Inter-State Variations in Technical Efficiency of Indian Manufacturing Sector-A Non-Parametric Analysis

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Abstract
The present paper endeavors to analyze the efficiency performance of Indian manufacturing sector both at aggregated and disaggregated inter-state level by taking into account the entire study period of 35 years from 1980-81 to 2014-15 and three distinct sub- periods viz., (i) Pre-reforms period (i.e.;1980-81 to 1990-91) ii) Post-reforms period phase-I(i.e.;1991-92 to 2000-2001) iii) Post- reforms period phase-II(i.e.;2001-02 to 2014-15). The study utilizes the single output (gross value added) and two input (gross fixed capital stock and total employees) framework and employs input – oriented Data Envelopment Analysis (DEA) approach to compute the overall technical efficiency scores and scores ofits two prime sources (i.e.; Pure Technical Efficiency (PTE) and Scale Efficiency (SE)). From the comparative analysis of efficiency measures between pre- and post-reforms period, the study observed that the economic reforms process has not made any significant dent on the efficiency performance of manufacturing sectorin Indian states.The results also depicted scale inefficiency as the major source and pure technical inefficiency (managerial inefficiency) is relatively a scant source of overall technical inefficiency. The study revealed that most of the states are operating under the increasing returns to scale which implies that these states had the potential to wipe out the overall technical inefficiencies by expanding their scale of operations in the reformed era.

Keywords: manufacturing sector, technical efficiency, data envelopment analysis

I Introduction

Industrial sector plays a dynamic role in the development process of developing economies like India. Among industrial sector, the manufacturing sector itself offers greater prospects for capital accumulation, technical change and inter-sectoral linkages. As far as India is concerned, the path of manufacturing growth in India has been a subject of scrutiny and intense debate. Manufacturing holds a key position in the Indian Economy, accounting for nearly 16 percent of its share in real GDP and employing about 12 percent of India's labour force. In India, major economic reforms had been undertaken since July, 1991 with the objectives to expand the international competition and thus compel the India's industries to improve their efficiency and productivity growth through adoption of new technology. However, there has been a running debate on the role of economic reforms on productivity and efficiency of manufacturing sector in India. There is one set of the studies in literature positive impact of economic reforms on productivity growth and technical efficiency of manufacturing sector in India (e.g. Unel(2003), TSL(2003),Ray(2002), Kumar(2006) etc.), whereas there is another set of the studies which found negative impact of reforms process on productivity and efficiency of manufacturing sector in India (e.g.Mitra(1999),Pradhan and Barik(1999),Parameshwaran(2002),Trivedi etal.(2000), Das(2004) etc.). While there are large number of studies on productivity growth and efficiency of Indian manufacturing sector[1], a scant attention has been paid to analyze the sources of Technical Efficiency (TE) of Indian manufacturing sector at regional perspective[2].

Therefore, in this paper an attempt has been made to examine the efficiency performance of manufacturing sector[3] of 16 major Indian states[4]. Further, to see the impact of reforms on the efficiency of these states the whole study period of 35 years have been bifurcated into three sub- periods. To present the discussion in

lucid manner, the whole paper has been divided into four sections, section II includes database and methodology used in the study. Section III discusses the empirical results of the study and section IV concludes the discussion along with some policy implications.

II Database and Methodology

The present study involves the inter-state analysis of efficiency performance of Indian manufacturing sector using non parametric approach DEA over the period of 35 years from 1980-81 to 2014-15 and three sub-periods[5] viz., (i) Pre-Reforms period (i.e;1980-81 to 1990-91), ii)Post- Reforms period phase-I(i.e;1991-92 to 2000-2001),iii) Post- Reforms period phase-II(i.e;2001-02 to 2014-15). The primary source of our data is the 'Summary Results of Annual Survey of Industries (ASI): Factory Sector'.

2.1Measurement of Variables

In our study, gross value added at constant prices have been taken as the output variable whereas, the gross fixed capital at constant prices and total number of employees have been taken as a measure of capital input and labour input respectively. Since price deflators were not available at state level, hence, all monetary data have been deflated using appropriate national price deflators. The nominal values of gross value added have been deflated by using 'Wholesale Price Index (WPI) of Manufactured Products' at 2004-05 prices. The standard practice of perpetual inventory method (PIM) has been followed here to generate the series of gross fixed capital stock at constant prices. This requires a use of benchmark capital stock, depreciation rate and gross real investment in fixed capital. To obtain the series following steps has been taken:

Step I: Following Veermani and Goldar (2004), the value of capital stock for initial (benchmark) year (K_0) has been estimated as:

$$K_0=2*B_0$$

Where, B_0 is the book value of fixed capital in the benchmark year. Following Kumar and Arora (2007) and Arora(2010), using a factor of 2 to the book value of fixed capital in 1980-81 at the prices of 2004-05, the capital stock for the benchmark year has been obtained.

Step II: The gross real investment (I_t) has been obtained by using relationship:

$$I_t = \frac{B_t - B_{t-1} + D_t}{P_t} \times 100$$

Where B_t = Book value of fixed capital in the year t,

D_t = Depreciation f fixed assets in the year t, and

P_t = Implicit deflator for gross fixed capital formation for registered manufacturing (2004-05=100) in the year t.

Step III: After obtaining the estimates of fixed capital for the benchmark year (B_o) and gross real investment (I_t), the following equation has been used for the measurement of gross fixed capital (K_t) series at 2004-05 prices:

$$K_t = K_{t-1} + I_t - (0.05 \times K_{t-1})$$

Following Veermani and Goldar (2004) and Unel (2003), we have taken annual rate of depreciation of capital equal to 5 percent.

The figures of total persons engaged provided by ASI consisting of both non-production and production workers have been taken as the measure of labour. After obtaining the figures for gross value added at constant prices, gross fixed capital at constant prices and number of employees, we followed Ray (2002) and Kumar (2003) and divided these variables by number of factories in each state. This step provides us GVA at constant prices per factory, GFC at constant prices per factory and employees per factory in a particular state.

2.2Technical Efficiency (Conceptual Framework) and its Measurement

"The technical efficiency of the firm is their capacity and willingness to produce maximum output with given technology and inputs"(Ghosh and Neogi). According to Farrell (1957) efficiency can be decomposed into two parts i.e.; Technical Efficiency (TE) and Allocative Efficiency (AE).Technical Efficiency is a form of productive efficiency and is concerned with the maximization of output for a given set of resource inputs. Therefore, Technical Inefficiency (TIE) is the failure to achieve the maximum possible output of a decision

making unit (DMU) for a given level of inputs during a production process. On the other hand Allocative Efficiency (inefficiency) is the optimal (poor) allocations of inputs given the set of prices of the product. Technical efficiency based on the assumption of constant Return to Scale(CRS) provides a measure of Overall Technical efficiency(OTE) also known as Global Technical Efficiency, whereas the assumption of varying Return to Scale (VRTS) provides a measure of Pure Technical Efficiency(PTE). Further the scale efficiency which reflects the choice of optimum scale of production at which DMU is operating can be obtained using the ratio of PTE to OTE. If SE=1,than DMU is operating at the most productive scale(CRS), but if, SE <1, DMU is operating at sub-optimal scale.

2.3 Measurement of Technical Efficiency (with DEA)

We have estimated the efficiency scores using data envelopment analysis (DEA) approach[6], which is a non parametric approach. DEA can be both input-oriented DEA and output-oriented DEA. Our study employs the input- oriented DEA to estimate the efficiency scores.DEA separates the efficient firms(states in our case) from the inefficient ones on the basis of whether they lie on the efficiency frontier which is spanned by the best firms in the data set. The firms that lie on the efficiency frontier are called efficient firms. Alternately, the firms that do not lie on the efficiency frontier are regarded as relatively inefficient. Simply, the best firm relative to the efficiency frontier is than determined using a linear programming (LP) algorithm.

The technical efficiency (TE) of i–th firm/state can be obtained from the following input-oriented DEA model (also known as CCR model developed by Charnes, Cooper and Rhodes).

$$\min \theta_i^{CRS}.\boldsymbol{\lambda\theta_i^{CRS}}$$

s.t

$$-y_i+Y\boldsymbol{\lambda}\geq 0,$$
$$\theta_i^{CRS}x_i-X\boldsymbol{\lambda}\geq 0,$$
$$\boldsymbol{\lambda}\geq 0, \qquad (1)$$

Whereθ is a Technical Efficiency measure also known as overall Technical efficiency scores of i-th state under constant returns to scale (CRS) and $\boldsymbol{\lambda}$ is an N×1 vector of constants. The K×N input matrix, X; and M×N output matrix Y, represent for all N states.

If θ^{crs} =1, the firm is said to be on efficiency frontier and is technically efficient under CRS. If θ^{CRS}<1, then the firm lies below the frontier and is technically inefficient.

The CRS DEA model is only appropriate when all the firms are operating at an optimum scale. Further, this model provides only overall technical efficiency scores. The use of the CRS specification when not all states or firms are operating at the optimal scale results in measure of TE which is confounded by scale efficiency (SE) effects.

This model (1) can be modified for Varying returns to scale (VRS) by an additional constraint N1′$\boldsymbol{\lambda}$=1(known as convexity constraint).This gives us the new model known as BCC model developed by Banker, Charnes and Cooper(1984).

$$\min \theta_i^{VRS}.\boldsymbol{\lambda\theta_i^{VRS}}$$

s.t

$$-y_i+Y\boldsymbol{\lambda}\geq 0,$$
$$\theta_i^{CRS}x_i-X\boldsymbol{\lambda}\geq 0,$$
$$N1'\boldsymbol{\lambda}=1$$
$$\boldsymbol{\lambda}\geq 0, \qquad (2)$$

Where θ_i^{VRS} is a PTE measureof the i-th state under VRS and N1 is N×1 vector of ones.Further, Overall Technical efficiency(OTE) can be decomposed into Pure Technical efficiency (PTE) and Scale efficiency(SE) of the i-th state can be obtained as follows:

Scale efficiency (SE_i)=$\frac{\theta_i^{CRS}}{\theta_i^{VRS}}$ (hereθ_i^{CRS} gives OTE scores and θ_i^{VRS} provides PTE scores)

Here, SE_i =1 indicates that i-th state is operating on optimum scale and is scale efficient while SE_i<1 indicates that i-th firm is scale inefficient.

To know, whether the firm is operating in an area of increasing or decreasing returns-to-sacle, an additional DEA problem with non –increasing returns-to –scale (NIRS) is imposed. This is done by substituting the N1′$\boldsymbol{\lambda}$=1 restriction in model(2) with N1′$\boldsymbol{\lambda}$≤1, which provides:

$$\min \theta_i^{NIRS}.\boldsymbol{\lambda\theta_i^{NIRS}}$$
$$\text{s.t} \quad -y_i + Y\boldsymbol{\lambda} \geq 0,$$
$$\theta_i^{NIRS} x_i - X\boldsymbol{\lambda} \geq 0,$$
$$N1'\boldsymbol{\lambda} \leq 1$$
$$\boldsymbol{\lambda} \geq 0, \quad (3)$$

The nature of the scale inefficiencies (i.e.; due to increasing or decreasing returns to scale) for a particular state can be determined by seeing whether θ_i^{VRS} is equal to θ_i^{NIRS} or not.
If $\theta_i^{VRS}=\theta_i^{NIRS}$, then decreasng return to scale exists.
If $\theta_i^{VRS}\neq\theta_i^{NIRS}$, then increasing returns to scale exists.

III Results and Discussion

This section discusses the empirical results relating with Overall Technical Efficiency(OTE) scores and its two main non additive but mutually exclusive components, Pure Technical Efficiency (PTE) and Scale Efficiency(SE) for the major 16 sates of registered manufacturing sector in India over the period 1980-81 to 2014-15.Pure technical efficiency scores reflects the managerial efficiency i.e.; the ability of the management to convert the resources into output(s), whereas the scale efficiency measures whether the output producing state/firm in question is operating at optimum scale or not.
Table:1 provides the year-wise results of the Overall Technical Efficiency(OTE) scores as well as Pure Technical Efficiency (PTE) scores and Input Scale Efficiency(SE) scores of manufacturing sector of 16 states in India.

Table: 1 Technical Efficiency Scores in Indian manufacturing sector (Year-wise)

Year	Overall Technical Efficiency	Pure Technical Efficiency	Scale Efficiency
1980-1981	0.807	0.922	0.875
1981-1982	0.778	0.916	0.849
1982-1983	0.797	0.915	0.873
1983-1984	0.759	0.908	0.834
1984-1985	0.614	0.788	0.782
1985-1986	0.733	0.854	0.855
1986-1987	0.750	0.951	0.789
1987-1988	0.857	0.937	0.915
1988-1989	0.805	0.919	0.874
1989-1990	0.846	0.935	0.903
1990-1991	0.810	0.911	0.887
1991-1992	0.801	0.915	0.873
1992-1993	0.720	0.899	0.807
1993-1994	0.693	0.914	0.756
1994-1995	0.599	0.821	0.733
1995-1996	0.757	0.939	0.801
1996-1997	0.717	0.893	0.803
1997-1998	0.767	0.937	0.814
1998-1999	0.780	0.910	0.857
1999-2000	0.739	0.934	0.791
2000-2001	0.770	0.942	0.825
2001-2002	0.789	0.977	0.808
2002-2003	0.807	0.966	0.836
2003-2004	0.832	0.963	0.863

2004-2005	0.706	0.891	0.793
2005-2006	0.776	0.948	0.818
2006-2007	0.770	0.920	0.837
2007-2008	0.751	0.940	0.799
2008-2009	0.806	0.944	0.850
2009-2010	0.800	0.935	0.856
2010-2011	0.752	0.949	0.794
2011-2012	0.740	0.908	0.813
2012-2013	0.752	0.918	0.824
2013-2014	0.702	0.909	0.774
2014-2015	0.727	0.911	0.803
Pre-Reforms Period	0.775	0.904	0.857
Post-Reforms Period Phase I	0.732	0.910	0.805
Post-Reforms Period Phase II	0.764	0.934	0.819
Entire period	0.758	0.917	0.827

Source: Author's calculations

It has been observed that for the entire study period (i.e.; 1980-81 to 2014-15), OTE score on average basis turned out to be 0.758. This implies that, on an average, these states are producing 76 percent of the output that could be produced with their current level of input resource. So, technical inefficiency(OTIE) turned out to be 24 percent or in other words, output can be increased by 24 percent with the same level of inputs used. Output loss on average basis turned out to be 22 percent, 27 percent and 24 percent respectively in case of pre reforms period, post-reforms period phase-I and post-reforms period phase-II. To know exactly the cause of OTIE in these states, measure of OTE has been decomposed into Pure Technical Efficiency(PTE) and Scale Efficiency(SE). The average output loss due to PTIE and SIE was observed to the tune of 8 percent and 17 percent respectively for the entire study period (i.e.; 1980-81 to 2014-15). Similarly, results for the three distinct sub-periods on average basis showed PTIE to the tune of 10 percent, 9 percent and 7 percent respectively. Whereas, the scores on SIE on average basis were found to be 14 percent, 19 percent and 18 percent for the three sub periods respectively.
Thus, from the results of the **table 1** on efficiency scores it is clear that Scale inefficiency is the dominant source and pure technical inefficiency is relatively meager source of overall technical inefficiency in states manufacturing sector.
Table:2 provides an inter- state analysis in the overall technical efficiency(OTE) and its two aforementioned components i.e.; PTE and SE for the entire period and the three distinct sub-periods.

Table:2 Technical Efficiency Scores in Indian manufacturing Sector (State-wise)

States	Overall Technical Efficiency				Pure Technical Efficiency				Scale Efficiency			
	I	II	III	IV	I	II	III	IV	I	II	III	IV
AP	0.750	0.749	0.747	0.870	0.901	0.960	0.948	0.991	0.836	0.782	0.791	0.878
ASS	0.735	0.798	0.853	0.823	0.853	0.959	0.937	0.916	0.857	0.825	0.908	0.892
BIH	0.761	0.761	0.692	0.663	0.803	0.910	0.966	0.889	0.575	0.833	0.718	0.741
DEL	0.672	0.751	0.766	0.876	0.879	0.970	0.948	0.942	0.768	0.886	0.807	0.876
GUJ	0.838	0.885	0.917	0.848	0.951	0.954	0.977	0.970	0.881	0.926	0.939	0.875
HAR	0.757	0.891	0.874	0.869	0.950	0.974	0.974	0.955	0.798	0.915	0.998	0.911

KAR	0.754	0.862	0.957	0.872	0.951	0.977	0.986	0.963	0.792	0.882	0.971	0.902
KER	0.818	0.771	0.842	0.880	0.953	0.981	0.973	0.972	0.857	0.786	0.865	0.905
MP	0.580	0.790	0.817	0.714	0.912	0.923	0.914	0.977	0.634	0.856	0.893	0.730
MAH	0.742	0.930	0.940	0.827	0.958	0.990	0.978	0.976	0.775	0.939	0.961	0.849
ODI	0.679	0.841	0.821	0.820	0.871	0.917	0.969	0.958	0.775	0.914	0.846	0.858
PUN	0.562	0.809	0.887	0.627	0.829	0.943	0.974	0.953	0.681	0.858	0.911	0.657
RAJ	0.537	0.812	0.884	0.679	0.931	0.947	0.975	0.967	0.576	0.858	0.907	0.705
TN	0.879	0.940	0.961	0.862	0.953	0.983	0.989	0.964	0.922	0.950	0.972	0.895
UP	0.654	0.889	0.966	0.751	0.959	0.987	0.994	0.954	0.685	0.899	0.971	0.792
WB	0.854	0.908	0.839	0.878	0.925	0.967	0.936	0.987	0.925	0.938	0.897	0.890

Source Author's calculations

Note: 1)The abbreviations used for various states are:Andhra Pradesh(AP), Assam(ASS), Bihar(BIH), Delhi(DEL), Gujarat(GUJ), Haryana(HAR), Karnataka(KAR), Kerala(KER), Madhya Pradesh(MP), Odisha(ODI), Punjab(PUN), Rajasthan(RAJ), Tamil Nadu(TN), Uttar Pradesh(UP) and West Bengal(WB) 2)'I','II','III' and'IV'indicate entire period(1980-81to 1990-91), Pre-Reforms period(1980-81 to 1990-91) ,Post-reforms period Phase-I(1991-92 to 2000-01) and Post-Reforms Period Phase II (2001-02 to 2014-15)

It has been observed that in the pre -reforms period, the mean TE of 16 states lies in the range from 0.741 to 0.940. The highest (lowest) level of technical efficiency (inefficiency) on average basis has been observed in the manufacturing sector of the states Tamil Nadu followed by the states Maharashtra and West Bengal. The lowest (highest) level of technical efficiency (inefficiency) on average basis has been observed in the manufacturing sector of the state Andhra Pradesh followed by the states Bihar and Kerala for the same study period. Similarly, for the second sub period viz.; post reforms period phase I, the mean OTE scores ranged from 0.692 to 0.966. The highest (lowest) level of technical efficiency (inefficiency) on average basis has been observed in the manufacturing sector of the states Uttar Pradesh followed by the states Tamil Nadu and Maharashtra. The lowest (highest) level of technical efficiency (inefficiency) on average basis has been observed in the manufacturing sector of the state Bihar followed by the states Andhra Pradesh and Delhi for the same time period. Results for the third sub period viz.; post reforms period phase II, the mean OTE scores ranged from 0.627 to 0.880. The highest (lowest) level of technical efficiency (inefficiency) on average basis has been observed in the manufacturing sector of the state Kerala followed by the states West Bengal and Andhra Pradesh.

Similarly, results for the PTE scores revealed the state Uttar Pradesh as the most efficient state for the entire period as well as in the post reforms period phase-I, where as the state Maharashtra in Pre- reforms period and the state Andhra Pradesh in post reforms phase II were found to be the most efficient states among all states taken under consideration. In case of input scale efficiency (SE) scores, the state West Bengal was registered as the most efficient state for the entire period whereas, the state Uttar Pradesh was found to be the more efficient in first sub period and the state Haryana in other two sub periods. Thus, state-wise results on average basis again revealed Input scale inefficiency as the dominant source of overall technical inefficiency for the whole study period and its three distinct sub periods.

Table: 3, 4 and 5 depict the results of overall technical efficiency (also known as global technical efficiency), pure technical efficiency (PTE) and scale efficiency (SE) in each state at disaggregated level.

Table :3 Overall Technical Efficiency Scores

Year	AP	ASS	BIH	DEL	GUJ	HAR	KAR	KER	MP	MAH	ODI	PUN	RAJ	TN	UP	WB
1980-1981	0.484	0.542	0.886	1.000	0.783	0.958	0.757	0.683	1.000	1.000	0.963	0.704	0.767	0.854	0.685	0.870
1981-1982	0.543	0.620	1.000	1.000	0.731	0.933	0.671	0.645	0.946	1.000	0.652	0.716	0.725	0.830	0.599	0.826
1982-1983	0.582	0.626	1.000	1.000	0.725	0.881	0.748	0.698	0.971	1.000	0.631	0.706	0.790	0.884	0.744	0.744
1983-1984	0.625	0.843	0.918	1.000	0.736	0.700	0.780	0.612	0.810	1.000	0.673	0.598	0.937	0.737	0.492	0.690

1984-1985	0.432	0.711	0.930	0.543	0.624	0.650	0.600	0.554	0.709	1.000	0.456	0.511	0.634	0.585	0.457	0.430
1985-1986	0.491	1.000	0.970	1.000	0.732	0.720	0.680	0.592	0.770	1.000	0.605	0.619	0.659	0.687	0.582	0.617
1986-1987	0.580	1.000	0.897	1.000	0.790	0.812	0.725	0.709	0.723	1.000	0.786	0.624	0.748	0.850	0.774	0.750
1987-1988	0.785	1.000	1.000	1.000	0.859	0.879	0.770	0.815	0.922	1.000	0.817	0.701	0.794	0.794	0.764	0.815
1988-1989	0.822	0.624	0.981	1.000	0.911	0.783	0.702	0.730	0.887	1.000	1.000	0.676	0.685	0.812	0.675	0.595
1989-1990	0.576	1.000	0.934	1.000	0.830	0.844	0.832	0.927	0.818	1.000	1.000	0.822	0.699	0.858	0.819	0.574
1990-1991	0.443	0.876	0.893	1.000	0.800	0.875	0.815	0.610	0.938	1.000	0.996	0.749	0.780	0.827	0.749	0.602
1991-1992	0.424	0.672	1.000	1.000	0.841	0.913	1.000	0.641	0.865	1.000	0.938	0.740	0.762	0.710	0.812	0.498
1992-1993	0.417	0.613	0.673	1.000	1.000	0.734	0.874	0.554	0.719	1.000	0.717	0.602	0.680	0.711	0.741	0.484
1993-1994	0.405	0.555	0.712	1.000	0.880	0.778	0.804	0.470	0.717	1.000	0.563	0.712	0.565	0.709	0.690	0.534
1994-1995	0.366	0.402	0.572	1.000	0.853	0.641	0.660	0.348	0.641	1.000	0.502	0.520	0.603	0.509	0.606	0.369
1995-1996	0.547	0.524	0.686	1.000	0.978	0.967	0.893	0.611	1.000	1.000	0.567	0.661	0.689	0.715	0.704	0.509
1996-1997	0.516	0.429	0.529	1.000	1.000	1.000	0.892	0.592	0.714	0.972	0.451	0.779	0.640	0.672	0.804	0.487
1997-1998	0.676	0.565	0.944	1.000	0.869	1.000	0.799	0.632	0.989	1.000	0.530	0.738	0.687	0.628	0.755	0.463
1998-1999	0.505	0.678	0.879	1.000	1.000	0.758	0.755	0.767	0.823	1.000	0.753	0.766	0.711	0.644	0.827	0.604
1999-2000	0.464	0.627	1.000	1.000	0.915	0.876	0.653	0.544	0.783	1.000	0.709	0.725	0.833	0.597	0.656	0.444
2000-2001	0.571	0.525	0.752	1.000	0.957	0.887	0.771	0.730	0.849	1.000	0.731	0.693	0.869	0.780	0.723	0.567
2001-2002	0.617	0.450	0.681	1.000	1.000	1.000	0.826	0.653	0.985	1.000	0.688	0.818	0.853	0.691	0.812	0.556
2002-2003	0.569	0.977	0.889	1.000	1.000	1.000	0.858	0.671	0.841	1.000	0.673	0.715	0.718	0.618	0.802	0.578
2003-2004	0.678	1.000	0.967	1.000	1.000	0.991	0.835	0.826	0.862	1.000	0.683	0.739	0.681	0.710	0.741	0.603
2004-2005	0.613	0.769	1.000	0.919	0.641	0.902	0.834	0.659	0.661	0.718	0.577	0.605	0.573	0.610	0.615	0.600
2005-2006	0.639	0.736	0.968	0.981	0.954	0.975	0.794	0.691	0.711	1.000	0.780	0.619	0.667	0.710	0.664	0.539
2006-2007	0.732	0.652	0.757	0.921	0.800	0.858	0.917	0.478	0.908	1.000	0.848	0.705	0.783	0.721	0.701	0.545
2007-2008	0.668	0.501	1.000	0.959	0.693	0.776	0.823	0.670	0.814	1.000	0.809	0.790	0.661	0.646	0.654	0.554
2008-2009	0.771	0.436	0.768	0.995	0.752	0.874	0.901	0.848	0.724	1.000	1.000	0.724	0.841	0.657	0.948	0.609
2009-2010	0.638	0.698	0.860	1.000	1.000	1.000	0.688	0.698	0.626	1.000	0.841	0.766	0.886	0.712	0.829	0.561
2010-2011	0.632	0.667	0.920	1.000	0.862	0.736	0.690	0.620	0.527	1.000	0.760	0.749	0.638	0.794	0.975	0.550
2011-2012	0.544	0.676	0.759	0.749	0.837	0.742	0.666	0.622	0.546	1.000	0.862	1.000	1.000	0.649	0.744	0.441
2012-2013	0.425	0.631	0.776	1.000	0.944	0.887	0.726	0.696	0.580	1.000	0.790	0.633	0.856	0.744	0.882	0.466
2013-2014	0.382	0.660	0.772	1.000	0.901	0.698	0.610	0.635	0.657	1.000	0.884	0.584	0.642	0.550	0.838	0.423
2014-2015	0.487	0.690	0.748	1.000	1.000	0.900	0.634	0.556	0.701	1.000	0.688	0.630	0.746	0.628	0.847	0.385
Average	0.561	0.685	0.858	0.973	0.863	0.855	0.771	0.651	0.792	0.991	0.741	0.698	0.737	0.710	0.735	0.568

Source Author's calculations

Note: 1)The abbreviations used for various states are: Andhra Pradesh(AP), Assam(ASS), Bihar(BIH), Delhi(DEL), Gujarat(GUJ), Haryana(HAR), Karnataka(KAR), Kerala(KER), Madhya Pradesh(MP), Odisha(ODI), Punjab(PUN), Rajasthan(RAJ), Tamil Nadu(TN), Uttar Pradesh(UP) and West Bengal(WB)

Table: 4 Pure Technical Efficiency Scores

Year	AP	ASS	BIH	DEL	GUJ	HAR	KAR	KER	MP	MAH	ODI	PUN	RAJ	TN	UP	WB

1980-1981	0.648	0.574	0.896	1.000	0.885	1.000	0.823	0.686	1.000	1.000	1.000	1.000	0.895	0.866	0.721	1.000
1981-1982	0.628	0.638	1.000	1.000	0.903	0.979	0.812	0.680	1.000	1.000	0.772	1.000	0.876	0.630	0.603	0.859
1982-1983	0.678	0.647	1.000	1.000	0.819	0.942	0.844	0.750	1.000	1.000	0.710	0.997	0.892	0.890	0.793	1.000
1983-1984	0.734	0.876	0.918	1.000	0.831	0.796	0.896	0.698	0.816	1.000	0.762	0.900	1.000	0.799	0.549	0.767
1984-1985	0.711	0.883	0.947	1.000	0.820	0.783	0.772	0.703	0.760	1.000	0.612	0.882	0.809	0.786	0.603	0.441
1985-1986	0.851	1.000	1.000	1.000	0.904	0.838	0.867	0.728	0.848	1.000	0.708	0.926	0.868	0.789	0.638	0.716
1986-1987	0.827	1.000	1.000	1.000	0.961	0.899	0.897	0.776	0.746	1.000	0.828	0.911	0.920	0.851	0.782	0.789
1987-1988	0.889	1.000	1.000	1.000	0.968	0.893	0.890	0.875	0.925	1.000	0.870	0.851	0.917	0.806	0.792	1.000
1988-1989	0.955	0.716	1.000	1.000	1.000	0.836	0.809	0.768	0.890	1.000	1.000	0.884	0.914	0.830	0.705	0.684
1989-1990	0.906	1.000	1.000	1.000	0.949	0.866	0.861	0.927	0.530	1.000	1.000	0.928	0.580	0.866	0.828	0.609
1990-1991	0.825	0.896	1.000	1.000	0.965	0.899	0.846	0.637	0.987	1.000	1.000	0.880	0.929	0.829	0.770	0.720
1991-1992	0.950	0.697	1.000	1.000	0.900	0.920	1.000	0.683	0.880	1.000	0.938	0.887	0.852	0.771	0.833	0.660
1992-1993	0.939	0.634	0.674	1.000	1.000	0.764	0.891	0.615	0.725	1.000	0.723	0.887	0.934	0.835	0.758	0.528
1993-1994	0.724	0.567	0.734	1.000	0.949	0.778	0.838	0.533	0.723	1.000	0.623	0.748	0.828	0.741	0.701	0.609
1994-1995	0.833	0.533	0.623	1.000	0.919	0.667	0.698	0.665	0.670	1.000	0.577	0.808	0.907	0.766	0.684	0.369
1995-1996	0.637	0.631	0.720	1.000	1.000	1.000	0.954	0.670	1.000	1.000	0.634	0.678	0.841	0.723	0.727	0.599
1996-1997	0.814	0.471	1.000	1.000	1.000	1.000	0.932	0.671	0.717	1.000	0.553	0.812	0.827	0.707	0.821	0.530
1997-1998	0.764	0.569	0.950	1.000	0.931	1.000	0.806	0.715	1.000	1.000	0.589	0.722	0.896	0.653	0.806	0.572
1998-1999	0.546	0.772	1.000	1.000	1.000	0.963	0.766	0.886	1.000	1.000	0.812	0.788	0.805	0.684	0.882	0.800
1999-2000	0.516	0.683	1.000	1.000	0.996	0.995	0.676	0.581	0.799	1.000	0.736	0.782	0.997	0.670	0.783	0.450
2000-2001	0.574	0.545	0.757	1.000	1.000	0.943	0.784	0.852	1.000	1.000	0.748	0.709	1.000	0.815	0.816	0.648
2001-2002	0.622	0.473	0.682	1.000	1.000	1.000	0.834	0.710	1.000	1.000	0.710	0.828	0.957	0.695	0.856	0.556
2002-2003	0.571	1.000	1.000	1.000	1.000	1.000	0.859	0.672	0.864	1.000	0.706	0.761	0.889	0.660	0.809	0.579
2003-2004	0.713	1.000	1.000	1.000	1.000	0.992	0.854	0.832	0.686	1.000	0.721	0.788	0.897	0.740	0.798	0.606
2004-2005	0.668	0.785	1.000	1.000	0.883	0.914	0.846	0.739	0.729	0.835	0.688	0.748	0.882	0.660	0.693	0.617
2005-2006	0.668	0.739	0.974	1.000	1.000	0.977	0.796	0.728	0.788	1.000	0.813	0.736	0.901	0.707	0.727	0.542
2006-2007	0.758	0.696	0.899	1.000	0.929	0.865	0.923	0.727	0.917	1.000	0.863	0.766	0.977	0.749	0.769	0.560
2007-2008	0.711	0.609	1.000	1.000	0.838	0.782	0.827	0.701	0.826	1.000	1.000	0.815	0.769	0.658	0.688	0.561
2008-2009	0.773	0.634	0.918	1.000	0.852	0.874	0.901	0.851	0.728	1.000	1.000	0.797	0.959	0.659	0.999	0.610
2009-2010	0.698	0.736	1.000	1.000	1.000	1.000	0.698	0.891	0.762	1.000	1.000	0.772	0.941	0.738	0.844	0.611
2010-2011	0.672	0.670	1.000	1.000	0.908	0.757	0.691	0.621	0.615	1.000	1.000	0.775	0.722	0.724	1.000	0.555
2011-2012	0.767	0.700	0.766	1.000	0.895	0.857	0.688	0.731	0.629	1.000	1.000	1.000	1.000	0.710	0.748	0.515
2012-2013	0.871	0.640	0.891	1.000	0.964	1.000	0.738	0.721	0.647	1.000	1.000	0.642	0.864	0.785	0.961	0.467
2013-2014	0.831	0.692	0.901	1.000	0.940	0.756	0.629	0.670	0.703	1.000	1.000	0.593	0.710	0.597	0.907	0.457
2014-2015	0.909	0.706	0.884	1.000	1.000	0.976	0.635	0.557	0.753	1.000	1.000	0.647	0.783	0.633	0.891	0.473
Average	0.748	0.726	0.918	1.000	0.940	0.900	0.817	0.721	0.819	0.995	0.820	0.819	0.878	0.743	0.780	0.630

Source Author's calculations

Note: 1)The abbreviations used for various states are: Andhra Pradesh(AP), Assam(ASS), Bihar(BIH), Delhi(DEL), Gujarat(GUJ), Haryana(HAR), Karnataka(KAR), Kerala(KER), Madhya Pradesh(MP), Odisha(ODI), Punjab(PUN), Rajasthan(RAJ), Tamil Nadu(TN), Uttar Pradesh(UP) and West Bengal(WB) .

Table: 5 Scale Efficiency Scores

Year	AP	ASS	BIH	DEL	GUJ	HAR	KAR	KER	MP	MAH	ODI	PUN	RAJ	TN	UP	WB
1980-1981	0.747	0.944	0.989	1.000	0.885	0.958	0.895	0.996	1.000	1.000	0.963	0.704	0.858	0.986	0.951	0.870
1981-1982	0.865	0.971	1.000	1.000	0.810	0.952	0.834	0.948	0.946	1.000	0.844	0.716	0.828	0.993	0.993	0.961
1982-1983	0.858	0.968	1.000	1.000	0.886	0.936	0.886	0.931	0.971	1.000	0.889	0.708	0.886	0.994	0.938	0.797
1983-1984	0.851	0.962	0.999	1.000	0.886	0.880	0.870	0.877	0.992	1.000	0.884	0.665	0.937	0.923	0.897	0.900
1984-1985	0.607	0.805	0.982	0.543	0.761	0.830	0.777	0.787	0.933	1.000	0.745	0.579	0.783	0.746	0.758	0.975
1985-1986	0.577	1.000	0.970	1.000	0.810	0.859	0.795	0.812	0.910	1.000	0.854	0.668	0.760	0.870	0.911	0.861
1986-1987	0.702	1.000	0.897	1.000	0.822	0.903	0.808	0.914	0.976	1.000	0.949	0.685	0.813	0.999	0.990	0.951
1987-1988	0.883	1.000	1.000	1.000	0.872	0.984	0.866	1.000	0.997	1.000	0.939	0.824	0.866	0.985	0.965	0.815
1988-1989	0.600	0.872	0.981	1.000	0.911	0.936	0.868	0.952	0.996	1.000	1.000	0.765	0.750	0.979	0.958	0.872
1989-1990	0.636	1.000	0.934	1.000	0.875	0.975	0.967	0.999	0.958	1.000	1.000	0.886	0.813	0.990	0.990	0.942
1990-1991	0.537	0.978	0.893	1.000	0.829	0.973	0.962	0.957	0.950	1.000	0.996	0.851	0.840	0.997	0.972	0.835
1991-1992	0.446	0.964	1.000	1.000	0.935	0.993	1.000	0.939	0.982	1.000	1.000	0.834	0.894	0.921	0.974	0.705
1992-1993	0.444	0.965	0.998	1.000	1.000	0.961	0.981	0.900	0.991	1.000	0.992	0.679	0.728	0.851	0.978	0.918
1993-1994	0.559	0.978	0.970	1.000	0.928	1.000	0.960	0.881	0.993	1.000	0.904	0.952	0.682	0.956	0.984	0.877
1994-1995	0.440	0.753	0.917	1.000	0.929	0.948	0.945	0.525	0.956	1.000	0.871	0.643	0.665	0.664	0.886	0.998
1995-1996	0.859	0.927	0.953	1.000	0.978	0.967	0.936	0.913	1.000	1.000	0.895	0.974	0.819	0.990	0.968	0.850
1996-1997	0.634	0.911	0.529	1.000	1.000	1.000	0.957	0.883	0.996	0.972	0.816	0.960	0.774	0.950	0.980	0.919
1997-1998	0.885	0.993	0.994	1.000	0.933	1.000	0.992	0.884	0.989	1.000	0.900	0.956	0.766	0.961	0.936	0.820
1998-1999	0.926	0.878	0.879	1.000	1.000	0.788	0.986	0.865	0.823	1.000	0.928	0.973	0.882	0.942	0.937	0.754
1999-2000	0.900	0.918	1.000	1.000	0.918	0.880	0.967	0.932	0.980	1.000	0.963	0.927	0.835	0.891	0.838	0.986
2000-2001	0.995	0.962	0.994	1.000	0.957	0.940	0.983	0.871	0.849	1.000	0.977	0.978	0.869	0.954	0.886	0.872
2001-2002	0.991	0.952	0.999	1.000	1.000	1.000	0.990	0.920	0.985	1.000	0.968	0.988	0.891	0.994	0.948	0.999
2002-2003	0.990	0.977	0.889	1.000	1.000	1.000	0.998	0.999	0.973	1.000	0.952	0.940	0.807	0.936	0.991	0.998
2003-2004	0.952	1.000	0.967	1.000	1.000	0.999	0.978	0.993	0.993	1.000	0.947	0.938	0.758	0.968	0.929	0.995
2004-2005	0.918	0.979	1.000	0.919	0.725	0.987	0.986	0.891	0.906	0.860	0.839	0.810	0.650	0.928	0.888	0.973
2005-2006	0.957	0.995	0.994	0.981	0.954	0.999	0.998	0.949	0.903	1.000	0.959	0.841	0.740	0.991	0.914	0.933
2006-2007	0.967	0.937	0.842	0.921	0.861	0.992	0.994	0.658	0.989	1.000	0.982	0.920	0.801	0.936	0.912	0.973
2007-2008	0.939	0.822	1.000	0.959	0.826	0.995	0.996	0.957	0.925	1.000	0.809	0.970	0.860	0.981	0.951	0.987
2008-2009	0.998	0.688	0.837	0.995	0.883	1.000	1.000	0.996	0.822	1.000	1.000	0.912	0.877	0.997	1.000	0.999
2009-2010	0.914	0.948	0.860	1.000	1.000	1.000	0.986	0.784	0.857	1.000	0.841	0.993	0.942	0.966	0.982	0.917
2010-2011	0.927	0.995	0.920	1.000	0.950	0.973	0.998	0.998	0.869	1.000	0.760	0.966	0.884	0.987	0.975	0.990
2011-2012	0.709	0.967	0.992	0.749	0.935	0.866	0.968	0.500	0.897	1.000	0.862	1.000	1.000	0.914	0.995	0.857
2012-2013	0.488	0.986	0.871	1.000	0.979	0.887	0.984	0.966	0.935	1.000	0.790	0.986	0.986	0.991	0.948	0.999
2013-2014	0.459	0.953	0.857	1.000	0.959	0.924	0.970	0.948	0.915	1.000	0.884	0.985	0.958	0.904	0.924	0.927
2014-2015	0.536	0.977	0.846	1.000	1.000	0.922	0.998	0.997	0.931	1.000	0.688	0.974	0.974	0.953	0.951	0.813

Average	0.763	0.941	0.936	0.973	0.914	0.949	0.945	0.895	0.945	0.995	0.903	0.861	0.834	0.943	0.943	0.910

Source Author's calculations

.Note: 1)The abbreviations used for various states are: Andhra Pradesh(AP), Assam(ASS), Bihar(BIH), Delhi(DEL), Gujarat(GUJ), Haryana(HAR), Karnataka(KAR), Kerala(KER), Madhya Pradesh(MP), Odisha(ODI), Punjab(PUN), Rajasthan(RAJ), Tamil Nadu(TN), Uttar Pradesh(UP) and West Bengal(WB)

For OTE scores, Results of the states at disaggregate level revealed the two states, Maharashtra and Delhi as the most efficient states among all the states taken under consideration for the present study. On average basis, TIE in these two states was found to be less than 1 percent in case of Maharashtra and less than 3 percent in case of Delhi. The most inefficient state was found to be Andhra Pradesh followed by West Bengal and. Similarly, in table 4 year wise results of PTE scores in each state shows Delhi and Maharashtra as the most efficient states similar to the results found in case of OTE . The state West Bengal is recorded as the most inefficient state followed by the states Kerala and Assam. Again, in case of SE scores, minimum level of inefficiency was recorded by the states Delhi and Maharashtra, whereas, the highest level of inefficiency was recorded by the state Andhra Pradesh.

Table: 6 reports year-wise results of the states operating in the range of Constant returns to Scale (CRS), Decreasing Returns to scale (DRS) and Increasing Returns to scale (IRS). In order to determine the scale of returns a state operates, we estimate Technical efficiency under CRS (T^{CRS}),VRS(T^{VRS}) and NRS(T^{NRS}) following Grosskoff (1986) and Kumar(2006).

Table :6 Return- to-Scale in States

Year	CRS	DRS	IRTS
1980-1981	DEL,MP,MAH	TN,UP,WB	AP,ASS,BIH,GUJ,HAR,KAR,KER,ORI,PUN,RAJ
1981-1982	BIH,DEL,MAH	KER,MP,TN,UP,WB	AP,ASS,GUJ,HAR,KAR,ORI,PUN,RAJ
1982-1983	BIH,DEL,MAH	MP,TN,UP,WB	AP,ASS,GUJ,HAR,KAR,KER,ORI,PUN,RAJ
1983-1984	DEL,MAH	ASS,WB	AP,BIH,GUJ,HAR,KAR,KER,MP,ORI,PUN,RAJ,TN,UP
1984-1985	MAH	-	AP,ASS,BIH,DEL,GUJ,HAR,KAR,KER,MP,ORI,PUN,RAJ,TN,UP,WB
1985-1986	ASS,DEL,MAH	WB	AP,BIH,GUJ,HAR,KAR,KER,MP,ORI,PUN,RAJ,TN,UP
1986-1987	ASS,DEL,MAH	BIH,TN,UP,WB	AP,GUJ,HAR,KAR,KER,MP,ORI,PUN,RAJ
1987-1988	ASS,BIH,DEL,KER, MAH	UP,WB	AP,GUJ,HAR,KAR,MP,ORI,PUN,RAJ,TN
1988-1989	DEL,MAH,ODI	BIH,WB	AP,ASS,GUJ,HAR,KAR,KER,MP,PUN,RAJ,TN,UP
1989-1990	ASS,DEL,MAH,ODI	BIH,KER,MP,WB	AP,GUJ,HAR,KAR,PUN,RAJ,TN,UP
1990-1991	DEL,MAH	ASS,BIH,HAR,MP,ODI,WB	AP,GUJ,KAR,KER,PUN,RAJ,TN,UP
1991-1992	BIH,DEL,KAR,MAH ,KER	HAR,WB	AP,ASS,GUJ,MP,ORI,PUN,RAJ,TN,UP
1992-1993	DEL,GUJ,MAH	BIH,MP,ODI,WB	AP,ASS,HAR,KAR,KER,PUN,RAJ,TN,UP
1993-1994	DEL,HAR,MAH	KAR,WB	AP,ASS,BIH,GUJ,KER,MP,ORI,PUN,RAJ,TN,UP
1994-1995	DEL,MAH	-	AP,ASS,BIH,GUJ,HAR,KAR,KER,MP,ORI,PUN,RAJ,TN,UP,WB
1995-1996	DEL,MP,MAH	ASS,HAR,KAR,KER,TN,WB	AP,BIH,GUJ,ORI,PUN,RAJ,UP
1996-1997	DEL,GUJ,HAR	BIH,KAR,MP,MAH,WB	AP,ASS,KER,ORI,PUN,RAJ,TN,UP
1997-1998	DEL,HAR,MAH	ASS,BIH,KAR,MP,WB	AP,GUJ,KER,ORI,PUN,RAJ,TN,UP
1998-1999	DEL,GUJ,MAH	ASS,BIH,HAR,KER,MP,ORI,WB	AP,KAR,PUN,RAJ,TN,UP
1999-2000	BIH,DEL,MAH	ASS,HAR,WB	AP,GUJ,KAR,KER,MP,ORI,PUN,RAJ,TN,UP

2000-2001	DEL,MAH	AP,HAR,KAR,KER,MP,TN,WB	ASS,BIH,GUJ,ORI,PUN,RAJ,UP
2001-2002	DEL,GUJ,HAR,MAH	KER,MP,PUN,WB	AP,ASS,KAR,KER,ORI,RAJ,TN,UP
2002-2003	DEL,GUJ,HAR,MAH	ASS,BIH,MP	AP,KAR,KER,ORI,PUN,RAJ,TN,UP,WB
2003-2004	ASS,DEL,GUJ,MAH	BIH,HAR,KER,MP	AP,KAR,ORI,PUN,RAJ,TN,UP,WB
2004-2005	BIH	-	AP,ASS,DEL,GUJ,HAR,KAR,KER,MP,MAH,ORI,PUN,RAJ,TN,UP,WB
2005-2006	MAH	-	AP,ASS,BIH,DEL,GUJ,HAR,KAR,KER,MP,ORI,PUN,RAJ,TN,UP, WB
2006-2007	MAH	-	AP,ASS,BIH,DEL,GUJ,HAR,KAR,KER,MP,ORI,PUN,RAJ,TN,UP,WB
2007-2008	BIH,MAH	ORI	AP,ASS,DEL,GUJ,HAR,KAR,KER,MP,PUN,RAJ,TN,UP,WB
2008-2009	HAR,KAR,MAH, ORI,UP	-	AP,ASS,BIH,DEL,GUJ,KER,MP,PUN,RAJ,TN,WB
2009-2010	DEL,GUJ,HAR, MAH	ORI	AP,ASS,BIH,KAR,KER,MP,PUN,RAJ,TN,UP,WB
2010-2011	DEL,MAH	ASS,BIH,HAR,KAR,KER,ORI,PUN,TN,UP, WB	AP,GUJ,MP,RAJ
2011-2012	MAH,PUN,RAJ	HAR,ORI	AP,ASS,BIH,DEL,GUJ,KAR,KER,MP,TN,UP,WB
2012-2013	DEL,MAH,WB	ASS,HAR,KAR,KER,ORI,PUN,RAJ,TN,UP	AP,BIH,GUJ,MP
2013-2014	DEL,MAH	ASS,HAR,KER,ORI,PUN,UP	AP,BIH,GUJ,KAR,MP,RAJ,TN,WB
2014-2015	DEL,MAH	ASS,HAR,KER,ORI,PUN,UP	AP,BIH,GUJ,KAR,MP,RAJ,TN,WB

Source Author's calculations

Note:1)CRS,DRS and IRS stands for Constant Returns- To -scale, Decreasing Returns- To- scale and Increasing Returns- to -scale respectively.

2)The abbreviations used for various states are: Andhra Pradesh(AP), Assam(ASS), Bihar(BIH), Delhi(DEL), Gujarat(GUJ), Haryana(HAR), Karnataka(KAR), Kerala(KER), Madhya Pradesh(MP), Odisha(ODI), Punjab(PUN), Rajasthan(RAJ), Tamil Nadu(TN), Uttar Pradesh(UP) and West Bengal(WB)

In our study, most of the states were operating in the range of IRS. Maharashtra operates in the range of CRS in 32 out of 35 years, while Delhi operates in the same range for 23 years out of 35 years. Thus, the operation of most of the states operating in the range of IRS helps to explain the cause of inefficiency observed. This implies that these states had the potential to wipe out the overall technical inefficiencies by expanding their scale of operations.

IV Conclusion

The manufacturing sector of India is going through a stage of transition because of various policy reforms undertaken after 1990.India's manufacturing sector is on a high growth trajectory. As targeted by the National manufacturing Competitiveness Council (NMCC), it is set to contribute 25 percent to the GDP by 2025 compared to the current share of nearly 16 percent.

In this paper, an attempt has been made to evaluate the efficiency performance of the organized manufacturing sector in the Indian states by using Data Envelopment Analysis during both the pre-reforms and reforms periods. Finding of the study revealed that in the pre-reforms period overall technical inefficiency was found on the tune of 22 percent per year while in the post-reforms period the corresponding inefficiency was found on the tune of27 percent in phase I and 24 percent in phase II. Scale inefficiency is found as the major source of overall technical inefficiency in these states. States that depict significant improvement in their OTE scores during Post-Reforms period are Andhra Pradesh, Assam, Delhi and Kerala. While Haryana, Karnataka, Madhya Pradesh, Odisha and Gujarat are the states that do not show any significant impact of reforms on their efficiency performance. However, the states like Punjab, Rajasthan and West Bengal registered a declining trend in their efficiencies during post-reforms period depicting negative impact of reforms in these states. Study also found that most of the states are operating under the increasing returns- to- scale. This implies that these states had the potential to wipe out the overall technical inefficiencies by expanding their scale of operations. A look into the characteristics of the efficient and the inefficient states indicates that the efficient states have become more efficient over a period of time. From thecomparative analysis of efficiency measures between pre- and post-reforms period, it has been observed

that the economic reforms process has not made any significant dent on the efficiency performance of manufacturing sectors in Indian states.

In this context, it can be concluded that productivity growth in Indian manufacturing sector can be improved through innovations or by technological adoptions among firms. Hence, in order to accelerate the efficiency performance and productivity growth in Indian manufacturing sector, a significant amount of investment in research and development, human resource development and radical upgradation of technology are essentially required in the current economic scenario. Moreover, government must initiate R&D activities both at state level and all India level.

End notes

1. A comprehensive set of studies on various aspects of manufacturing sector can be found in Tendulkar et al. (2006).
2. Trivedi et al. (2011) provides a review of studies on regional Manufacturing performance.
3.The registered(organized) manufacturing sector includes all factories covered under section 2m(i) and 2m(ii) of the 1948 Indian Factories Act(IFA) which refers to factories employing 10 or more workers and using power, or those employing 20 or more workers but not using power on any day of the preceding 12 months.
4. These 16 states for which consistent data for the study period are taken, viz.; Andhra Pradesh, Assam, Bihar(undivided Bihar and Jharkhand), Delhi, Gujarat, Haryana, Karnataka, Kerala, Madhya Pradesh(undivided Madhya Pradesh and Chhattisgarh), Odisha, Punjab, Rajasthan, Tamil Nadu, Uttar Pradesh(undivided Uttar Pradesh and Uttarakhand) and West Bengal. It is worth- mentioning that these states constitute 91.48 percent of total population in India (2011 census) and 64 percent of GDP(20011-12).
5. The logic behind the idea of dividing the entire period into three sub-periods is that the reforms process was initiated in 1991 and still on. But later on many policies like EXIM policy (2000), foreign trade policy (2004), new foreign trade policy (2009) etc. were taken to strengthen the reform process especially in later nineties and after 2000s
6. For this Data envelopment analysis (DEA) as described by Coelli,T.(1996) DEAP software version 2.1 have been used to compute TE scores, PTE scores and SE scores.

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