II. REVIEW OF LITERATURE

The literature relating to the current study is discussed under the following heads:

A. Efficiency in manufacturing industries.
B. Malmquist productivity index in manufacturing industries.
C. Causal relationship in manufacturing industries.
D. Production function estimates in manufacturing industries.
E. Productivity in manufacturing industries
F. Other related studies

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A. Efficiency in manufacturing industries

Yun Zhang and Robert Bartels (1998) studied the impact of sample size on DEA estimates of mean technical efficiency of Electricity Distribution industry in Australia, Sweden and New Zealand. The results showed that as sample increases the estimated mean technical efficiencies decreases. The rate of decrease also depends on the sample size. When sample is small the rate is high and when sample size is large the rate is low. The study also showed that a difference in sample size of different countries does not have major impact on such comparisons.

Richard Ian Harris (2000) compared regional technical efficiency in UK manufacturing plants with that of Northern Ireland during 1974-1995, based on the stochastic frontier production function approach, applied to more than 200 four-digit manufacturing industries. It showed that manufacturing plants in Northern Ireland on an average, operated at lower levels of technical efficiency when compared to their counterparts in other regions of the UK (and especially plants located in South East England). This lower level of efficiency in the province was analysed both at the aggregate and industry level. At the industry level the provinces had fewer plants exhibiting the highest levels of efficiency within most industries and few plants open and close to ‘cleanse’ manufacturing of the worst plants and those plants that do open and close often do not have efficiency levels such as to bring about improvements in the aggregate efficiency level. The major conclusion was that Northern Ireland needs to reduce the long tail of weaker plants that tend to drag down average efficiency. One way of achieving this was for plant turnover to increase, whereby less efficient plants are replaced by more efficient plants.

Singh (2000) studied the productivity efficiency of 21 State Road Transport Undertakings (STUs) in India over the period from 1984-85 to 1996-97. It was observed that there were wide disparities among state road transport undertakings according to their productive efficiency levels and growth. On an average small-sized state road transport undertakings experienced higher level of productive efficiency than their larger counterparts. And by and large Tamil Nadu state road transport undertakings seem to be more productive than their counter parts operating in other states of the country. The average annual growth of productive efficiency ranged from 2.39 percent to 4.41 percent. The distribution of ranks of state road transport undertakings with respect to their productive efficiency level had remained broadly unchanged over the year.

Chidambaram and Muthukrishnan (2003) made an attempt to measure the operating efficiency in terms of productivity of Madras Cements and India Cements, the two major cement companies in Tamil Nadu for the study period 1990-91 to 2001-02. The study used three ratios namely overall productivity, selling, distribution, administration and labour productivity. The overall productivity indicated that Madras Cements performance was outstanding than India Cements. In the area of selling, distribution, administration and labour productivity, the Madras Cements performance was commendable. Martly's F-max applied to determine whether the three areas of productivity had any difference or not showed that differences were found in Madras Cements.

Goldar et al. (2003) analysed the effect of ownership on efficiency of 63 large engineering firms in India for the reference period from 1990-91 to 1999-2000 a decade of major economic reforms. Technical efficiency of firms were estimated with the help of stochastic frontier production function for three groups of firms namely (i) firms with foreign ownership, (ii) domestically owned private sector firms and (iii) public sector firms. The results clearly indicated that foreign firms in Indian engineering industry had higher technical efficiency than domestically owned firms. There were indications of a process of efficiency convergence (i.e.) the domestically owned firms tending to catch up with foreign owned firms in terms of technical efficiency. In the first half of the 1990s, there were significant positive productivity spillover effects from foreign owned firms. This effect became relatively less important in the second half of the 1990s, when access to imported inputs became an increasingly more important source of efficiency of engineering firms in India.

Ray (2004) examined the changes in competitiveness of Indian manufacturing firms over the period 1991-2001. The firm level efficiencies had been calculated using data from 27 industry groups and using the Data Envelopment Approach (DEA). It was found that ownership of domestic firms by MNE's clearly helped in enhancing the efficiency of these firms. Developing countries had progressively adopted market friendly reforms during 1980s and 1990s. Productivity spillovers took place when the entry or presence of MNE's affiliates lead to efficiency benefits for domestic firms. There was clear scope for more reforms that can make the process less dependent on foreign firms.

Hossain and Karunaratne (2004) investigated the effects of trade liberalisation on the technical efficiency of the Bangladesh manufacturing sector by estimating a combined stochastic frontier efficiency model using panel data for the period 1978-94 for 25 three-digit level industries. The results showed that the overall technical efficiency of the manufacturing sector as well as the technical efficiencies of the majority of the individual industries had increased over time. The findings also clearly suggested that trade liberalisation, proxy by export orientation and capital deepening, has had significant impact on the reduction of the overall technical inefficiency. Similarly, the scale of operation and the proportion of non-productive labour in total employment appeared as important determinants of technical inefficiency. The evidence also indicated that both export-promoting and import-substituting industries had experienced rises in technical efficiencies over time. Besides, the results were suggestive of neutral technical change (at the 5 percent level of significance) although the empirical results indicated that there were no technical changes in the manufacturing industries.

Shazali Abu Manson et al. (2004) examined the efficiency of Wooden Furniture industry in Malaysia by determining the technical efficiency using stochastic frontier production model. The results showed that the Furniture industry in Malaysia, despite being able to increase its production significantly over the years, produced at a low level of efficiency. This has resulted in an inefficient utilization of resources, and so does the potential to increase firm output from the existing level of inputs. The technical inefficiency in individual firm varied greatly from 21.17 percent to 94.69 percent. The study concluded that the policy should be driven to consolidate the scattered industries so as to reap the economies of scale leading to higher efficiency.

Saon Ray (2004) examined the efficiency of Indian manufacturing firms over the period 1991 to 2001. Firm level data has been used to estimate efficiency for firms in 27 industry groups by using DEA in calculating efficiency. A decline in average efficiency from 1991 to 1996 was observed. Efficiency increased after that but it did not reach the 1991 levels. An analysis of the results further showed that certain industries have performed well in 2001 compared to 1991. These industries like automobiles, personal care or electronics have been characterized by product differentiation and strategic alliances. An analysis of the variables explaining efficiency indicated that equity and no equity forms of foreign participation have proved to be significant as also capital intensity. This highlighted the fact that technological development has been important in defining efficiency over the period 1991 to 2001.

Vidya Mahambare and Balasubramanyam (2005) attempted to investigate the impact of liberalisation on productive efficiency at the micro firm level taking into account the differing characteristics of the firms in each of India's 13 major manufacturing sectors. They evaluated the changes in firm level technology in India since the 1991 reforms by estimating a frontier production function. The data covered four year period from 1988-89 to 1991-92 for the pre reform period and six years from 1992-1993 to 1997-98 for the post reform period. The results showed that the impact of 1991 reforms on the efficiency of manufacturing sector appeared to be mixed. Average technical efficiency of firms increased in eight industries. Improved access to imported technology in the post reform period seems to have a positive impact on the efficiency. Although foreign owned firms continue to be the most efficient, their advantage in technical efficiency seems to have declined in the late 1990s. There was evidence of productivity spillover from the presence of foreign firms in three sectors. In general, there are signs that the reforms have had the desired effect.

Burki and Mahmoodul Hassan (2005) analysed the implications of allocative efficiency on resource allocation and energy substitutability in Pakistan's economy. The study covered the period 1969-70 to 1990-91 and utilized pooled time series data from Pakistan's large scale manufacturing sector. The results pointed out strong evidence of allocative inefficiency leading to over or under-utilization of resources and higher cost of production.

The efficiency of the large scale manufacturing sector of Pakistan was examined by Mahmood et al. (2007) using the stochastic production frontier approach. This frontier was estimated for two periods 1995-96 and 2000-01, for 101 industries at the 5-digit PSIC. The results of this study showed that there was some improvement in the efficiency of the large scale manufacturing sector, although the magnitude was small. The results were mixed at the disaggregated level, whereas a majority of industries had gained in terms of technical efficiency and some industries were also weaker in terms of their efficiency level.

Sunil Kumar and Nitin Arora (2007) made an attempt to measure technical and scale efficiency in Indian manufacturing sector in the year 2007. The mean of overall Technical Efficiency (OTE) scores had turned out to be 0.603 (with standard deviation of 0.177) and OTE score ranged from a minimum of 0.345 to a maximum of 1. The major finding of this study was that in manufacturing sector, on an average, 39.7 percent of resources were being wasted in the production process. Only 9 industrial groups attained the status of globally efficient groups with OTE score equal to 1. The decomposition analysis of OTE score into its two mutually exclusive non-additive components viz., Pure Technical Efficiency (PTE) and Scale Efficiency (SE) delineated that 31.2 percent points of 39.7 percent of Overall Technical in Efficiency (OTE) was due to inappropriate management practices being adopted by firm's managers in organizing the inputs in the production process.

Anup Kumar Bhandari and Pradip Maiti (2007) evaluated the efficiency of Indian manufacturing firms: textile industry as a case study. The study considered with gaps of: 1985-1986, 1990-1991, 1996-1997, 1998-1999 and 2001-2002 in which the study has been chosen the textile industry as a case study on the grounds that it is one of the largest industries in India. Stochastic frontier production function was fitted to estimate technical efficiency of firms. It was found that average technical efficiency varied between 68 to 84 percent across these years and that individual TEs varied with firm-specific characteristics such as size and age. Further, public sector firms were found to be relatively less efficient.

Idris Jajri and Rahmah Ismail (2007) attempted to analyse the trend of technical efficiency, technological change and Total Factor Productivity (TFP) growth in the Malaysian manufacturing sector. Seven industries were chosen: food, beverages and tobacco; textile, wearing apparel and leather; wood and wood products; paper and paper products; chemicals, petroleum, coal, rubber and plastic products; non-metallic mineral; and iron and steel products industries. This study used annual time series data for the above mentioned industries for the period 1984-2000. The results showed that during the period of study, TFP growth has increased and the major contribution to TFP growth was from change in technical efficiency. Nevertheless, technological change also showed increasing trend overtime. The industries that experienced high technical efficiency were food, wood, chemical and iron products. However, for food and wood industries, technical efficiency was high; and for the textile industry it was low as both the values obtained was below unity.

According to the attempt made by Jabir Ali (2007) the average technical efficiency score was estimated to be 0.57 under CRS model and 0.95 under VRS model. The average scale efficiency for the entire period was 0.60. During 1980-81 and 1990-91, the average efficiency under the CRS and VRS technologies was 0.42 and 0.94 respectively. During 1990-91 to 2002-03, efficiency under CRS model improved to 0.67, whereas in case of VRS model the efficiency slightly declined to 0.95. The scale efficiency also improved from 0.44 to 0.70 during this period. Scale efficiency scores suggested sizeable deviation from optimal scale of operation but it has approached unity over time. The performance scores based on CRS model were equal to one for the years 1994-95 and 1996-97. For all the other years, the recorded efficiency scores were less than one, indicating inefficient use of resources under constant returns to scale. However, the efficiency score based on VRS model indicated that the performance scores were equal to one during more number of years than the CRS model. Similarly, meat processing industry was scale inefficient during most of the years except 1994-95 and 1996-97. This is mainly because of increased investment in meat processing sector to capture the export potential with emergence of WTO and liberal foreign trade policy of the government.

Mainak Mazumdaret et al. (2009) examined the competitiveness of Indian pharmaceutical firms by computing their technical efficiency for the period 1991 to 2005 using the non-parametric approach of Data Envelopment Analysis (DEA). The analysis establishes that even though the output efficiency levels of firms revealed a declining trend, firms have been able to make efficient use of labour and raw material inputs. An analysis carried out to identify the determinants of technical efficiency reveals that in contrast to popular belief, neither R&D and export expenditure nor the use of imported technology improved the technical efficiency of firms.

Sabuj Kumar Mandal and Madheswaran (2010) made interstate analysis of environmental efficiency for the Indian Cement Industry. The study aimed at measuring environmental efficiency within a joint production framework of both desirable and undesirable output using Data Envelopment Analysis. Carbon dioxide was considered as an input in one context and as an undesirable output in the other with the environmental efficiency being defined accordingly. The study used 3 digit state level data from the Annual Survey of Industries for the years between 2000-01 and 2004-05. The empirical findings showed that Indian cement industry, faced with environmental regulation, has the potential to expand desirable output and contract undesirable output with the given inputs. The empirical results also showed that compared to the initial year, 2000-01, the average environmental efficiency declined in 2004-05.

Sangho Kim and Muthusamy Saravanakumar (2012) studied on “Economic Reform and Total Factor Productivity Growth in Indian Manufacturing Industries,” by applying stochastic frontier production function model 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.

Sunil Kumar and Nitin Arora (2012) investigated the patterns of variations in Indian industrial performance at both industry and state levels, applying stochastic frontier analysis to an unbalanced panel of 15 Indian states, 22 industries at the 2-digit level, and an 11-year period spanning 1992-2002. The results represented novel contributions to the growing debate on Indian industrial productivity; three primary sets of conclusions were arrived. First, there was considerable variation across industries in terms of their aggregate efficiency performance. However, overall industrial performance appears to be driven more by input growth, with technical efficiency having a marginal effect at best. Second, results also showed considerable regional variation in efficiency patterns, with southern and western states, out-performing northern and eastern states in terms of their overall manufacturing efficiencies. Punjab was surprisingly the worst performing state in the country in terms of this yardstick.

Manonmani (2013) examined the efficiency of Indian textile industry between 1991-92 and 2009-10 by applying stochastic frontier production function approach. The maximum likelihood estimates for productive efficiency showed that in the single output case, parameters of capital input were positive and statistically significant. Hence, capital was the main input factor for these industries as its value was higher than labour. The coefficients were statistically significant though their signs differed. The estimated levels of output considerably differed from their potential levels due to factors which were within the control of the industries. The summation of the elasticity of factors of production of 1.8419 indicated increasing returns-to-scale. The industry recorded an average technical efficiency of 0.941.The average technical inefficiency was negligible.

Teerawat Charoenrata and Charles Harvie (2013) used a Stochastic Frontier Analysis (SFA) and technical inefficiency effects model to analyse 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 was approximately 50 percent, signifying a high level of technical inefficiency which was reducing potential output. The inefficiency effects model revealed that firm size, firm age, skilled labour, ownership characteristics and location were firm-specific factors that significantly affected the technical efficiency of production. Key measures to improve the technical efficiency of Thai manufacturing SMEs were: adequate supply of inputs, access to credit facilities, extensive infrastructural development and training programs for employees.

Manonmani (2014) in her research on “Different Forms of Efficiency in the Manufacture of Furniture Products in India – An Application of DEA” for the reference period between 2001-02 and 2011-12 found that under Constant Returns to Scale (CRS) production technology, technical efficiency between 2001-02 and 2011-12 was 0.919. This implied that the industry would have needed only 91.9 percent of the inputs currently being used. In terms of average inefficiency it would have needed 22.5percent more inputs to produce the same output. Under VRS production technology, the number of efficient DMUs exceeded the number of efficiency DMUs under CRS production technology. Always under VRS production technology, higher average efficiency was recorded. The average scale efficiency was 94.4 percent. In terms of average inefficiency, it could increase additional production to the extent of 5.6 percent, by taking advantage of their scale characteristics.

Under Constant Returns to Scale (CRS) technology, the industry was cost efficient to the extent of 84.5 percent. Under Variable Returns to Scale (VRS) production technology the industry was more efficient to the extent of 89.2 percent. Estimates revealed that over the study period, the industries under CRS production technology had on an average allocative efficiency level of 92.2 percent implying that the industries were 7.8 percent inefficient respectively.

Manonmani (2015) analysed technical, scale, cost and allocative efficiencies of Khadi and Village industries of India between 2000-01and 2010-11. The efficiency scores were obtained by applying Data Envelopment Approach (DEA). It could be found that for the entire period technical, scale, cost and allocative efficient DMUs were more under Variable Return to Scale (VRS) than under Constant Returns to Scale (CRS) production technology. Also it was very clear that inefficiency could be due to the existence of either increasing or decreasing returns to scale.

Manonmani (2015) demonstrated that the technical, scale, cost and allocative efficient DMUs were more under Variable Returns to Scale (VRS) production technology in comparison with Constant Returns to Scale (CRS) production technology. For the period 2002-3 to 2011-12, the calculations on the efficiency of Decision Making Units (DMUs) in the manufacture of basic metals in India have been done. Under Constant Returns to Scale (CRS) production technology, technical efficiency between 2002-03 and 2011- 12 was 0.716. This implied that the industry would have needed only 71.6 percent of the inputs currently being used. In terms of average inefficiency, it would have needed 28.4 percent more inputs to produce the same output, which meant waste of resources to the extent mentioned above. The average scale efficiency was 84.6 percent. In terms of average inefficiency, it could increase additional production to the extent of 15.4 percent. Under Constant Returns to Scale (CRS) technology, the industry was efficient to the extent of 65.7 percent. Under Variable Returns to Scale (VRS) production technology the industry was more efficient to the extent of 87.5 percent. Estimates revealed that over the study period, the industries under CRS production technology had on an average allocative efficiency level of 91 percent implying that the industries were 9 percent inefficient, respectively. In the case of VRS production technology, an average allocative efficiency of 88 percent has been measured, implying that the industries were on an average 12 percent inefficient.

B. Malmquist productivity index in manufacturing industries

Fare et al. (1995) made an analysis of productivity in four Taiwanese manufacturing industries during 1978-1989 by decomposing the Malmquist productivity change index into technical change and technical efficiency change. Further this method was also compared to traditional and parametric approaches. The results of this study suggested that TFP growth in the long run was totally because of technical change. On an average the liberalisation period's TFP was higher than the pre liberalisation period. Further results suggested that technical efficiency and technical progress could not move together and technical change was positively related with research and development.

Bjurek and Durevall (2000) analysed the increase in total factor productivity for Zimbabwe's manufacturing sub-sectors against the structural adjustment program implemented from 1991 to1995. Malmquist productivity Index was used to evaluate productivity for thirty one manufacturing sub-sectors for the period 1980 to 1995. Further econometric methods were used to test the effect of trade reforms and market liberalisation to the structural adjustment program. In general, the results suggested a great variation in growth rates across sectors and over time period. There was no growth in the total factor productivity during structural adjustment program except for the last two years, where most of the sub-sectors showed a growth in total factor productivity. The results of econometric analysis showed only import growth as influencing variable and all other variables measuring trade liberalisation had no influence on productivity growth.

Rolf Fare et al. (2001) analysed the relative trend in the total factor productivity in Australia and New Zealand manufacturing sector during 1986-1996. Their objective was to see whether reforms in the two countries have impact on the productivity performance, because both the countries had a major structural change with different pace and intensity. Malmquist Productivity Index was used to calculate the total factor productivity. Further it was decomposed into technical efficiency and technical change which helped in analysis to check the source of TFP in the relative performance for two countries. In general, the results suggested that New Zealand performed better than Australian in terms of total factor productivity for manufacturing sector. This lower TFP in Australia was due to low capital intensity in production process. Further, the major source of TFP growth in New Zealand was technical change rather than efficiency change.

One of the studies by Fu (2005) for panel of Chinese manufacturing industry was carried out to estimate total factor productivity. TFP growth was estimated for period 1990-

1997 using Malmquist Productivity Index. This Index was decomposed into technical progress and efficiency change. The analysis of the results showed that there was no evidence of significant productivity gains at industry level as a result of exports in a transition economy. It was suggested that a developed domestic market and a neutral outward oriented policy is necessary for exports to generate positive effect on TFP growth.

Idris Jajri and Rahmah Ismail (2006) attempted to analyse trend in technical efficiency, technological change and TFP growth in the Malaysian manufacturing sector. The analysis was based on data from the Industrial Manufacturing Survey of 1985 to 2000 collected by the Department of Statistics, Malaysia using Data Envelopment Analysis (DEA). The results show that during the period under study, TFP growth increased the major contributor was technical efficiency. The industries that experienced high technical efficiency were food, wood, chemical and iron products. However, for food and wood industries technical efficiency was higher than technical progress. The other industry that showed larger technical progress than technical efficiency was textile industry but both values were below unity.

Madheswaran et al. (2007) examined Total Factor Productivity (TFP) growth during 1979-80 to 1997-98 at sector-level data within manufacturing sector in India. The analysis had focused on the trend of technical progress (TP) and Technical Efficiency Change (TEC). Their results suggested that the TFP growth in a large number of industries have improved during 1997-98 compared to 1980-81. TFP growth was mainly driven by TP not by TEC in case of Indian Industry.

Basti and Akin (2008) compared the productivity of domestic owned and foreign owned firms operating in Turkey. They selected non-financial firms listed on Istanbul Stock Exchange for period 2003-2007. Non-parametric technique called DEA was used to calculate Malmquist Index as measurement of productivity. This Malmquist productivity was further decomposed into efficiency change and technical change. The results of the study indicated that there were no differences in terms of productivity of domestic owned and foreign owned firm. The average productivity of both types of firms decreased throughout the period under analysis except 2006.

Shallu Sehgal and Suparn Sharma (2011) using pooled data for the period of 1981-82 to 2007-08 for different categories of organized manufacturing industries for the sample state of Haryana, analysed the inter-temporal and inter-industry comparison of Total Factor Productivity (TFP) measured by Malmquist Productivity Index (MPI), which is an application of DEA to panel data to calculate the indices of TFP change, technology change and efficiency change. The study revealed that technical efficiency change was the key driver of TFPG in the manufacturing sector of Haryana during pre-reform period. However the picture has turned around during the post reform period. A positive impact of liberalisation policy on technological advancement of the manufacturing sector of the state has been experienced. But, during the post reform period the state has realized inefficiency in the utilization of resources in hand and it is really an alarming sign indicating that the incapability of manufacturing sector of the state in question to cope up with the technological advancement.

Fulwinder Pal Singh (2012) analysed the TFP growth trends in Indian manufacturing sector at both aggregated and disaggregated inter-state levels. Using the Malmquist productivity index for panel data set of 16 major industrial state over a period of 29 years spanning over 1979-80 to 2007-08, the study observed manufacturing sector of India was growing with 9.1 percent per annum growth of Total Factor Productivity (TFP) during the entire study period. Out of sixteen industrial states there were five states namely Uttar Pradesh, Madhya Pradesh, Gujarat, Orissa and Rajasthan, where double digit TFP growth has been noticed. The manufacturing sector of Uttar Pradesh was growing with highest TFP growth at the rate of 12.8 percent per annum followed by Madhya Pradesh with TFP growth of 11.8 percent per annum. The analysis of the sources of the TFP growth in Indian manufacturing sector revealed that both technical progress and technical change were equally contributing TFP growth in sector under evaluation. It has also been observed that at all India level, efficiency change was greater than technical progress.

Arnab Deb and Subhash Ray (2014) under took a study on “Total Factor Productivity Growth in Indian Manufacturing: A Biennial Malmquist Analysis of Inter-State Data,” for the period from 1970-71 to 2007-08. They compared the pre and post reform performances of Indian manufacturing in terms of total factor productivity growth. Results showed that at the all-India level, total factor productivity growth rate in manufacturing was higher, during the post reform period. Although, the majority of states experienced accelerated productivity growth, some states did experience decline in productivity after the reforms. Both before and after the reforms, technological progress was the most important component of productivity growth in Indian manufacturing.

Sandeep Kumar Baliyan et al. (2015) made an attempt to examine the firm level performance of manufacturing and service sectors in India in terms of the level of technical change, technical efficiency change, and productivity growth. The study used the Malmquist Productivity Index (MPI) with decomposition into catching up effect and the innovation effect of the common set over the study period during 1991-92 to 2010-11. For analytical convenience, this period has been divided into two sub-periods, namely, 1990-91 to 1999-2000 (Phase-I: Liberalisation) and 2000-01 to 2010-2011 (Phase-II: Liberalisation). The study found that for the enhancement of TFPG the level of openness, raw material, energy, and advertising, profit margin and investment are the major contributions.

C. Causal relationship in manufacturing industries

Hondroyiannis and Papapetrou (1997) examined the short and long-run link between productivity, inflation and wages for the period 1975-1992 using recently developed techniques on co-integration and seasonal integration in Greece. When quarterly data were used over the whole period it was found no evidence of co-integration. However, when the incorporation of the 1986 stabilization program evidence of co-integration between the three variables was not found, the evidence on short-run dynamic results were indicative of a negative effect of inflation on productivity but not of a clear-cut effect of wages on productivity.

A study by Ghauman and Singh (1998) comprising of nine public sector enterprises of India for the period 1977-78 to 1995-96 did not find the feedback relationship between wage rate and labour productivity. The study concluded that causality was clearly one way and that was from wage rate to labour productivity. They observed that the rise in wage rate has a much larger impact on labour productivity than that of labour productivity on wages.

Donald Freeman and David Yerger (2000) tested the hypothesis that inflation has a causal impact (in the Granger sense) on labour productivity growth in manufacturing for 12 countries of the Organization for Economic Co-operation and Development (OECD) for the reference period from 1955 to 1994. In bivariate tests of inflation and productivity and in multivariate tests using controls for cyclical effects, there were no evidence of a consistent relationship between inflation and productivity growth with regard to either sign or magnitude. Therefore, the analysis did not support the view that further reductions in inflation from already low single-digit levels would have a positive impact on labour productivity growth for major industrial countries.

Evangelia Papapetrou (2003) examined the causality issue, in a Granger-temporal causal sense between price level and productivity in a bivariate and multivariate context in Poland over the period 1991-1998. The empirical results suggested that a bivariate relationship between inflation and productivity was spurious. When control for fluctuations of monetary policy on the bivariate relationship between price level and productivity was made, the evidence suggested that Granger causation must exist in at least one direction. Vector error-correction model estimation, showed that productivity growth and inflation were econometrically endogenous variables and bi-directional causality from inflation to productivity growth and vice versa might exist.

Efthymios Tsionas (2003) investigated the inflation-productivity nexus in fifteen European countries over the period 1960-1997. Modern econometric techniques organized co-integration analysis test for the existence of a long-run relationship between inflation and productivity. Bayesian and recently developed causality testing procedures were employed to examine the inflation-productivity relationship. The empirical results suggested the existence of causality in seven countries. Causality was bi-directional in five cases.

Jack Strauss and Mark E. Wohar (2004) analysed the long-run relationship between prices and wage-adjusted productivity as well as between real wages and average labour productivity at the industry level for a panel of 459 US manufacturing industries over the period 1956-1996. Granger causality tests showed that prices were weakly exogenous and caused movements in unit labour cost. Increases in prices led to less than one-for-one movements in unit labour costs, although the one-for-one relationship received some support for a sub-sample of industries. Bi-directional Granger-causality was found between real wages and productivity; however, a one-to-one relationship was strongly rejected between real wages and productivity. Increases in labour productivity were associated with a less than unity increase in real wages.

Goh Soo Khoon (2009) investigated the relationship between real wages, labour productivity and unemployment in Malaysia at the macroeconomic level, using time-series econometric techniques from 1970 to 2005. The study found a long-term equilibrium relationship between labour productivity and real wages, but that unemployment was apparently unconnected to the system. The results suggested that labour productivity was positively related to real wage in the long run. However, the increase in real wage exceeded the increase in labour productivity causing an increase in unit labour cost. In addition, the study found a positive causal flow from productivity to wages in the short-run supporting the marginal productivity theory.

Saten Kumar et al. (2009) presented an analysis of real wages, inflation and labour productivity interrelationships using co-integration, Granger-causality and most importantly, structural change tests. The study was based on Australian data over the period 1965-2007. The result showed that a percent increase in manufacturing sector real wages led to an increase in manufacturing sector productivity between 0.5 percent and 0.8 percent. The study found that the comparable estimates for the effect of inflation on manufacturing sector productivity had limited statistical significance. Granger causality test results suggested that both real wages and inflation showed the outcome of Granger-cause productivity in the long run.

Abdel-Aziz and Hala Fares (2010) examined causality between change in prices and wage inflation over the period 1990-2005 in the Egyptian Economy. The study used Granger causality test. As per the finding of the study, wages was independent from changes in prices and the wages in public sector were function of lagged changes in prices but not with expected inflation rates.

Algis Sileika et al. (2010) while analysing the relationship between wages and labour productivityfrom2001 to 2008 in Lithuania and EU-15 countries, a different change in these two indicators was noticed. Till 2009, Lithuanian economy was rapidly growing. The borders of EU countries opened. And these changes had influence on the increase in wages and labour productivity. However, an obvious difference was noticed between the wages and labour productivity in Lithuania and other EU countries. The performed analysis had shown that wages (calculating in Euros) in Lithuania in comparison to old EU countries were lower 3 to 7 times, but labour productivity calculated as GSDP per capita, only 2 times. In rapidly developing countries, wages and labour productivity adjust to economic changes. Therefore, there was a necessity in the context of other EU countries to investigate the relationship between wages and labour productivity in Lithuania so that these differences could be gradually reduced.

Filiz Ozkan (2011) investigated the relationship between the data regarding steel production: consumption, import, export, the Gross Domestic Product (GSDP) and the Industrial Production (IP). In order to determine aforementioned relation between the data regarding steel and the GSDP – the Engle Granger co-integration, Error Correction Model (ECM) and the Granger causality tests were applied. It has been found that the steel export and the production have direct relations with the GSDP, whereas the steel export has a direct relation with the IP and both relations had causality effects.

Mostafizur Rahman et al. (2011) examined the causal relationship among GSDP, agricultural, industrial and service sector output for Bangladesh using time series data from 1972 to 2008. The study used the granger causality/block exogeneity Wald tests statistics to examine the causal relationship among these variables. From empirical study it was found the existence of long run equilibrium relationship among these variables and bi-directional causality was observed between GSDP and agricultural sector, industrial sector and GSDP, and also industrial sector and service sector. The empirical study also found the unidirectional granger causality from industrial sector to agricultural sector and GSDP to service sector. Finally, the results indicated that agricultural and industrial sector are the influencing factor of the GSDP of Bangladesh and vice versa, where service sector did not influence the GSDP but GSDP influenced the service sector to grow up.

Nir Klein (2012) found that while there is a co-integrating link between the real wage and labour productivity, the deviations from equilibrium are persistent and thus contribute to a weak link between real wage growth and labour productivity growth in the short term during 1996-2009. This finding is also supported by a cross-country analysis, which showed that in South Africa the link between the real wage and labour productivity is substantially weaker than in other emerging markets, even after controlling for labour market tightness indicators.

Manikandan et al. (2012) attempted to examine the relationship between bank credit and industrial production in India using time series data pertaining to 18 years, from 1991-1992 to 2008-2009. The study employed the Granger Causality Test in the Vector Auto Regressive (VAR) model to examine the direction of causality between bank credit deployment and industrial production. The results of the Granger Causality Test in the VAR framework adopting 2 lag lengths did not show significant causality in any direction between bank credit deployment and industrial production. The non-existence of causality implied that the proportion of bank credit in the overall capital structure of the industries is too small to cause any impact on industrial production pointing to the scope for bankers to play a greater role in financing the industrial sector. The main contribution of the study was that it had opened up avenues for further research on finding causality of relationship between various categories of financial systems and relevant components contributing to economic growth adopting the VAR framework.

Hussain Ali Bekhet and Nor Hamisham Binti Harun (2012) examined the causal relationship between production and energy of industrial manufacturing in Malaysia. Time series data for production (Q), capital (K), labour (L) and energy (E) for the period of 1978-2009 was applied. However, production theory was used to explore the characteristics of the capital, labour and energy within time series procedures. The results of the ADF and PP tests showed that all variables were stationary in the first differences, except for energy, which was stationarity at second differences. Meanwhile, all variables were co-integrated at 1% significance level using CRDW test. Results showed that there was unidirectional causality in the long run running from energy to the production. Therefore, energy played an important role in the production of industrial manufacturing in Malaysia. No significant relationship between all variables appeared to be in the short run.

Woo-Yong Song and Bongsuk Sung (2013) investigated the causal relationships among environmental regulation, export performance and factor intensity, using panel data from South Korea's manufacturing sector for the reference period 1991-2009. There was evidence of a positive short-run linear causal relation running from environmental regulation to export performance, suggesting that environmental-protection expenditure might constitute a comparative advantage. The short-run linear causal relation from export performance to investment in activities related to environmental protection was insignificant.

Emre Aksoy (2013) analysed the relationships between employment and growth from industrial perspective by considering employment incentives in the case of Turkey. The study covered the period of 1988-2010 and used unit root test and Granger causality test. As per the study, there was a positive Granger causalities from the aggregate employment to the aggregate economic growth, from the employment in the energy production and distribution industry to the economic growth in the energy production and distribution industry, from the employment in the financial intermediation industry to the economic growth in the financial intermediation industry to the economic growth in the financial intermediation industry, from the economic growth in the manufacturing industry to the employment in the manufacturing industry and from the economic growth in the tourism and commerce industry to the employment in the tourism and commerce industry.

Ditimi and Philip Ifeakachukwu (2013) examined the relationship between unemployment rate and productivity growth in Nigeria for the period 1986 to 2010. The study utilized co-integration and error correction model approach. Although, the unit root tests showed that the variables were integrated of different orders, the Johansen co-integration result showed that the variables were co-integrated. The regression estimate based on the short run and long run models showed that unemployment rate had an insignificant influence on productivity growth in Nigeria over the study period. Based on these findings, this study recommended that there is still the need for government to take urgent steps against the rising unemployment rate, because unemployment is a major impediment to social progress and results in waste of trained manpower.

Johannes Tshepiso Tsoku and Florance Matarise (2014) analysed the relationship between remuneration (real wage) and labour productivity in South Africa at the macro-economic level, using time series and econometric techniques on annual time series data from 1970 to 2011. The variables were tested for stationarity using the Augmented Dickey-Fuller and Phillips Perrson and were proved to be integrated to order one. Further analysis yielded a result which depicted significant evidence of a structural break in 1990 and a long run co-integrating relationship between remuneration, labour productivity and unemployment. The coefficient of the error correction term in the labour productivity was large, indicating a rapid adjustment of labour productivity to equilibrium. However, remuneration did not Granger-cause labour productivity and vice versa.

Joao Paulo A. de Souza (2014)investigated by using panel data for the year 2014 to unveil the direction of long-run causality between the real product wage and labour productivity at the industry level by calculating co-integration and error correction models. The study covered two datasets of manufacturing industries: the EU-Klems dataset covering 11 industries in 19 developed economies, and the Unido Industrial Statistics Database covering 22 industries in 30 developed and developing economies. In both datasets evidence of co-integration between the two variables, as well as evidence of two-way, long-run Granger causality was observed. These findings were consistent with theories of technical change, which claimed that a rise in labour costs sparks the adoption of labour-saving innovations. There were also consistent with distributive theories whereby real wages keep a pace of labour productivity growth, giving rise to long-run stability in functional distribution.

Milner Siboleka et al. (2014) investigated whether or not there is a causal and long term relationship between agriculture and manufacturing sector growth in Namibia over the period 1981-2012. Ascertaining the direction of the relationship was part of the objectives. Analytical methods that were used include unit root, correlation test and a Granger Causality model. With the use of time series data, the results confirmed stationarity of the data. With 31 observations, no causal relationships were established between agriculture and manufacturing in Namibia. It was suggested based on the study that appropriate policy interventions are required to influence how the two sectors should benefit from each other. Such holds potential for both sustained employment creation opportunities and economic growth in Namibia.

Zekeriya Yildirim (2015) examined the interrelationships among productivity, real wages and inflation in the Turkish manufacturing industry for the period from 1988 to 2012. By employing both co-integration analysis and a Granger causality test it was found that inflation had a greater effect on labour productivity than do real wages. Furthermore, the Granger causality test showed that there was a strong feedback between labour productivity and inflation, suggesting policy makers targeting inflation should follow labour productivity. This test suggested that there was no causal link running from productivity to real wages in the Turkish manufacturing industry. This absence of a link was largely due to lower bargaining power and structural problems, including high unemployment, a huge tax burden on wages and the large share of the informal sector, absence of a link is largely due to lower bargaining power and structural problems, including high unemployment, a huge tax burden on wages and the large share of the informal sector.

Ozcan Karahana (2015) attempted to identify the relationship between the business enterprise R&D expenditure and productivity growth via role of transformation in manufacturing sector towards high tech production. Thus, the hypothesis tested in this study was whether business enterprise R&D expenditure is a main determinant of high tech sectors of manufacturing. The study examined the relationship between the intensity of business enterprise R&D expenditure and high technology specification in European countries based on a panel causality analysis performed by Generalized Method of Moments (GMM) for the annual data from 2000 to 2013. Empirical findings supported that there is a strong causality from increasing business enterprise R&D intensity to the expanding share of high and medium-high manufacturing.

Adel Shakeeb Mohsen et al. (2015) attempted to investigate the determinants of industrial output in Syria over the period 1980-2010. The ADF unit root test, Johansen co-integration test, Granger causality test, impulse response functions, variance decomposition analysis, and stability tests were used in this study. The Johansen co-integration test indicated that industrial output was positively related to capital, manufactured exports, population and agricultural output, but negatively related to the oil price. Agricultural output has the biggest effect on industrial output. The Granger causality test indicated bidirectional causality between capital, oil price, manufacturing exports, population, agricultural output and industrial output in the short and long run.

D. **Production function estimates in manufacturing industries**

Epaminondas E. Panas (1980) estimated the elasticity of substitution between capital and labour for two-digit Greek manufacturing industries for the period 1958-1971. The elasticity of substitution for all industries differed significantly from zero. For ten out of seven industries, the OLS estimates were significantly different from unity i.e., the Cobb-Douglas hypothesis was rejected. Increasing returns to scale was observed for seven industries. In some industries the elasticity of substitution was greater than unity.

Jae Won Kim (1984) analysed CES production function for two-digit manufacturing industries in Korea across different size groups. The estimates of the co-efficient of production function showed that the elasticity of substitution between capital and labour were substantially different from zero in all industries except Wood production and Non-metallic industries and in both small and medium groups.

Sandhu and Sodhi (1985) estimated output elasticity with respect to labour and capital, returns to scale and substitution elasticity between labour and capital in Punjab for the reference period 1972-73 and 1977-78. It was found that capital elasticity was greater than labour elasticity in the Engineering goods industries which pointed out the scope for greater use of capital relative to labour. The increasing returns to scale as estimated signified the scope for economies of scale. There were not substantial capital-labour substitution possibilities especially in Machine Tools and Printing Machinery industries. This meant that changing relative factor prices may bring about only a marginal substitution of capital for labour input in these industries.

Dhanajayan and Muthulakshmi (1989) measured elasticity of substitution in the Indian non-traditional large scale industries during 1973-74 to 1979-80. CES production function for 75 industries was estimated. The study indicated uniformly less than unitary elasticity of substitution in a number of Indian large scale industries.

Raja Sekhara Reddy and Subbrami Reddy (1989) wanted to specify the inverse labour demand equations by applying CES production function for the period 1947-1977 for some selected Indian industries such as Cement, Cotton Textile, Glass and Glass ware industry, Iron and Steel, Jute Textile industry, Matches industry, Paints and Varnishes industries, Tanning industry and Woollen Textile industry. In each industry, the labour demand equation based on CES production function appeared to be reasonable. The elasticity of substitution in each industry stayed well below unity indicating the rigidity of capital-labour substitution.

Somasekhara et al. (1990) attempted to analyse trends in economies of scale, elasticity of output with respect to capital and labour and their marginal productivities in Indian factory sector manufacturing industries for the period 1975-76 to 1984-85. The results showed that elasticity of output with respect to labour was more than that of the capital. Diseconomies of scale characterized these industries during the period under study. On an average, the marginal productivity of both labour and capital experienced a decreasing trend over the years. The changes in value added were mainly due to the changes in capital and labour.

Mani and Sathyanarayana (1990) studied production function in sugar industry in a backward region with special reference to Chittoor Co-operative Sugars Limited, Chittoor, Andhra Pradesh, India for the period 1964-65 to 1984-85. The study revealed that the industry was found to have zero neutral technical progress. The industry was found to be operating under constant returns to scale. Labour was found to be relatively more important factor than capital in terms of factor elasticity of output and marginal factor productivity. It was also found that, in general labour was marginally more efficient than capital. This suggested that sugar industry under study should become more labour-intensive. The analysis of factor contribution to the relative mean value added revealed wild fluctuations in the contribution of labour while contribution of capital was found to be relatively stable.

The most exhaustive study of production function for the Indian industries had been done by Ahluwalia (1991). The estimation of CD production function (ratio form) for manufacturing industries consistently indicated constant returns to scale and TFP growth after 1982-83. The co-efficient of capital in the range of 0.35 to 0.43 was statistically significant. The labour's share was in the range of 0.57 to 0.65. The assumption of unitary elasticity of substitution underlying CD production function was not rejected when it was estimated using CES production function. The result of panel data for 64 industry groups with Translog specification rejected the hypothesis of Hicks neutrality of technical progress and found labour using bias in the technical progress.

Sarma and Appa Rao (1991) found that higher growth rates of capital relative to labour which indicated the process of substitution of capital for labour in Indian cement industry for the period 1959-1982. Labour productivity was found to be positively associated with capital intensity. Returns to scale was found to be constant during 1959-82. Further, output was more responsive to a unit increase in capital input. Neutral technical progress was found to exist in Indian cement industry.

Chandrasekaran and Bhavani Sridharan (1993) estimated elasticity of output with respect to capital which was found to be statistically insignificant whereas elasticity of output with respect to labour represented by the co-efficient of labour was significant at 5 percent level for the Cotton Textile industry of India. Sum of the factor elasticities showed constant returns to scale in the industry. The Constant of Elasticity of Substitution (CES) was positive and significant.

Indrakant and Muppalla Sambasiva Rao (1993) estimated the degree of factor substitution and returns to scale in Indian manufacturing sector of Andhra Pradesh for the period from 1973-74 to 1984-85 for six major groups. The extent of factor substitutability was substantial (i.e. significantly different from zero) in the selected manufacturing industry groups of Andhra Pradesh which implied that the manufacturing sector responded to the economic changes in a very short time. Analysis of returns to scale revealed that Beverages and Electrical Machinery industries were operating under increasing returns to scale while Food and Electricity industries were operating under decreasing returns to scale. There were no economies of scale in the case of Cotton Textile and Basic Metal industries. Capital elasticity was higher than labour elasticity and there were wide inter-industry differences in input elasticities.

Wen-Jen Hsieh (1995) examined output and scale elasticities across individual industries for a pooled data set of 20 US manufacturing industries during 1987-91. It was found that output-labour elasticities varied from a low of 0.18 for Tobacco to a high of 0.70 for Apparel industries. Output-capital elasticities also ranged from 0.31 for Apparel to 0.88 for Petroleum. Total output or scale elasticities ranged from 0.51 for Tobacco to 1.24 for Primary Metal. Thus, individual industries exhibited different output and scale elasticities. Although many industries showed constant returns to scale, there were a number of industries that displayed decreasing or increasing returns to scale.

Sajal Chattopadhyay and Diposis Bhadra (1997-98) investigated the state of manufacturing production for some two-digit industries in West Bengal prior to India's current economic liberalisation reforms which started in the 1990s. It was found that the elasticity of substitution parameter was significantly different from zero and returns to scale parameter were greater than one. These could have provided considerable leverage in policy in this period.

Io Segoura (1998) estimated jointly the degree of internal returns to scale and the extent of external economies in Greek two-digit manufacturing industries during the period 1963-90. It was found that only two industries showed evidence of internal increasing returns namely, Food Products and Transport Equipment. On the other hand, there was presence of external economies. According to the estimates, if an industry increases its inputs in isolation by 10 percent, its output rises by 6 percent. However, if all industries act together its output rises by 10 percent, implying social constant returns to scale.

Shubhashis Gangopadhyay and Wilima Wadhwa (1998) estimated production function for aggregate manufacturing sector of India using panel data by pooling cross-section and time series data for 18 two-digit industries for the period 1973-74 to 1992-93. The estimates of TFP growth, estimated at the means of variables, showed a trend rate of -0.20 percent (compounded annually). Their results also showed a labour saving ($B_{LT}<0$) and capital-using ($B_{KT}>0$) bias in technological progress. The results also indicated that technical change was not Hicks-neutral but capital augmenting.

Harry Bloch and Sam Hak Kan Tang (1999) examined the difference between the dual rate of technical change and the total factor productivity growth. It was found that the majority of Singapore's manufacturing industries exhibited, on the one hand, substantial increasing returns to scale and on the other hand, no significant technical change. However, the largest and fastest growing industries such as Electronic Products and Components showed both significant cost-saving technical progress and decreasing returns to scale.

Sang Nguyen and Mary Streitwieser (1999) by using micro data for 10,412 U.S. manufacturing plants estimated the degree of factor substitution by industry and by plant size. It was found that (1) capital, labour, energy and materials were substitutes in production and (2) the degrees of substitution among inputs were quite similar across plant sizes in a majority of the industries. Two important implications of these findings were that (i) small plants were typically as flexible as large plants in factor substitution; consequently, economic policies such as energy conservation policies that result in rising energy prices would not cause negative effects on either large or small U.S. manufacturing plants; and (ii) since energy and capital were found to be substitutes, the 1973 energy crisis was unlikely to be a significant factor contributing to the post 1973 productivity slowdown.

Sumru Altug and Alpay Filiztekin (2002) estimated the degree of returns to scale using non-parametric measures of primal and dual productivity for two-digit US manufacturing industries. Both the primal and dual estimates indicated the existence of increasing returns to scale for the durable goods industries. The simulation results indicated that there was a slight tendency for the dual equation estimates to overestimate the degree of returns to scale. However, small sample bias appeared to be most severe for the Non-durable goods industries.

Laxmi Narayan (2003) estimated production function for the selected manufacturing industries in India such as sugar, paper and paper board, fertilizer and pesticides, motor vehicles, watches and clocks for the period 1973-74 to 1995-96. The results showed that returns to scale was constant in all industries except in watches, clocks and motor vehicles industries which witnessed increasing returns to scale. Increasing returns to scale in these industries implied that labour and capital were not employed to their optimum level, i.e., inputs remained underemployed. Elasticity of substitution has been low or unity in all industries except Motor Vehicles industries. This implies that capital in these industries cannot be replaced by labour.

Seema Sharma Upadhay (2003-2004) had analysed returns to scale, technical progress, elasticity of substitution, scale bias and technical bias over a period of 25 years from 1973-74 to 1997-98 in Indian Fertiliser industry. It was found that this industry exhibited decreasing returns to scale during the entire study period. Technical progress had taken place at an increasing rate. Technical bias had been in favour of material input. At the same time analysis showed that scale bias had been against this input. Energy and material came out to be substitutes for capital leading to a major implication that output can be produced beyond the installed capacity (i.e. without adding to the capacity) by using more energy and material specially when these inputs emerge as complementary to each other.

Upender and Mulakala Upender (2009) analysed the magnitude of elasticity of substitution between labour and capital across twenty six major Industries [Factory Sector] in India has been estimated in the by fitting a Constant Elasticity of Substitution Production Function for the year 2004-05. The empirical results emerged out of the cross section data demonstrated that the estimate of the elasticity of substitution between labour and capital across the major Indian Industries was significantly more than unity implying that substitution possibilities were rather more in favour of labour in the Indian major industries.

Moyazzem Hossain et al. (2012) by estimating the parameters of the production function for Bangladesh by using Cobb-Douglas production function observed that there were economies of scale in the manufacturing of drugs and pharmaceuticals, furniture and fixtures (wooden), iron and steel basic, leather footwear, fabricated metal products, plastic products, printing and publications and tobacco. There were diseconomies of scale in the beverage, chemical, glass and glass products, leather and leather products, paper and paper products, textile, wood and crock products industries, transport equipment industries.

Manonmani (2013) by fitting Cobb-Douglas production function examined the technical progress of the corporate sectors by calculating marginal productivity labour (MPL), marginal productivity of capital (MPK), marginal rate of technical substitution between labour and capital ($MPTS_{LK}$) and capital intensity(K/L). The study covered the period from1999-2000 to 2010-11. MPL ratios of various sectors during the period showed that among the sectors on an average public limited company had recorded the maximum ratio. Public corporation has recorded the maximum average MPK ratios of 5.3239 across the years. The mean $MRTS_{LK}$ was the maximum in public corporation. Wage coefficient (β) was positive in all sectors and statistically significant. This implied that wage contributed significantly to output.

Joel Chongela et al. (2013) estimated the impact of capital and labour inputs to the gross output of agri-food products using Constant Elasticity of Substitution (CES) production function in Tanzanian context from 1981 to 2010. The CES production functional form was estimated by Maximum Likelihood Estimator (MLE). The empirical results revealed that capital and labour inputs have impacted the gross output of the agri-food products by 97, 96, 94, 78 and 61%, for bakery, grain mill, fruits and vegetables, oil seeds and fats, meat and dairy products, respectively. However, interventions in terms of economic policy instruments such as capital goods and skilled labour are highly encouraged for the worthwhile economies of the agri-food firms' in the country.

Manonmani (2015) analysed the contribution of labour, capital and technology in the growth of total output of non-research intensive industries in India for the reference period from 2002-03 to 2011-12 based on Cobb-Douglas production function. It was observed that MP_L ratios across major non-research intensive industries of India showed that during the period as a whole the average growth was the maximum in the manufacture of food products and beverages. On the other hand across the period it had shown gradual increase from the beginning of the period to the end of the period. It is also found that the magnitude variability in the growth of MP_L ratios were more across the reference period when compared with the trend across the industries. MP_K ratios of non-research intensive industries showed that it was positive across the years and across the manufacturing sectors, which implied that capital has contributed positively to output. It is also evident from the analysis that many variations were not observed across the reference period, while it was showing different picture across the non-research intensive industries. It is evident that $MRTS_{LK}$ ratios during period were positive which implied that MP_L was greater than MP_K. The inter- industry ratio was high in the manufacture of food products and beverages, textiles, paper and paper products and $MRTS_{LK}$ varied widely across the non-research intensive industries. And across the period, indicating differences in the marginal productivity ratios. Efficiency parameter 'A' or the organisational efficiency was positive in all the industries. This implied that the contribution of entrepreneurship to output was positive. Capital co-efficient β1 was positive in all the selected industries in India which implied that there existed positive relationship between output and capital. Labour co-efficient β2, was also positive and statistically significant for all the industries. This implied that there existed positive relationship between inputs- output. The sum of co-efficient β1 and β2 showed increasing returns to scale in all the industries excepting wearing apparel, dressing and dyeing of furniture. It was also surprising to note that the R_2 was high in all the industries. The percentage share of factor inputs indicated that the percentage share of labour was high in 5 out of 9 industries than capital. The manufacture of food products and beverages and paper and paper product (98 percent) followed by wood and wood products, cork except furniture (91 percent), textiles (89 percent) and publishing, printing and reproduction of recorded media (81 percent). With regard to the type of technology adopted by the industries it could be observed that 5 out of 9 industries were adopting labour intensive technology since the co-efficient of labour (β2) was greater than capital co-efficient (β1).

Muniyandi and Vadivel (2016) based on secondary sources which obtained from Annual Survey of Industry (ASI) during the period from 1980-81 to 2007-08 analysed on economic analysis of return to scale of manufacturing industries in Tamil Nadu by applying Cobb-Douglas Production function. It was found that the manufacturing industries were operating under increasing returns to scale in Tamil Nadu. The manufacturing industries contributed a sizeable percentage to total income of the state in Tamil Nadu. It was observed from the estimated results that the value of R^2 was 0.9927, which indicated that the capital input and labour input were the important factors for explaining variation in the production of manufacturing industries in Tamil Nadu. It was noted from the regression results that the regression coefficients of Capital and Labour (elasticities of output with respect to capital and labour respectively) were significantly positive but less than one i.e., α =0.7831, since $\alpha+\beta$ =1.5588>1, the manufacturing industries in Tamil Nadu were working under increasing returns to scale.

Manonmani (2016) estimated production function in India's manufacturing sector with particular reference to government department enterprises covering the period 2001-02/ 2012-13. Cobb-Douglas production function was applied to measure the productivity ratios and technical progress. Marginal productivity of labour varied between 0.157 units and 8.416 units across the years. These enterprises recorded marginal productivity of capital of 2.1862 units. The average capital intensity ratio was found to be 3.919. Organizational efficiency in the sector was found high.

E. Productivity in manufacturing industries

Susan Linz (2000) estimated industry-wise and regional differences in labour productivity in Russian industry at the beginning of the transition from a planned to a market economy for the year 1992. It was found that firms with below industry, average labour productivity was expected to experience a higher than average reduction in work force size. Spinning, machine-building, forestry, wood, and paper and construction materials industries ranked lowest in terms of labour productivity. Labour productivity in the Ural, Western Siberia and Black Earth Regions was significantly below that of firms in the Volga region.

Tarlok Singh (2000) analysed total factor productivity in the manufacturing industries in India. The study used annual data from 1973-74 to 1993-94 for a sample set of ten industries in the manufacturing sector. The results showed that the Total Factor Productivity (TFP) recorded improvements in all sample industries except for the basic metal industries in which the TFP witnessed a declining trend during the period. The highest growth in TFP was observed in the case of food products followed by transport equipment, metallic products, electrical machinery, non-electrical machinery, wool and silk textiles, chemical and jute textiles.

Biswanth Goldar (2001) analysed econometrically the relationship between technology acquisition and productivity growth in 82 large chemical firms in India for the years 1985-1986 to 1989-90.The results of the study showed that research and development efforts of the firm had significant favourable effect on productivity growth. On the other hand, the results indicated that technology imports did not make a significant growth. Export intensity, firm size and intermediate goods, import intensity were positively related with productivity growth.

Soumyendra Kishore Datta (2001-02) analysed partial productivity as well as wage productivity nexus in the mill sector for the period from 1966-67 to 1990-91. It was found that capital intensity changes had a greater impact on changes in labour productivity ratio whereas the rise in per capita emoluments, reflecting increased wellbeing of the employees, although had a positive influence on changes in labour productivity could not make a significant impact with regard to the movement of capital productivity. There was a more or less increasing trend till 1979-80, but gradually declined till 1988-89 with a slight recovery in the remaining two years of the last two decades. Labour productivity in cotton mill industry had out stripped the rise in capital productivity and contributed to the growth of output and total factor efficiency achieved. Factor productivity increases were largely due to increment in labour productivity.

Hay (2002) analysed the degree of change in productivity through changes in the level of production across different sectors. The period chosen for the analysis covered between 1984 and 1991. It was found that labour productivity in the Brazilian manufacturing sector had grown at a rate of 7.35 percent in the period 1991-95. This period of productivity growth included two different phases. In the first phase, up to 1992 there was a deep recession with output falling, but employment falling ever faster. In the second phase, after 1992 productivity and output grew, but former grew faster to employment at a lesser rate than in 1990-92. There was a marked fall in 1990, followed by rapid growth to 1994. The co-efficient suggested a cumulative growth in total productivity of 58 percent during 1990-94.

Rao et al. (2003) study aimed at assessing the productivity of the industrial sector in Maharashtra during the period 1980-89. In 11 industries, the share of capital in the total output has showed a tendency to increase after the firms. The study used the following total factor productivity method for measuring efficiency – Direct Method, Dormer Index, Kendrick Index, Solow Index and Translog Index. The study found that the transport equipment industry had experienced a negative total factor productivity growth.

Unel Bulent (2003) investigated productivity trends in India's (registered) manufacturing sectors during the period 1980s and 1990s. The main findings of the study were that labour and Total Factor Productivity (TFP) growth in total manufacturing and many of the component sectors since 1980 were markedly higher than that in the preceding two decades, although the extent of the acceleration in TFP growth depends critically on the underlying assumptions about factor elasticities and the assumed structure of the production function, productivity growth for total manufacturing as well as for many subsectors picked up further after the 1991 reforms and classification of the best performing sectors and the weakest performing sectors, based on comparative TFP, remained robust to changes in underlying assumptions.

Mitra et al. (2003) examined the effect of in infrastructure on manufacturing industries, Total Factor Productivity (TFP) and Technical Efficiency (TE) in case of Indian states for 15 industries from 1976-92. Consumption goods industries showed constant returns to scale whereas heavy industries showed decreasing returns to scale. Light industries were less capital intensive than heavy industries. The productivity growth differences showed that Indian heavy industry exhibited a higher growth potential in terms of total factor productivity than did light industry. The impact of infrastructure on long run productivity by manufacturing industry showed the greatest impact on industrial total factor productivity growth. The second item of importance was financial development. The impact of financial development on total factor productivity was more significant since the country was long subject to a controlled financial policy regime that hindered the development of savings.

Deb Kusum Das (2004) examined the productivity performance of Indian manufacturing under varying trade regimes for the overall period of 1980-2000. It was found that total factor productivity growth of 0.08 percent per annum averaged over 75 three digit industries for the entire period. The total factor productivity growth rates for individual industries were either negative or in the 0 to 2 percent range. The capital goods sector was the only one to register a positive growth. TFP growth in the 1990's was found to be lower than in the 1980. In addition, for all three use-based sectors (intermediate, consumer and capital goods) TFP growth in the second half of the 1990's (1996-2000) was lower than in the first half (1991-95).

Jayamalathi and Manonmani (2004) undertook a study on productivity in selected manufacturing industries viz., Basic chemical and chemical products, Rubber, Plastic, Petroleum and Coal products and Non-metallic mineral products in Tamil Nadu for the reference period of 1979-80 to 1997-98. The major objectives of the study were to the study the trends, growth rates and magnitude of variability in factor productivity. It was found that labour productivity in all the industries had increased. Capital intensity which has increased significantly in all industries seems to be major factor behind the increase in labour productivity. The share of capital in total factor input had been increasing and that of labour was decreasing in all industries.

Spyros Arvanitis (2006) investigated the determinants of innovation performance and the impact of innovation performance on labour productivity of Swiss manufacturing firms for the period 1994-2002. The data used in this study came from the KOF panel data base and were collected in 1996, 1999 and 2002 respectively based on a questionnaire quite similar to that used in the Community Innovation Surveys (CIS). The use of a wide spectrum of indicators helped to test the robustness of the specification of the innovation equation as well as the robustness of the impact of innovation on economic performance. A clear-cut positive effect of innovation on labour productivity was found.

Manjappa and Mahesha (2008) analysed productivity performance of selected capital-intensive and labour-intensive industries in India during reform period on the panel data of 10 manufacturing industries by classifying them in to capital-intensive and labour-intensive industries for the period 1994 to 2004.The investigation revealed that four out of five industries in capital-intensive segment showed productivity growth during the sample period, while one has recorded no change. A somewhat contrasting picture was observed for labour-intensive sector, where productivity decline was statistically significant in three industries.

Gayathri and Manonmani (2008) undertook a study on productivity, employment and wages in the aggregate manufacturing sector of India for the reference period between 1990-91 and 2004-05. The major objectives of the study were to analyse the partial and total factor productivity trends, find out the sources of productivity change, examine the relationship existing between wage and productivity and analyse the trends in distribution of productivity gains. The study found that capital productivity had either declined or stagnated to mean that capital requirement per unit of output had increased. The total factor productivity had increased significantly. Increase in total factor productivity implied that overall efficiency of the sector was increasing. Growth in value added had significantly and positively related to productivity. The movement of wages was positively related with labour productivity.

Gomathi and Manonmani (2008) undertook a study on the productivity performance of manufacturing sector of Tamil Nadu in the Pre and Post Liberalisation period for the reference period between 1979-1991 (pre-liberalisation period) and 1991-2003 (post-liberalisation period). The major objectives of the study were to analyse the partial and factor productivity trends in the pre and post-liberalisation period, find out the sources of productivity change in the pre post-liberalisation period and examine the relationship existing between wage and productivity in the pre and post-liberalisation period and analyse the trends in factors share in the pre and post liberalisation period. It was found that labour productivity had increased in the manufacturing sector of Tamil Nadu. This implied that labour productivity in an industry can be increased by a host of factors such as capital intensity, economies of scale, growth of industry, and work environment. Capital intensity seems to be major factor behind the increase in labour productivity. The total factor productivity had increased in both the periods, implying overall efficiency of the sector.

Rajan et al. (2008) measured total factor productivity in selected Indian manufacturing industries, at the 3-digit level NIC classification, over the period 1973-74 to

2004-05. The study examined the productivity growth for two sub-periods, i.e., 1973-74 to 1992-93 (pre reform period) and 1993-94 to 2004-05 (post reform period). As far as iron and steel industry was concerned, productivity growth had declined in the second sub-period (post reform period). Technological progress during the 1990's was significantly slackened though it remained positive. On the other hand, aluminium and refined petroleum industries have maintained consistency in their productivity growth without much volatility. It was worth noting that the productivity in refined petroleum products has continued to rise consistently in spite of two big oil crises and increasing cost of crude oil. Labour productivity for all the three industries showed a positive and significant trend.

Adhikary Maniklal and Ritwik Mazumder (2009) examined about the liberalisation and spatial variation in manufacturing sector's productivity: a study of selected Indian states. The study was intended to search for regional inequalities in manufacturing sector's productivity during the three distinct phases of liberalisation since 1981 across four traditionally industrially developed states West Bengal, Tamil Nadu, Maharashtra and Uttar Pradesh respectively. It was found that TFPG (Total Factor Productivity Growth) was poor in all the four states. West Bengal was the only state where TFPG exhibited a continuously rising trend. Interestingly, TFPG growth was significantly higher during the post 1991 period in all states with the expectation of Uttar Pradesh.

Arza et al. (2010) adopted the approach to estimate the relationship between innovation and productivity and the realities of innovative activities in developing countries. Panel data for Argentina during the period 1998-2004 was used to estimate a structural model in which different types of firm's innovative behaviour—including in-house activities and the incorporation of external technologies fed into the probability of achieving successful results in product and process innovation, which in turn explained labour productivity. The endogeneity of this three-stage process was controlled for. The results suggested that all types of innovative activities were relevant to explain success in product and process innovation, and both were important factors to explain labour productivity. Moreover, investing systematically in R&D implies an extra payoff in labour productivity. These results suggested that investing in different types of innovative activities—and not only in R&D—and doing in-house activities systematically contributed to firms` innovative and economic performance.

Arbelaez et al. (2011) in their study attempted to establish a formal relationship between innovation and productivity using Colombian firm-level data for 1998-2006. It was found that the production of goods and services new to the firm and to the domestic market enhances firm's sales per worker, and innovation that results in introducing new goods and services to the international market boosts both sales and Total Factor Productivity (TFP). Innovation in processes likewise improves firm's productivity and sales. Finally, innovation in marketing and management increases sales per worker and enhances TFP when investment was made in Research and Development.

Nataraj and Shanthi (2011) using a unique data set of firm-level surveys that are representative of the entire Indian manufacturing industry, showed that India's unilateral reduction in final goods tariffs increased the average productivity of small, informal firms, which accounted for 80 percent 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 examining the effect of the tariff liberalisation on the distributions of productivity and firm size, evidences were found consistent with the exit of the smallest, least productive firms from the informal sector. In addition, 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.

Manonmani and Geetha (2012) in their study analysed wage-productivity relationship in the manufacture of wood and wood products. The reference period of the study was from 1979-80 to 2008-09. In order to clearly understand the links between wages and productivity in selected industries, this study had used a simple econometric analysis namely, step-wise regression model. The wage-productivity relationship that existed in the manufacture of wood and wood products in majority of the cases (either insignificant or negative) disproved the hypothesis that wage rate was significantly related to labour productivity. This explained the fact that there were factors other than those considered in this model that have influenced the real wage rate in this industry.

Manonmani (2012) made an attempt to analyse determinants of productivity based on the indices of partial and total factor productivity in rural, urban and aggregate industries of India for the reference period between 1998-99 and 2007-08. Multiple linear regression models were applied to analyse the data. To find out the average annual growth rate in partial as well as total factor productivity, exponential growth function was applied. It was found that the trend rates of partial and total factor productivity indices were positive. The analysis also revealed an inverse relationship between labour productivity and unit- labour cost in these industries. Significant relationship existed between all forms of productivity indices and the major factors which influence productivity. It was concluded that productivity of capital and total factor productivity may be taken into account along with labour productivity while granting wage increase so that wage increase is not of inflationary nature. In order boost the total factor productivity growth there is a pressing need to harmonise the industrial relations with workers and management In this context amendments in labour laws, greater participation of workers in management and rehabilitation of workers especially in case of disinvestment of public sector units are some spheres which require quick attention of policy makers to create conducive environment.

Manonmani and Nithya (2012) studied the determinants of industrial productivity in India before and after liberalisation. The reference period chosen for the study covered both pre and post liberalisation period. The pre liberalisation period covered between 1972-73 and 1990-91 and post liberalisation period between 1991-92 and 2009-10. Discriminant function was applied to find out the dominant factors which determine the productivity in these states. It was found that time factor was the first dominant factor to determine the pre and post liberalisation period labour productivity. The pre and post liberalisation period capital productivity was dominated by wage rate. In determining the total factor productivity net value-added was the prime factor between pre and post liberalisation period.

Saba Vahid (2012) focused on the productivity changes of the manufacturing industries in the U.S. from 1997 to 2002. The results showed 5 percent increase in productivity of the whole sector on an average over the study period, while the productivity of the wood product manufacturing decreased by 1 percent over the same period. The efficiency decline of the industry was the main contributor to the decline of its productivity. The decline in investments on capital and training and education of work force in wood manufacturing industry could be among the factors affected its productivity and if this trend continues, it would affect the productivity and consequently the competitive position of the industry more negatively.

Chidambaran Iyer (2013) in his study on “Urbanization in India and Productivity of Manufacturing Industries: An Empirical Study” attempted to empirically analyse the impact of urbanization on the productivity of manufacturing industries in India. The results from a panel of 15 industries across 13 states during the period 1981-2008 suggested that, there was variation in the effect of urbanization both within and across industries. The variation in productivity within an industry was observed across different time periods.

Manonmani and Geetha (2013) in their study attempted to analyse productivity linked wage in the manufacture of paper and paper products in Tamil Nadu. The reference period of the study was from 1979-80 to 2007-08. The findings supported the positive relationship between the real wage rate and labour productivity. A negative and insignificant relationship between consumer price index for industrial workers and change in real earnings was observed in all the models. The trend variable explained the fact that there were other institutional factors that influenced wage rate other than labour productivity. The analysis of the relationship between wage rate and total factor productivity index revealed equal chances of showing significant as well as insignificant relationship that existed between the two.

Manonmani and Geetha (2013) attempted to analyse the wage led productivity at the regional level by concentrating on one particular state namely, Tamil Nadu. The reference period of the study was from 1979-80 to 2007-08.The outcomes of regression analysis of functions exploring relationship between wages and productivity in the manufacture of Food Products; Beverages showed a strong association of wage rate (Lnw) and labour productivity (LnGVA/L).

Manonmani (2014) analysed the impact of economic reforms on productivity performance of manufacturing sector in South India during 1991-92 – 2011-12. The annual trend rates revealed that labour productivity growth rate was the maximum in the state of Tamil Nadu (9.15percent). The indices of capital productivity had shown increasing trend in case of Andhra Pradesh, Kerala and Tamil Nadu except Karnataka. The total factor productivity was found to be increasing from the beginning of the post-liberalisation period in all the southern states.

Manonmani (2014) examined in her study on “Total Factor Productivity of Indian Corporate Manufacturing Sector” by applying the non-parametric index number approach of measuring total factor productivity during 1999-2000 to 2010-11 for the Indian corporate manufacturing sector. The approach includes Kendrick index, Solow index and Translog index. It was found that in the private limited companies all the indices of total factor productivity except, Kendrick method had shown increasing trend. In public corporations except Translog all the other total factor productivity indices had shown negative trend rates. In government departmental enterprises, the total factor productivity indices of all the methods showed a declining trend. The total factor productivity indices of aggregate corporate sector revealed that excepting Kendrick index, all the other total factor productivity indices had increased.

Sanjoy Saha (2014) in his study on "Total Factor Productivity Trends in India: A Conventional Approach" attempted to estimate the aggregate Total Factor Productivity (TFP) for the Indian economy using the conventional growth accounting method during the study period 1961-2008. It has been observed that on an average the TFP has grown by 1.49 percent during the study period but it was erratic in nature. Although during 1960s the average TFP growth in India was positive, it was very low and almost close to zero. Similarly, the economy experienced technological regress instead of technical progress during 1970s due to the average negative TFP growth. External shocks like war, drought, oil price-hike along with rigid rules and regulations during these periods could be the probable reasons for low productivity of the economy. However, the economy's overall productivity has increased considerably after the initiation of internal economic reforms measures during 1980s. The economy has been experiencing continuous rise in TFP growth since the introduction of external economic reforms. The study revealed that TFP estimates in India were not sensitive to factor shares.

Sripoorni and Manonmani (2014) attempted to evaluate the major factors of productivity in the aggregate manufacturing sector in southern states. The study covered the period from 2000 to 2012. The major findings of the study were that labour productivity, gross output and capital intensity were significant at 1 percent level. The variable capital productivity was alone insignificant and labour productivity; capital productivity had positive signs indicating that these variables had higher discriminating power in the period. In other words, these variables distinguished the level of productivity in the reference period. The variable gross output and capital intensity having negative sign implied that these variables acted as a suppressor variable. Capital productivity was the first dominant factor to determine productivity and it alone contributed for 79.72 percent and labour productivity contributed negatively.

Manonmani (2016), made an effort to study the growth and determinants of partial and total factor productivity and measure technical efficiency in Indian handloom industries covering the period between 2003-04 and 2012-13. It was found that the growth rates of structural variables, labour, capital and total factor productivity indices registered an insignificant growth. Labour productivity was mainly influenced by the growth of net value added. Excepting the growth rate of net value added and total factor productivity, all the other factors namely size of industries, capital intensity, labour productivity and capital productivity had positively contributed to improve the efficiency of the industries.

F. Other related studies

Miguel and Leon-Ledesma (1998) examined economic growth and Verdoorn's law in the Spanish regions during 1962-1991. This study was attempted to test Verdoorn's Law with different specifications for the 17 Spanish regions using a pool of average rates of growth between 1962-73, 1973-83 and 1983-91. It was found that there was overwhelming support for the hypothesis of increasing returns to scale in the manufacturing sector of the Spanish regions. From the test of the static-dynamic paradox, the outcome was that Verdoorn's Law has not been derived from a Cobb-Douglas production function. Moreover, in the case of the Spanish regions, the paradox was also found using Rowthorn's specification, casting doubts on the adequacy of the production function approach to measuring economic growth. That was, the analysis of the level of productivity and output may be incomplete without the consideration of their dynamic behaviour.

Nagaraj (2000) analysed the employment growth in organized manufacturing sector over the period 1973-74 to 1997-98. The relationship existed between employment's wages and value-added was found to be statistically significant. On the contrary, the jobless growth in 1980s registered manufacturing employment growth annually at about three percent during 1991-97. The annual growth rate of earning per worker declined from 4.8 percent in the 1980s to 2.5 percent in the 1990s.

Dipa Mukherjee (2004) examined the growth dynamics of the Informal Manufacturing Sector (IMS) in India over the period 1984-2000 and also made an attempt to identify the plausible factor determining the growth pattern. The informal manufacturing sector had seen a flurry of research activities over the last few years. It was found that the growth pattern of informal manufacturing sector had changed significantly from the pre reform period to post reform period. It had provided employment to a substantial number of jobseekers especially in the post reform period. It had expanded substantially to compensate the slackening employment opportunities in the organized sector. The growth oriented activities (i.e.) non-metallic mineral products, basic metal, transport equipment, beverage and rural basic chemicals and metal products sector were also exhibiting positive employment growth in most as well as at the national level in the post reform period indicating that they are the dynamic sector.

Suresh Chand Agarwal (2004) provided the educational composition of the manufacturing workers in the eighteen selected states of India during the period 1983 to 1999-2000. It also presents a labour quality index based on the Jorgenson, Gallop and Fraumeni methodology for both the rural and urban sectors of the states. The labour quality indices showed that the quality changes have been quite slow and there was a lot of variation among the states for both rural and urban sectors of the selected states. The association of the labour quality index with the state's characteristics was found to be weak but urban labour quality index had stronger links with human development index of the states, the urban poverty ratio of the state, the number of ITI's in a state, and the intensity of industrialization.

Lili Wang and Adam Szirmai (2008) focused on the contribution of structural change to aggregate manufacturing and industrial productivity in China during the period 1980-2000 using shift-share techniques. This study examined three types of structural change: changes in the sectoral structure of production, changes in the ownership structure and changes in the regional structure of production. Overall productivity growth was slow in the 1980s, but accelerated dramatically from 1990 onwards. In 1980s, the study found evidence of a structural change bonus, with sectoral shifts contributing 24 percent to overall productivity growth. When productivity growth accelerated in the 1990s, the contribution of the shift effect dropped to a mere 3.3 percent. In contrast to sectoral changes, changes in the ownership structure in the early 1980s were contributed negatively to overall productivity growth. The contributions of ownership change were positive after 1985, reaching 23 percent of productivity growth in the period 1992-1997. Shifts in ownership explained a substantial part of productivity growth during the productivity boom. Likewise shifts in ownership, regional shifts initially contributed negatively to productivity growth till 1992, and positively thereafter. However, the general contributions of regional shifts were lower than the contributions of sectoral and ownership shifts. Contrary to initial expectations, the regional analysis of productivity trends did not indicate regional divergence.

Gustavo Britto (2008) for the period from 1996 to 2002 in Brazil for 6,027 firms found that the regressions using different specifications, which included a proxy for the rate of growth of capital stock, revealed a Verdoorn's co-efficient remarkably similar to those estimated using aggregated data. The success of the estimations had important theoretical and practical implications. From a theoretical point of view, the regressions result showed that, regardless of the true level at which the increasing returns to scale were generated, it is possible to successfully estimate Verdoorn's Law at the lowest level of aggregation. From a more practical point of view, the exercise showed that the manufacturing industry in Brazil was dynamic on the whole, given that firms' productivity growth showed to be highly sensitive to output growth. The significant Verdoorn's coefficients could be taken as an indication of the dynamism of the manufacturing industry, in the sense that firms were able to translate the pull of output growth into productivity gains. From the point of view of the long-run path of economic growth in general, and the country's inability to achieve higher growth rates after the 1980s in particular, the results presented suggested that the relative loss of importance of the manufacturing sector from the 1980s was a key piece of the puzzle.

Deb Kusum Das and Gunajit Kalita (2009) attempted to address the issue of declining labour intensity in India's organized manufacturing in order to understand the constraints on employment generation in the labour intensive sectors using primary survey data covering 252 labour intensive manufacturing-exporting firms across five sectors namely apparel, leather, gems and jewellery, sports goods and bicycles for 2005-06. The study showed several constraints in the path of employment generation in labour intensive sectors such as non-availability of trained skilled workers, infrastructure bottlenecks, low levels of investment, labour rules and regulations and a non-competitive export orientation. The study suggested a set of policy initiatives to improve the employment potential of these sectors.

Ceyhun Elgin and Tolga Umut Kuzubas (2012) found that there existed a significant widening gap between real wages and marginal product of labour over the period 1950-2009 in Turkish manufacturing industry. Using different time-series econometric techniques it was showed that this gap was foremost correlated with the unemployment rate over the period of study. To provide an economic mechanism for this relationship a search model of employment with endogenous bargaining was built. The model implied that this observation was consistent with declining bargaining power of the workers, which was also supported by the data.

Manoj Sharma and Rajiv Khosla (2013) examined the extent and magnitude of regional disparities in the industrial economy of India from 1980-81 (pre reforms) to 2009-10 (post reforms) using discriminant function approach. Results indicated that huge disparities in industrial development still exist. Inclusion of some states in the list of developed ones in the recent past hints at amiable conditions for the industrialization of any state in the country provided state governments frame proper industrial policies. Further, productivity measures along with the physical measures turned out to be the factors responsible for regional imbalances during post reforms period instead of productivity and profitability measures during the pre reforms period.

Research gap identified

The present study differs from earlier studies in the following aspects: First, the inter-relationships among productivity, real wages and inflation have not been examined in the manufacturing sector of southern states of India. Second, there is no study that examined the causal linkages among the variables in the manufacturing sector of southern states of India testing the theoretical framework namely Efficiency Wage Theory, Marginal Productivity and Bargaining Theory, Standard Theoretical View and Alternative Theoretical View. Only very few comparative studies have been undertaken in the southern states of India, taking into account the aggregate manufacturing sectors. Studies measuring marginal productivity of labour, marginal productivity of capital and marginal rate of technical substitution of labour for capital are handful.