, efficiency analysis has been performed and the result is presented in Table 7.5. The analysis suggests that the maximum percentage i.e. 38.60% of highly productive sample firms is 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 sample firms are having high ITE as well as OTE. This result is diagrammatically represented by Figure 7.5.

7.3 Conclusion

The empirical results of this chapter suggest that high growth implies high productivity but does not necessarily imply efficiency for 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 sample firms are having high ITE as well as OTE.

Chapter 8

Summary & Conclusion

8.1 Conclusion

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. 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 disaggregated study. The thesis will follow Centre for Monitoring Indian Economy (CMIE) Prowess Database at the company (firm) level for the whole 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. The present study measures the extent of growth, efficiency and productivity at a firm level for the said nine groups of industry in post-reform era. It also finds out the factor influencing the determinants of those performances using simultaneous equation approach.

The estimated results on growth of output suggest that the sample manufacturing firms are experiencing 13.95% of growth 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 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 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 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 & 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 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 & 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 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 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 Scale change is the highest (1.017) for metal industry and the lowest (0.995) for non-metallic mineral product industry. The 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, implying 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. 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 comparative analysis between growth, efficiency (both ITE & OTE) and productivity suggest that high growth implies high productivity but does not necessarily imply efficiency for 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 sample firms are having high ITE as well as OTE.

The determinant analysis is carried out for each of the performance indicator growth, efficiency (both ITE and OTE) and productivity for each of the considered industry using firm level data considering the following determinants: advertising-intensity (ADV), marketing-intensity (MKT), R&D-intensity (RD), net export-intensity (NX i.e. difference between export intensity and import intensity), firms-size, diversification index and age of the firms in a simultaneous panel regression framework.

The determinant analysis of growth of output for the sample firms included under the considered nine industry groups suggests that ADV of the current period has positive marginal effect on GROUT in leather, machinery, metal, non-metallic mineral products and paper industries. Increase in ADV increases growth of output (GROUT) in these industries in the current period. But, ADV of the current period has U-relationship with GROUT with negative marginal effects in chemical, food products, textile and transport industries. For the 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 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 of the current period has positive marginal effect on GROUT in food products, leather, non-metallic mineral products and textile industries. Increase in MKT increases GROUT in these industries in the current period. But MKT of the current period has U-relationship with GROUT with negative marginal effect in chemical, machinery, metal, paper and transport industries. 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. 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 dominates 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 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, machineryand 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 implies that its exports have become more expensive and its imports have become 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 can further influence 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.

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 of the current in the machinery industry. Increase in ADV in the previous period increases ITE of 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 increase ITE in the current period in all these industries.

MKT of the previous period has positive effect with 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 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 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 and MKT in chemical industry, ADV and MKT in food products industry, 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, increases; 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.

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 implies that its exports have become more expensive and its imports have become 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 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. Increase in ITE increases MKT, RD and NX of the sample firms 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 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. 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. 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 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 import; 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 lead to the rise in OTE of 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 these industries as a result their OTE 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 influenced.

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 increases; 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 implies that its exports have become more expensive and its imports have become 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 determinant analysis of TFPG for the sample firms of the considered nine industry groups suggests that ADV of the current period has positive marginal effect on TFPG in machinery, non-metallic mineral products and paper industries. 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 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 of the current period on TFPG is positive in food products, leather, machinery, metal, non-metallic mineral products, paper and textile industries. 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 the current period in these industries.

RD of the current period has positive marginal effect on TFPG in chemical, food products, leather, machinery, paper and textile industries. Increase in RD increases TFPG in these said industries. 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 effects 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 of the current period in these industries.

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 increase TFPG as ADV in leather industry is the significant determinant of TFPG.

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 determinant 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 implies that its exports have become more expensive and its imports have become 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 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 whole analysis of the thesis highlights the role of industry specific influences regarding all the explanatory variables for determining the performance indicators: growth, efficiency (both input oriented technical efficiency and output oriented technical efficiency) and total factor productivity growth. It has also been observed that there are interactions between one strategic variable with others.

8.2 Policy Suggestions

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 expemditure is very important. Tax incentives to key sectors have played a crucial role in RD. Since RD activity is mainly dependent on imported inputs, the facilitated imports will also increase 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 presently available fiscal measures include the exemption of import duties on key RD expenditure, customs duty exemption on capital equipment and spares imported for RD by approved institutions, weighted tax deduction for sponsored research and on in-house RD expenditure, custom duty exemption on imports for RD projects supported by Government, an excise duty waiver on indigenous items purchased by approved institution for RD. These measures must 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 will basically enhance RD activity. The firms also 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, because the empirical evidences suggest that the quality of exports is one of the main determinants of exports. This in turn suggests greater role of RD because the sustained increase in RD will in turn help to improve the product - quality.

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 firm 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 enhanced that will also result in the enhancement of growth, productivity and efficiency (both input oriented and output oriented TE) in different 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 have positive impact on further rounds increase in advertising, marketing, RD and net export activities.

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 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.

8.3 Limitation of the study

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.

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