CHAPTER - II
REVIEW OF LITERATURE

2.1 INTRODUCTION
This Chapter presents a brief review of earlier studies related to automobile industry, growth, production function, technical efficiency, technology and productivity growth in the manufacturing industries.

2.2 EARLIER STUDIES RELATED TO AUTOMOBILE INDUSTRY
Das (1986) attempted to estimate demand for different categories of commercial vehicles up to the end of this decade (i.e. 1990). The study contends that the official demand forecasts are exaggerated because the assumptions about growth of traffic on which they are based are unrealistic. In the light of demand projection the author argues that the current policies of licensing a number of new units is likely to result in under utilization of capacity and consequent loss of economics of scale. A preferable policy would be to increase capacity in the existing units would achieve greater efficiency and introduce some competition in the industry.

Kathuria (1987) attempted to show that although Hindustan Motors and premier automobiles were established prior to independence, the real history of the Indian automobile industry begins with the Tariff Commission Report of 1953, when firms without a phased manufacturing programme were asked to withdraw from India. By 1965 there were seven firms manufacturing commercial vehicles, four of which also produced passenger cars / jeeps. In 1981, the Government approved the entry of four new firms (with Japanese collaborations) into the market for light commercial vehicles. This was followed by further liberalization in

---


industrial policies, viz, broad-banding exemption from the provisions of section 21 and 22 of the MRTP Act, and the announcement of minimum economic scales.

**Gumaste (1988)** attempted to explain that the Indian industry has responded to the governments promotional measures to encourage in-house research and development units and the money they spend have grown considerably over the last four decades. But what are the concrete results? How strong is the technological capability of Indian industry today? How effective is it in enabling the country to be technologically self-reliant? This study is based on discussions with the principals, the men in the wings and those behind the scenes in the industry-the automobile and ancillary industry.

**Agarwal (1988)** attempted to explain the Indian automobile industry problems and prospects with the objective of the study is to pinpoint the main causes of the sickness of the industry and then to suggest remedial measures. It appears prima-facie that the industry is caught in the vicious circle of small size of the market; for its products and near absence of innovations in technology over the three decades. The industry has not developed its own vehicles and the export demand for its vehicles is negligible. Broadly they may classify the causes of sickness under the following heads. (1) Technology and cost structure (2) Government policies and (3) Certain other economic factors.

**Pradeep and Mridul (1989)** attempted to analyze the determinants of export performance for fifty five units in the “Machinery and Transport equipment” industry of India. The methodology adopted applied pooling of cross section and time series data over the years 1980-81, 1982-83 and 1983-84. The study followed the neo-factor proportion and neo-technology approaches. These approaches came into vogue as the Heckscher (H-O) theorem, due to its restrictive assumptions, was found incapable of explaining real world phenomenon of monopolistic competition

---


in the arena of International Trade and foreign investment. Under the assumptions of the HO theorem, such as perfect competition and perfect foresight, constant returns to scale, absence of product differentiation, all firms in an industry will have access to technology, factors and product markets. As a result they are expected to perform in similar fashion.

Sharipad and Setharaman (1995)\(^6\) studied the technology transfer and export performance of Indian automobile industry. Also examined the determinants of the export intensity of the automobile industry. The empirical literature on technology transfer and export performance showed that no clear cut conclusion can be drawn regarding the relationship between the two.

Chugan (1995)\(^7\) attempted to explain an investigation of the factors related to foreign technology vis-a-vis their role in determining the firms development, adaptation and absorption (DAA) capabilities reveals that while the number of foreign collaboration agreements (FCA) and foreign equity do influence DAA capabilities, the impact is limited; for, other technology transfer related factors restrict the firms freedom to operate in a manner it deems fit. A comparative analysis of FCA and non FCA units indicates that in spite of weaker R&D base; the non FCA units spend more on R&D in relative terms and develop / adapt larger number of products than the former.

Avinandam and Satry (1996)\(^8\) attempted to explain the automobile industry in South Korea, Brazil, China, and India is currently going through impressive growth. Governments have played a key role in the evolution of the industry in all these countries. South Korea, a relatively amount to the automobile industry, has made the most significant progress, and is now exporting cars to developed countries. It is the only country that invested in research & development for product development, retained management control in ventures with multinational companies, and had ambitious export targets. The industry in Brazil is much bigger

---


\(^7\) Chugan P. K. (1995), “Foreign Collaborations and Industrial R and D in Developing Countries: Case of Indian Automobile Ancillary Industry”, Economic and Political Weekly, August 26.

\(^8\) Avinandam Mukherjee and Satry Trilochan (1996),“Automobile Industry in Emerging Economies: A comparison of South Korea, Brazil, China and India”,Economic and Political Weekly,November 30.
than that in South Korea, but indigenous product development capabilities are lacking and manufacturing competitiveness is limited even though the industry is entirely controlled by NINCS. The Indian industry is experiencing with rapid growth and the entry of the largest number of MNCs.

Narayanan (1998) attempted to analyse the effects of de-regulation policy, introduced in India during the mid 1980s, on technology acquisition and competitiveness in the Indian automobile industry during the 1980s. Following evolutionary theoretical framework, the study argued that asymmetry among firms in terms of technology acquisition explain much of the firm level differences in competitiveness. Asymmetry in technology acquisition is largely due to differences in the firms’ ability to bring about technological paradigm and trajectory shifts. The results of the econometric exercise support the view that, even in an era of capacity licensing, development of competitive skills crucially depended upon the ability to build specific technology trajectory advantages. This is achieved by successfully complementing imported technology with in-house technological efforts. Competitiveness in a de-regulated regime would, however, depend upon the ability of the firm to bring about technological paradigm shifts. New firms who depended on intra-firm transfer of technology and firms with in-house R&D efforts, to accomplish paradigm shifts, appear more successful. Further, in a liberal regime, advantages of vertical integration over sub-contracting also appear to be important in the determination of competitiveness.

Mohanakumar and George (2001) attempted to assess the impact of economic reforms on the automotive tyres manufacturing industry. The analysis focused on the dominant truck and bus tyres segment. With the entry of MNCs in the post-reform period, the sector is on the verge of a major shake-up, underlining the need for nationalisation of the product mix, favouring radical tyres with large-scale investment.


Husain et al., (2002) conducted to analyze technology management practices of firms in the automobile industry in India. The case studies of three firms which collaborated in post Indian independence (i.e. after 1947) period and after the economic reforms began (i.e. after 1985) have been presented. The cases were prepared using interviewing and observation techniques. Profitability, liquidity, and turnover ratio analyses have been carried out to assess the firms’ financial health. Input from the questionnaire survey has been presented to compare the perception of the firm’s performance compared to industry on select variables. The situation–actor–process–learning–action–performance (SAP-LAP) paradigm was used to analyze the cases. Learning issues have been synthesized.

Nagaraj (2003) studied the industrial policy and performance since 1980: which way now? He observed that, since 1980-81, manufacturing sector output has grown at 7 per cent per year, with economic reforms making little difference to the trend in the 1990s. But growth has decelerated over the last seven years, after peaking in 1995-96. Why is this so? The reforms have narrowly focused on policy-induced restrictions on supply, ignoring the demand constraint due to the cut in public infrastructure investment since the late 1980s, and indifferent agricultural performance in the 1990s. These issues have to be squarely addressed to revive industrial growth, and to reap the benefits of the investment boom in organised manufacturing in the last decade. He also found that there was an investment boom in manufacturing without a corresponding rise in output growth, there is now a huge excess capacity, especially in consumer durable goods, the automotive industry—and more generally in capital goods.

Rani and Unni (2004) analysed the impact of economic reforms on the organized and unorganised manufacturing sectors. It also seeks an explanation for the growth trends observed by looking at specific trade and industrial policies. The


analysis indicated that economic reform policies had a differential impact on various industry groups. In particular, the growth in the automobile industry and the infrastructure sector helped the growth of the manufacturing industry, especially in the unorganised segment and the generation of quality employment. The sub-sector analysis thus showed that in the liberalised era two sectors, automobile and the construction industry, have actually helped the growth of the manufacturing industry, especially the unorganised segment.

Banga (2004)\textsuperscript{14} examined the impact of Japanese and US foreign direct investments (FDI) on total factor productivity growth of firms in the Indian automobile, electrical and chemical industries in the post-reforms period. The study estimated both parametric and non-parametric techniques to estimate production frontiers to arrive at conclusions with respect to impact of FDI from different sources on the TFPG. The results of the ‘time varying firm specific’ technical efficiency approach showed that Japanese-affiliated firms have higher average productivity growth than domestic firms and US-affiliated firms. Interestingly, domestic firms in these industries are found to have higher productivity growth than US-affiliated firms. The study further used a non-parametric approach to estimate production frontier and decompose TFP change into efficiency change and technology change within each industry. This analysis is used as a complement rather than a substitute of the first analysis. Used the DEA approach, Malmquist indices of productivity growth are estimated and the two components of productivity growth, efficiency growth and technological progress, achieved by Japanese-affiliated, US-affiliated and domestic firms in an industry are compared. The analysis showed that US-affiliated firms rely mainly on technological improvements to achieve productivity growth, while the major thrust to productivity growth in Japanese-affiliated firms comes from efficiency improvements. One of the important findings of the study was that in the post-reforms period, domestic firms have experienced both technological progress and efficiency growth in some industries such as the electrical and chemical industries. This is indicative of the fact that

domestic firms are ‘catching up’ with the higher productivity levels of foreign firms in these industries.

Ito (2004)\textsuperscript{15} investigated the productivity differentials between foreign and local plants in the Thai automobile industry using plant-level data for 1996 and 1998. The findings showed that labor productivity is higher at foreign-affiliated plants than at local plants. However, foreign plants in the motor vehicle bodies and the motor vehicle parts industries tend to have a lower capital productivity than local plants. Moreover, comparisons of TFP levels reveal no evidence that foreign plants have higher TFP that can be related to their ownership-specific advantages.

Narayanan (2004)\textsuperscript{16} examined the determinants of the growth of firms in automobiles. It underwent rapid technological change and saw the entry of new firm in the liberalized era. His sample covered the period 1980-86. The study identified two policy changes during the period, namely, partial deregulations introduced in 1985 and liberalization measures launched since 1991. Consequently, three sets of regressions were presented for three periods-licensing 1980-81 to 1984-85 Deregulations 1985-86 to 1990-91 and liberalization 1991-92 to 1995-96. Firms in the automobile industry witnessed a change in basic technology configuration of the production process during the sample period. The study used two-way fixed effect estimation of the growth function. The results of estimated model support the hypothesis that inter-firm differences in growth were determined mainly by variables capturing technology paradigm and trajectory shifts. Thus he concluded that the growth was mainly technology driven.

Ranawat and Tiwari (2009)\textsuperscript{17} examined the influence of Government polices on industry development of India’s automotive industry. The study evaluated the India’s automotive industry and identified to have occurred in four phases. In the


first (1947-1965) and second phase (1966-1979), the important policies identified were related to protection, indigenization and regulation of the industry. On the one hand, these policies helped India to build an indigenous automotive industry, while on the other it led to unsatisfactory industry performance. In the third phase (1980-1990), the single most important policy identified was the one with regard to relaxation in the means of technology acquisition. The foreign competition inducted into the industry transformed its dynamics. Lastly, in the fourth phase (1991 onwards) the liberalisation with regard to foreign investment had a significant influence on the Indian automotive industry in the recent year. Also major shift in policies made by the Indian Government, the automotive industry has come out stronger and better. While the shift in policies seems to have mostly been brought by chance events, the Indian Government has at least to be credited for making the right decisions and implementing them correctly. It is paradoxical that the Indian middle class, the most attractive feature for foreign investment in the liberalisation phase, was an outcome of the statistic ideologies in the regulatory phase. The product innovations of domestic firms like Tata Motors and Bajaj Auto recent year are the fruits of indigenization and protection policies of the regulatory phases.

Lee and Jung (2009) evaluated the economic effects of trade patterns on productivity and evidence from the Korean automobile industry. Among inter-firm trade patterns, the cooperative trade system has proved to be superior to arms-length or market-oriented trade in the long run. Within the cooperative trade system, the transition from dedicated (single supplier) trade to network trade is proving a remarkable phenomenon. In our theoretical model, they compared the relative economic efficiencies between dedicated and network trade systems. Then in empirical analysis, they examined the relationship between alternative trade patterns and the productivity of the automobile industry. The main results of the theoretical model showed that network trade results in a higher profit level than dedicated trade as a rule, although network trade is less stable than dedicated trade. Empirical study revealed that increasing network trade leads to higher productivity.

Motohashi and Yuan (2010)\textsuperscript{19} studied the productivity impact of technology spillover from multinationals to local firms and comparing China's automobile and electronics industries. In the automobile industry they find that both multinationals and local firms in the assembly industry have vertical spillovers to local parts supply firms. In contrast, in the electronics industry, only a small amount of vertical spillover effects from local firms can be found. Furthermore, they find that horizontal spillovers exist in neither the automobile industry nor the electronics industry.

Gaddam (2013)\textsuperscript{20} analysed the total factor productivity growth of automobile industry and all industries in India. The study also analyzed the Kendrick total factor productivity growth of the industry. The empirical results revealed that the capital productivity (V/K) in the automobile industry is much higher compared to the capital productivity (V/K) of all industries during the study period. The study concluded that the industry is a capital intensive industry. The low exponential growth rate of total factor productivity and insignificant p-values of time and dummy variables indicate that there is no positive growth of total factor productivity in the automobile.

Vijayakumar (2013)\textsuperscript{21} studied the productivity, technical progress and scale efficiency in Indian automobile industry and used Malmquist productivity index. The comprehensive economic reform policy statement was formulated for India in July 1991 in the form of industrial and trade sector liberalization. Over the years several measures were undertaken by them for boosting up the industrial productivity. Therefore, analysed productivity and efficiency changes during the post reform period becomes essential for providing strategic inputs to the producers, the government and other stake holders. Therefore, in this study, an attempt has been made to assess the effects of economic reforms on productivity growth in Indian


automobile companies using Malmquist Productivity Index, decomposes the TFP change into technical and efficiency changes. The results of the study showed that most of the Indian automobile companies must increase their TFP and efforts must be made to provide a stable pattern to the productivity growth. However, the benefits of technological progress were not converted into productivity gains, as there was no improvement in efficiency in the reform period. The results of the study suggested that there is need for the implementation of specific policies to improve technical progress and efficiency change, in order to precipitate a long-run balance in TFP growth.

Gale (2014) described the EPA’s voluntary energy star program and the results of the automobile manufacturing industry’s efforts to advance energy management as measured by the updated Energy star Energy Performance Indicator (EPI). A stochastic single-factor input frontier estimation using the gamma error distribution is applied to separately estimated the distribution of the electricity and fossil fuel efficiency of assembly plants using data from 2003 to 2005 and then compared to model results from a prior analysis conducted for the 1997–2000 time period. This comparison provides an assessment of how the industry has changed over time. The frontier analysis showed a modest improvement (reduction) in “best practice” for electricity use and a larger one for fossil fuels. This is accompanied by a large reduction in the variance of fossil fuel efficiency distribution. The results provide evidence of a shift in the frontier, in addition to some “catching up” of poor performing plants over time.

2.3 EARLIER STUDIES RELATED TO GROWTH

Chuang (1996) studied the source of growth in Taiwan’s manufacturing industry and found that a major part of external effects among two digits industries was generated by trade-induced learning, which accounted for about three-fourth of the measured external effect. The study showed that the trade-induced learning

---


variable explained most of TFPG in that sector accounted over 40 per cent of Taiwan manufacturing output growth.

Shanta (1999)\textsuperscript{24} observed that the corporate sector as a whole was gaining significance in the economy between 1989-90 and 1995-96. It was further observed that the corporate sector in manufacturing had recorded a faster growth in its gross output, net value added and net fixed capital in the early 1990s as compared to the 1980s. She further noted that growth of the private corporate sector was not at the expense of the public sector, but at the expense of the non-corporate sector with in the private sector (arguably the house hold sector).

Balakrishnan and Suresh Babu (2003)\textsuperscript{25} in their study of the evolution of the Indian manufacturing sector over close to three decades found that the annual average rate of growth in the nineties to have risen almost across the board at the two-digit level of industry. Nevertheless, the acceleration is not particularly impressive for what is often hailed as the most significant policy-regime shift since 1950. There was a hefty rise in investment, however, though without a corresponding increase in its efficiency.

Panagariya (2004)\textsuperscript{26} argued that reforms in India cannot be credited with higher growth because growth rate had crossed the 5 per cent mark in the 1980s, well before the launch of the July 1991 reforms. This is a wrong reading of the Indian experience for two reasons. First, liberalisation was already under way during the 1980s and it played a crucial role in stimulating growth during that decade. Second, growth in the 1980s was fragile and unsustainable. The more systematic and systemic reforms of the 1990s, discussed in detail, gave rise to more sustainable growth. He concluded that the growth rate in India nevertheless continues to trail that of China.


Das (2007) explored the economic reform, output and employment growth in manufacturing and tested Kaldor’s Hypotheses. The rate of manufacturing growth as of overall economic growth has increased after the mid-1980s compared to the earlier period. The recent growth in India has been driven to some extent by the explosion of information technology (IT) related services. But IT cannot be a long run source of growth because it currently accounts for a very small share of GDP and employment and even an explosive growth will not change its relative insignificance. Industries such as telecom and entertainment have also registered impressive growth. The automobile industry has improved its growth capability after the abolition of licensing. But the portrait of these two industries alone cannot give us a rounded picture of the Indian manufacturing or services and higher growth in the post-reform period conceals much turbulence. Economic reforms including the withdrawal of subsidies and reservation for small enterprises have opened up new opportunities for the growth of giant enterprises, particularly transnational corporations, and have created increasing vulnerability of small enterprises.

Balakrishnan and Parameswaran (2007) studied the economic growth in India and by testing multiple structural breaks to identify phases of growth in India since 1950. The noteworthy feature of the methodology allows the data to parametrise the model, thus yielding results that are immune to the prior beliefs of the researcher. Their results revealed that there were two growth regimes in India since 1950. Further the study decomposed economic growth by sectors and the contributions to the change in the growth rate across these regimes were estimated. The results of this study indicated little role for a liberalised trade and industrial policy having been the trigger of a new growth dynamic in India via faster manufacturing growth, at least up to the mid-1990s.


Kaur (2007) made an attempt to examine the growth acceleration in India. The Indian economy experienced a structural break and acceleration in trend rate of growth during the mid-1980s. The mild reforms of this period played a key role in crossing the 5 per cent benchmark as far as economic growth was concerned. The more comprehensive reforms of the 1990s provided a further boost to growth during the post-1991 reform period. The average annual growth rates during the pre-1991 reforms and the post-1991 reforms periods are significantly different. Further, the concerns of “fragility” and “unsustainability” of growth during the 1980s are overstated.

Nagaraj (2008) found in his study that there has been a turnaround in Indian manufacturing since 2002-03, ending the period of deceleration that lasted for seven years since 1995-96. The annual average growth rate in manufacturing between 2002-03 and 2006-07 was 8.8 per cent, up from 5.6 per cent during previous five years. The study ascertained that there is no unanimity among the researchers regarding the impact of economic reforms on growth of Indian manufacturing.

Joseph and Reddy (2009) analysed the spillovers from foreign direct investment through multinational enterprises have attracted considerable attention in recent times. Existing empirical studies on FDI spillovers largely look at the productivity enhancing effects and horizontal spillovers of foreign firms in the same industry sector ignoring the possibility of spillovers through buyer-supplier or backward linkages. The study also examined the impact of horizontal as well as backward spillovers from the presence of foreign firms, on the export performance of domestic firms in the Indian manufacturing industry during 1993-2008. Increased competition in the domestic market post-liberalisation through sales of foreign firms is forcing domestic firms to look for export markets. The results indicated that domestic firms are not benefited in improving their export performance through any

buyer-supplier linkages with the MNES. The result also found that, the export intensities of domestic firms are significantly higher in chemicals industry sector when compared to foreign firms and the same in automobiles and food products sectors, whereas foreign firms have significantly higher export intensities in all the other sectors.

Chakravarty and Mitra (2009)\textsuperscript{32} empirically proved that the manufacturing is still the engine of growth delineates the inter-connections among several activities based on time series data on employment in different components of the organized sector in India. The study was pursued in the vector auto-regression (VAR) framework taking into account the results of variance decomposition analysis and the impulse response function. The findings suggested that some of the activities are growing independent of the manufacturing sector. Nevertheless, manufacturing, construction and community, social and personal services are the most important drivers. Finally, this study predicted employment in the informal sector based on the magnitude of employment in different components of the organized or formal sector. Given the narrow margin of error of forecast the study argued that in the absence of time series information on total employment, the time series on organized sector employment can be used for necessary predictions and planning for employment and poverty.

Goldar (2009)\textsuperscript{33} analysed the impact of trade on manufacturing employment in India, it is found that exports had a favourable effect on industrial employment, but the positive effect of export increase was offset by the negative effect of increases in imports. The net effect was marginal. The failure of trade to raise industrial employment is traced primarily to the changing product composition of trade and the changing direction of trade. Petroleum products have emerged as a major item of India’s exports whereas the traditional labour-intensive products have lost their share. The analysis revealed an adverse effect of changing factor prices on manufacturing employment. One interesting finding of the study is that after a long


period of jobless growth, the corporate sector organized manufacturing has achieved in the last four years (2004-05 through 2007-08) a high rate of growth in employment, about 7 per cent per annum on average.

**Siggel and Agrawal (2009)**[^34] studied the impact of economic reforms on Indian manufacturing and used a small sample survey. Although there has been much theorizing on the impact of India’s economic reforms of 1991 on Indian manufacturers, there is hardly any previous study that has taken up the task of actually asked the manufacturing firms as to what the true impact of economic reforms has been on them. In this study, they reported the findings of a small sample survey of manufacturing enterprises in the Delhi region regarding perceptions of the impact of economic reforms of 1990s. Most firms felt that the reforms were helpful by increasing access to foreign technology and making imports of capital and intermediate goods cheaper. They also felt that improvement in infrastructure and more flexible labour laws will facilitate further growth of India’s manufacturing sector.

**Rajakumar (2011)**[^35] studied the size and growth of private corporate sector in Indian manufacturing. Used information from the National Accounts Statistics and Annual Survey of Industries, this study examined the performance of the corporate sector vis-à-vis the public and the household sectors in manufacturing during the period 1973-74 to 2007-08. The share of the corporate sector in industry characteristics such as number of employees, total emoluments, gross output and value added has increased since the early 1990s, with a corresponding decline of the public sector. Moreover, in absolute terms, the manufacturing GDP of the corporate sector grew at a faster rate compared to the public and household sectors since 1999-2000. Indian manufacturing is thus increasingly being led by the private corporate sector. However, the share of compensation to workers and employees in corporate income has steadily declined, pointing to the limited benefits accruing to employees from corporate growth.


Coad et al., (2011)\textsuperscript{36} presented a multidimensional empirical analysis of firm growth. Exploiting census data on Italian manufacturing firms in 1989–1997 and they estimated a reduced-form VAR to analyze the co-evolution of employment growth, sales growth, growth of profits and labour productivity growth. The main findings suggested that (i) employment growth precedes sales growth; (ii) productivity growth lacks any strong association with subsequent growth of the other indicators; (iii) profits growth represents the ‘absorbing dimension’ of the growth processes. This picture contrasts with ‘accelerator models’, predicting sales are the driver of the growth process, and is also at odds with theories of firm or industry evolution assuming productivity or profits advantages to be the driver of strong market selection/reallocation mechanisms. Instead, the findings revealed the existence of (weak) Penrose and (strong) Kaldor–Verdoorn effects, and more generally convey the view that employment growth is the key driver of firm expansion, while profits, once made, are not reinvested.

Babu and Raj (2011)\textsuperscript{37} examined the trends in regional industrial growth in India. The comparative trends since 1991 to the earlier decade and decipher the extent of the effectiveness of policy changes in disbursing industrial activity regionally. The study finds that organized manufacturing activity is concentrated in few states. The early movers continue to dominate cornering substantial share of the national industrial investments and production. Even in an era of market reforms the trend continues. This indicated a degree of “path dependence” in industrialization in the economy. There seems to be slight dispersal of activities in the unorganized segment. New forms of organization of production have fostered industrial growth in the unorganized segment. However, regions which dominate in the organized segment have been able to increase their share in the value added of the unorganized segment as well.


Bhat (2013) deals with the growth and structural changes in Indian industries, particularly the manufacturing sector over a period of 1950 to 2010. For the purposes of analysis the period has been divided into four segments. These are: 1) immediate post-independence era; 2) era of controls and regulations; 3) slow move towards liberalizations; and 4) post-liberalisation scenario. Issues relating to structural changes, productivity trends, and role of the public sector are also discussed with a view to trace the story Industrialization in a proper perspective. Industrial structure in India inherited the colonial legacy and continued in the same path with marginal changes till the end of the Second Five year Plan. Third Plan accorded emphasis on heavy industries with prominence to public sector. This policy failed to realize the targeted growth. The industrial policy was largely responsible for stagnation in Industrial growth. The licensing policy crippled the growth industries till the end of 1980s. Thereafter, India slowly moved towards liberalization. Post-liberalisation phase was marked with dismantling of controls and import liberalisation. The licensing system was done away with to a large extent. However, the industrial growth did not pick-up due to variety of reasons. The growth did accelerate after 2003-04 and continued till the worldwide depression 2008-09. The most structural change and occurred was industries shift towards capital intensity with rise in productivity of labour. Employment did not grow. It appears that industry is moving towards growth without jobs.

2.4 EARLIER STUDIES RELATED TO EFFICIENCY, TECHNOLOGY AND TOTAL FACTOR PRODUCTIVITY GROWTH

Caves (1974) analysed econometric techniques of Australian industry level data on 22 industries at 2-digit for 1962 and 1966. He concluded that relatively high subsidiary shares in Australian manufacturing sectors are associated with higher productivity levels in competing domestic firms.

---


Findlay (1978) found that FDI can increase the productivity of the host country as the more advanced management techniques and technologies of the foreign firms spread to local firms. Multinational companies are usually at the technological frontier and have access to latest and most advanced technologies. It is expected that as the investment in plants in developing countries. It is hoped that the technology that is embedded in the multinational companies’ plant will spread to other plants in the countries.

Savithri (1993) analysed growth, technical efficiency, productivity, and export performance of Indian engineering industries during 1980-81 to 1993-94. She found that the cross-section characteristic of Kendrick index of TFP growth for the period 1980-81 to 1993-94, found was better in the reference period. Moreover the cross section characteristic of Solow index of TFP growth was higher than the base year value of 100 in 13 of the 14 years study period. In general, her study found a positive TFP trend in the Indian engineering industries.

Fujita (1994) evaluated the effect of liberalisation policies on productivity growth in Indian manufacturing industries for the period 1981-82 to 1987-88. He argued that increase in the share of public sector in value added usually reflects restrictions in attempts at liberalisations. He thus used this share as a proxy for trade policy and found a negative relationship between increase in share of public sector and TFP growth.

Fare et al., (1995) analyzed the productivity in Taiwanese manufacturing industries. The study focused on four Taiwanese major industry groupings, comprising essential goods, chemicals, metal machinery and electrical precision. Used the non-parametric DEA approach, the TFP level of the overall manufacturing


sector measured by the Malmquist TFP index progressed at 3.59 per cent annually solely due to technological progress during the period 1978-1989. Subsequently, Fare et al., (2001) extended their earlier study and calculated Malmquist productivity indexes for 16 of Taiwan’s manufacturing industries between 1978 and 1992. They suggested that Taiwan’s manufacturing sector has on average enhanced TFP by 2.89 per cent per annum.

Upender (1996) estimated the elasticity of labour productivity so as to find the substitution possibilities of labour for capital in the Indian manufacturing sector covering the period 1973-74 to 1989-90. The results of this exercise showed that Indian manufacturing (factory) sector is capital intensive and is operating under decreasing returns to scale. The elasticity of labour productivity is found to be significantly more than unity implying that substitution possibilities in favour of labour are quite high. Therefore there is need to redirect the Indian manufacturing sector towards greater use of labour intensive technology until the marginal productivity of labour is equal to marginal wage rate.

Singh (1996) evaluated total factor productivity in the manufacturing industries in India for the period 1973-74 to 1993-94. The data were collected from various issues of the Central Statistical Organisation (CSO) publications viz. National Account Statistics and Annual Survey of Industries, the Reserve Bank of India (RBI) publications viz. Economic Survey and Index Numbers of Wholesale Prices. The total factor productivity was computed in levels using the Solow’s residual for different industries in the manufacture sector in India. He concluded that the TFP in the Food product industry recorded trend growth rate of 2.68 per cent during the overall period 1973-94. TFP recorded improvement in all the sample industries, except for the basic metals industries. The highest growth in TFP was observed in the case of the Food product industry.


Neogi and Ghosh (1998)\textsuperscript{47} studied the impact of liberalisation on the performance of selected Indian industries with firm level data. The performance indicators chosen for this study are growth of value added, capital intensity, labour productivity (partial productivity indicator) and total factor productivity (TFP). The study also observed the performance of these industries in terms of inter-temporal changes in efficiency from 1989 to 1994. The study concluded that productivity growth and efficiency level have not improved as per expectation during the post-reform period and the distribution of efficiency is skewed. However, the time period is not long enough to reach any final conclusion. But such study is needed to review the impact of liberalisation on Indian industries for better monitoring of reform policies.

Goldar and Agarwal (1999)\textsuperscript{48} measured technical efficiency/inefficiency and its determinants for the top 100 firms of the Indian engineering industry for the period 1987-88. The study based on the data published by the Confederation of Engineering Industries (CEI). A Cobb-Douglas frontier production function with three inputs viz. labour, capital, and energy had been used. A modified COLS method had been used to construct the efficiency index. They concluded that around 25 per cent of firms were found to have below 50 per cent efficiency level. Major determinants of efficiency were: size of the firm, expenditure on research and development, import intensity and retention ratio. Further, it was found that efficiency was lower in public sector firms compared to firms in the private sector.

Balakrishnan et al., (2000)\textsuperscript{49} estimated the trade liberalisation and productivity growth in manufacturing industries evidenced from firm-level panel data. They Used panel data comprising firm-level information drawn from groups within manufacturing industry which have experienced the most significant tariff reduction, this study investigated the trend in productivity growth since 1988-89.


The sample of 2,300 firms and 11,009 observations, spanning the period 1988-89 to 1997-98 is very likely the largest assembled for the purpose thus far. They find no evidence of acceleration in productivity growth since the onset of reforms in 1991-92. The result is evaluated in relation to the changes till date in the policy regime in the Indian economy.

**Kathuria (2000)** employed techniques from stochastic production frontier and panel data literature to test a spillover hypothesis for large sized firms that ‘presence of foreign-owned firms and foreign technical capital stock in a sector leads to reduced dispersion in efficiency in the sector and fall is higher for the firms that invest in R&D activities’. Dispersion being a relative concept, it may still fall if both the leading foreign firm and domestic firms showed fall in technical efficiency over the period and the fall for the leader is higher and vice versa. Given the focused of the study, where concern is for the learning by the domestic firms, the study tries to get around with the problem partially, by testing the hypothesis for those local firms that have showed productivity improvement over the period. Results suggested that foreign-owned firms are close to the frontier in 13 of the total 26 sectors studied. Spillovers result of these 13 sectors indicated that there exist negative spillovers from the presence of foreign firms in the sector, but available foreign technical capital stock has a positive impact. Interesting differences emerge when the sample is bifurcated into scientific and non-scientific subgroups. Results for the scientific subgroup indicate that the indirect gains or spillovers are not automatic consequence of foreign firm’s presence, but they depend to a large extent on the efforts of local firms to invest in learning or R&D activities so as to decodify the spilled knowledge. On the other hand, the evidence of spillovers to non-scientific non-FDI firms is not very strong.

**Trivedi et al., (2000)** presented the TFP estimates for five major industrial groups namely, Textile, Metals and Metal products, Machinery and Transport, Cement, Chemical and Chemical product, and Leather and Leather product. For

---


Textile and Chemicals, the growth rate of TFP is lower in the 1990s compared to the 80s, for Metal and Metal products, and Leather and Leather product the growth rate is higher in the 1990s for Machinery and Transport equipment, no significant change in the TFP growth rate is indicated.

Aw et al., (2001)\textsuperscript{52} analysed the firm-level evidence on productivity differentials and turnover in Taiwanese manufacturing, applied the multilateral TFP index to three Industrial and Commercial Census data in 1981, 1986 and 1991 in order to investigate the TFP differentials of Taiwanese firms. They subsequently computed TFP growth for the nine manufacturing industries at the 2-digit level. With the exception of the transportation equipment industry, all other industries gained TFP growth between 7.8 per cent (clothing) and 36.6 per cent (chemicals) over the period 1981-1991. At the manufacturing level, the weighted TFP growth was estimated to be 32.4 per cent during the decade (or 3.2 per cent per annum).

Oczkowski and Sharma (2001)\textsuperscript{53} examined the relationship between trade liberalisation and productivity growth in Australian manufacturing. The data used for the analysis were taken from Industry Commission (1995). The study found that in significant improvements in productivity growth were identified for four industries; these improvements were accompanied by lower mark-ups and falling scale parameters. A minority of industries however, experienced no change or falling productivity growth in response to reforms, these industries tended to have the highest absolute protection levels.

Kim and Han (2001)\textsuperscript{54} applied a stochastic frontier production model to Korean manufacturing industries, to decompose the sources of total factor productivity (TFP) growth into technical progress, changes in technical efficiency,
changes in allocative efficiency, and scale effects. Empirical results based on data from 1980–1994 show that productivity growth was driven mainly by technical progress that changes in technical efficiency had a significant positive effect, and that allocative efficiency had a negative effect. This study suggested that specific guidelines are required to promote productivity in each industry, and provides additional insight into understanding the recent debate on TFP growth in Korean manufacturing.

Parameswaran (2002) studied the technical efficiency of selected Indian industry during 1989-90 to 1997-98 and found that the changes in the policy environment has a positive effect on technical efficiency in all except one industry and the level of efficiency lower in the post-reform period in all industries considered. The decline in the level of technical efficiency happened in the context of higher level of technical progress, identified as the upward shift of the best practice technology in all industries. indicated that majority of the firm failed to catch up with the shifting frontier technology, resulting in an increase in their inefficiency. Then hypothesis that a more liberalised trade regime enables the firms to acquire foreign technological knowledge through their export, import of technology and raw material import and there by enhance the production efficiency was also examined. He also studied that firms export activity, import of technology and raw materials are contributing to higher efficiency.

Ray (2002) estimated the impact of economic reforms on the efficiency improvement and productivity. He analyzed the state level input and output quantity data constructed from the Annual Survey of Industries (ASI) for the period 1986-87 through 1995-96 and measuring technical efficiency by using non-parametric method of Data Envelopment Analysis (DEA). The study also measured both Tornqvist and Malmquist indexes of multi-factor productivity for each state for individual years treated the preceding year as the base. This study suggested that, on


average, the annual rate of productivity growth has been higher in the post-reform period than in the pre-reform year. However, some states have actually experienced a slowdown in the productivity growth or even productivity decline after the reforms. Further, the decomposition of the Malmquist productivity index shows that improvement in technical efficiency as well as faster rates of technical progress contributed to the observed acceleration in the growth rate. A subsequent regression shows that there is a tendency towards convergence in productivity growth rates across states.

**Driffield and Kambhampati (2003)**\(^{57}\) studied trade liberalization and the efficiency of firms in Indian manufacturing and analysed the determinants of firm-level efficiency in six manufacturing sectors in India while focusing the effects of liberalization and domestic competition. They found that there was an increase in overall efficiency in the post-reform period in India in five out of the six sectors. While imports do not seem to improve efficiency, liberalization did increase efficiency in four of the sectors.

**Patinayak and Thangavelu (2003)**\(^{58}\) studied the Economic reform and productivity growth in Indian Manufacturing Industries. Translog cost function was used to analyze the production structure in terms of biased technical change and economies of scale. The objective of the study was to compare the changes in production structure of the post liberalization period of 1990’s with semi liberalization period of 1980’s. The results supported the evidence that there were economies of scale in the Indian manufacturing industries and it has been exploited after the economic reforms in 1991. Most of the industries revealed bias technology change and majority of the industries have experienced capital using technical change. They suggested that the key economic reforms of liberalizing the capacity licensing regime that allowed greater investment in capital goods would have a positive impact on productive performance of the industries if the price of capital does not substantially increase after the economic reforms.


Unel (2003) examined the impact of reforms of the 1980s and the 1990s on the manufacturing sectors in India by analyzing the productivity performance of manufacturing over the period 1979-80 to 1997-98. The main data source was Annual Survey of Industries (ASI). This study covered the data for 13 manufacturing sector. He concluded that over the period of 1978-80 to 1997-98, the capital-output ratio has been virtually constant. Output-Labour ratio and Capital-Labour ratio had growth rate of 6 per cent and 7 per cent respectively. The average annual growth rate of TFP was 1.8 per cent, which was about 30 per cent of overall labour productivity growth; under the assumption of a constant elasticity of 0.6, the average annual growth rate of TFP was 3.1 per cent, which is about 50 per cent of overall labour productivity.

Mahadevan and Asafu-Adjaye (2004) evaluated the causal links between productivity growth and two price series given by domestic inflation and the price of mineral products in Australia’s mining sector for the period 1968-1969 to 1997-1998. The study also used a stochastic translog cost frontier to generate improved estimates of total factor productivity (TFP) growth. The results indicated negative unidirectional causality running from both price series to mining productivity growth. Regression analysis further showed that domestic inflation has a small but adverse effect on mining productivity growth, thus providing some empirical support for Australia’s inflation first monetary policy, at least with respect to the mining sector. Inflation in mineral price, on the other hand, has a greater negative effect on mining productivity growth via mineral export growth.

Sun (2004) identified the sources of output growth using a varying coefficients frontier model in which total factor productivity (TFP) growth can be decomposed into change in technical efficiency and technological progress, taking account of industry-specific characteristics. The study also compares high-tech and low-tech industries on the basis of two proposed hypotheses and analyses the

---


components of TFP growth using long-term trends in technological progress and change in technical efficiency. The empirical result showed that the level of TFP in Taiwan’s manufacturing sector merely increased by 0.2 per cent a year during the period 1981-1999, stemming from 0.4 per cent technological progress and 0.2 per cent decline in technical efficiency. The insignificant TFP growth of 0.2 per cent over the past two decades was mostly driven by TFP slowdown in the 1990s.

Margono and Sharma (2004) estimated the technical efficiencies and total factor productivity (TFP) growth in food, textile, chemical and metal products industries during 1993 to 2000 in Indonesia by using the stochastic frontier model. Furthermore, the determinants of inefficiency are also analyzed and the TFP growth is decomposed into technological progress, scale component, and efficiency growth. The results revealed that the food, textile, chemical and metal products sectors are on average 50.79 per cent, 47.89 per cent, 68.65 per cent and 68.91 per cent technically efficient respectively. It is noted that ownership contributed to technical inefficiency in the food sector; location and size contributed to technical inefficiency in the textile sector, whereas size, ownership and age contributed to inefficiencies in the chemical and metal products sectors. The estimates of TFP growth indicate that productivity in Indonesian manufacturing industries decreased at the rate of 2.73 per cent, 0.26 per cent, 1.65 per cent and 0.5 per cent in food, textile, and metal products respectively, whereas in the chemical sector, it increased at a rate of 0.5 per cent during the period of the study. The decomposition of TFP growth indicated that the growths are driven positively by technical efficiency changes and negatively by technological progress in all four sectors.


before and after Infitah, explores the impact of the Infitah liberalization policies that began in 1974, and compares the findings to those of earlier studies. A longer time series data set is used than in earlier studies. The analysis points to structural change in the manufacturing sector within the twenty year period as evidenced in changes in the shares of the private and public sector, and in the shares of different sub-sectors in employment and output. The data analysis suggested that the period following Infitah, 1974-1983 witnessed the most rapid growth in private sector manufacturing output and investment but measured productivity growth remained low for the public and private sector. Also estimated individual, firm-specific measures of productive efficiency among Egyptian glass factories in 1981-1986. The procedure combines techniques developed on stochastic production functions, panel data estimation, and analysis of covariance. The procedure performed well in estimating actual differences in technical efficiency among establishments, with similar rankings from three estimation models; assuming time invariant inefficiency, time varying efficiency and efficiency estimated as a random variable. The mean firm technical efficiency lies between 78 percent and 95 percent depending on the estimation method. There was no evidence of improvement over time. The firm characteristics most significantly associated with these rankings were the age and size of the firm. Larger firms, most of which were public, outperformed the medium and small private firms. Lower education level of the manager, higher replacement cost of capital, and more complete book-keeping records also helped explain variations in productive efficiency.

Sampathkumar (2006) studied the impact of economic reforms on the productivity levels of a chemical industry at the aggregate and sub-sectors level. While the net impact of the reform process on total factor productivity growth was found to be poor at the aggregate level, the sub-sectors declining in the post-reform period. This study concluded that there was no significant improvement in the post-reform period.

---

Kim and Park (2006)\textsuperscript{65} studied the productivity gains in Korean manufacturing and found it was efficiency improvement rather than from technical progress for the productivity growth. These findings are contrary to those of previous sectoral studies of Korean and Taiwanese manufacturing, but are consistent with those of cross-country studies. Regression results estimated by this study showed that both domestic and foreign R&D played an important role in increasing efficiency and technical progress in Korean manufacturing. However, domestic R&D has more effect on technical progress, while foreign R&D has played a relatively stronger role in efficiency improvement.

Kumar (2006)\textsuperscript{66} studied the decomposition of total productivity growth of a regional analysis of Indian industrial manufacturing growth. The findings of the study indicated the improvement in total factor productivity. The recent change in TFP is governed by the technical progress in contrast with similar gain caused by the improvement in technical efficiency in the pre-reform regime. The technological progress in state manufacturing exhibited a capital-using bias during the study period. Regional differences in TFP persist, although the magnitude of variation has declined in the post-reform period. Moreover, it is also found that there is a tendency for convergence in terms of TFP growth rate among Indian states during the post-reform years and only the states that were technically efficient at the beginning of the reforms remain innovative.

Ahmed (2006)\textsuperscript{67} examined the Malaysia’s manufacturing productivity growth input driven and the productivity indicators within the manufacturing sector for the period 1959-2001 were compared. In order to study the effects of Government policies in improving the sector’s productivity growth, the study period was split into three phases, viz., 1971-1979, 1980-1986 and 1987-2001, which corresponded with the major policy changes. Two models were generated from the production


functions to measure manufacturing sector productivity growth. The first models is an extensive growth theory model and the second one is an intensive growth theory model. The extensive theory model had a gap that cast doubt in the results. A statistical analysis was provided to close this gap. The results showed a slowdown in the contribution of total factor productivity growth and negative growth of labour productivity of the sector. A negative impact of quality of inputs used by the sector was observed in the contribution of TFP and labour productivity growth in comparison with other productivity indicators of the sector. This study found that productivity growth of Malaysia’s manufacturing sector is input driven rater than total factor productivity driven.

Fingleton (2007) studied a multi-equation spatial econometric model is used to explain variations across EU regions in manufacturing productivity growth based on recent theoretical developments in urban economics and economic geography. The study showed that temporal and spatial parameter homogeneity is an unrealistic assumption, contrary to what is typically assumed in the literature. Constraints are imposed on parameters across time periods and between core and peripheral regions of the EU, with the significant loss of fit providing overwhelming evidence of parameter heterogeneity, although the final model does highlight increasing returns to scale, which is a central feature of contemporary theory.

Sampathkumar (2007) analysed and compared the structural changes in the industrial sector in the southern states of the country in relation to the on going economic reforms of the country. The Divisia-Tornquist (D.T) approximation has been used for the calculation of total factor productivity growth. The study found that the increased capital-labour ratio and a decline in the output-labour ratio in the post-reform period, at the aggregate and state level, indicate the availability of more capital and relative increase in the labour productivity.


Montes-Rojas and Santamaria (2007)\textsuperscript{70} studied labour and total factor productivity in the Mexican manufacturing sector for the 1994 to 2002 period. Labour productivity increased at an annual rate of 3 percent, while total factor productivity has null or negative growth depending on the methodology used. They conducted several robustness checks by providing alternatives measures of productivity growth. Moreover, they investigated the sources of productivity growth by studied the impact of international trade, investment, quality of the labour force and labour market institutions.

Sharma (2007)\textsuperscript{71} analysed the impact of liberalisation on the productivity performance of the Indian cement industry. Under the growth accounting approach, Divisia Tornquist index has been used to construct the Total Factor Productivity Growth (TFPG) index and the Partial Productivity Indices (PPIs) of four factors of production viz., capital, labour, material and energy. The findings reveal that the Indian cement industry has experienced a sharp decline in the TFP index over a study period from 1989 to 2005. The results on PPIs also corroborate with TFP findings indicated the fact that in the Indian cement industry, the inputs have not been used efficiently. Though the empirical analysis of productivity revealed a dismal state, but at the same time it also indicated that the reversal of this phenomenon can play a crucial role in enhancing the competitiveness of this industry.

Kim (2007)\textsuperscript{72} decomposed total factor productivity (TFP) growth into technical progress (TP), technical efficiency change (TEC), allocative efficiency change (AEC) and scale efficiency change (SEC) to Malaysian manufacturing data from 2000 to 2004. The study also identified the factors that determine each TFP component. Empirical results show that TFP was driven mainly by TP, but plagued by deteriorating TEC. The skill and quality of workers represent the most important


determinants of TE, whereas foreign ownership, imports and employee quality represent those of TP. The impact of firm size on SEC differed across industries, and AEC determinants were identified.

Kalirajan and Bhide (2007)\textsuperscript{73} provided an assessment of the technical efficiency of the firms in the food processing sector and showed that there were large levels of inefficiency and that catching-up with the best performance had been slow. They showed significantly high levels of productivity inefficiency, particularly in the use of labour input and overall general firm’s level productivity. Although the response of output to the use of capital did not show variation across firms, there was considerable variation in the output response to labour input and other disposable inputs such as raw material. The decline in technical efficiency was more concentrated among firms producing lower level of output rather than among firms producing larger amount of output.

Natarajan and Raj (2007)\textsuperscript{74} studied the technical efficiency in the informal manufacturing enterprises and used firm level evidence from an Indian state. The small and medium enterprise sector plays a pivotal role in the socio-economic development and growth of nations. But there is evidence that the firms in this sector are less efficient than those in the large enterprise sector. Hence it is imperative to examine their efficiency levels in order to identify the factors that contribute inefficiency in these firms and to generate information for designing support policies for them. In this study, level and sources of technical efficiency in the unorganised manufacturing sector in the Indian state of Kerala is examined using translog stochastic frontier production function. The analysis is conducted for five broad industry groups and the sector as a whole using firm level data. The findings showed that high levels of technical inefficiency, which reduce their potential levels significantly, characterize the unorganised manufacturing enterprises in Kerala. Regarding the factors contributing to inefficiencies, it is observed that size, ownership, region (location) and nature of seasonality of operation significantly


influence technical efficiency level in most of the industry groups. They also find that credit availability and employment of hired labour play an important role in explaining technical efficiency levels.

Anbumani and Saravanakumar (2008) examined the total factor productivity (TFP) growth and its components (technical efficiency change and technology change) in the Indian textile industry during pre and post economic liberalisation period. The TFP growth was estimated applying Data Envelopment Analysis (DEA) based Malmquist Productivity Index (MPI) on both time series and cross-sectional data for the period 1980-81 to 2004-05. Based on the Malmquist productivity indices, they found that TFP had grown at the rate of 4.5 per cent in the pre-reform period but declined by 0.7 per cent in the post reform era. The pre-reform TFP growth was due to technical change and post-reform was influenced by technical efficiency.

Bhattacharya et al., (2008) examined spillovers from foreign direct investment (FDI), research and development (R&D) and exporting activities on productivity both for foreign and domestic manufacturing firms. The data is obtained from the PROWESS database provided by the Centre for Monitoring Indian Economy (CMIE). Balanced panel of over 1,000 manufacturing firms in India between 1994 and 2006 are considered for our empirical analysis. Findings indicated that foreign presence has a significant spillover effect on the productivity of the Indian manufacturing firms compared to the alternative spillovers such as from R&D and export initiatives.

Haouas and Yagoubib (2008) investigated the effects of trade liberalization on labour demand elasticities. The employment demand equation is estimated by using data for manufacturing industries in Tunisia covering the period from 1971 to 1996. The empirical results suggested a weak support for the idea


assuming that trade liberalization will lead to an increase in labour demand elasticities: in the vast majority of industries considered, the study cannot reject the hypothesis of no relationship between trade openness and labour demand elasticities. This weakness of labour demand elasticity in practice is perhaps explained by the tight labour market regulations in place during the 1987–1996. However, these results are robust to the type of labour considered (contract labour and permanent labour). This supports the conclusion that under liberalization labour markets have become more flexible, and that employers prefer recruiting contract workers.

**Goldar and Mitra (2008)**\(^78\) analysed how productivity increase and changing sectoral composition in India have contributed to an accelerated economic growth in the post1980 period. Productivity analysis revealed that a faster total factor productivity growth in the services sector in the post-1980 period has been an important contributor to accelerated economic growth. Within the services sector, the post-1980 hike in the growth rate of productivity was found to relatively higher in the trade, hotels and restaurants group and the public administration and other community, social and personal services group. Econometric analysis of the impact of different sectors on the rest of the economy brings out that the trade-transport sector and the secondary sector are important determinants of the growth of the economy. Variance decomposition analysis aimed at assessing the inter-sectoral growth linkages indicates that the causality runs from secondary sector to the trade-transport sector rather than in the revere direction. It is accordingly argued that though there has been a major shift in the composition of GDP towards services and this has contributed to the overall growth in India, it is the secondary sector which is the lead sector in the medium to long run, and the policy focus should therefore be on manufacturing.

**Chandran and Pandiyan (2008)**\(^79\) examined the total factor productivity (TFP) growth by decomposing it into technical efficiency and technological change for the 20 service industries in a developing country – Malaysia from 1987 to 1992.

---


On average, the TFP growth of the service industries experienced positive TFP growth of 1.8 per cent. The contributing factors for TFP growth was technical efficiency while technological regress was found to dampen the TFP progress.

Raj et al., (2008)\textsuperscript{80} analyzed total factor productivity growth of the unorganized manufacturing sector in India using several rounds of the large scale national sample survey state level data for 15 major Indian states for the period 1978-1979 to 2000-2001. Data envelopment analysis is used to compute Malmquist total factor productivity index and its components. The impact of economic reforms on efficiency and productivity is examined. Evidence suggested that total factor productivity registered a positive growth during the period in the country as a whole. Most states in the country witnessed higher total factor productivity growth in the post 1990s reforms period than in the pre-reforms period. Decomposition of the Malmquist productivity index shows that improvement in technical efficiency rather than technical progress had contributed to the observed acceleration in the growth rate. Econometric analysis of the determinants of total factor productivity growth demonstrates that ownership, literacy, farm growth and infrastructure availability significantly influence total factor productivity growth in the sector.

Ali et al., (2009)\textsuperscript{81} analysed efficiency and productivity changes in 12 broad segments of food manufacturing industries during pre and post liberalisation periods, covering a period of two decades, from 1980-1981 to 2001-2002. The nonparametric Data Envelopment Analysis (DEA) approach is used to compute the Malmquist Total Factor Productivity (TFP) change, which has been further decomposed into efficiency and technical change. The study also evaluated the performance of major inputs used in the food processing industry and identifies the causes of inefficiency across various segments. Based on the findings, the study suggested that can be used by policy makers and food processors in making decisions regarding various technical and managerial aspects to improve productivity and efficiency.


Majumdar (2010) focused on contribution of technical efficiency change (TEC) and technological progress (TP) to output growth (OG) and addresses the issue of poor total factor productivity growth of electronics hardware industry during liberalization. Inter-sector differences in productivity have been explained from the perspective of management decision making and their performances. The study suggested that the industry, in general, emphasized more on TP than TEC as the industry moved to a greater liberalization regime. The industry lacked the efforts to develop indigenous technology. It catered to huge domestic demand by importing technology without proper adaptation leading to poor TEC.

Kathuria et al., (2010) analysed the productivity performance of both the organised and unorganised segments of the Indian manufacturing sector using unit level data. Both partial and total factor productivity measures are employed. This analysis reveals that labour productivity has increased for the organised sector over time, whereas both labour productivity and capital intensity growth have slowed down in the unorganised sector during the period between 2000-01 and 2004-05. The improvement in TFP growth in organised manufacturing in the post-2000 period as compared to the second half of the 1990s across most states in India is heartening as also the fact that output growth was mostly productivity-driven in the post-reform period. However, the declining TFP and the increasing capital intensity of the unorganised sector are causes of worry and raise several important questions.

Hamit-Haggar (2010) applied a stochastic Frontier production model to Canadian manufacturing industries, to investigate the sources of total factor productivity (TFP) growth. As productivity (growth) appears to be the single most important determinant of a nation’s living standard or its level of real income over long periods of time, it is important to better understand the sources of productivity.


growth. In Canada, TFP growth is the major contributing factor (relative to changes in capital intensity) to labour productivity growth, particularly in manufacturing sector. However, the TFP gap is also the main source of labour productivity gap between Canada and other industrialized (Organization for Economic Co-operation and Development) countries in recent years. The decomposition revealed that during the period under study, TP has been the main driving force of productivity growth, while negative efficiency changes observed in certain industries have contributed to reduce average productivity growth. In addition, the empirical results showed that research and development expenditure, information and communications technology investment, as well as trade openness exert a positive impact on productivity growth through the channel of efficiency gains.

**Sampathkumar and Saravanakumar (2010)** estimated the changes in total factor productivity (TFP) of the Indian chemical sector during the period 1980-81 to 2001-02. The Malmquist indices of TFP growth are computed and decomposed into technical change and efficiency change. The obtained estimates of TFP change at the aggregate and sectoral levels indicate that the net impact of economic reforms on the productivity growth of chemical sector was negative. It is evident from the study that the negative TFP change in the chemical sector at the aggregate level aggravated (from 0.4 per cent to 4.1 per cent) in the post-reform period. It is seen that technical change is the factor that leads to deterioration in the overall productivity of the Indian chemical sector. Similar trends are also observed at the sub-sectoral level.

**Radam et al., (2010)** studied the technical efficiency of the Malaysian wooden Furniture industry and used a stochastic frontier production approach. The Wood furniture industry is an important component in our manufacturing sector for it significantly contributes to the industrialization of Malaysia’s economy. Evaluating wood furniture industry’s level of efficiency is important to assist and provide a relative direction to small and medium firms on their business. The

---


The objective of this research was to examine the efficiency of the wooden furniture industry by determining the technical efficiency using a stochastic frontier production model. Results showed that firm output is 54 per cent less than the maximal output which can be achieved from the existing inputs. The technical inefficiency on individual firm varies from 1.63 to 94.69 per cent and so does the potential to increase firm output from the existing inputs. This evidence suggested that many firms still operate below the efficiency level, confirming the conventional view that labour-intensive firms are most likely inefficient.

Goldar (2010) examined the hypothesis that trade liberalisation raises labour demand elasticity is tested for Indian industries, and inter-temporal changes in the elasticity during 1973-74 to 2003-04 are analysed. Econometric results indicated that trade liberalisation in India had a positive effect on the labour demand elasticity. However, the estimated elasticity for the post-reform period (1991 onwards) is found to be lower than that for the pre-reform period. A closer examination reveals a marked upward trend in the labour demand elasticity after the mid-1990s, which seems attributable, among other factors, to trade liberalisation, weakening of trade union bargaining power and labour market reforms.

Mariappan (2011) estimated the economic returns to scale, marginal productivities of labour and capital inputs for two-digit level industries in India’s unorganised manufacturing sector. The results showed that the elasticity of output with respect to labour and capital has increased and significantly contributed to the output growth during the post-reform period compared with pre-reform period. The sum of elasticities of labour and capital is greater than unity in all types at industries in 2005-06 at the aggregate level. The estimated coefficient of the year dummy variable for 1989-90 is negative in the Cobb-Douglas, Translog and CES production functions. The coefficient estimates for year dummies reflect the noticeable output differential at aggregate and sub-sector.


Velnampy (2011)\textsuperscript{89} examined the value added, productivity and performance of few selected companies in Sri Lanka with the sample of 15 financial companies listed under the Colombo Stock Exchange (CSE). The study revealed that, profit before tax per employee and value added per rupee of fixed asset is positively correlated and labour cost to sales and gross profit is also positively correlated. Further the labour cost to value added is correlated with gross profit and value added per rupee of fixed asset and no relationship was found between the rest of the productivity and performance measures.

Sehgal and Sharma (2011)\textsuperscript{90} used different categories of organized sector manufacturing industries pooled data for the periods of 1981-1982 and 2007-2008 in Haryana state (India). They analyzed the inter-temporal and inter-industry comparison of Total Factor Productivity (TFP) measured by Malmquist productivity index-an application of DEA which calculates the indices of TFP and its components including technology and efficiency changes. The general development pattern observed by the Haryana was definitely not a healthy sign of structural change in the economy. The analysis of the discussion reflects that while the tertiary sectors have maintained its lion’s share in GDP of India and Haryana as well, the declining trend in the share of primary sector and more or less stable contribution of the secondary sector is noticeable. The study revealed that technical efficiency change is the key driver of TFPG in the manufacturing sector of Haryana during pre-reforms period, however, the picture has turned around during the post-reforms period. A positive impact of liberalization policy on technological advancement of the manufacturing sector of the state has been experienced. The post-reforms period the state has showed the inefficiency in the utilization of resources in hand as an alarming sign indicating the incapability of manufacturing sector of the state in question in dealing with the level of technological advancements.


Nataraj (2011)\textsuperscript{91} investigated the impacts of trade on firm productivity, there is almost no evidence on how small firms react to trade liberalization. Used a unique dataset of firm-level surveys that are representative of the entire Indian manufacturing industry, the study showed that India’s unilateral reduction in final goods tariffs increased the average productivity of small, informal firms, which account for 80 per cent of Indian manufacturing employment but have been excluded from previous studies. In contrast, the increase in productivity among larger, formal firms was driven primarily by the concurrent reduction in input tariffs. By examined the effect of the tariff liberalization on the distributions of productivity and firm size, he find evidence consistent with the exit of the smallest, least productive firms from the informal sector. In addition, he find that although the decline in final goods tariffs did not significantly impact average formal sector productivity, it did increase productivity among the top quantiles of the distribution.

Bogliacino and Pianta (2011)\textsuperscript{92} estimated the diversity of technological activities that contribute to growth in labour productivity is examined in this study for manufacturing and services industries in eight major EU countries. They tested the relevance of two “engines of growth”, i.e., the strategies of technological competitiveness and cost competitiveness and their impact on economic performance. They proposed models for the determinants of changes in labour productivity and they carry out empirical tests for both the whole economy and for the four Revised Pavitt classes that group manufacturing and services industries with distinct patterns of innovation. Tests are carried out by pooling industries, countries and three time periods, used innovation survey data from CIS 2, 3 and 4, linked to economic variables. The results confirmed the specificity of the two “engines of growth”; economic performances in European industries appeared as the result of different innovation models, with strong specificities of the four Revised Pavitt classes.


Arzu and Ghosh (2012) analyzed the factors influencing the value added growth in Turkish public and private manufacturing sectors during 1980-2001. With this aim in view, a Two-Deflator Growth Accounting (TDA) method is applied in the study. It is revealed that industries as a whole have positive value added growth with no negative contribution of capital. Although human capital’s contribution to the industrial sector’s growth as a whole and especially to public sector industries is not very significant, its contribution to the private sector industries remains significantly high. The overall contribution of raw labor is able to explain most of the contribution of labor to value-added growth in Turkish manufacturing industry during the period 1980-2001.

Saravanakumar and Kim (2012) applied the Malmquist productivity index in order to estimate total factor productivity growth and its components (efficiency change and technological progress) in Indian manufacturing during the pre- and post-reform periods. The results illustrate that the economic reforms have not exerted positive effects on productivity growth in Indian manufacturing. However, the impacts of economic reforms differ between sectors and between components of total factor productivity. First, after reform, the productivity of heavy industries increased, whereas the productivity of light industries decreased. Second, reform improves both the efficiency and the technological progress in the heavy industries, but failed to improve efficiency in light industries. The results of this study suggested that specific policies should be implemented in order to improve efficiency as well as technical progress, thus ultimately facilitating long-run productivity growth.

Ray (2012) used the methodology in measuring productivity growth by decomposing it into technical change and technical efficiency change in India’s paper industry. The prime objective of this article is to assess the impact of


liberalization on productivity growth of India’s paper industry. Specifically, this study quantifies the level of technical efficiency and technical change in this particular manufacturing sector. The study applied Malmquist Productivity Index method to different sub-sectors of India’s Paper and pulp industry at aggregate level in order to have trend in productivity growth covering a period of 28 years commencing from 1979-80 to 2006-07. Finally, regressing the log difference of the measured productivity growth on the log difference of the capacity utilization rate which is a proxy for business cycle, attempt has been made to find out capacity utilization adjusted TFP growth. The result of this study reveals decline in growth rate of TFP during post-reforms (1991-92 to 2006-07) period showing adverse impact of liberalization at aggregate level. Results also indicated that during the study period, industry also experienced regress in technological progress along with stagnation in technical efficiency. Non-responding technical efficiency change and the deteriorating technical change were the main ingredients responsible for declining productivity change in Indian paper and pulp industry. Moreover, removal of short run variations in capacity utilization from the estimated TFP growth hardly affects its overall movement but remarkably mitigates its variation because variations between sub-periods are lesser after adjusting capacity utilization as cyclical factor.

Kim and Saravanakumar (2012)\textsuperscript{96} examined a stochastic frontier production function model is applied to Indian manufacturing industries, to decompose the sources of total factor productivity growth into technical progress, technical efficiency, scale efficiency, and allocative efficiency. Empirical results based on data from 2000 to 2006 suggested that increased investment needs time to deliver increased productivity and efficiency, because new technology combined with fresh investment requires higher numbers of skilled workers, better managerial practices and an advanced input mix, all of which generally take time to develop. Thus, the Indian economy must boost technical efficiency by providing skilled workers and high quality managers to further economic reform.

Charoenrat et al., (2013) found that the Thai manufacturing small and medium sized enterprises (SMEs) face intense competition in domestic and foreign markets. Given their importance to the economic development of the country it is important to have a clear understanding of their readiness to face the rigors of international competition, including the barriers and specific problems that they face. This study used a stochastic frontier analysis (SFA) and technical inefficiency effects model to analyze the technical efficiency of Thai manufacturing SMEs and key factors impacting upon it. Analysis of cross-sectional data from a 2007 census of Thai manufacturing SMEs indicated that their weighted average technical efficiency is approximately 50 percent, signifying a high level of technical inefficiency which is reducing potential output. The inefficiency effects model revealed that firm size, firm age, skilled labor, ownership characteristics and location are firm-specific factors that significantly affect the technical inefficiency of production. Key measures to improve the technical efficiency of Thai manufacturing SMEs are an adequate supply of inputs, access to credit facilities, extensive infrastructural development and training programs for employees.

Vijayakumar and Gomathi (2013) studied the productivity growth in Indian oil refineries of efficiency improvement or technical improvement. Productivity acts as a parameter to measure the efficiency of an industry. Productivity studies help to estimate the measure of protection to be granted to an industry. An increase in the level of productivity reflects an increase in the efficiency of inputs. In this study DEA (Data Envelopment Analysis)-Malmquist Index was used to identify the sources of Total Factor Productivity growth which will help the policy makers to know the performance of industry and take steps to increase productivity and efficiency in selected oil refineries in India. The inference made in the analysis reveals that all the companies recorded productivity improvement and a similar trend was noticed in the technical change also. In


efficiency change, there are four companies that reported negative efficiency change during the study period. On the whole the impact of economic reforms on the Total Factor Productivity at the aggregate level was impressive as the TFP change was estimated at 8.6 per cent for all the companies. It is evident from the results that the free economic environment has benefited only in technology not in efficiency of Indian manufacturing industry.

**Kathuria et al., (2013)**\(^9^9\) examined the effects of economic reforms on manufacturing Dualism and evidence from India Dualism is a pervasive feature of the manufacturing sectors of less-developed countries, with large differences in productivity between the informal and the formal sectors. Policy distortions are viewed as an important factor behind the prevalence of manufacturing dualism. They examined whether tariff reforms, industrial de-licensing and the withdrawal of reservation of products for small firms implemented since the mid-1980s have had any effects on efficiency differentials between informal and formal firms in Indian manufacturing. They find strong evidence that economic reforms have exacerbated dualism by increasing the productivity differentials between the more efficient formal firms and the less efficient informal firms.

**Jung et al., (2013)**\(^10^0\) investigated the hypothesis that technological convergence has been a major driving force for the recent productivity increase in Korea. Based on the dynamic panel data of Korean industries, the direct impact of information and communication technology (ICT) on labour productivity is assessed through growth accounting, and the indirect network effect of ICT on industrial total factor productivity (TFP) is estimated. The results confirmed the essential role of broadband networks for successful convergence. The policy implications for the regulatory change are drawn from the empirical analysis.

---


Ghosh (2013)\textsuperscript{101} used data on 3-digit industry for 1981–2004, the study examined the association between total factor productivity and economic reforms. He first obtain the industry-level productivity numbers using advanced econometric techniques and thereafter ascertain the time frame over which economic reforms impact productivity. The evidence suggested that productivity growth is not reliably higher after reforms than prior to reforms. At the sectoral level, the interest rate channel and also the financial accelerator and labour market variables play an important role in explaining productivity improvements. At the macroeconomic level, trade policy, foreign direct investment and credit availability are found to be important in accounting for productivity growth.

Honma and Hu (2014)\textsuperscript{102} computed the total-factor energy efficiency (TFEE) of industries in 14 developed countries for 1995–2005 used data envelopment analysis. They used four inputs viz., labour, capital stock, energy, and non-energy intermediate inputs. Value added was the only relevant output. Results indicated that Japan can further optimize energy conservation because it experienced only a marginal decrease in the weighted TFEE, from 0.986 in 1995 to 0.927 in 2005. To improve inefficient industries, Japan should adapt energy conservation technologies from benchmark countries such as Germany, the United Kingdom, and the United States.

Oh et al., (2014)\textsuperscript{103} presented the parametric estimation of the rates of technical change and total factor productivity (TFP) growth of 7462 Korean manufacturing firms over the period 1987–2007. Two alternative formulations of technical change measured by the time trend and the general index approaches are estimated with panel data models assuming flexible functional forms. Several extensions of each approach are also considered and their benefits and limitations are discussed. In addition to making estimates of the TFP growth and its


decomposition, the study compared the parametric TFP growth measure with the non-parametric Solow residual serving as a benchmark. Several hypotheses related to technology level, firm sizes, industrial sectors, skill biased technological change and macroeconomic and industrial policies are tested to explain the growth patterns and heterogeneity in technical change, input biases and TFP growth rates. Used second regression analysis, the study explored the determinants of TFP growth and their policy implications.

Caglayan (2014)\textsuperscript{104} investigated the level and volatility effects of real exchange rates on productivity growth of manufacturing firms with heterogeneous access to debt, and domestic and foreign equity markets in Turkey. He find that while volatility affects productivity growth negatively, having access to foreign or domestic equity, or debt markets does not alleviate these effects. Furthermore, foreign or publicly traded companies do not appear to perform significantly better than the rest. They detect, however, that productivity is positively related to credit market access. Additionally, they find that while export-oriented firms react positively to currency appreciations, they are hurt more from volatility.

Addessi (2014)\textsuperscript{105} studied the effect of permanent and temporary labour contracts on both labor-augmenting and TFP-augmenting technological factors used a panel dataset of Italian manufacturing firms. The empirical analysis applied a structural approach in which firm TFP follows a controlled Markov process that is affected by the relative used of labour contracts, and labour services are perfect substitutes but with different labour-augmenting factors. The empirical results showed that when including labour-contract composition in the TFP process: i) the difference between permanent and temporary contracts in the labour-augmenting productivity factor is not significant and ii) the incidence of permanent contracts in total contracts has a positive effect on TFP dynamics.


2.5 CONCLUSION

Thus it is evident that most of the studies reviewed above had focused on the issue of output growth and technological change, efficiency change and total factor productivity growth in traditional industries. But the studies related to automobile industry are few and scanty. The present study makes an attempt to overcome this shortcoming by focusing on estimation of growth of output, labour and capital in Indian automobile industry during post-reform period.