REVIEW OF LITERATURE

Manufacturing sector is an important sector of an economy and can exert a significant influence on its growth and development. Therefore, a large body of literature has been devoted, both internationally as well as in India, to examine the performance of an industry through various performance measurement indicators like efficiency measurement, productivity measurement, growth rates etc. In particular, an attempt will be made in this chapter to review studies relating to performance of manufacturing as measured in terms of productivity and efficiency, factors influencing productivity and efficiency etc. Accordingly, section 2.1 analysed various studies as regards to decomposition of TFP growth. Section 2.2 discusses the determinants of TFP growth. Section 2.3 throws light on some of the studies relating to TFP growth of manufacturing at international level. Section 2.4 highlights the TFP growth of Indian manufacturing as explained by different studies. Section 2.5 analysed the technical efficiency of manufacturing at both Indian and at international level.

The Appendix-1 shows some of the studies conducted on measurement of productivity in manufacturing sector in different countries using different techniques over different time periods.

2.1. Decomposition of Total Factor Productivity Growth

Total Factor Productivity growth (TFPG) is usually decomposed into technical progress (TP) and technical efficiency change (TEC). This decomposition throws light on which of the two factors is responsible for total factor productivity growth i.e. whether improvement in it is due to TP (i.e. shifting of the frontier) or TEC (i.e. moving towards the frontier or catching up effect).
Table-2.1

Decomposition of Total Factor Productivity

<table>
<thead>
<tr>
<th>Both TEC and TP contributed to TFPC</th>
<th>Only TEC contributed to TFPC</th>
<th>Only TP contributed to TFPC</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>TEC &gt; TP</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Raheman et. al. (2009)</td>
<td></td>
<td>Karadog et. al. (2005)</td>
</tr>
<tr>
<td><strong>TEC &lt; TP</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Numerous studies (Jajri and Ismail (2006), Kim and Park (2006), Mahadevan (2002), Margano and Sharma (2006), Raheman et. al. (2009), Tan (2006)) presented in appendix-1 found that though both TEC and TP contributed to TFPG but TE improvement have contributed more. Kim and Park (2006) analysing the TFP of light and heavy manufacturing industries for the period 1970 to 1996 found that TFP growth took place in both types of industries. This growth was attributed by efficiency change in these types of industries. Mahadevan (2002) using the data of 18 manufacturing industries for the period 1981 to 1996 analysed that TFP growth of these industrial groups came from technical change. 16 of these industrial groups operate at the low end of the manufacturing operations and hence have scope to use better and advanced technology. These industries enjoy efficiency gains through experience as these are using the same technology over the years. Further, Raheman et. al. (2009) considering 11 industrial groups of Pakistan for the
period 1998 to 2007 found that these industrial groups are lacking in terms of technological adoption. Hence, technical change contributes more to TFP growth. Natarajan et. al. (2008) and Lee (2012) have found that technology has degraded (i.e. by -9.6 percent and -1.8 percent respectively), and it is only technical efficiency improvement that resulted in positive TFPG during the study period. Lee (2012) while analysing the TFP growth of 20 manufacturing industrial groups for the period 2001 to 2010 observed that TFP growth was mainly driven by technical efficiency improvement. Lack of innovation and diffusion of technology resulted in technological regression. On the other hand, skills programmes initiated in the 2000’s improved the efficiency of workers. Also, during this period, manufacturing sector has undergone major restructuring which resulted in efficient use of resources and improved management skills. Further, it is observed in this study that technical efficiency change and technological progress are inversely related. Improvement in technology and equipment resulted in decline in efficiency due to organisational slack. Contradicting it, Fare et. al. (2001), Fu (2005), Karadog et. al. (2005) and Madheswaran et. al. (2007) are of the view that it is only TP that has contributed to TFPG. They have found that average TE degraded during the study period. Fare et. al. (2001) decomposing TFP growth of Taiwan’s manufacturing for the years 1978 to 1992 examined that technical progress contributed more than technical efficiency change. It was so because Taiwan authorities undertook many projects to upgrade production. A manufacturing sector has increased its R&D activities which resulted in technological progress. The percentage of firms with greater than four percent R&D intensity (R&D expenditure to sales revenue) increased from four percent in 1986 to 23 percent in 1989. All this resulted in technological progress. Considering the period 1990 to 1998, Karadog et. al. (2005) while measuring TFP growth of Turkish public and private sector for the period 1990 to 1998 revealed that TFP improved in public sector while no improvement was experienced by private sector. In public sector, TFP growth was accounted by technological progress only. Economic crisis of 1994 resulted in decline in efficiency. However, the negative effect of technical progress was weakened by improvements in technology which resulted in TFP growth. Thus, it was only technical progress that resulted in TFP
growth. Madheswaran et. al. (2007) using the data from 1979-80 to 1997-98 of 17 two digit industrial groups viewed that TFP growth is mainly driven by technological progress. New industrial policy and economic reforms that initiated in 1985 encouraged new technological innovations and hence caused impressive technological progress. On the other hand, technical efficiency registered a negative trend. It is because of poor technical know how of Indian workers and weak socio-economic characteristics i.e. child labour, poverty, poor health of workers, non-firm income of the workers etc. Moreover, most of the industries are labour intensive in India and hence Indian workers lack labour skills. They have little knowledge about optimal utilisation of best practice technology. On the other hand, Fare et. al. (1994), Kong et. al. (2006), Mahmood and Afza (2008), and Sowlati et. al. (2006) observed that though both TE improvement and TP resulted in improvement in total factor productivity growth, but TP have contributed more. Mahmood and Afza (2008) considering the different sectors of Singapore worked out TFP growth of Singapore economy for the period 1986 to 2000. Of all the sectors, manufacturing sector experienced maximum technological progress. It was so because many manufacturing companies started using new technologies like high end computers and sophisticated machineries for production. Even transport and financial sectors adopted computerised software. Only community, social and personal services were laggards in technological upgradation because of their nature of operation. These sectors donot involve any technological capabilities. Sowlati et. al. (2006) throws light on TFP growth of Canadian manufacturing sector with special emphasis on wood products industries for the period 1994 to 2002. It revealed that on average, technological progress contributed more to TFP growth. Wood products industry experienced negative TFP growth due to negative technical efficiency with positive technological change. It is so because the labour is not efficient enough to operate the technologically advanced equipments. Education level is low in Canada and most of the labour force is unskilled and it becomes difficult for them to work on new equipments.
Technical efficiency change (TEC) is further decomposed into pure technical efficiency change (PTEC) and scale efficiency change (SEC)\(^3\). Most of the studies (Jajiri and Ismail (2006), Lee (2012), Mahadevan (2002), Natarajan et. al. (2008), Raheman et. al. (2009), Raj and Duraiswamy (2007), and Tan (2006)) observed that PTE improvement contributed more to TEC while according to Fare et. al. (1994), Fare et. al. (2001), and Mahmood and Afza (2008), it is SEC that resulted in TE improvement.

### 2.2. Determinants of Total Factor Productivity

Economists have found that besides, TEC and TP, TFP is influenced by many other factors as shown in table-2.3.

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\(^3\) PTE improvement implies better and more efficient utilisation of existing resources with given technology whereas SE improvement means improvement in efficiency due to changed scale of production.
Table-2.3
Determinants of Total factor Productivity

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Determinant</th>
<th>Positive impact on TFPG</th>
<th>Negative impact on TFPG</th>
<th>Insignificant impact</th>
</tr>
</thead>
</table>
| 1.    | Annual rate of growth in gross value of output | Babu and Natarajan (2013)  
Goldar and Kumari (2002)  
Kiran and Jain (2012)  
Raj and Duraiswamy (2007)  
Sharma et. al. (2000)  
Yean (1997) |                                                                                        |                                                                                         |                      |
Raj and Duraiswamy (2007)  
Babu and Natarajan (2013)  
Fu (2005)  
Sharma et. al. (2000) |                      |
| 3.    | Research and Development Expenditure       | Fu and Gong (2011)  
Mitra (1999)  
Saunders (1980)  
Breisebroeck (2003)  
Fu and Gong (2011)  
Sjoholm (1997)  
Sharma et. al. (2000) |                      |
| 5.    | Annual rate of change in imports           | Halpern et. al. (2011)  
Sjoholm (1997)  
<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
</table>
|   | **Infrastructure** | Babu and Natarajan (2013)  
Goldar and Kumari (2002)  
Mitra (1998)  
Raj and Duraiswamy (2007)  
Sharma et. al. (2000) |
|   | **Adult Literacy** | Babu and Natarajan (2013)  
Goldar and Kumari (2002)  
Raj and Duraiswamy (2007)  
Sharma et. al. (2000) |
Babu and Natarajan (2013)  
Raj and Duraiswamy (2007)  
Sharma et. al. (2000) |
|   | **Change in concentration ratio** | Saunders (1980) |
|   | **Foreign Investment** | Yean (1997)  
Saunders (1980)  
Mahmood and Afza (2008)  
Sharma et. al. (2000) |
|   | **Liberalisation dummy** | Babu and Natarajan (2013)  
Raj and Duraiswamy (2007)  
Goldar and Kumari (2002) |

TFP is affected by capital intensity. Different studies have come up with different viewpoints regarding the relation between both. Fu (2005) found that
capital intensity had insignificant relation with total factor productivity of manufacturing industries in China. Sharma et. al. (2000) while supporting his viewpoint found insignificant relation between total factor productivity of Nepal’s manufacturing and capital intensity. Contradicting it, Yean (1997) observed that with improvement in capital intensity, the productivity in Malaysia’s manufacturing declined. The study observed that there were labour constraints like declining skill intensity (ratio of skilled to semi-skilled labour), illiteracy, etc. that put hindrances in the absorption of productivity gains from the growth in capital in Malaysia. Opposing it, Babu and Natarajan (2013) found that the insignificant relation of TFP growth with capital intensity is because of lack of technological progress in this sector for over a period of time. There is a need for making more capital investment in this sector. Supporting it, Sharma et. al. (2000) also finds the same relationship between both for Nepal’s manufacturing. On the other hand, Kiran and Jain (2012) observed that more capital intensity resulted in improving productivity of Punjab’s manufacturing. It means that there is no unanimity as regards relation of capital intensity with total factor productivity in different countries.

Exports also have a positive and significant relation with TFP of manufacturing industries (Baldwin and Gu (2003), Biesbroeck (2003), Fu and Gong (2011), Sjoholm (1997), Yean (1997)). But Sharma et. al. (2000) is of the view that more exports have no influence on TFP. Supporting him, Fu (2005) also found the same. He observed that Chinese government was eager to develop non-export industries such as metallurgical industry, the electrical and machinery industries and the Chemical industry. Majority of the imported machinery and equipment goes to these industries. Secondly, whatsoever FDI comes in China mainly provides market and trade facilities and do not provide many new techniques. So, Exports has insignificant relation with technical change and hence, TFP growth. Yean (1997) viewed that TFP has negative relation with imports in Malaysian manufacturing sector. Sjoholm (1997) observed that importing high-tech technology resulted in improved productivity of Indonesian establishments. Halpern et. al. (2006) supports his viewpoint and observed that imported inputs improved productivity of Hungarian manufacturing. Vogel and Wagner (2008) also observed a positive relation between imports and productivity of manufacturing in Germany.
He viewed that imports act as an important vehicle for knowledge and technology transfer. Further, import of intermediate goods helps a firm to specialise in activity where it has particular strengths. It provides opportunities for exploiting global specialisation. Thus in all, imports enhances the productivity of a firm/industry.

Regarding research and development expenditure, some studies (Fu and Gong (2011), Mitra (1991), Saunders (1980), Wakelin (2000)) found that introducing new techniques, innovation and increasing expenditure on research and development also improve productivity of manufacturing sector while Fu (2005) observed that it has no influence on productivity.

Foreign investment also influences productivity. Yean (1997) is of the opinion that more the foreign investment, more will be the productivity of industry. But, Saunders (1980) observed that foreign investment decreases the productivity of domestic industry. Further, Mahmood and Afza (2008) and Sharma et. al. (2000) viewed that productivity has no relation with foreign investment. Mahmood and Afza (2008) pointed out that FDI has a stronger relation with total value added. He viewed that for productivity growth, internally developed technology and production methods alongwith local policy initiatives are more important than foreign investment.

Babu and Natarajan (2013), Goldar and Kumari (2002), Kiran and Jain (2012), Raj and Duraiswamy (2007), Sharma et. al. (2000), and Yean (1997) opined that TFP is directly influenced by output growth, i.e. more the annual rate of growth of output of an industry, more will be its TFP. These studies follow ‘Verdoon’s Law’ in this view which states that output growth is positively related with productivity growth as economies of scale acts as a source of productivity growth.

Further, some economists found that higher growth rate of agricultural sector improves the productivity of manufacturing sector (Goldar and Kumari (2002), Babu and Natarajan (2013), Raj and Duraiswamy (2007), Sharma et. al. (2000)). In support of it, Goldar and Kumari (2002) found in their study that agricultural growth declined in the post reform period which in turn resulted in decline in productivity in the post reform period. It is so because slower agricultural growth resulted in slow demand for industrial products which in turn cause under utilisation of resources and
hence lower productivity. Opposing it, Trivedi et. al. (2011) viewed that agricultural growth has insignificant relation with total factor productivity growth. He viewed that since unorganised sector is excluded, so due to data limitations this relationship is found. Even though the relationship is insignificant, but still it plays an important role in providing demand for manufacturing sector. Also, good infrastructure has a positive influence on the productivity of manufacturing sector (Babu and Natarajan (2013), Goldar and Kumari (2002), Mitra (1998), Raj and Duraiswamy (2007), and Sharma et. al. (2000)). Babu and Natarajan (2013) measuring the productivity of Indian states found that regional infrastructure availability influences regional manufacturing productivity growth in India. Regions with good infrastructure facilities enjoy greater productivity than those with poor infrastructure facilities. In addition, more the adult literacy in an economy, more will be the productivity of manufacturing sector (Babu and Natarajan (2013), Goldar and Kumari (2002), Natarajan (2008), Raj and Duraiswamy (2007), Sharma et. al. (2000)). Babu and Natarajan (2013) viewed that improving the education base of workers in the unorganised manufacturing sector increases the productivity growth.

Apart from the above determinants of productivity, productivity of manufacturing sector has a positive relation with efficient utilisation of resources (Mitra (1999)), real exchange rate, non-tariff barriers (Goldar and Kumari (2002)). It has a negative relation with one year lagged technical efficiency (Fu (2006)), pre-productivity growth rate (Natarajan (2008)) and investment ratio (Goldar and Kumari (2002)). Productivity has no relation with firm size, nominal rate of protection, and ownership structure (Sharma et. al. (2000)).

Thus, total factor productivity is influenced by numerous factors. Also, the relation of these factors with productivity varies in different studies.

2.3. Total Factor Productivity Growth at International Level

Apart from the above differences, controversy also arises as regards measuring the productivity of the same country. Using the data on 17 OECD countries, Fare et. al. (1994) by applying MPI measured the mean TFP to be 0.7 percent for the period 1979-88. Ray and Desli (1997) using same set of countries and adding two more years to the entire period (1979-90) noticed that mean TFP
degraded by 0.4 percent. According to Fare et. al. (1994), among the 17 OECD countries, Greece showed degraded TFP by 3.8 percent. But Ray and Desli (1997) observed improvement in Greece’s productivity by 0.36 percent. Contradicting results were found also in case of Italy, Sweden and U.S.A. Fare et. al. (1994) observed that these three countries have shown improvement in TFP ((1.95 percent in Italy), (0.19 percent in Sweden) and (0.85 percent in U.S.A)). But Ray and Desli (1997) noted that productivity degraded by 2.14 percent in Italy, 1.81 percent in Sweden and 5.55 percent in U.S.A.

Contradictory results were found also for Singapore’s manufacturing. Kong and Tongzon (2006) examined productivity in the ten major sectors of Singapore (of which one is manufacturing) using the data from 1985 to 2000. The results showed that the mean total factor productivity is 1.9 percent in the entire sampled data, and of manufacturing alone is 4.0 percent. Manufacturing sector is ranked at second place among all the sectors. Further, Tan (2006) using the data on 18 industrial groups from 1974 to 1998 noted that the productivity of Singapore’s manufacturing sector improved by 0.34 percent. Further, only half of the total industrial groups experienced productivity improvement. Medical, optical instruments, watches and clocks have shown maximum improvement i.e. 1.86 percent in productivity, followed by electronic products and components (1.51 percent). Lee (2012), using the same variables and data source applied the same technique on 20 industrial groups of Singapore’s manufacturing for the period spanning 2001 to 2010. The results revealed that productivity grows at an annual rate of 1.9 percent, and 14 of 20 industrial groups registered growth in total factor productivity. Other manufacturing industrial groups registered highest growth in productivity i.e. 8.7 percent, followed by electrical equipment (8.0 percent).

Similar differences were observed while measuring productivity of manufacturing sector in Malaysia. Mahadevan (2002) measured the TFP of Malaysian manufacturing sector using 28 three digit industrial groups from 1981 to 1996 and found that mean TFP was 0.8 percent. Yean (1997) using the same industrial groups and variables for the time period spanning 1986 to 1991 of Malaysia found that mean TFPG is 0.3 percent. Further, he observed that 12 out of
28 industrial groups showed degraded productivity. But, Mahadevan (2002) found degraded TFP only in one of 28 industrial groups.

### 2.4. Total Factor Productivity Growth of Indian Manufacturing

#### Table-2.4

**Database for TFP Measurement in India**

<table>
<thead>
<tr>
<th>State-wise analysis</th>
<th>Industry-wise analysis</th>
<th>Both industry-wise and state-wise analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kumar et. al. (2010)</td>
<td>Pattnayak et. al. (2005)</td>
<td></td>
</tr>
<tr>
<td>Natarajan et. al. (2008)</td>
<td>Trivedi et. al. (2000)</td>
<td></td>
</tr>
<tr>
<td>Trivedi (2004)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unni et. al. (2001)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

To reflect TFP in India, some studies have used statewise-data (Babu and Natarajan (2013), Deb and Ray (2013), Kumar (2006), Kumar et. al. (2010), Mukherjee and Ray (2004), Natarajan et. al. (2008), Raj and Duraiswamy (2006), Ray (2002), Trivedi (2004), Unni et. al. (2001)); and some have used industry-wise data (Ahluwalia (1991), Bhandari et. al. (2010), Das (2003), Pattnayak et. al. (2005), Pradhan and Barik (1999), Trivedi et. al. (2000), Unel (2003), and Veermani and Goldar (2005)); and some others have used both state-wise and industry-wise data ((Mitra (1999), Mitra et. al. (2002), Raj and Mahapatra (2009)).

To measure TFP, two broad techniques were used. Bhandari et. al. (2010), Deb and Ray (2013), Kumar (2004), Natarajan et. al. (2008), and Rajesh et. al. (2009) have used DEA technique i.e. MPI while others (Goldar (2004),
Madheswaran et. al. (2007), Mitra (1999), and Trivedi et. al. (2000)) have used SFA for measuring total factor productivity. Kumar (2006) compared total factor productivity results by using both MPI and SFA.

2.4.1. Impact of Economic Reforms on Indian Manufacturing Productivity

While measuring TFP, most of the studies found impact of economic reforms on Indian manufacturing.

Table-2.5

<table>
<thead>
<tr>
<th>Impact of Economic Reforms on Productivity of Manufacturing Sector of India</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive Impact</td>
</tr>
<tr>
<td>-----------------</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

Some are of the view that liberalisation of Indian economy has resulted in improved growth rate of TFP ((Deb and Ray (2013), Krishna and Mitra (1998), Madheswaran et. al.. (2007), Natarajan et. al.. (2008), Pattnayak and Thangavelu (2003), Unel (2003)), while others showed that economic reforms have adversely affected productivity ((Balakrishnan et. al.. (2000), Bhandari et. al.. (2010), Datta (2011), Goldar (2004), Goldar and Kumari (2002), Raj and Mahapatra (2006), Trivedi et. al.. (2000), and Unni et. al.. (2001)). Kumar (2006) using the data on 15 states viewed that productivity has improved from 1.7 percent per annum during 1982-83 to 1990-91 to 3 percent per annum during 1991-92 to 2000-01. Deb and Ray (2013) using the data on 22 states observed that liberalisation has increased TFP growth from 1.06 percent per annum during 1970-91 to 2.74 percent per annum during 1991-08. Raj and Duraiswamy (2007) also found that productivity of manufacturing of 15 states, on an average, improved from -11.6 percent per annum during 1978-90 to 8.6 percent per annum from 1991-2001. Patnayak et. al. (2005)
while using the data on 13 industrial groups experienced that with the onset of liberalisation, 10 out of 13 industrial groups experienced a growth in total factor productivity. Contradicting the above studies, Goldar and Kumari (2002) found that TFP decreased from 1.89 percent per annum during 1981-90 to 0.69 percent per annum during 1991-98. Further, liberalisation resulted in reduced productivity from 2.23 percent per annum during 1979-90 to 1.65 percent per annum during 1991-2000 according to Goldar (2004). Supporting it, Datta (2011) predicts that productivity fell from 2.05 percent per annum during 1980-91 to -0.45 percent per annum during 1991-04. Using almost the same time period, Pardeep et. al. (2005) also found that liberalisation has resulted in fall in TFP of Indian manufacturing from 1.7 percent per annum to -0.4 percent per annum. Unni et. al. (2001) found that in case of organised sector, TFP has decreased from 1.13 percent per annum during 1978-90 to -1.28 percent per annum during 1990-95 while in case of unorganised sector, it increased from -2.66 percent per annum to 3.13 percent per annum as per the same period. Raj and Mahapatra (2006) while analysing the productivity growth of organised industrial sector in India found that productivity fell from 1.40 percent per annum in pre-reform period (1981-1990) to -0.52 percent per annum in post-reform period (1991-2003). Natarajan et. al. (2008) using the data of 15 Indian states for the period 1978 to 2001 observed that liberalisation resulted in improving the TFP growth from 1.6 percent per annum in pre-reform period to 8.1 percent per annum in post reform period.

Further, while examining the role played by TE and TP in TFPG during post reform period, Pradeep et. al. (2005) viewed that no doubt technology has improved, but TE has fallen. This is due to the fact that the present entrepreneur and skills were not able to adopt the new technology and hence their efficiency growth declined (from five percent per annum to -1.9 percent per annum) more than technological change (0.1 percent per annum to 2.0 percent per annum). This resulted in decline in TFP in post reform period. But, Kumar (2006) observed that technological progress overweighted technical efficiency regress and thus resulted in improvement in TFP growth. Further, Raj (2011) viewed that technological progress has taken place and technical efficiency remained same due to which TFP improved. Natarajan et. al.
(2008) observed that technical efficiency improvement resulted in TFP growth. On the other hand, technological regression took place at a lower rate in post reform period when compared with pre-reform period. It is so because industrial units work for improving the technological capabilities of the production process. States started investing more in fixed capital stock which resulted in improving technical progress.

2.4.2. Industry-Wise and State-Wise Analysis of Total Factor Productivity Growth of Indian Manufacturing

It was noted that industry-wise analysis and state-wise analysis of Indian manufacturing produce contradictory results. While evaluating the performance of 15 two-digit industrial groups, Madheswaran et. al. (2007) observed that Chemical and Chemical products industry (30) is most productive followed by Rubber, petroleum and coal industry (37) and metal products industry (34). Trivedi et. al. (2011) study supports these results which observed that Chemical and Chemical products is most productive industrial group by applying Stochastic Production Frontier Approach. Advocating it, Goldar and Kumari (2002); and Pattanayak and Thangavelan (2005) noted that Chemical and Chemical products though is not most productive but is counted in first three most productive industries. According to Goldar and Kumari (2002), other manufacturing products industry (38) is most productive while it is metal products and parts industry (34) as per the results of Pattanayak and Thangavelan (2005). Even Trivedi et. al. (2011) also obtained it as the most productive industrial group by applying Malmquist Productivity Index.

Inter-state analysis of Indian manufacturing unfolds the position of each state’s manufacturing relative to other states. Thomas (2002) while examining the contribution of all sampled states in total share of Indian manufacturing through GVA stated that western states i.e. Maharashtra and Gujarat have highest share in total GVA (33 percent) of Indian manufacturing (of which Maharashtra alone contributes 23 percent). North-West states have 18 percent of share in total, of which Punjab has only 3 percent share. Further, measuring the productivity of Indian manufacturing, different studies come up with different results. Babu and Natarajan (2013) viewed that Bihar, Gujarat and Orissa recorded highest total factor
productivity growth for the period 1980-81 to 2007-08 while West Bengal and Tamil Nadu are least productive Indian states. Trivedi et. al. (2011) study also supports these results who reported that West Bengal and Tamil Nadu are least productive states for the years 1980-81 to 2003-04, while Maharashtra has recorded highest total factor productivity growth. A study conducted by Mitra (1999) revealed that Assam is the most productive state as far as manufacturing is concerned. Kumar (2006) and Natrajan et. al. (2008) contradicted it and examined that Assam’s productivity has been negative during the study period. Instead, Kumar (2006) viewed that Rajasthan is the most productive state. But, as per Natarajan et. al. (2008), its productivity is also negative. Natarajan et. al. (2008) revealed that Punjab is the most productive state. Further, contradicting all, Deb and Ray (2013) observed that the most productive state is Haryana. The differences in the above results may have aroused because of different time periods being used by these studies.

Further, while examining the impact of liberalisation on different states of India, again contradictions were noted. Kumar (2006) noted that liberalisation has resulted in improved performance of manufacturing sector in Andhra Pradesh, Gujarat, Haryana, Madhya Pradesh, Maharashtra, Rajasthan and Tamil Naidu. Apart from these states, Deb and Ray (2013) revealed that liberalisation has also brought prosperity in the states of Assam, Karnataka, Kerala, Orissa, Punjab, Uttar Pradesh and West Bengal. Natarajan et. al. (2008) while finding the impact of economic reforms came up with different results. He reviewed that these reforms have improved the performance of manufacturing in Bihar, Harayana, Kerala, Madhya Pradesh, Orissa and Punjab only.

In inter-state analysis of TFP, Mitra (1999) highlighted that though Punjab has experienced increase in productivity from -11.61 percent per annum in first sub period (1976-84) to 9.36 percent per annum in second sub period (1985-93), but its aggregate figure remains negative i.e. -1.13 percent among the sampled 15 Indian states. The study revealed that chemical and chemical products (30) is most productive industry in Punjab followed by leather products industry (29). Also, productivity of basic metal industry (33) has deteriorated from -8.5 percent per
annum in first sub-period to -59.72 percent per annum in second sub-period, and hence is the worst performing industry. Further, Deb and Ray (2013) found that total factor productivity growth has improved from -0.253 percent per annum in pre-reform period (1970-1991) to 2.28 percent per annum in post reform period (1992-2007) in Punjab. In support of his view, Natarjan et. al. (2008) examined that total factor productivity growth rate increased from 1.42 percent per annum in pre-reform period (1978-1990) to 2.39 percent per annum in post reform period (1990-2001) of Punjab’s manufacturing sector. Supporting it, Deb and Ray (2013) while evaluating inter-state analysis found that total factor productivity growth of Punjab’s manufacturing has improved from being negative, i.e. -0.25 percent per annum during 1970-71 to 1990-91, to 2.287 percent per annum during post reform period (1991-92 to 2007-08). Overall, total factor productivity of Punjab has improved by 0.868 percent per annum during the entire study period. Contradicting him, Kumar (2006) while doing inter-state analysis found that liberalisation had a negative impact on Punjab’s manufacturing sector. Its total factor productivity decreased from 3.14 percent per annum in pre-reform period (1982-1990) to 1.64 percent per annum in post-reform period (1991-2001). Kiran and Jain (2012) studied the TFP growth of Punjab’s manufacturing in post TRIPS regime i.e. from 1994 to 2008 on 22 industrial groups. They observed that productivity was highest in Food and Food products followed by Wood and Wood products and Basic Metals; while it was least in Electrical Machinery and Apparatus followed by Coke, Refined Petroleum. Both Natarajan et. al. (2008) and Kumar (2006) are of the view that whatever productivity growth has taken place both in pre and post-reform period is only due to TEC rather than TP. Deb and Ray (2013) contradicted it and viewed that it is TP rather than TEC that resulted in total factor productivity growth.

2.5. Technical Efficiency Estimation:

Apart from TFP, another indicator for measuring the performance of manufacturing sector is its technical efficiency (TE). Mahadevan (2000) measured the TE of Singapore’s manufacturing sector by using 28 industrial groups for the time period 1975 to 1994. By applying SFA, the study examined that mean TE of all
the industrial groups ranged between 52 percent and 97 percent. Baten et. al. (2009) while applying the same technique on 31 three digit industrial groups of Bangladesh evaluated the mean technical efficiency of Bangladesh manufacturing industries during the period 1988-1989 to 1999-2000 for the truncated normal distribution is found to be 0.339 whereas the mean efficiency is 0.356 for the half-normal distribution. Using the second census data, Nikaido (2004) measured the TE of 18 two digit industrial groups in India and found the mean TE to be 81 percent. Mukherjee and Ray (2004) studied the impact of reforms on Indian manufacturing sector by applying DEA. Using aggregate data of manufacturing of 22 Indian states from 1986 to 2000, the results revealed that mean TE has reduced from 96 percent in pre-reform period (1986-90) to 93 percent in post reform period (1990-00). Bhaumik and Kumbhakar (2008) using SFA measured the TE of 14 two digit industrial groups of India from 1989-90 to 2000-01. The results revealed that the TE ranged from 51 percent to 65 percent. Saputra (2011) while analysing the technical efficiency of 23 Indonesian manufacturing industries for the period 1990 to 2001 found that mean technical efficiency, though fluctuating, but, overall speaking, increased marginally from 45.8 percent in 1990 to 46.4 percent in 2001.

Besides inter-industry analysis, TE is also measured at firm level. Faria et. al. (2005) measured TE using SFA of Portugese manufacturing industries and found that mean TE is 67 percent. Albert and Maudos (2002) using the same technique measured the TE of Spanish manufacturing firms and found it to be 76 percent. Bhandari and Maiti (2007) using SFA measured TE of India’s textile firms. He observed that liberalisation has resulted in deterioration in technical efficiency. It varied between 68 percent to 84 percent of textile firms during the entire study period. Goldar et. al. (2004) measured the TE of engineering firms using SFA from 1990-91 to 1999-00. By classifying the firms on ownership basis, he observed that foreign owned firms (79 percent) are more efficient than private firms (72 percent) and public firms (66 percent). Kambhapati (2003) using the data from 1986 to 1994 measured the TE of cotton textile firms in India by applying SFA. He observed that efficiency improved in the post reform period from 80 percent to 90.3 percent. With
liberalisation, dispersion of firms also decreased. Barros and Perrigot (2008) using DEA measured the TE in French Grocery retailing industry and found it to be 77.9 percent. Using the same technique, Zhang and Zhang (2001) examined that the TE of China’s iron and steel industry is 54.6 percent. By applying SFA, Jafarullah (1999) found the TE of handloom textile industry of Bangladesh to be 41 percent.

Apart from measuring technical efficiency, studies have also examined the factors effecting technical efficiency.

Table-2.6
Determinants of Technical Efficiency

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Determinant</th>
<th>Positive impact on TE</th>
<th>Negative impact on TE</th>
<th>Insignificant impact on TE</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td>Bhandari and Maiti (2007)</td>
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<td>Kambhapatii (2003)</td>
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<td>Mini and Rodriguez (2000)</td>
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<td>Zhang and Zhang (2001)</td>
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<td>Mini and Rodriguez (2000)</td>
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</table>
### 6. Market concentration
- Albert and Maudos (2002)
- Kambhapati (2003)

### 7. Capital intensity
- Faria et. al. (2005)
- Kambhapati (2003)

### 8. Ownership structure
- Mini and Rodriguez (2000)
- Shiu (2002)
- Albert and Maudos (2002)
- Majumder (1994)

### 9. Modernization of physical capital
- Zhang and Zhang (2001)

### 10. Market share
- Kambhapati (2003)

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Age of the firm is a very important determinant of technical efficiency. Albert and Maudos (2002), Bhandari and Maiti (2007), and Kambhapati (2003) stated that young firms are more efficient than old ones while Bhandari (2010) and Mini and Rodriguez (2000) observed no relation between age of the firm and technical efficiency. Apart from age of the firm, size of the firm also influences its efficiency. Bhandari and Maiti (2007), Bhandari (2010), and Mini and Rodriguez (2000) found that larger the size of the firm, more will be its efficiency.

Ownership structure also influences efficiency of the firm. State owned firms are more efficient than non-state owned firms (Mini and Rodriguez (2000) and Shiu (2002)). Albert and Maudos (2002) contradicted it and found that private firms are more efficient than state owned firms, while Majumder (1994) observed no relation between ownership type and efficiency of a firm.

Efficiency of a firm is also affected by the expenditure on innovation. Firms adopting new techniques of production are more efficient than those using old techniques (Bhandari and Maiti (2007), Zhang and Zhang (2001)). But, Albert and Maudos (2002) found opposite results. Further, according to Faria et. al. (2005), more capital-labour ratio results in more efficiency of a firm while Kambhapati...
(2003) is of the view that higher the capital-labour ratio, lesser will be the efficiency of a firm.

Apart from the above determinants, technical efficiency is affected by many other factors, Technical efficiency (TE) of a firm is positively related with experience of workers (Alvarez and Crespi (2003)). It is also positively related to market share, distance from regional centre (Kambhapati (2003)). Further, Kambhapati (2003) and Mini and Rodriguez (2000) found a positive relation between export intensity and technical efficiency. On the other hand, as per the studies of Albert and Maudos (2002) and Kambhapati (2003), technical efficiency is negatively related to market concentration and import intensity. Technical efficiency has no relation with owner’s education, outward orientation, participation in public programs according to Alvariz and Crespi (2003) and legal organisations as per the study of Mini and Rodriguez (2000).

It thus can be concluded from the above discussion that there are differences in the opinions of the studies being reviewed. While measuring the productivity of different countries, different studies came up with different results. Differences also arise while evaluating that whether technical efficiency change or technological change results in total factor productivity growth. Skill programmes initiated, working experience, restructuring of manufacturing sector resulted in improved efficiency and TFPG. On the other hand, initiation of new projects, new policies and reforms, and R&D activities undertaken caused technological progress which in turn resulted in TFPG. Further, it has been noticed by different researchers that total factor productivity is affected by many factors like capital intensity, foreign investment, research and development expenditure, exports and imports, output growth, capital-labour ratio etc. Further, researchers have also shown how technical efficiency is influenced by size of the firm, age of the firm, research and development expenditure, ownership structure, experience of workers etc. Among the above reviewed studies, some studies showed a direct relation of these factors with TFPG/TE; some examined an inverse relation while others experienced no relation between them. This section also reviewed the studies relating to measuring the performance of Indian manufacturing sector. It has also highlighted the opinion of different studies regarding the impact of liberalisation on Indian manufacturing.
Some viewed that liberalisation brings in new technology and caused technological progress and hence TFPG. While others contradicted and viewed that existing labour force was unable to adopt the new technology which resulted in decline in technical efficiency more than improvement in TP and hence TFP regressed. Further, the performance of Punjab’s manufacturing is taken from the interstate analysis of Indian states. Not much work has been done to measure the total factor productivity of Punjab’s manufacturing sector by taking industry-level data at two or three digit classification. In this study, such an effort is made.