



# Technical efficiency and total factor productivity of Indian industries – An inter-state and inter industry comparison between pre and post global financial crisis of 2008-09

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## ABSTRACT

Technical efficiency, total factor productivity, scale efficiency etc are very important phenomenon for the industrial growth of a nation. Industrial growth means more employment, more export more income and a steady improvement in the overall of the economy. Efficiency in production becomes an inevitable phenomenon for sustainability in the era of globalization. This paper tries to through some light on the measurement of such efficiencies. It considers a state wise comparison taking all industries at a time and side by side individual industries as well for comparison with respect to global financial crisis during the end of 2007 up to 2009. As far as methodology is concerned in this study, we have applied Output orientated DEA, Malmquist DEA methods to panel data to calculate indices of total factor productivity change, which consists of technological change, technical efficiency change and scale efficiency change. This study finds that not all states of India nor individual industries behaved in a similar fashion. Few industries have taken this crisis as a challenge and improved in their technical efficiencies and total factor productivity, but many other industries could not able to accept this challenge.

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## 1 | INTRODUCTION

Globalisation is “the integration of poor countries into a world economy of open competition” (Martell 2017, 148) In simple term globalisation is related to removal of government’s restrictions for the free movement of labour, capital, products, knowledge, technology etc It integrates the whole world in to a global village. It makes the proverb struggle for existence and survival of the fittest into reality. Since the domestic companies have to face with foreign companies for their survival. So efficiency in production becomes an inevitable phenomenon for sustainability in the era of globalization. Though there are another view also who opine globalisation is the main culprit for increasing inequality, un employment and the poor nations becoming poor and rich nations are rich day by day. But the reality is that whatever its pros and cons now no nations can live alone and the relationship among nations became interdependent. Under these circumstances the developing nations have to face the foreign competitions, the foreign companies are getting level playing field, and side by side poorer nations also getting an opportunities to prove themselves through innovation though raising efficiency in production and also getting the opportunity to sale their product in to the large market. So the completions among nations are open to all. Now starting from our primary sector, agriculture provides us food, otherwise we could not survive. After food we need clothes, we need shelter thereafter. These are the very basic needs of our life. After the fulfilment of basic needs we want its variety, we need more options, more choices. We need education, health care etc. Everyone wants to be better-off today compared to previous day. To fulfil these desires, we need to earn money. For more income we need better employment opportunities, which may not be possible only through agriculture. Hence we need to depend on Industry. We know the impact of industrial revolution in European nations whose fruits are still enjoyed by the people of these nations. After fulfilling our consumption needs agriculture supplies its products to industries as raw materials or for value addition of these products. Thus agricultural development is essential for the development of agro based industries. Now development of industries depend on its efficiency of production

Productivity is the ratio of output and the weighted sum of inputs and total factor productivity growth reflects productivity growth. In simple term total factor productivity growth can be obtained just by subtracting the growth of output with the growth of primary inputs. Total factor productivity growth consists of technological progress, technical efficiency change, change in the scale efficiency and allocation efficiency change. As we know ‘The Data Envelopment Analysis (DEA) involves the use of linear programming methods to construct a non-parametric piecewise surface or frontier over the data, so as to be able to calculate efficiencies relative to this surface.’ In this

study we have applied Malmquist DEA methods to panel data to calculate indices of total factor productivity change, which consists of technological change, technical efficiency change and scale efficiency change (Fare, Grosskopf, Norris and Zhang, 1994) Traditionally, a production function puts forward a well defined technical relationship between a vector of most outputs and a vector of factor inputs. The term frontier may be defined as best practice production function which implies the maximum output, given a set of factor inputs. Diagrammatically it may be defined as the outward shifts of the production function The gap between frontier production function of any observed production function is the inefficiency. According to Lovell (1993), a distinction between the observed and optimal values of its output and inputs is the efficiency of the production unit. By the term efficiency actually there are three other concepts included. Allocation efficiency, scale efficiency and the technical efficiency or inefficiency (if we consider the gap between frontier production function of any observed production function) Regarding allocative efficiency actually this efficiency reflects the ability of a firm to use the inputs in optimal proportions given their respective prices. The economic efficiency is the product of these two efficiencies. The technical efficiency may be Output –Oriented as well as Input oriented. When the firm can expand its output quantity without altering or changing its input quantities it is Output oriented technical efficiency, on the other hand, when the firm faces the situation about the proportional reduction of input quantities without altering the output quantities produced, then the firm thinks about input oriented technical efficiencies. Although these two measures provide equivalent measures of technical efficiency when constant returns to scale (CRS) exist, but in case of variable returns to scale (VRS) these two measures differ. Actually, the Constant returns to scale is suitable when all the decision making Units are operating at an optimal scale which is equivalent to the position of the firm at flat portion of the LRAC curve. However many reasons such as imperfect competition, constraints on finance etc may prevents a decision making firm to operate at the optimal scale. Here lies the importance of Variable returns to scale, since the use of variable returns to scale will allow the calculation of technical efficiency of a firm by taking into account of the effects of scale efficiencies which the CRS specifications cannot, (Banker, Charnes and Cooper, 1984) Many studies have decomposed the technical efficiencies (through CRS DEA technique ) in to two parts One is due to scale inefficiency and the other one is pure technical inefficiency. If we run DEA separately for CRS and VRS on the same set of data and if there exists a difference in score, this difference is due to scale inefficiency in the literature it is seen that Farrell (1957) was the first researcher to began with an estimation of efficiency, before that productivity of labour, value comparison etc were used for estimating efficiency. However the important limitation of Farrell’s approach was the deterministic frontiers that didn’t allow any shocks

within the production method that are outside the management of the firm and in and of itself few extreme observations confirm the frontier and exaggerate the most potential output given inputs (Lee 1983) Aigner, Lovell and Schmidt (1977) and Meeusen and Van den Broeck (1977) handled this downside with an additional satisfactory abstract basis by explicitly including an error component which is stochastic, to capture the inefficiency error element across the production unit (Lee, 1983) Thus there are two fundamental methods to calculate technical efficiency of a decision making unit or firm. One is deterministic and non parametric which is popularly known as Data Envelopment Analysis (DEA) and the other is stochastic and parametric popularly known as Stochastic Frontier Analysis (SFA) According to Bauer 1990, Stochastic Frontier Approach appears more superior on theoretical grounds due to the inclusion of 'random shocks' or 'statistical noise' in the calculation of efficiency. However the stochastic frontier approach also suffers from the problem of selecting the acceptable form of functional distribution of the inefficiency  $U_i$  which may be half normal, exponential, truncated normal distribution and gamma distribution, as the different specifications do provide different estimates (Lee, 1983) Mortimer & Peacock in 2002 opined that frontier approach by incorporating the chance variable (both random error and inefficiency error) treats deviations from production function which allows a distinction between a random symmetrical element that accounts for measurement errors and random effects (regression equation error) and a symmetric deviation element that represents the inefficiency error. Moreover, since frontier approach is estimated through Ordinary least square or maximum likelihood technique hence the problem of multicollinearity and auto correlation might cause severe problems in this method.

Hence the Malmquist Index of total factor productivity for the industries using the non-parametric method of Data Envelopment Analysis (DEA) becomes another alternative. This method was introduced by Caves, Christensen and Diewert (1982), and operationalised by Fare, Grosskopf, Lindgren, and Roos (1992) to measure productivity change is a normative measure based on a reference technology underlying determined input – output information, (Roy, Jena & Nayek, 2022) Moreover this method has another advantage of using disaggregated inputs and multiple output technologies in different time periods. According to Bates et al 1996, this method is the most effective for constructing production frontier and then permits the information to speak for themselves.

TFP growth is usually measured by the Solow residual since Solow (1957) Let  $g_Y$  denote the growth rate of aggregate output,  $g_o$  the growth rate of aggregate capital,  $g_L$  the growth rate of aggregate labour, and  $\alpha$  the capital share. The Solow residual is then defined as

$$g_Y - \alpha^* g_K - (1 - \alpha^*) g_L$$

The Solow residual accurately measures TFP growth if

- the production function is Cobb–Douglas,
- there is perfect competition in factor markets, and
- the growth rates of output and the inputs are measured accurately.

TFP plays a critical role on economic fluctuations, economic growth and cross country per capita income differences. At business cycle frequencies, TFP is strongly correlated with output and hours worked (Prescott 1982) Long-run growth in income per capita in an economy with an aggregate neoclassical production function must be driven by growth in TFP (Robert Solow 1957). Solow (1956) also demonstrated that cross-country differences in technology may generate important cross-country differences in income per capita. Klenow and Rodriguez-Clare (1997) and Hall and Jones (1999) have confirmed that most of the gap in income per capita between rich and poor countries is associated with large cross-country differences in TFP. Cross-country differences in TFP can be due to differences in the physical technology used by countries or in the efficiency with which technologies are used. Comin, Hobbijn and Rovito (2006) put together direct measures of technology adoption for approximately 75 different technologies and show that the cross-country differences in technology are approximately four times larger than cross-country differences in income per capita. Further, technology is positively correlated to income per capita. Thus, cross-country variation in TFP is, to a large extent, determined by the cross-country variation in physical technology. There are plethora of studies on productivity growth in literature although the standard of analytical part is improving day by day. However to sum up considering most of the literature we can broadly classified into three major groups. The 1<sup>st</sup> group embraces with the estimates of total factor productivity growth specially on manufacturing industries Another group drew attention to the biases in productivity estimates originates from the application of value added function and specially the application of single deflated value added (Roy et al, 2022) Finally the 3<sup>rd</sup> group have mainly focussed on the impact of trade and national trading policy reforms on industrial productivity growth in the post reform period in India ( since 1991-92) This group mainly uses the gross output function for the measure of total factor productivity. Moreover this group considers services as an associate input in addition to labour capital raw materials and energy

etc. Very few studies are there in literature which combines all industries, hence this study tries to make a bridge in the existing literature by incorporating region/state wise technical efficiency, industry wise total factor productivity estimates.

## 1.1 | Objectives of the Study

In this paper an attempt has been taken to measure technical efficiencies of the Indian industries through Data Envelopment Analysis (DEA) techniques and also Malmquist Productivity index to examine the change of various technical efficiencies of industries prior to global economic crisis of 2007-09 and post financial crisis year that is from 2010-11 to 2019-20 of India. This study is completely based on secondary data and the data are collected from the Ministry of Statistics and Programme Implementation (<https://mospi.gov.in/>).

## 2 | METHODOLOGY OF THE STUDY

The DEA approach provides an alternative approach, and it has been applied to a wide range of industries. The primary advantage of the DEA approach is that it does not assume specific parametric functional forms for the production frontiers and avoids the use of distributional assumptions on the disturbance term in econometric models. It also provides a measure of inefficiency. Another advantage of the DEA model is that it can easily accommodate multiple outputs and multiple inputs simultaneously thereby avoiding inappropriate aggregation of multiple outputs and inputs which are common in service industries such as transportation. Several techniques can be used to evaluate the efficiency decision making units (DMUs) Data Envelopment Analysis (DEA) is a non-parametric mathematical programming technique in which multiple inputs and outputs are used to measure the relative efficiencies of DMUs The original DEA model was proposed by Charnes, Cooper and Rhodes (1978) which had an input orientation and assumed constant returns to scale (CRS) Their model is popularly known as CCR model of DEA. Though the CRS assumption is only appropriate when all DMU's are operating at an optimal scale. In practice imperfect competition, constraints on finance, etc may cause a DMU to be not operating at optimal scale. Later on Banker, Charnes and Cooper (1984) suggested an extension of the CRS DEA model to account for Variable Returns to scale situations. The use of the CRS specification when not all DMU's are operating at the optimal scale, will result in measures of TE which are confounded by scale efficiencies (SE) Hence the use of the VRS specification will permit the calculation of TE devoid of these SE effects. Their model is popularly known as BCC model of DEA.

### 2.1 | Charnes–Cooper–Rhodes (CCR) model

In the Charnes–Cooper–Rhodes (CCR) model, the efficiency of an evaluated entity is the ratio of its weighted output to its weighted input where the ratio for each entity is not greater than 1. Assume that there are  $n$  DMUs,  $m$  inputs, and  $s$  outputs. Suppose  $x_{ij}$  ( $i = 1, \dots, m, j = 1, \dots, n$ ) is the quantity of input  $i$  consumed by DMU $_j$  and  $y_{rj}$  ( $r = 1, \dots, s, j = 1, \dots, n$ ) is the quantity of output  $r$  produced by DMU $_j$ . The original CCR Model measured efficiency of DMU $_o$  where index  $o$  is the DMU evaluated as follows (technical efficiency)

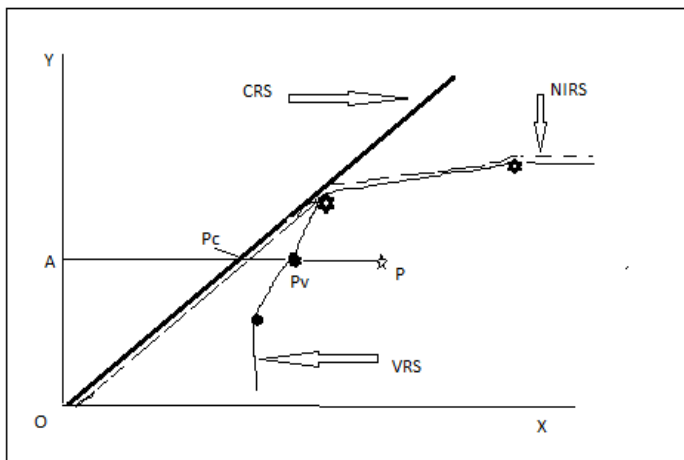
$$\begin{aligned} \text{Max } \theta_o &= \sum_{r=1}^s u_r y_{r0} \text{ ----- (1)} \\ \text{Subject to } &\sum_{i=1}^m v_i x_{i0} = 1 \\ &\sum_{r=1}^s u_r y_{rj} - \sum_{i=1}^m v_i x_{ij} \leq 0, \forall j, \\ &u_r, v_i \geq 0, \forall r, i \end{aligned}$$

where  $\theta_o$  is obtained using the inputs and outputs of DMU $_o$  by maximizing the objective function in Equation. (1) with respect to the weight variables. Using the first two constraints in Eq. (1), the  $\theta_o$  of DMU $_o$  is  $(0, 1)$  Adding  $w$  to the objective function and 2<sup>nd</sup> constraint of Eq. (1) relaxes the CRS restriction and envelopes the data more closely than does CRS technology. Technical efficiency is a relative measure of efficiency under a less restrictive variable for returns to scale technology by the addition of variable  $w$ . This model is known as the BCC model. Therefore the BCC model may be written as

$$\begin{aligned} \text{Max } \theta_o &= (\sum_{r=1}^s u_r y_{r0} + w) \text{ ----- (2)} \\ \text{Subject to } &\sum_{i=1}^m v_i x_{i0} = 1 \\ &\sum_{r=1}^s u_r y_{rj} - \sum_{i=1}^m v_i x_{ij} \leq 0 + w, \forall j, \\ &u_r, v_i \geq 0, \forall r, i \end{aligned}$$

Many studies decomposed the TE scores obtained from a CRS DEA into two components, one due to scale inefficiency and one due to pure technical inefficiency. This may be done by conducting both CRS and a VRS DEA upon the same data. If there is a difference in the two TE scores for a particular DMU, then this indicates that the DMU has scale inefficiency, and that the scale inefficiency can be calculated from the difference between the VRS TE

score and the CRS TE score. Hence we can say that the CRS TE measure is decomposed into pure technical efficiency and scale efficiency. But one short coming of this measure of scale efficiency is that the value does not indicate whether the DMU is operating in an area of increasing or the decreasing returns to scale. This may be determined by running an addition DEA problem with non-increasing returns to scale (NIRS) imposed. The nature of scale inefficiencies (i.e due to increasing or decreasing returns to scale) for a particular DMU can be determined by seeing whether the NIRS TE score is equal to the VRS TE score. If they are unequal then increasing returns to scale exist for that DMU. If they are equal then decreasing returns to scale apply. This is shown in the figure below.



The Malmquist Product Index (MPI) is based on the output distance function that provides the efficiency change of a Decision Making Unit (DMU) between two time periods. The non-parametric MPI that measures productivity with a linear programming model based on DEA is proposed by (Färe, R.; Grosskopf, S.; Norris, M.; Zhang, Z. 1994) The MPI has the following advantages: First, it does not need maximization of profit or minimization of expenses. Second, it does not assume the input and output prices and their information (Kirikal, L.; Tallinna, T. P.,2005) The change into productivity between time period t and t + 1 id defined as follows:

$$M(x^{t+1}, y^{t+1}, x^t, y^t) = [D^t_e(x^{t+1}, y^{t+1}) / D^t_e(x^t, y^t)] \times [D^{t+1}_e(x^{t+1}, y^{t+1}) / D^{t+1}_e(x^t, y^t)]$$

$$= [D^{t+1}_e(x^{t+1}, y^{t+1}) / D^t_e(x^t, y^t)] \times [D^t_e(x^{t+1}, y^{t+1}) / D^{t+1}_e(x^t, y^t)]$$

where M is the input-oriented MPI, y represents the output vector that can be produced using the input vector x. The MPI can be calculated as the product of catch-up (technical efficiency change) and frontier shift (technical change) as shown below: MPI = TEC × (Frontier Shift)

The MPI describes the total factor productivity DMUs and reflects positive or negative direction change to the frontier technology. In an input-oriented calculation, Index > 1 indicates progress in relative efficiency, while Index = 1 and Index < 1 indicate the position quo and regress inefficiency, respectively. The represented Total Productivity Change (TPC) can be decomposed into two mutually exclusive components: First is calculating a change in technical efficiency (catching-up effect) Second is calculating a change in technology (frontier shift) Thus, the TFPI is defined as the product of technical efficiency change index (TECI) and technical change index (TCI) The TECI (Technical Efficiency Change Index) is the ratio between two successive output distance functions and is related to the degree of efforts that the DMU attained for improving its efficiency. It measures the producer's capacity to move closer to or further away from the frontier technology from t to t + 1. Meanwhile, the TCI reflects a change in the efficient frontiers surrounding the DMUs between the two time periods and measures the shift in the output set or the movement of the production frontier between the periods.

2.2 | Variables used in this study

Since DEA technique need input/s and Output/s, to measure total factor productivity change, technical efficiency change, technological change, scale efficiency change we use Factories, Fixed capital,, Invested Capital, Total Persons Engaged,, Input (raw materials), as the inputs and Value of Output, is the output in this study.

3 | EMPIRICAL FINDINGS

Table-1 : State wise Technical Efficiencies of all Industries of India in various Year

States/UTs	Technical Efficiencies in				
	Pre Financial crisis period		Post Financial Crisis Period		
	1999-2000	2005-2006	2010-11	2015-16	2019-20
Gujarat	0.947	0.939	0.976	0.978	1.000
Maharashtra	0.968	0.992	0.916	0.823	0.927
Tamil Nadu	0.930	0.704	0.801	0.777	0.843
Karnataka	0.913	0.838	0.816	0.722	0.782
Uttar Pradesh	0.923	0.760	0.885	0.843	0.900
Haryana	0.974	1.000	0.913	0.887	1.000
Rajasthan	0.959	0.776	0.873	0.803	0.787
Andhra Pradesh	0.909	1.000	0.872	0.792	0.823
West Bengal	0.930	0.760	0.867	0.786	0.902
Madhya Pradesh	0.927	0.844	0.869	0.847	0.992
Punjab	0.955	0.762	0.869	0.814	0.866
Himachal Pradesh	1.000	1.000	0.997	0.893	0.855
Odisha	0.950	0.840	0.814	0.780	1.000
Jharkhand	1.000	1.000	0.887	0.798	0.769
Chattisgarh	0.906	0.902	0.841	0.730	0.873
Kerala	0.975	0.950	0.895	0.789	1.000
Assam	0.983	0.911	0.903	0.822	0.806
Jammu & Kashmir	0.987	1.000	1.000	0.887	0.942
Bihar	1.000	1.000	1.000	1.000	1.000
Delhi	1.000	1.000	1.000	1.000	1.000
Meghalaya	--	0.949	1.000	0.781	0.804
Puducherry	0.991	1.000	1.000	0.910	0.997
Chandigarh	0.973	1.000	1.000	0.937	0.857
Tripura	--	0.863	0.821	0.863	0.951
Nagaland	--	1.000	0.976	0.716	0.843
Manipur	--	1.000	0.823	0.800	1.000
Mean	0.949	0.924	0.917	0.848	0.910

Source: Authors Own calculation using DEAP Version 2.1, Output orientated DEA, Scale assumption: CRS

Table -1 shows State wise technical efficiencies of all industries of India in various Year say 1999-2000, 2005-06, 2010-11, 2015-16 and 2019-20. From this table we get a clear picture about the technical efficiencies of all industries in various states of India especially prior to the global financial crisis and post financial crises time period. Table -2 shows a regional classifications about the technical efficiencies On the basis of geographical location all states are categorised as Northern India, North Eastern India, Western India, central India, Southern India etc. Technical efficiency scores are also classified as more than 0.9 to 1 as the most efficient states in Industrial production similarly more than 0.8 to 0.9 as moderate level of technical efficiency states and finally low level of efficiency states in industrial production. Table 2 depicts pre crisis period (2005-06) and table 3 shows the situation in technical efficiencies of states just after the global financial crisis period (2010-11)

Table 2: Regional distribution of Technical Efficiency (in year 2005-06)

Region	States & UTs with Technical Efficiency Limit		
	More than 0.9 to 1.00	More than 0.8 to 0.9	More than 0.7 to 0.8
Western India	Gujarat Maharashtra		Rajasthan
North India	Chandigarh Jammu & Kashmir Himachal Pradesh Haryana Delhi	Punjab	Uttar Pradesh
South India	Kerala Chhatisgarh Andhra Pradesh Puducherry	Karnataka	Tamil Nadu
Eastern India	Bihar	Orissa West Bengal Jharkhand	
North – Eastern India	Assam Nagaland Manipur Meghalaya Mizoram Chhastisgarh	Tripura	
Central India		Madhya Pradesh	

(Source: authors own calculation)

**Table 3:** Regional distribution of Technical Efficiency (in year 2010-11)

Region	States & UTs with Technical Efficiency Limit		
	More than 0.9 to 1.00	More than 0.8 to 0.9	More than 0.7 to 0.8
Western India	Gujarat Maharashtra	Rajasthan	
North India	Chandigarh Jammu & Kashmir Himachal Pradesh Haryana Delhi	Uttar Pradesh  Punjab Chandigarh	
South India	Puducherry	Tamil Nadu Karnataka Kerala Andhra Pradesh Chhattisgarh Kerala	
Eastern India	West Bengal Bihar	Orissa Jharkhand	
North – Eastern India	Assam Meghalaya Nagaland	Tripura	
Central India		Madhya Pradesh	

(Source: authors own calculation)

Comparing table 2 and 3 it is clear that, western Indian states are unchanged in their rankings both in 2005-06 and 2019-20. Gujarat & Maharashtra, are maintaining their level of technical efficiencies in all industrial production same between these two time period but the rank of Rajasthan has promoted to moderate level of technical efficiency from low level. In Northern region Chandigarh 's industrial performance shows a deterioration from high level of efficiency to moderate level although Uttarpradesh has shown an improvement from low level to moderate level of efficiency in the post crisis period. In the southern region Tamil Nadu is shown an improvement in their efficiency and promoted from low level to moderate level of technical efficiencies in industrial production. So overall Indian states are not shown deterioration in the efficiencies in their industrial production just after the global financial crisis in 2008-09. Al though the mean value showing a deterioration in 2015-16. So the impact of deterioration in efficiencies came after 4 to 5 years of global financial crisis moreover this deterioration has been overcome in 2019-2020, since there is an improvement in mean score of efficiencies

**Table 4:** Technical Efficiency of all industries in various States of India in Pre financial Crisis Period and Post Financial Crisis Period

Output orientated DEA Scale assumption: CRS					
State	Pre financial Crisis Period		Post Financial Crisis Period		
	TE (1999-2000)	TE (2005-06)	TE (2010-11)	TE (2015-16)	TE (2019-20)
Andhra Pradesh	0.900	1.000	1.000	0.560	0.715
Assam	0.993	0.782	0.782	0.616	0.793
Bihar	0.953	1.000	0.933	0.881	1.000
Chattisgarh	0.895	0.880	0.880	0.702	0.819
Delhi	1.000	1.000	1.000	1.000	1.000
Goa	1.000	1.000	1.000	1.000	0.969
Gujarat	0.952	0.915	0.915	0.916	0.916
Haryana	0.950	0.890	0.872	0.796	0.951
Himachal Pradesh	1.000	1.000	1.000	0.729	0.825
Jammu & Kashmir	0.938	1.000	0.965	0.840	0.936
Jharkhand	1.000	0.959	0.959	0.793	0.759
Karnataka	0.914	0.784	0.784	0.680	0.763
Kerala	0.936	0.869	0.863	0.741	0.985
Madhya Pradesh	0.932	0.796	0.796	0.670	0.801
Maharashtra	0.962	0.918	0.918	0.807	0.856
Manipur	--	0.948	0.926	0.762	0.885
Meghalaya	--	0.849	0.849	0.591	0.718
Nagaland	--	0.806	0.806	0.680	0.843
Odisha	0.950	0.808	0.808	0.660	1.000
Puducherry	0.991	1.000	1.000	0.884	0.979
Punjab	0.949	0.761	0.757	0.791	0.864
Rajasthan	0.953	0.766	0.766	0.717	0.782
Tamil Nadu	0.922	0.673	0.673	0.723	0.819
Tripura	--	0.802	0.802	0.778	0.862
Uttar Pradesh	0.924	0.743	0.743	0.740	0.875

Uttaranchal	0.914	0.848	0.848	--	--
West Bengal	0.867	0.692	0.692	0.691	0.758
Mean	0.947609	0.869963	0.864333	0.759538	0.864346

Results from DEAP Version 2.1 (authors own calculation)

Table-5 and 6 show the results of Malmquist index summary of various industries in the pre- crisis period and post financial crisis period.

**Table 5:** Malmquist Index summary of Firm means (Year 2003 to 2008, Pre Global Financial Crisis Period )

Industry	Effch	Techch	Pech	Sech	Tfpch
Agriculture and related activities	1.000	1.063	1.000	1.000	1.063
Basic Metals	1.017	1.005	1.008	1.009	1.022
Chemical	1.001	1.003	0.998	1.003	1.004
Coke and Refined Petroleum Products	1.000	1.089	1.000	1.000	1.089
Electrical Machinery	1.009	1.025	1.005	1.004	1.034
Fabricated Metal Products	0.991	1.025	1.002	0.989	1.016
Food products and Beverages	0.987	1.023	0.987	1.000	1.009
Furniture Manufacturing	1.000	1.052	1.000	1.000	1.052
Leather and related Products	0.992	1.017	0.992	1.000	1.009
Machinery and Equipments	1.001	1.045	1.000	1.001	1.046
Medical precision & Optical instruments	1.000	1.024	1.000	1.000	1.024
Motor Vehicle	0.999	1.009	0.996	1.003	1.008
Non Metallic Mineral products	1.013	1.032	1.004	1.009	1.045
Office accounting & computing machinery	0.989	1.004	0.990	0.999	0.992
Other Industries	1.048	1.011	1.040	1.008	1.059
Other Mining & Quarrying	0.961	1.002	1.000	0.961	0.963
Other Transport Equipments	0.990	1.046	0.995	0.995	1.035
Paper	0.983	1.018	0.979	1.004	1.000
Publishing	0.993	1.013	0.993	1.000	1.006
Radio	0.988	1.014	0.989	0.999	1.002
Recycling	0.983	1.055	1.000	0.983	1.036
Rubber & Plastic Products	0.993	1.013	0.994	0.999	1.006
Textile Products	0.988	1.015	0.988	0.999	1.002
Tobacco and related products	1.000	1.000	1.000	1.000	1.000
Wearing apparel & Dressing	0.978	1.020	0.992	0.985	0.997
Wood and Wood Products	0.989	1.020	0.990	0.999	1.009
Mean	0.996	1.024	0.998	0.998	1.020

Malmquist Index Summary of Industry means. [Note that all Malmquist index averages are geometric means] Output orientated Malmquist DEA)Source: Results from DEAP Version 2.1 (authors own calculation),Effch=Efficiency,Change,Techch=Technological Change, Pech= Pure efficiency Change,Sech=Scale Efficiency change, Tfpch= Total Factor Productivity Change

**Table 6:** Malmquist Index summary of Firm means (Year 2010-11 to 2019-20, Post Global Financial crisis Period)

Industry	Effch	Techch	Pech	Sech	Tfpch
Basic metals	1.000	0.880	1.000	1.000	0.880
Beverages	1.037	0.941	1.000	1.037	0.976
Chemicals and chemical products	0.996	0.950	0.999	0.997	0.946
Coke and refined petroleum products	1.000	0.876	1.000	1.000	0.876
Computer, electronic and optical products	1.119	1.073	1.048	1.067	1.200
Electrical equipment	1.171	0.841	1.000	1.171	0.984
Fabricated metal products,	1.000	0.879	1.000	1.000	0.879
Food products	0.987	0.840	0.990	0.997	0.830
Leather and related products	1.000	0.957	1.000	1.000	0.957
Machinery and equipment n.e.c.	1.000	0.898	1.000	1.000	0.898
Manufacture of furniture	1.000	0.944	1.000	1.000	0.944
Motor vehicles, trailers and semi-trailers	1.000	0.978	1.000	1.000	0.978
Other industries	1.000	0.895	1.000	1.000	0.895
Other manufacturing	0.996	1.059	1.012	0.984	1.055
Other non-metallic mineral products	1.145	0.853	1.014	1.128	0.977
Other transport equipment	1.000	0.916	1.000	1.000	0.916
Paper and paper products	1.000	0.952	1.000	1.000	0.952
Pharmaceuticals,	1.000	0.973	1.000	1.000	0.973
Printing and reproduction of recorded media	1.000	0.911	1.000	1.000	0.911
Publishing activities	1.000	1.062	1.000	1.000	1.062
Repair	0.996	1.004	1.000	0.996	1.001
Rubber and plastics products	1.041	0.895	1.000	1.041	0.932
Textiles	0.888	1.088	0.997	0.891	0.966
Tobacco products	1.085	0.842	0.991	1.094	0.914
Waste collection,	0.978	0.948	0.983	0.995	0.927
Wearing apparel	1.000	1.107	1.000	1.000	1.107
Wood and products of wood and cork, except furniture	0.994	0.983	1.000	0.994	0.978
Mean	1.015	0.943	1.001	1.013	0.957

Results from DEAP Version 2.1 (authors own calculation), Effch=Efficiency Change, Techch=Technological Change, Pech= Pure efficiency Change, Sech=Scale Efficiency change, Tfpch= Total Factor Productivity Change

From the above two tables it is clear that total factor productivity change was declined only a few industries for example Office accounting & computing machinery, Other Mining & Quarrying, Wearing apparel & Dressing etc prior to the global financial crisis period. On the other hand for rest of the industries as mentioned in the table- 5 total factor productivity have increased. If we subtract the Tfpch with 1 and multiply the residual with 100 we get the percentage increase of total factor productivity of the industries. For example industries related to Agriculture and related activities tfpch has improved by 0.06%, basic metals 0.02%, Coke and Refined Petroleum Products 0.08% and so on. Table -6 shows the effects on change of various efficiencies after the global financial crisis period. During these time period only a few industries was seen an improvement in their total factor change, for example industries related to Computer, electronic and optical products, Other manufacturing, industries related to publishing activities, repair, and wearing apparel industries, where as the rest of the industries have shown a deterioration in their total factor productivity change. For example total factor productivity of basic metals industries have declined by 12%, beverages declined by 0.03%, chemicals and chemical products by 0.06% etc during the post financial crisis period. From this table it is clear that global financial crisis has declined the total factor productivity of most of the industries in India. Figure 1 to 5 below shows a diagrammatic comparison of each efficiency score between pre and post crisis period. For example figure -1 shows technical efficiency change between these two time frames. The red line shows post crisis situation and the blue line indicates pre crisis time situation. Textile industries have shown deterioration in technical efficiencies in the post crisis period. Similarly basic metals, chemicals and chemical products etc also have shown a decline in technical efficiencies in the post crisis period. But some industries are also there who are showing their improvement after the global financial crisis for example, Tobacco products, Electrical equipment, Non Metallic Mineral products etc. Hence it is clear that every crisis also brings some opportunities. Hence those who can exploit those opportunities can able to raise efficiencies, total factor productivity etc.

Figure -1 Efficiency Change of various industries in the pre and post global financial crisis of 2008-09

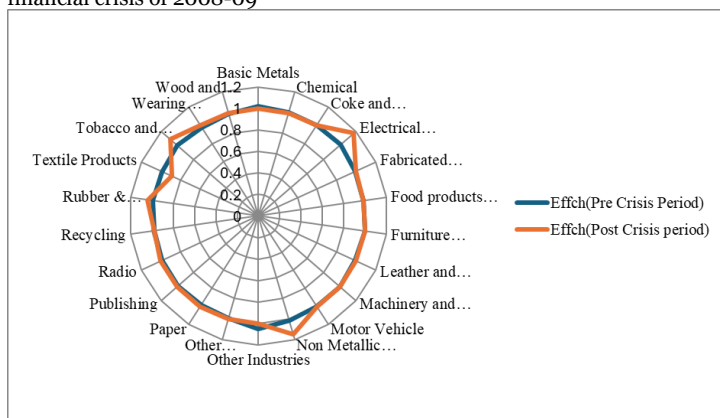


Figure -2 below shows a comparison about technological change of Indian industries during the pre and post global financial crisis situation. From this figure it is clear that except for a few say Publishing activities, textiles, wearing apparel etc industries the technological improvement has taken place, on the other hand for all other industries technological deterioration has taken place after the crisis.

Figure -2 Technological Change of various industries in the pre and post global financial crisis of 2008-09

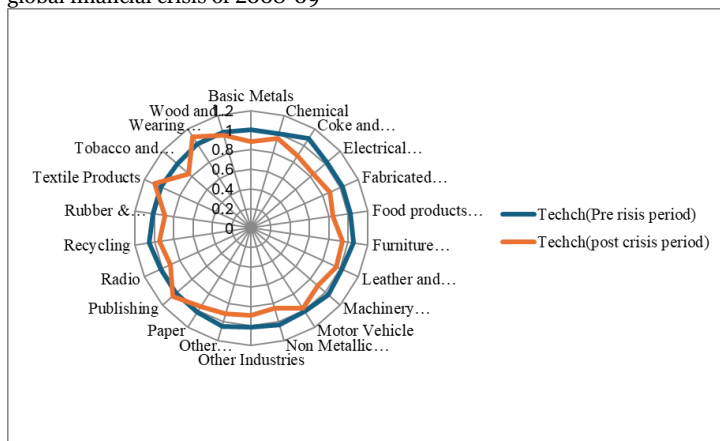


Figure -3 Pure efficiency Change of various industries in the pre and post global financial crisis of 2008-09

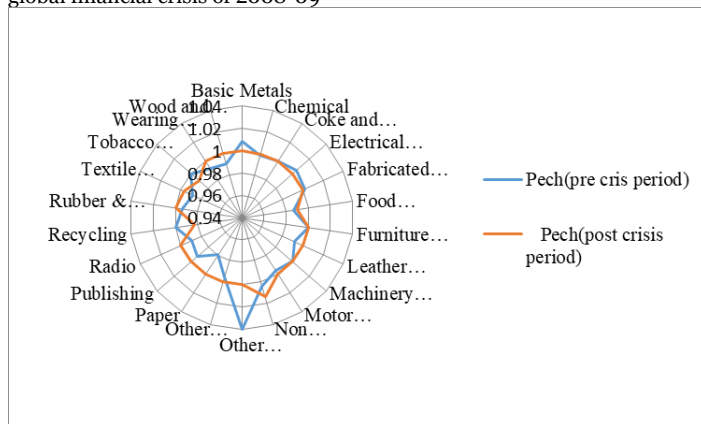


Figure -4 Scale efficiency changes of various industries in the pre and post global financial crisis of 2008-09

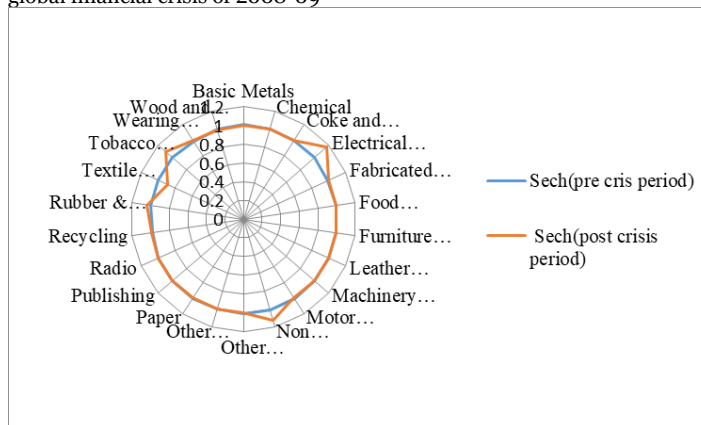
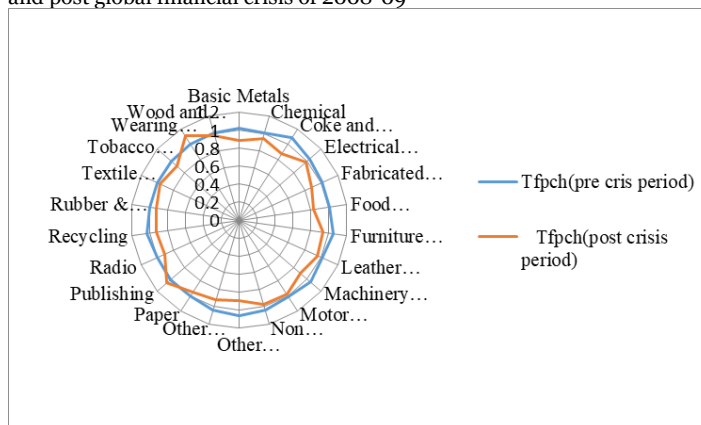


Figure- 3 and figure 4 show the comparison of pure efficiency change and scale efficiency change between pre and post global financial crisis period. Rubber and plastics products industries have shown an improvement in their scale efficiencies after the crisis, similar situation exists for tobacco and related products, Electrical equipments, non-metallic mineral products industries etc.

Figure -5 Total Factor Productivity Change of various industries in the pre and post global financial crisis of 2008-09



Finally table -5 shows a comparison of total factor productivity change between pre and post global financial crisis situation. Industries who have increased their total factor productivity and who could not able to maintain their total factor productivity after the financial crisis have already mentioned in the previous section. In the diagram it is also reflecting that publishing, wearing apparel, etc industries have increased their total factor productivity after world the financial crisis but many other industries have declined total factor productivity after this financial crisis.

4 | SUMMARY AND CONCLUSION:

Technical efficiency, total factor productivity, scale efficiency etc are very important phenomenon for the industrial growth of a nation. Industrial growth means more employment more export more income and a steady improvement of the overall of the economy The term globalization refers to

the integration of economies of the world through uninhibited trade and financial flows, also through mutual exchange of technology and knowledge. Ideally, it also contains free inter-country movement of labour, ( Sulaiman N., 2012) Moreover in the era of globalization the domestic industries have to face competition from foreign made products. Hence with respect to price, quality the domestic industries should move at par with foreign made products or foreign industries. So technical efficiency and other measure of efficiencies in production should be improved time to time for sustenance. Enhancing productivity is not limited to inputs as separate variables, but what is more crucial is total factor productivity (TFP), which reflects the productivity for all inputs combining together. TFP refers to the productivity of all inputs, which are derived from better and more efficient utilization and management of inputs, such as labor, capital, technology and intermediate inputs, (Ismail R. Et. El.2017)

Though there are many channels through which openness influences on productivity. Out of these many the most important among them is the transfer of technology, since openness encourages technology transfer. This transfer is achievable through the imports of capital equipment, intermediate goods or material (Feenstra et al., 1992; aMarkusen, 1989) and through export intensity (Keller, 2010) Damijan et al. (2009) argued that firms exporting to more advanced markets will be demanded to fulfil higher standards, for example, high quality products, technical production and safety. Similarly, firms importing materials are forced to meet the stringent technical standards of the advanced markets. These two factors may result in higher quality products and productivity, (Yasin M, 2021) However, the value of imported material depends on the exchange rate of the country (Sari et al., 2016) For the case of dynamic analysis with a deflating method, the value of imported material contributing to output might fluctuate from time to time as the exchange rate fluctuates. Higher imported material may weaken productivity when the domestic exchange rate is weak, but this potentially negative effect can be compensated by exporting goods. Considering this, it is essential to include the interaction between import and export in a productivity analysis.

Similarly Foreign Direct Investment another indicator of Openness also plays an important channels which influences productivity. FDI may be defined as a foreign-acquired firm is affiliated with a parent company headquartered in a foreign country (Dachs & Peters, 2014) The parent company may provide its subsidiary firm, that is, the foreign-acquired firm, with an access to new technologies. As a result, the foreign acquired firm will benefit from a transfer of technology that strengthens its competitiveness. Suyanto et al. (2009) found that foreign direct investment (FDI) significantly promotes firms' productivity in pharmaceutical and chemical industries. Damijan et al. (2009) also suggested that foreign investment, in a form of ownership, helped the restructuring of domestic firms and improved their productivity. Absorptive capacity which is nothing but the Ratio of total workers' expense with total workers also plays a pivotal role in accelerating the openness channel. Absorptive capacity is a firm's ability to recognize relevant external knowledge, adopt the knowledge and assimilate it into the existing knowledge (Todorova & Durisin, 2007) Henry et al. (2009) postulated that a high level of human capital can prompt higher technology absorption. Firms with many highly skilled labourers will find it more easily to adopt advanced technology. Le and Pomfret (2011) proxied this absorptive capacity with labour costs per person, like training and wages. A firm can empower its highly skilled labourers so that they can absorb technology transfer more easily and accelerate higher productivity. (Yasin M,2021)

This paper tries to through some light on the measurement of such efficiencies. It considers a state wise comparison taking all industries at a time and side by side individual industries as well for comparison with respect to global financial crisis during the end of 2007 up to 2009. So the comparison is made pre financial crisis period and post financial crisis period. Since we know every crisis brings some opportunities also, Hence not all states of India nor individual industries behaved in a similar fashion. Few industries have taken this crisis as a challenge and improved in their technical efficiencies and total factor productivities but many other industries could not able to accept this challenge. Though we have a huge domestic market but for intermediate good many industries have to depend on foreign nations. So global financial crisis must affect our industries also. Though in this study why this deterioration has not been investigated intensively, although there is an ample scope to examine such decline considering industry wise or taking all industries together in each states of India separately. Moreover in future there is many opportunities to incorporate the issues like determinants of total factor productivity, the relationship between total factor productivity and or technical efficiency and globalisation measured by trade as a percentage of GDP, percentage of intermediate goods imports, exchange rate, Foreign direct investment, skilled human resources measured by imported managerial assistance, training for skill development, tertiary education etc.

## 5 | REFERENCES

- Banker, R. D., Charnes, A., and Cooper, A. A. (1984) Some models for estimating technical and scale inefficiencies in data envelopment analysis. *Management Science*, 9, 1078–092
- Bauer, P. W. (1990) : Decomposing TFP in the Presence of Cost Inefficiency, Nonconstant Returns to Scale, and Technological Progress, *Journal of Productivity Analysis*, 1, 287-299.
- Charnes, A., Cooper, W.W., and Rhodes, E. (1978) Measuring the efficiency of Decision Making Units. *European Journal of Operational Research*, 2, 429– 444.
- Coelli, T. (1996) A guide to DEAP Version 2.1: A Data Envelopment Analysis (Computer) Program," CEPA Working Paper 96/08, University of New England, Australia.
- Coelli, T. J., Rao, D. S. P., & Battese, G. E. (1998) : An Introduction to Efficiency and Productivity Analysis, Kluwer Academic Publishers, London, UK.
- Comin D., Hobijn B & Rovito E. Five facts you need to know about technology diffusion, Working Paper 11928 <http://www.nber.org/papers/w11928>, (2006) National Bureau of Economic Research 1050 massachusetts avenue cambridge, ma 02138
- Dachs, B., & Peters, B. (2014) Innovation, employment growth, and foreign ownership of firms: A European perspective. *Research Policy*, 43 (1), 214–232.
- Damijan, J. P., De Sousa, J., & Lamotte, O. (2009) Does international openness affect the productivity of local firms? Evidence from South-Eastern Europe. *Economics of Transition*, 17 (3), 559–586.
- Fare, Rolf and Lovell, C. A. K. (1978) Measuring the Technical Efficiency. *Journal of Economic Theory* 19 (1), 150–162. Farrell, M. J. (1957) The Measurement of Productive Efficiency. *Journal of Royal Statistical Society Series A* 120, 253–281.
- Feenstra, R. C., Markusen, J. R., & Zeile, W. (1992) Accounting for growth with new inputs: Theory and evidence. *American Economic Review*, 82 (2), 415–421.
- Fried, H., Lovell, C. A. K., and Schmidt, S. E. (1994) The Measurement of Productive Efficiency: Techniques and Applications. London: Oxford University Press.
- Hall, R. & Jones, C. (1999) : Why do some countries produce so much more output per worker than others? *Quarterly Journal of Economics*, 114 (1), 83-116.
- Henry, M., Kneller, R., & Milner, C. (2009) Trade, technology transfer and national efficiency in developing countries. *European Economic Review*, 53 (2), 237–254.
- Ismail R., Sulaiman N., & Abdullah M. (2017), Globalization and Total Factor Productivity Growth in the Malaysian Construction Sector, *Global Economy and Finance Journal Vol. 10. No. 2. September 2017 Issue. Pp. 24 – 40*
- Keller, W. (2010) International trade, foreign direct investment, and technology spillovers. In B. H. Hall & N. Rosenberg (Eds.), *Handbook of the economics of innovation* (1st ed, Vol. 2) Elsevier.
- Kirikal I.Y, (2005) Productivity, the Malmquist Index and the Empirical Study of Banks in Estonia, School of Economics and Business Administration, Department of Economics Tallinn University of Technology Dissertation was accepted for the commencement of the degree of Doctor of Philosophy in Economics on August 26,
- Lee, Y. H. & Schmidt, P. (1993) : A Production Frontier Model with Flexible Temporal Variation in Technical Efficiency in Fried, H., Lovell, C. A. K. & Schmidt, S. (eds) The Measurement of Productive Efficiency, Oxford University Press, New York, USA.
- Lovell, C.K. (1993) Production Frontiers and Productive Efficiency. In: Fried, H.O., Lovell, C.K. and Schmidt, S.S., Eds., The Measurement of Productive Efficiency-Techniques and Applications, Oxford University Press, Oxford, 3-67.
- Martell L, 'The Sociology of Globalization', Second edition, 2017 Polity, Cambridge, UK ; Malden, MA, USA, 2017
- Meeusen W., &Julien van Den Broeck, (1977) Efficiency Estimation from Cobb-Douglas Production Functions with Composed Error, *International Economic Review*, Vol. 18, No. 2 (Jun., 1977), pp. 435-444
- Mortimer D., Peacock S., (2002) Hospital Efficiency Measurement: Simple Ratios vs Frontier Methods, working paper 135, The Centre for Health Program Evaluation (CHPE)
- Robert M. Solow, Technical Change and the Aggregate Production Function, *The Review of Economics and Statistics*, Vol. 39, No. 3 (Aug. 1957), pp. 312-320
- Rolf Fare, Shawna Grosskopf, Mary Norris, and Zhongyang zhang, Productivity Growth, Technical Progress, and Efficiency Change in Industrialized Countries, : *The American Economic Review*, Vol. 84, No. 1 (Mar., 1994), pp. 66-83
- Roy R.,Jana S.K.,& Nayek D.K., (2022) Productivity growth and its constituents : A Study of the 4-Digit Manufacturing Industries of Transport Equipment in India, *iassi Quarterly*, Vol. 41, No.4, Page 549-568

- Salim Suyanto, R. A., & Bloch, H. (2009) Does foreign direct investment lead to productivity spillovers? Firm level evidence from Indonesia. *World Development*, 37 (12), 1861–1876.
- Sari, D. W., Khalifah, N. A., & Suyanto, S. (2016) The spillover effects of foreign direct investment on the firms' productivity performances. *Journal of Productivity Analysis*, 46 (2–3), 199–233.
- Sulaiman N.et el, (2012), The Impact of Globalization on Total Factor Productivity of the Manufacturing Sector in Malaysia, Prosiding Perkem vii, JILID 1, 409 - 422 ISSN: 2231-962x
- Yasin M., Technical Efficiency and Total Factor Productivity Growth of Indonesian Manufacturing Industry: Does Openness Matter?, *Studies in Microeconomics*, 10 (2) 195– 224, 2022

## Appendix

State wise Data Related to Inputs and Outputs of all Industries in various states and UTs of India

States	Output	Net Value Added	Factories	Fixed Capital	Productive Capital	Invested Capital	Workers	Total Persons Engaged	Wages to Workers	Emoluments	Input
Gujarat	162953192	19025721	28479	7485603	85899653	96172342	1589730	2068743	2834366	6365751	13940478
Maharashtra	12397685 <sup>7</sup>	17793632	25610	42320376	55837150	62312362	1454788	2038255	3224768	8287260	10239084 <sup>4</sup>
Tamil Nadu	92735522	1322999 <sup>0</sup>	38837	30725218	42079449	44976835	2209217	2663069	3496213	6787108	76337925 <sup>7</sup>
Karnataka	55687658	8792590	14169	2249282 <sup>2</sup>	29912800	31149746	839728	1081116	1779896	3718193	45046778
Uttar Pradesh	56269111	7244344	16184	15294771	22886078	24756617	886908	1130778	1322763	3138912	47795050
Haryana	59630890	6587303	11252	14227981	19756349	21511211	806160	1023667	1347440	3388966	51466623
Rajasthan	32933342	5128763	9694	13067726	17420689	17774383	475252	598791	837272	1773322	26697552
Telangana	25493068	4923196	15271	9690004	16490005	14302114	656397	787105	988934	1835148	19739912
Uttarakhand	24068474	4864961	2969	5841571	8318931	8336981	343377	437816	556418	1156769	18647678
Andhra Pradesh	40046283	3798994	16924	2065465 <sup>6</sup>	22944888	27357821	541799	663574	1024315	1784255	34876286
West Bengal	35753186	3722935	9650	1330088 <sup>9</sup>	13395170	19728930	579882	736165	933537	1796002	31037641
Madhya Pradesh	28925578	3298041	4771	18741641	19628661	22947689	315540	413475	509216	1170066	24531573
Punjab	21356458	2904789	13092	5624889	8690509	9744089	528933	661932	748660	1352403	17934461
Himachal Pradesh	11718159	2839423	2687	4699152	5866064	6185551	166950	227975	292224	712961	8472915
Odisha	27670833	2727609	3079	31867015	29529908	3608203 <sup>5</sup>	233455	281911	552440	1014342	23481405
Jharkhand	13738059	2206660	2875	9892803	12104897	12193479	169248	205976	418413	816389	10910329
Chattisgarh	16540759	1927593	3892	11466364	12781100	14029038	185553	228927	402650	745754	14000035
Kerala	21484484	1864044	7796	5621182	7496165	7612714	261438	341411	493368	890811	19231806
Assam	7748672	1521363	5196	3185207	4183207	4173065	219176	263106	200107	380280	5992796
Goa	4591143	1312049	711	1333049	2328779	2075348	52017	74197	130318	331153	3125709
Dadra & N Haveli	9184607	1126058	1355	2958793	4963369	4183883	107535	132695	166151	349701	7837455
Sikkim	1967242	944805	84	734106	996097	970232	17482	23039	40266	92060	945777
Daman & Diu	4419661	840764	1682	1239408	2472061	1949111	93792	122078	132399	315367	3445036
Jammu & Kashmir *	3006906	657564	1022	832888	1285956	1220350	51774	66759	73007	156525	2276818
Bihar	7617888	603224	3429	1501129	2025403	2334141	108416	128203	111710	192353	6899222
Delhi	4670423	577475	3259	688888	1319205	1422142	71352	108232	143931	364124	4019369
Puducherry	2679769	554984	727	642177	925986	977631	40902	50958	77938	149608	2064817
Meghalaya	740369	124374	158	358224	490872	478469	10635	12904	16967	38706	571556
Chandigarh	352387	50769	250	96626	203150	163235	6293	10167	14951	37406	293268
Tripura	172792	29007	657	49991	61907	81688	20388	24266	9552	14961	138200
Nagaland	51901	11107	190	17982	32419	25893	4591	5361	2683	3772	38557
Ladakh *	24727	10376	3	74137	76280	75664	163	214	336	1788	8776
Manipur	49845	8700	204	14553	16083	21645	5675	6898	4023	5445	39364
Arunachal Pradesh	59716	8182	116	16100	36646	27817	1975	2581	1543	3117	49294
Mizoram #	6300	2523	215	5436	6775	5844	1417	1664	1353	1455	3189
A & N. Island	3871	860	15	1378	2584	2258	216	286	389	664	2813

Data Source: ( <https://mospi.gov.in> )

Data on Inputs and Outputs of Major Industry Group in India															
NIC-2008	Description	Total Output	Net Value Added	Factories	Fixed Capital	Productive Capital	Invested Capital	Workers	Total Persons Engaged	Wages to Workers	Total Emoluments	Total Input	Depreciation	Rent Paid	Interest Paid
19	BASIC METALS	83762	7847	1178	6552	64347	8007	7729	9869	1716	332647	72652	326316	104	3959
		775	214	8	0716	333	0003	81	91	326	0	392	9	953	158
20	BEVERAGES	71107	1445	2272	3208	40293	4282	1226	1601	1851	401982	5364	30069	188	1576
		89	402		320	11	014	88	15	99		694	3	37	78
10	CHEMICALS AND CHEMICAL PRODUCTS	58300	11970	1216	2859	35447	36255	588	7902	9993	254162	4468	164221	154	1222
		834	904	8	7417	688	042	806	63	32	9	7712	8	906	201
21	COKE AND REFINED PETROLEUM PRODUCTS	87632	1607	1691	4108	33159	50077	1199	1544	408	95368	7002	153957	102	9218
		800	3156		5725	572	459	03	49	623	4	0066	9	818	95
29	COMPUTER, ELECTRONIC AND OPTICAL PRODUCTS	16490	2954	2325	2102	47557	4386	1559	2243	288	110349	13270	264944	104	2043
		030	395		498	08	207	82	36	001	2	690		255	73
28	ELECTRICAL EQUIPMENT	27860	4578	7745	5749	10187	10290	402	5404	7127	169527	22673	608947	782	5387
		902	531		889	595	479	907	32	77	9	424		96	22
23	FABRICATED METAL PRODUCTS, EXCEPT MACHINERY AND EQUIPMENT	2040	3507	17521	70115	11443	11106	5493	7088	8472	172585	16259	634570	698	5252
		2267	782		45	526	710	66	27	16	3	915		18	23
13	FOOD PRODUCTS	10238	8797	3746	1939	28133	37487	1309	1693	1536	30705	91994	159590	1614	2029
		8166	727	8	6227	849	454	383	736	589	39	535	5	26	171
27	LEATHER AND RELATED PRODUCTS	57566	1021	4544	11545	18467	22625	3352	3928	388	643827	4604	130878	334	8518
		87	001		98	96	43	79	08	369		808		50	4
22	MACHINERY AND EQUIPMENT N.E.C.	32135	6882	1215	8893	15833	14596	5438	7786	1044	299291	2433	917851	1461	6393
		557	876	9	265	237	101	38	24	051	4	4830		69	64
	MANUFACTURE OF FURNITURE	18685	2730	1688	4848	13961	95195	504	7018	7617	192649	15476	47939	150	5440
		46	03		54	83	3	87	9	5		05		53	0
25	MOTOR VEHICLES, TRAILERS AND SEMI-TRAILERS	56255	8231	6012	1850	21880	24072	7668	9871	1476	34290	45751	227272	133	6841
		848	878		6612	517	025	15	91	694	84	248	2	923	96
26	OTHER INDUSTRIES	28797	3984	1249	4256	4089	45311	3110	4654	4877	109031	22479	233449	136	3065
		816	270	8	4915	4042	574	31	25	71	1	056	0	800	473
30	OTHER MANUFACTURING	20331	2016	3266	1473	47783	5028	2773	3520	4263	812569	18123	191940	442	2018
		934	088		028	63	205	56	20	21		906		36	98
14	OTHER NON-METALLIC MINERAL PRODUCTS	25229	5280	2799	19657	31956	2430	882	1078	924	186846	18367	158209	2113	909
		241	090	5	780	134	0667	228	918	067	0	061	0	51	926
32	OTHER TRANSPORT EQUIPMENT	16037	2938	2203	4854	52828	63970	2462	3163	4502	993210	12702	396562	347	2935
		915	397		553	92	40	26	91	38		956		73	85
12	PAPER AND PAPER PRODUCTS	98373	1261	6900	5769	63518	73391	1998	2534	3011	571435	81621	413479	239	2789
		44	676		824	04	27	14	23	48		90		56	72
11	PHARMACEUTICALS, MEDICINAL CHEMICAL AND BOTANICAL PRODUCTS	27195	8756	4946	1098	18021	16615	4317	6798	7924	24884	17441	998410	583	3927
		853	082		4295	413	389	32	91	26	92	361		40	45
17	PRINTING AND REPRODUCTION OF RECORDED MEDIA	39106	9613	4518	15656	2060	21046	1064	1614	1822	471064	27665	182694	328	9818
		63	82		22	957	09	96	06	83		87		20	6
15	PUBLISHING ACTIVITIES	69496	2239	255	3359	25869	4108	1137	2402	2568	113515	4349	36069	557	1130
		6	95		69	6	09	8	0	6		01		9	5
18	REPAIR AND INSTALLATION OF MACHINERY AND EQUIPMENT	78972	2529	721	3579	55933	4460	2195	2958	6238	116274	5028	33939	702	1929
		7	32		25	4	02	0	1	2		56		2	3
16	RUBBER AND PLASTICS PRODUCTS	26226	4568	1402	9083	14176	12833	5465	7005	8266	169209	2072	929782	690	5494
		547	081	7	942	668	861	16	03	51	8	8683		99	44
31	TEXTILES	39294	5237	17714	15574	18829	22375	1332	1560	1689	274210	3266	139687	564	1553
		883	865		407	677	358	482	102	376	7	0145	3	96	410
33	TOBACCO PRODUCTS	44043	1631	3692	71784	14451	15158	449	4683	2022	29044	2700	73203	977	4037
		18	054		2	62	89	079	98	58	7	062		1	5
58	WASTE COLLECTION, TREATMENT & DISPOSAL ACTIVITIES; MATERIALS RECOVERY	81550	6913	433	2401	42132	56651	1200	1544	1605	27412	72101	25356	217	308
		4	4		67	5	5	8	4	9		4		4	91
08	WEARING APPAREL	12838	2876	1004	2799	42236	52735	9801	1137	1150	188562	9705	256862	129	3053
		456	159	8	418	40	27	80	021	980	1	434		007	88
38	WOOD AND PRODUCTS OF WOOD AND CORK, EXCEPT FURNITURE	23504	3973	4579	6392	11459	12330	7028	9248	7466	152127	18874	65644	829	6265
		37	47		70	53	36	4	8	9		46		6	1

Source: Archives of ASI data base