International Journal of Social Science and Economic Research

ISSN: 2455-8834

Volume:09, Issue:05 "May 2024"

Efficiency and Effectiveness of Indian Textile Industry: An Interstate Network DEA Analysis

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DOI: 10.46609/IJSSER.2024.v09i05.001 URL: https://doi.org/10.46609/IJSSER.2024.v09i05.001

Received: 20 April 2024 / Accepted: 7 May 2024 / Published: 15 May 2024

ABSTRACT

The present paper aims at examining the technical efficiency of textile industry of India in a network in which the efficiency of industry has been computed in a two-staged network frontier analysis. Stage one being of production efficiency and stage two of social efficiency. The study has utilised Annual Survey of Industries (ASI) unit level data for NIC-2008 industry codes NIC-131 (spinning weaving and finishing of textile industry) and NIC-141 (manufacture of wearing apparel, except fur apparel) for the period of five years. Important finding of the analysis is that the managerial slacks are restricting the potential efficiency gains to Indian spinning, weaving and finishing of textile industry while, the large-scale inefficiency is potential threat to manufacturing of wearing apparel except fur industry.

Keywords: Technical efficiency, Textile industry, Data envelopment analysis, managerial efficiency, scale efficiency

Introduction

The effective use of the inputs which are influenced by the techniques of production, technological innovation, skills of the labour and the management is called efficiency (Farrel, 1957). Whereas, the technical efficiency is to maximise the output by a firm with a given set of inputs (Farrel, 1957; Kolte et. al., 2020). Veblen states that the technical efficiency exists where throughout the economy the mechanised production process which is interdependent works together "in an efficient manner, without idleness, waste, and hardship"(Veblen 1988, 18). Therefore, it is inevitable to strive for technical efficiency for economic growth.

In this paper we shall focus on the technical efficiency of the largest industry of India i.e., textile industry. The focus of the government of India on textile industry in planning periods show that

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role of textile industry in the growth of Indian economy is indispensable. India has a rich culture and tradition of textile industry and with adoption of modern technology this industry gives an advantage to India as India has been clothing the world since 3000BC and still demand for Indian textile is increasing globally. It is worth noting that if this industry is efficient in its operations and as well as it efficiently contributes to the welfare of the economy, it will lead to faster growth of Indian economy.

Insights from the literature

Technical efficiency of textile industry in India has been extensively analysed in the literature. Joshi and Singh (2012) studied technical efficiency adopting DEA methodology. The results obtained from the study showed that average efficiency of the Indian garment industry is 67.9%, indicating that the output can be increased by 32.1% with the present level of inputs. Further, Bhaskaran (2013) examined the productivity and technical efficiency of textile industry clusters in India. According to physical performance analysis, Ludhiana textile cluster got rank one and Tirupur textile cluster got the top rank in financial performance analysis. Additionally, Sen (2015) seeks to explore the relative factor productivity, production efficiency in the organised and unorganised sector and its change over the reform period of textile and garment industry of India. The productivities in unorganised sector experienced a considerable and statistically significant decline in the absolute term and also decline in relative efficiency in unorganised sector with respect to organised sector. Further the literature has explored the determinants of performance of this industry. It is seen that the low technological change and productivity of Indian textile machinery industry is attributed to lack of demand of textile machinery by the producers; low level of innovation in the industry; inefficient management (Malik, 2015; Joshi and Singh, 2012).

The studies so far have analysed the technical efficiency of the textile manufacturing states in maximising the output and profitability with inputs like labour, capital, intermediate inputs etc., but it is seen after reviewing the previous studies that only the technical efficiency of textile firms in achieving profit maximisation objective has been analysed and the welfare objective of the textile manufacturing states has been ignored. It is essential to assess the maximisation of welfare objective along with profitability and sales maximisation objective to analyse the overall technical efficiency of a manufacturing firm. An industry is considered globally efficient in its technology if along with its profit and sales maximisation objective it also maximises the level of investment and welfare of its manpower as ultimate objective should be welfare of the economy. A firm is considered technically efficient if it amplifies the investment level which adds up to the much-required capital formation as capital formation is a big-push for a developing economy like India, and shares the profit in wellbeing of the manpower. Both these objectives ultimately lead to welfare of the economy.

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The present paper aims at examining the technical efficiency of textile industry of India in a network in which the efficiency of industry has been computed in a network setup of 2 stages. Stage 1 represents production in which industry is supposed to maximise level of output and profitability for the given use of four inputs mainly labour, capital, fuels consumed and materials consumed. However, stage 2 represents social efficiency of industry that helps in stimulation of growth of the economy, in simple words, under stage 2 industry is supposed to maximise the level of investment and welfare of employees for employees for given level of output and profitability. The joint picture of two stages is being represented by network efficiency score which represents the global status of industry in entire network. The rationale behind assessing the technical efficiency of this industry in a network is that the efficiency scores of the overall network will portray the global image of the industry that how efficiently it contributes to the welfare of the economy given its profit and output.

Data and Methodology

The data for the network frontier analysis of technical efficiency in textile industry of India has been purchased from Ministry of Statistics and Programme Implementation (MOSPI). The study has utilised Annual Survey of Industries (ASI) unit level data for NIC-2008 industry codes NIC-131 (spinning weaving and finishing of textile industry) and NIC-141 (manufacture of wearing apparel, except fur apparel) for the period of five years (2011-12 to 2015-16). The analysis has been performed separately on two industries given huge difference in production operations of these two industries i.e., NIC code – 131 and NIC code – 141. The 3-digit code 131 represents 'spinning, weaving and finishing of textiles' while code -141 represents 'manufacture of wearing apparel, except fur apparel'. 22 textile manufacturing states and union territories have been selected for the analysis.

For the network frontier analysis of technical efficiency of textile industry of India, a network has been setup with two stages, first stage is the production efficiency stage and second stage is the welfare efficiency stage i.e., stage-1 shows the maximisation of output and profitability of the textile manufacturing state with the given bundle of inputs, namely, labour, capital, fuels consumed, and materials consumed. However, in stage-2, the objective is maximisation of investment level and welfare of employees for given level of output and profitability. The state-wise analysis has been done for the network and the stages individually. The network has been shown below:

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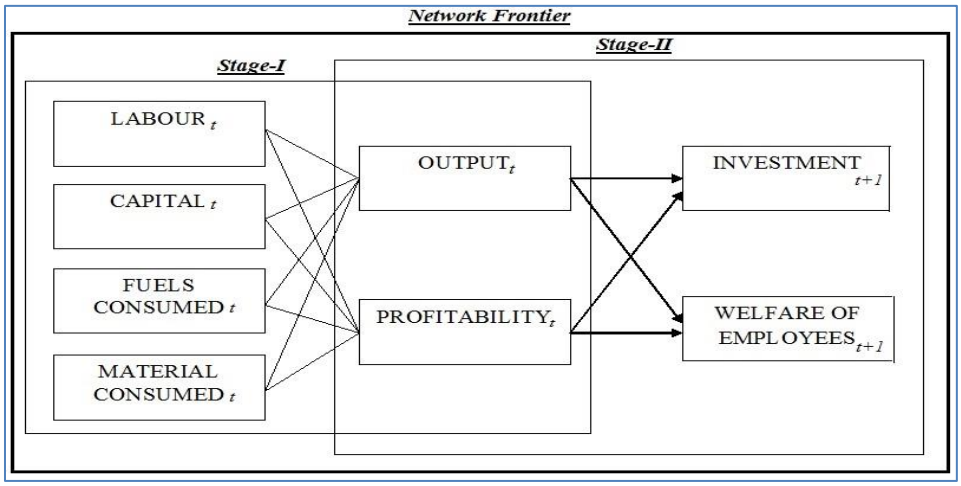
Figure-1: Network to Measure Operational and Welfare Efficiencies of Indian Textile Industry



Source: Author's Elaboration

The technical efficiencies in this paper are computed using data envelopment analysis (DEA). Data envelopment analysis[i] (DEA) is a non-parametric method which employs linear programming instead of usually known least square regression method. Also, DEA is non-statistical in nature i.e. it does not produce the standard errors and leaves no room for hypothesis testing. In DEA literature, the measure of technical efficiency corresponding to constant returns to scale (CRS) assumption is generally referred as *overall technical efficiency* (OTE)[ii] which captures the efficiency due to both managerial and scale effects. The CRS assumption is only appropriate if all DMUs are operating at an optimal scale. When DMUs are not operating at optimal scale (i.e., variable returns-to-scale (VRS) prevails), the *overall technical efficiency* (OTE) can be decomposed into *pure technical efficiency* (PTE)[iii] and *scale efficiency* (SE). The PTE measure provides a sort of managerial efficiency i.e., the capability of the management to convert the inputs into outputs. However, the SE measure indicates whether the DMU in question is operating at optimal scale size or not.

Network Efficiency of Spinning, Weaving and Finishing of Textile Industry (NIC-131)

Overall network efficiency

Table-1 provides network efficiency scores computed with CRS assumptions for 22 textile manufacturing states of India. It can be noticed that the industry is operating with an average network efficiency of 49.69 percent. Thus, there exists high network inefficiency to the tune of 50.31 percent in Indian spinning, weaving and finishing of textile industry. The maximum

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average efficiency has been noticed to the tune of 0.9584 for the union territory Dadra and Nagar Haveli. The said region is followed by New Delhi at second place with an average efficiency of 0.9171. The third place is occupied by Madhya Pradesh with an average efficiency of 0.7001. The spinning, weaving and finishing of textile industry of Madhya Pradesh is though ranked at third place on the bases of average efficiency during the study period; yet observed efficiency level is far below the average efficiency of same industry in Dadra and Nagar Haveli and New Delhi. The minimum score in the sample to the tune of 0.2507 has been noticed for spinning, weaving and finishing industry of Jammu and Kashmir, along with Jammu and Kashmir the two laggard states are Uttarakhand at 21st place and Daman and Diu at 20th place with average network efficiencies of 0.2655 and 0.2810, respectively. Given a huge difference between the efficiency scores of benchmark (i.e. Dadra and Nagar Haveli) and laggard (Jammu and Kashmir) states, it may be inferred that the Indian spinning, weaving and finishing of textile industry is operating with huge variation in network efficiency. In sum the level of inefficiency in handling production and welfare activities is very high in Indian spinning, weaving and finishing of textile industry.

The industrially advanced states like Maharashtra, west Bengal and Tamil Nadu found to be operating at 8th,4th and 7th places with average network efficiency scores of 0.5147, 0.6653 and 0.5627, respectively. Furthermore, the state of Gujarat with second largest number of spinning, weaving and finishing of textile firms has been ranked at 16th place with a low average network efficiency of 0.4908.

TABLE 1: Trends in Overall Network Efficiency Scores of Indian spinning, weaving and finishing of Textile industry

STATES	2011-12	2012-13	2013-14	2014-15	2015-16	AVERAGE	GROWTH RATE
Andhra Pradesh	0.5853	0.4594	0.5795	0.2094	0.2498	**0.4167**	-19.1722
Assam	0.7550	0.1631	0.8240	0.2578	0.1312	**0.4262**	-35.4334
Bihar	0.8965	0.0991	0.6878	0.2996	0.0934	**0.4153**	-41837
Dadra & Nagar Haveli	1.0000	1.0000	0.7739	1.0000	1.0000	**0.9548**	0.0000
Daman & Diu	0.5285	0.2826	0.1889	0.2975	0.1075	**0.2810**	-32.8475
Delhi	1.0000	0.5857	1.0000	1.0000	1.0000	**0.9171**	0.0000
Gujarat	0.8308	0.2355	0.4553	0.3962	0.1310	**0.4098**	-36.9854
Haryana	0.5045	0.1502	0.6116	0.2192	0.1413	**0.3254**	-27.2475

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Himachal Pradesh	0.4872	0.7903	0.4908	0.4034	0.3443	**0.5032**	-8.3121
Jammu & Kashmir	0.3958	0.1632	0.3327	0.1665	0.1955	**0.2507**	-16.1635
Karnataka	0.9618	0.5081	0.5926	0.1572	0.1502	**0.4740**	-37.1376
Kerala	0.8350	0.4575	0.7959	0.5958	0.2503	**0.5869**	-26.0057
Madhya Pradesh	0.2206	0.7932	0.8910	0.9430	0.6525	**0.7001**	31.1483
Maharashtra	0.5552	0.2863	0.5077	0.5034	0.7207	**0.5147**	6.7402
Odisha	0.7870	0.1490	0.6190	0.4153	0.0630	**0.4067**	-46.8082
Puducherry	0.6850	0.5593	0.9154	0.4974	0.3157	**0.5945**	-17.6055
Punjab	0.4755	0.5015	0.3237	0.7449	0.3543	**0.4800**	-7.0962
Rajasthan	0.8185	0.1799	0.4789	0.4473	0.2440	**0.4337**	-26.1067
Tamil Nadu	0.6600	0.3781	0.6372	0.4718	0.6665	**0.5627**	0.2452
Uttar Pradesh	0.3279	0.3166	0.3938	0.5867	0.1090	**0.3468**	-24.0629
Uttarakhand	0.0612	0.3809	0.2046	0.4646	0.2160	**0.2655**	37.0367
West Bengal	0.6159	0.8168	0.9603	0.6132	0.3204	**0.6653**	-15.0716
AVERAGE	**0.6358**	**0.4207**	**0.6029**	**0.4859**	**0.3389**	**0.4969**	
Q1	0.4915	0.1938	0.4612	0.2980	0.1337	**0.4074**	
Q2	0.6380	0.3795	0.6021	0.4560	0.2469	**0.4538**	
Q3	0.8277	0.5465	0.7904	0.5936	0.3518	**0.5809**	
Maximum	1.0000	1.0000	1.0000	1.0000	1.0000	**0.9548**	
Minimum	0.0612	0.0991	0.1889	0.1572	0.0630	**0.2507**	

Source: Author's calculation

Pure Network Efficiency

Table-2 shows the network efficiency scores computed with VRS assumptions for 22 textile manufacturing states of India. It is seen that average pure network efficiency for the textile manufacturing states is 63.64 percent, this shows that in the in the Indian spinning, weaving and

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finishing of textile industry the manufacturing states are moderately efficient in their managerial activities but inefficiency to the tune of 36.36 percent is noticed. Delhi has shown perfect managerial efficiency in spinning, weaving and finishing of textile industry with average network efficiency of 1.00 for the study period. The union territory Dadra and Nagar Haveli follows Delhi with pure network efficiency of 0.9682 in spinning, weaving and finishing of textile industry. The union territory that follows the above two i.e. state with third largest pure network efficiency of 0.9117 in spinning, Weaving and finishing of textile industry is Puducherry. The lowest score is of coastal union territory of India Daman and Diu to the tune of 0.3218 which shows huge managerial inefficiency in spinning, weaving and finishing industry of India. Along with Daman and Diu the other two states with lowest efficiency scores in the period under study are Jammu and Kashmir at 21st position with the pure efficiency score of 0.3780 and at the 20th place is Uttarakhand with the score of 0.3905. It can be inferred from the results shown in the table that historically important state of Gujarat in the field of textile industry shows inefficiency to the tune of 48.54 percent inefficiency. Another state i.e. Tamil Nadu which has highest number of weaving, spinning and finishing of textile industry firms is at 6th position with an efficiency score of 0.8096 which is noticeably lower score from Delhi and Dadra and Nagar Haveli which comparatively has lesser number of spinning, weaving and finishing of textile industry firms.

It can be deduced from the above discussed managerial efficiency scores of Indian spinning, weaving and finishing industry of India that the states (namely Gujarat, Maharashtra, Tamil Nadu, West Bengal) from which high managerial efficiency is expected in case of production and welfare goals due to their industrial advancement and large number of firms, do not show expected results i.e. low managerial efficiency is noticed in these states.

Table 2: Trends in Pure Network Efficiency Scores of Indian Spinning, Weaving and Finishing of Textile Industry

STATES	2011-12	2012-13	2013-14	2014-15	2015-16	Average	GROWTH RATE
Andhra Pradesh	0.6471	0.5749	0.7780	0.4148	0.5052	**0.5840**	-5.99837
Assam	0.8379	0.2178	0.9235	0.3154	0.3360	**0.5261**	-20.4218
Bihar	1.0000	0.1353	0.8311	0.3857	0.1685	**0.5041**	-35.9353
Dadra & Nagar Haveli	1.0000	1.0000	0.8412	1.0000	1.0000	**0.9682**	0

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Daman & Diu	0.5526	0.3429	0.2006	0.3210	0.1919	**0.3218**	-23.2335
Delhi	1.0000	1.0000	1.0000	1.0000	1.0000	**1.0000**	0
Gujarat	0.9226	0.3011	0.6161	0.4862	0.2471	**0.5146**	-28.0628
Haryana	0.5420	0.1990	0.8273	0.2746	0.2853	**0.4256**	-14.8244
Himachal Pradesh	0.5172	0.9880	0.6704	0.4943	0.5551	**0.6450**	1.787927
Jammu & Kashmir	0.4475	0.2221	0.4268	0.3108	0.4828	**0.3780**	1.915632
Karnataka	1.0000	0.6913	0.9592	0.2877	0.3473	**0.6571**	-23.233
Kerala	0.9846	0.6445	0.8810	0.8355	0.5751	**0.7841**	-12.5796
Madhya Pradesh	0.2441	1.0000	1.0000	1.0000	1.0000	**0.8488**	42.27176
Maharashtra	0.6153	0.3673	0.6536	0.6055	1.0000	**0.6483**	12.90854
Odisha	0.9757	0.1969	0.8317	0.6675	0.1176	**0.5579**	-41.0814
Puducherry	0.9656	0.9748	0.9872	0.8736	0.7574	**0.9117**	-5.89085
Punjab	0.5325	0.5912	0.3679	0.8491	0.5600	**0.5801**	1.264527
Rajasthan	0.9869	0.2474	0.6620	0.6524	0.4327	**0.5963**	-18.6282
Tamil Nadu	0.7772	0.5885	0.8407	0.9645	0.8771	**0.8096**	3.069176
Uttar Pradesh	0.3886	0.4048	0.6754	0.8671	0.1680	**0.5008**	-18.9103
Uttarakhand	0.0763	0.4967	0.2942	0.6961	0.3892	**0.3905**	50.26041
West Bengal	0.6298	0.9565	1.0000	0.8187	0.8299	**0.8470**	7.139389
Average	**0.7111**	**0.5519**	**0.7394**	**0.6418**	**0.5376**	**0.6364**	
Q1	**0.5349**	**0.2608**	**0.6557**	**0.3929**	**0.2980**	**0.5067**	
Q2	**0.7122**	**0.5358**	**0.8292**	**0.6599**	**0.4940**	**0.5901**	
Q3	**0.9824**	**0.8902**	**0.9129**	**0.8626**	**0.8118**	**0.8032**	
Maximum	**1.0000**	**1.0000**	**1.0000**	**1.0000**	**1.0000**	**1.0000**	
Minimum	**0.0763**	**0.1353**	**0.2006**	**0.2746**	**0.1176**	**0.3218**	

Source: Author's calculation

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Scale Network Efficiency

Table-3 shows scale network efficiency scores of Indian spinning, weaving and finishing of textile industry. The average scale network efficiency score for the 22 textile manufacturing states under study for the given period is 75.72 per cent which shows scale inefficiency to the tune of 228 per cent. Highest scale efficiency in the network is of the small union territory of India spinning, weaving and finishing of textile industry of Dadra and Nagar Haveli which has the score of 0.9839 which means that textile firms in Dadra and Nagar Haveli are operating at an optimum scale with a minute inefficiency of 1.61 per cent. The textile manufacturing of Delhi takes the second position in the comparative study of network scale efficiency scores of the states under study with a score of 0.9171. Surprisingly, the third position is taken by Daman and Diu with the score of 0.8417 as on the contrary this union territory had lowest managerial efficiency score but high score here shows high managerial efficiency in the spinning, weaving and finishing of textile industry of India. The lowest scale efficiency is seen in textile manufacturing in Puducherry whose network scale efficiency score is 0.6393 for Indian spinning, weaving and finishing of textile industry i.e. firms under the said industry are not operating on the optimum level. The spinning, weaving and finishing of textile industry of Karnataka and Jammu and Kashmir is positioned at 21st and 20th position with a score of 0.6586 and 0.6678 respectively thus, showing weak scale efficiency in the spinning, weaving and finishing of textile industry of India.

It is noticeable that spinning, weaving and finishing of textile industry of Karnataka was at 8th position when seen in the managerial efficiency scores but it has trickled down to 21st position when scale efficiency scores were analysed. Also, Jammu and Kashmir's performance was weak in both managerial and scale network efficiency in Indian spinning, weaving and finishing of textile industry.

TABLE 3: Trends in Scale Network Efficiency Scores of Indian spinning, weaving and finishing of Textile industry

STATES	2011-12	2012-13	2013-14	2014-15	2015-16	Average	GROWTH RATE
Andhra Pradesh	0.9045	0.7991	0.7448	0.5050	0.4944	**0.6896**	-14.0145
Assam	0.9011	0.7489	0.8923	0.8173	0.3905	**0.7500**	-18.8639
Bihar	0.8965	0.7326	0.8276	0.7767	0.5546	**0.7576**	-11.3142
Dadra & Nagar Haveli	1.0000	1.0000	0.9199	1.0000	1.0000	**0.9840**	0.0000
Daman & Diu	0.9563	0.8243	0.9417	0.9266	0.5600	**0.8418**	-12.5238

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Delhi	1.0000	0.5857	1.0000	1.0000	1.0000	**0.9171**	0.0000
Gujarat	0.9005	0.7822	0.7389	0.8149	0.5302	**0.7533**	-12.4033
Haryana	0.9308	0.7549	0.7392	0.7984	0.4954	**0.7438**	-15853
Himachal Pradesh	0.9421	0.7999	0.7320	0.8160	0.6202	**0.7821**	-9.9226
Jammu & Kashmir	0.8845	0.7350	0.7794	0.5355	0.4050	**0.6679**	-17.7393
Karnataka	0.9618	0.7350	0.6178	0.5464	0.4325	**0.6587**	-18.1127
Kerala	0.8481	0.7099	0.9034	0.7132	0.4353	**0.7220**	-15.3581
Madhya Pradesh	0.9036	0.7932	0.8910	0.9430	0.6525	**0.8367**	-7.8184
Maharashtra	0.9023	0.7793	0.7768	0.8315	0.7207	**0.8021**	-5.4631
Odisha	0.8066	0.7568	0.7443	0.6221	0.5358	**0.6931**	-9.7199
Puducherry	0.7094	0.5737	0.9273	0.5693	0.4168	**0.6393**	-12.4480
Punjab	0.8930	0.8483	0.8797	0.8773	0.6327	**0.8262**	-8.2564
Rajasthan	0.8294	0.7271	0.7234	0.6856	0.5640	**0.7059**	-9.1905
Tamil Nadu	0.8492	0.6425	0.7579	0.4892	0.7599	**0.6997**	-2.7399
Uttar Pradesh	0.8436	0.7820	0.5830	0.6767	0.6488	**0.7068**	-6.3541
Uttarakhand	0.8022	0.7669	0.6956	0.6674	0.5550	**0.6974**	-8.8006
West Bengal	0.9779	0.8539	0.9603	0.7490	0.3861	**0.7854**	-20.7309
Average	**0.8929**	**0.7605**	**0.8080**	**0.7437**	**0.5814**	**0.7573**	
Q1	**0.8483**	**0.7332**	**0.7390**	**0.6334**	**0.4501**	**0.6980**	
Q2	**0.9008**	**0.7618**	**0.7781**	**0.7629**	**0.5548**	**0.7469**	
Q3	**0.9393**	**0.7976**	**0.9006**	**0.8279**	**0.6448**	**0.7980**	
Maximum	**1.0000**	**1.0000**	**1.0000**	**1.0000**	**1.0000**	**0.9840**	
Minimum	**0.7094**	**0.5737**	**0.5830**	**0.4892**	**0.3861**	**0.6393**	

Source: Author's calculation

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Network Efficiency of Wearing Apparel, Except Fur Industry (NIC-141)

Overall network efficiency

Table-4 shows the efficiency scores calculated for the network by taking CRS assumptions to know the overall efficiency of states in manufacture of wearing apparel, except fur apparel in textile industry. The results show that average overall network efficiency of the 14 textile manufacturing states under study is to the tune of 57.86 percent which shows inefficiency of 42.14 percent in the manufacture of wearing apparel, except fur apparel industry. The textile manufacturing state which shows the highest average overall efficiency in the network in manufacture of wearing apparel, except fur apparel is the state of Tamil Nadu which shows average overall network efficiency score of 0.8651. The other two textile manufacturing states which follow the state of Tamil Nadu are Andhra Pradesh and Maharashtra with overall network efficiency score of 0.7979 and 0.7234 respectively. Both these states hold 2nd and 3rd rank respectively among the 14 textile manufacturing states. It is worth noting that Punjab which has an important textile cluster at Ludhiana ranks the lowest in the average overall network efficiency in manufacture of wearing apparel, except fur apparel with an average overall network efficiency score of 0.3410 which shows that Punjab has 65.9 percent inefficiency which is quite high. Kerala and Haryana are two other textile manufacturing states which have shown very low average overall efficiency scores in the manufacture of wearing apparel, except fur and rank at 13th and 12th position with average overall network efficiency scores of 0.3977 and 0.4173 respectively showing inefficiency almost above 60 percent (approx.).

The table also show the growth rates of overall efficiency in the network of 14 textile manufacturing states. The results show that 7 textile manufacturing states (Andhra Pradesh(6.3777), Daman and Diu(0.5915), Delhi(0.5525),Haryana(0.8648), Karnataka(1.4195), Rajasthan(0.0838) and Uttar Pradesh(2.5026)) out of 14 show positive growth in overall network efficiency during the study period.

TABLE 4: Trends in Overall Network Efficiency Scores of Indian Manufacture of wearing apparel, except fur apparel of Textile industry (NIC Code-141)

States	2011-12	2012-13	2013-14	2014-15	2015-16	AVERAGE	GROWTH RATE
Andhra Pradesh	0.5895	0.6858	1.0000	0.9593	0.7549	**0.7979**	6.3777
Daman & Diu	0.4705	0.5827	0.4228	0.4995	0.4817	**0.4914**	0.5915

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Delhi	0.6704	0.6669	0.8199	0.7508	0.6853	**0.7187**	0.5525
Gujarat	0.6108	0.5128	0.5319	0.5186	0.4153	**0.5179**	-9.1950
Haryana	0.4164	0.4295	0.2919	0.5179	0.4310	**0.4173**	0.8648
Karnataka	0.4307	0.5137	0.3959	0.5113	0.4556	**0.4614**	1.4195
Kerala	0.5293	0.3588	0.2777	0.4195	0.4033	**0.3977**	-6.5732
Madhya Pradesh	1.0000	0.6019	0.0385	0.6804	0.6288	**0.5899**	-10.9495
Maharashtra	0.9350	0.6712	0.6881	0.9603	0.3622	**0.7234**	-21.1053
Punjab	0.3451	0.3946	0.2393	0.4096	0.3166	**0.3410**	-2.1374
Rajasthan	0.6535	0.5622	0.5462	0.6170	0.6557	**0.6069**	0.0838
Tamil Nadu	1.0000	0.6556	1.0000	1.0000	0.6698	**0.8651**	-9.5351
Uttar Pradesh	0.5154	1.0000	0.6187	0.6498	0.5690	**0.6706**	2.5026
West Bengal	0.6078	0.3895	0.5060	0.5434	0.4607	**0.5015**	-6.6924
Average	**0.6267**	**0.5732**	**0.5269**	**0.6455**	**0.5207**	**0.5786**	
Maximum	**1.0000**	**1.0000**	**1.0000**	**1.0000**	**0.7549**	**0.8651**	
Minimum	**0.3451**	**0.3588**	**0.0385**	**0.4096**	**0.3166**	**0.3410**	
Q1	**0.4817**	**0.4503**	**0.3179**	**0.5129**	**0.4192**	**0.4689**	
Q2	**0.5986**	**0.5724**	**0.5189**	**0.5802**	**0.4712**	**0.5539**	
Q3	**0.6662**	**0.6641**	**0.6707**	**0.7332**	**0.6490**	**0.7066**	

Source: Author's calculation

Pure Network Efficiency

Table-5 gives the pure network efficiency scores of 14 textile manufacturing states in manufacture of wearing apparel, except fur apparel industry, calculated under VRS assumptions. The results show that average pure network efficiency scores of the 14 textile manufacturing states is 84.01 percent which shows inefficiency to the tune of 15.99 percent. It has been noticed

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that state of Tamil Nadu has the highest average pure efficiency score of 0.9395 in the manufacture of wearing apparel, except fur apparel industry of India. The textile manufacturing states which hold the second and the third rank among the 14 states in average pure network efficiency scores are Maharashtra and Andhra Pradesh with the scores 0.9124 and 0.8935 respectively. The state which showed lowest average pure efficiency score in manufacture of wearing apparel, except fur apparel industry is Madhya Pradesh with the score of 0.7415, though this score does not show that the manufacture of wearing apparel, except fur apparel is highly inefficient but in relation to other states Madhya Pradesh is ranked lowest, other two states which are ranked on the low positions in the list of 14 states are Punjab and Haryana with average pure efficiency scores of 0.7559 and 0.7830 respectively in manufacture of wearing apparel, except fur apparel.

TABLE 5: Trends in Pure Network Efficiency Scores of Indian Manufacture of wearing apparel, except fur apparel of Textile industry

STATES	2011-12	2012-13	2013-14	2014-15	2015-16	AVERAGE	GROWTH RATE
Andhra Pradesh	0.6174	0.9508	1.0000	1.0000	0.8998	0.8936	9.8757
Daman & Diu	0.5312	0.9535	0.9904	0.8643	1.0000	0.8679	17.1345
Delhi	0.6814	0.9368	0.9921	0.8253	0.9668	0.8805	9.1390
Gujarat	0.6807	0.8771	0.8812	0.7664	0.8427	0.8096	5.4826
Haryana	0.6514	0.9057	0.8078	0.7751	0.7751	0.7830	4393
Karnataka	0.4999	0.9300	0.8540	0.8446	0.8463	0.7950	14.0676
Kerala	0.9615	0.9161	0.8211	0.8252	0.8825	0.8813	-2.1187
Madhya Pradesh	1.0000	1.0000	0.0523	0.7831	0.8724	0.7416	-3.3541
Maharashtra	1.0000	0.9374	0.9915	1.0000	0.6334	0.9125	-10.7871
Punjab	0.5238	0.9590	0.7956	0.7194	0.7818	0.7559	10.5311
Rajasthan	0.7124	0.9156	0.8603	0.7186	0.9590	0.8332	7.7164
Tamil Nadu	1.0000	0.8204	1.0000	1.0000	0.8773	0.9395	-3.2198
Uttar Pradesh	0.5740	1.0000	0.9503	0.7564	0.9685	0.8498	13.9737

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West Bengal	0.6382	0.7321	0.9802	0.7701	0.9695	0.8180	11.0211
Average	**0.7194**	**0.9168**	**0.8555**	**0.8320**	**0.8768**	**0.8401**	
Maximum	**1.0000**	**1.0000**	**1.0000**	**1.0000**	**1.0000**	**0.9395**	
Minimum	**0.4999**	**0.7321**	**0.0523**	**0.7186**	**0.6334**	**0.7416**	
Q1	**0.5848**	**0.9082**	**0.8293**	**0.7673**	**0.8436**	**0.7986**	
Q2	**0.6661**	**0.9334**	**0.9157**	**0.8041**	**0.8799**	**0.8415**	
Q3	**0.8992**	**0.9528**	**0.9912**	**0.8593**	**0.9649**	**0.8811**	

Source: Author's calculation

Scale Network Efficiency

Table-6 presents the network scale efficiency scores of the 14 textile states in manufacture of wearing apparel, except fur apparel industry, these scores show that are the textile manufacturing states operating at an efficient scale or not. The average network scale efficiency of the 14 textile manufacturing states is 69.16 percent i.e. there is 30.84 percent of average network scale inefficiency. The most scale efficient state in the network is Tamil Nadu with average network scale efficiency score of 0.9125; it is worth noting that Tamil Nadu showed 100 percent scale efficiency in three years out of the five years of the study period. Andhra Pradesh and Delhi followed Tamil Nadu by showing average network scale efficiency score of 0.8949 and 0.8281 and ranking at 2nd and 3rd position respectively among the 14 states. The most scale inefficient state in manufacture of wearing apparel, except fur apparel industry has come out to be Kerala with average network scale efficiency score of 0.4491. The state of Punjab and Haryana also show high scale inefficiency in this industry with average network scale efficiency score to the tune of 0.4691 and 0.5398 respectively. Kerala and Punjab show inefficiency approximately above 55 percent.

TABLE 6: Trends in Pure Network Efficiency Scores of Indian Manufacture of wearing apparel, except fur apparel of Textile industry

STATES	2011-12	2012-13	2013-14	2014-15	2015-16	AVERAGE	GROWTH RATE
Andhra Pradesh	0.9548	0.7213	1.0000	0.9593	0.8389	**0.8949**	-1836

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Daman & Diu	0.8857	0.6112	0.4269	0.5779	0.4817	**0.5967**	-11231
Delhi	0.9838	0.7119	0.8264	0.9098	0.7088	**0.8281**	-7.8675
Gujarat	0.8974	0.5846	0.6036	0.6766	0.4928	**0.6510**	-13.9147
Haryana	0.6392	0.4742	0.3614	0.6681	0.5561	**0.5398**	-3.4225
Karnataka	0.8615	0.5523	0.4635	0.6053	0.5384	**0.6042**	-11.0883
Kerala	0.5505	0.3916	0.3382	0.5084	0.4569	**0.4491**	-5509
Madhya Pradesh	1.0000	0.6019	0.7356	0.8689	0.7208	**0.7854**	-7.8591
Maharashtra	0.9350	0.7160	0.6940	0.9603	0.5719	**0.7754**	-11.5658
Punjab	0.6589	0.4114	0.3008	0.5694	0.4049	**0.4691**	-11.4615
Rajasthan	0.9173	0.6140	0.6349	0.8586	0.6837	**0.7417**	-7.0858
Tamil Nadu	1.0000	0.7991	1.0000	1.0000	0.7634	**0.9125**	-6.5254
Uttar Pradesh	0.8980	1.0000	0.6511	0.8591	0.5875	**0.7991**	-10.0647
West Bengal	0.9524	0.5320	0.5162	0.7057	0.4752	**0.6363**	-15.9551
Average	**0.8667**	**0.6230**	**0.6109**	**0.7662**	**0.5915**	**0.6917**	
Maximum	**1.0000**	**1.0000**	**1.0000**	**1.0000**	**0.8389**	**0.9125**	
Minimum	**0.5505**	**0.3916**	**0.3008**	**0.5084**	**0.4049**	**0.4491**	
Q1	**0.8675**	**0.5371**	**0.4360**	**0.6210**	**0.4845**	**0.5986**	
Q2	**0.9076**	**0.6065**	**0.6192**	**0.7821**	**0.5640**	**0.6963**	
Q3	**0.9542**	**0.7150**	**0.7252**	**0.8996**	**0.7025**	**0.7957**	

Source: Author's calculation

Conclusion

In sum, the both components of Indian textile industry have been observed operating with high network inefficiencies. The managerial slacks are restricting the potential efficiency gains to

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Indian spinning, weaving and finishing of textile industry while, the large scale inefficiency is potential threat to manufacturing of wearing apparel except fur industry. The spinning, weaving and finishing industry of Dadra and Nagar Haveli has appeared to be benchmark/most effective industry in conducting the both production and welfare operations. However, in manufacturing of wearing apparel, except fur the industry of Tamil Nadu is most effective. The remaining states are operating with gargantuan levels of inefficiencies in production and welfare operations. The inefficiency levels either stems in Stage-I or Stage-II i.e., either the industry is failing in managing production operations or welfare operations.

Acknowledgment:

I am grateful to Indian council of Social Science Research (ICSSR) for their institutional scholarship which helped me financially to carry forward my research.

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Endnotes:

[i]See Dhiman and Sharma (2017), Gupta (2017), Anand (2014), Dhange (2013), Erkoc (2012), Jakhar et al (2012), Pusnik (2010), Saxena (2010), Sorri (2010), Saxena (2010), Douglas (2008), Bedi and Cororaton (2008), Berdine et al (2008), Bhandari et. al. (2007), Taplin (2006), Bruce (2004), Murillo (2004)

[ii] The OTE is also known as global technical efficiency.

[iii] The PTE is also known as local/managerial technical efficiency.

