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RESEARCH ARTICLE

RANKING OF MAJOR STATES IN INDIA USING DATA ENVELOPMENT ANALYSIS (DEA) APPROACH

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ABSTRACT

Data Envelopment Analysis (DEA), a non-parametric method, is used in this study to empirically measure the relative efficiency of major States in India, where the States are the Decision Making Units (or DMUs). The linear programming technique is employed to rank the 15 major states considered as DMUs in this study. Principal Component Analysis (PCA) is also applied to reduce the data structure and then the same linear programming (LP) technique is applied to the single reduced input and single reduced output. The states are ranked based on the result obtained by the analysis of reduced data and those rankings are compared with the rankings obtained by the analysis of original data. The results of this study showed that the ranking of States based on original data and the ranking of States based on reduced data vary considerably, which indicates that there may exists some inputs and/or outputs, though having less variance, can alter the rankings because of their high sensitivity, when processed using LP technique.

INTRODUCTION

Data Envelopment Analysis (DEA) is a nonparametric method used in operations research and economics to estimate the production frontiers. It is a linear programming method used for measuring the performance of homogeneous organizational units and is widely used in banking industries, where the bank branch will be the unit of measurement (Thanassoulis, 1999). DEA is not only used in banking, but also to analyze the relative efficiency of various sectors such as industrial firms, universities, military operations, banking, and healthcare or hospitals. In a study, it is used to evaluate the management of 60 Missouri Commercial Banks for the period from 1984 to 1990 (Yue, 1992). Jacobs (2000) has used three cost indices of the UK Department of Health to benchmark NHS Trusts. He compares the efficiency rankings from the cost indices with those obtained by the use of DEA and Stochastic Cost Frontier (SCF) Analysis. In this study, the DEA was applied to rank the states within Indian Territory based on some inputs and outputs of Factor Sector taken from the Economic Appraisal of Tamil Nadu. The procedure for ranking of states using DEA approach is clearly described in the flow chart presented in the next section.

Flow Chart of Analysis

The procedure of ranking of states is clearly explained in the following flow chart:

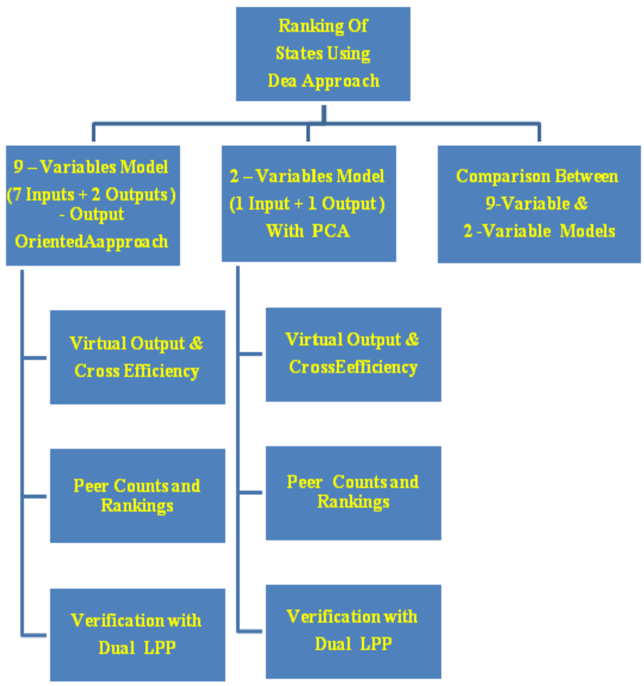

Figure 1. Flow Chart of Analysis

DEA Approach

Data Envelopment Analysis (DEA) is a nonparametric method used in operations research and economics to estimate the production frontiers. It is a linear programming (LP) model and used to empirically measure technical efficiency of decision

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making units (or DMUs). Although the concept of DEA is mostly applied in the field of production theory in economics, the tools of DEA are also used for benchmarking in operations management, where a set of measures is selected to improve the performance of manufacturing and service operations (Cooper *et al*., 2002).

In particular, DEA is a multi-factor productivity analysis model used to measure the relative efficiencies of a homogenous set of decision making units (DMUs). When there are multiple input and output factors, the efficiency score can be defined as follows:

$$Efficiency = \frac{Weighted Sum of\ Outputs}{Weighted Sum of\ Inputs}$$

Assuming that there are n DMUs with n_1 inputs and n_2 outputs, the relative efficiency score of a test DMU 'k' (i.e., with k^{th} DMU as the reference DMU) is obtained by solving the following LP model proposed by Cooper *et al.* (2002):

$$Maximize\, Z = \sum_{j=1}^{n_2} m_{kj} V_{kj}$$

Subject to the constraints

$$\sum_{j=1}^{n_1} l_{kj} U_{kj} = 1$$

$$\sum_{j=1}^{n_2} m_{kj} V_{ij} - \sum_{j=1}^{n_1} l_{kj} U_{ij} \le 0, \quad for\ i = 1,2,3,...,n$$

where

U_{ij} denoted the j^{th} Input of the i^{th} DMU

V_{ij} is the j^{th} Output of the i^{th} DMU

m_{kj} is the weights given to j^{th} output of k^{th} DMU (for j = 1 to n_2)

l_{kj} is the weights given to j^{th} input of k^{th} DMU (for j = 1 to n_1)

By solving the above Linear Programming Problem (LPP), the optimal weights can be obtained for a k^{th} reference DMU (i.e., m_{kj} and l_{kj}). Using these optimal weights of the k^{th} reference DMU, the Cross Efficiency of each of the other DMUs can be calculated as below:

Cross Efficiency (CE)

If there are n DMU's with n_1 inputs and n_2 outputs, then the Cross Efficiency of the s^{th} DMU (Doyle and Green, 1994), denoted by CE(s, k), is given by

$$CE(s,k) = \frac{\sum_{i=1}^{n_2} m_{ki} V_{si}}{\sum_{i=1}^{n_1} l_{ki} U_{si}},$$

where

- k is the reference DMU; s ≠ k; and s = 1, 2, 3, . . . , n
- $m_{k,i}$ and $l_{k,i}$ are the optimal weights derived for the k^{th} reference DMU for the corresponding outputs and inputs respectively
- $V_{s,i}$ = i^{th} output of the s^{th} DMU and $U_{s,i}$ = i^{th} input of the s^{th} DMU

If the Cross Efficiency, CE(s, k) of the s^{th} DMU is equal to 1, then the corresponding s^{th} DMU is considered as a Peer to the k^{th} reference DMU (a better terminology may be "Dominating DMU").

The Dual of the above LPP can be utilized to cross check the Peers obtained by the corresponding cross efficiency scores. Let k^{th} DMU be the reference DMU. Then the dual of the above LPP is given as follows:

Minimize Z^* = λ

Subject to the constraints

$$\sum_{i=1}^{n} p_{ki} U_{ij} \le \lambda U_{kj}\ , \quad j = 1,2,...,n_1$$

$$\sum_{i=1}^{n} p_{ki} V_{ij} \ge V_{kj}\ , \quad j = 1,2,...,n_2$$

$$p_{ij} \ge 0,\ \lambda \ge 0 \quad for\ \ all\ \ i,\ j$$

($U_{i,j}$ = j^{th} input of the i^{th} DMU & $V_{i,j}$ = j^{th} output of the i^{th} DMU; n = number of DMUs)

The concept of cross efficiency and peers can be cross checked with the help of the above dual i.e., if a DMU turns out to be a Peer for a particular reference DMU, then the DMU in the corresponding dual will a positive weight.

The DMUs can be ranked using the Peer counts. A DMU with high Peer counts is ranked first and the one with lower Peer count is ranked next. If there is a tie then the ranking can be decided by the Self Efficiency of each DMU.

The above LPP which maximizes the virtual output and its corresponding dual are known as Output Oriented Approach. In a similar way, we can have an Input Oriented Approach, in which the virtual input can be minimized, fixing the virtual output at a fixed level. The results arrived by both the approaches (i.e., Input oriented and Output oriented LPPs) will lead to the same set of rankings.

Data Reduction using PCA Technique

Principal Component Analysis (PCA) is a statistical technique used to linearly transform an original set of variables into a considerably smaller set of uncorrelated variables that represents majority of the information in the original set of variables. Principal Components are linear combinations of random or statistical variables which have special properties in terms of variance (Dunteman, 1989). The DMU theory is explorative in nature and the ranking of the DMUs is very much depends upon the Inputs and Outputs that are included in the model. Initially to begin with, a certain judicious choice of Inputs and Outputs are considered. Here, normally not all Inputs and Outputs considered are independent and thereby a multiple-colinearity exists in the Input-Output structure. To avoid this type of redundancy, which affects the efficiency of the ranking process, the 'Principal Component Analysis' is employed. Thus using PCA technique, the number of Inputs and number of Outputs are reduced to their first few Principal Components. After reduction if the structure and the final ranking of the DMUs remain unaltered then one can conclude that certain Inputs and Outputs are redundant and they can be dropped based on the weights of their Principal Components. On the other hand, if there is a change either in the structure of the Cross Efficiency matrix or in its final ranking then one can conclude that the reduction of Inputs and Outputs is not possible and the original set of Inputs and Outputs are to be maintained.

Dataset used in this study

In this study 15 major States within Indian Territory are considered and those States are as follows:

1. Andhra Pradesh
2. Assam
3. Bihar
4. Gujarat
5. Haryana
6. Karnataka
7. Kerala
8. Madhya Pradesh
9. Maharashtra
10. Orissa
11. Punjab
12. Rajasthan
13. Uttar Pradesh
14. West Bengal
15. Tamil Nadu.

For each State, 7 Inputs and 2 Outputs are considered, which are listed below:

The 7 Inputs are

1. The number of industries
2. Fixed Capital
3. Productive Capital
4. Number of workers
5. Wages paid to workers
6. Number of Employees
7. Total Emoluments

The 2 Outputs are

1. Value of Output
2. Net value added

The above inputs and Outputs are taken from the "Annual Survey of Industries (ASI)" – Survey results (Factory Sector) in Government of India – Ministry of Statistics and Programme Implementation (MOSPI). (http://mospi.nic.in/mospinew/upload/asi/asi_table3_9900.htm)

Data Analysis

Linear programming technique is exploited to rank or order the decision-making units (DMU). In our study each of the 15 major states is considered as a DMU. The process of ranking utilizes certain selected inputs (say n_1-inputs) and outputs (say n_2-outputs). The n_1 inputs are reduced to a single virtual input by taking the linear combination of the n_1 inputs, the weights being selected using a Linear Programming Problem (LPP) which maximizes the virtual output. This virtual output is again a linear combination of the corresponding n_2 outputs of a selected DMU, which is referred to as "REFERENCE DMU". That is, the DMU for which the weights are derived is called the 'Reference DMU' and its efficiency is called 'Self Efficiency'.

The inputs and outputs of particular units are used to derive an efficiency measure, which involves the ratio of virtual output to virtual input. The virtual input and virtual output are the weighted linear combination of the n1-Inputs and n2-Outputs respectively of a unit. The weights are selected in such a way that the ratio of virtual output to virtual input is maximized for a particular unit over the space which gives reasonable importance for other comparable decision making units i.e., the unit virtual output is maximized over the space governed by the performance of other comparable DMUs. If the weights derived for a particular Reference DMU are applied to other DMUs, the resulting efficiency of other DMUs is called 'Cross Efficiency'. For a particular DMU, if the Cross Efficiency corresponding to some other State is 1 (one) then that State is considered as a Peer (a better terminology may be "Dominating DMU") with respect to the corresponding Reference DMU. Thus the frequency of Peers of a particular State, which is denoted by "Peer Count", serves as a measure of "Relative Efficiency", which in turn will help us to rank the States.

If tie occurs among the Peer Counts then the Self Efficiency of each State can be utilized to rank the States.

Ranking of States using Virtual Efficiency

Calculation of Self-Efficiency: To begin with, the State "Andhra Pradesh" has been considered as a reference DMU and the optimal weights for the inputs and outputs are obtained using Linear Programming Technique. Then using these optimal weights, the self-efficiency of the State "Andhra Pradesh" has been calculated. The LPP for the State "Andhra Pradesh" has been formulated using the notations given in Section 2 and is shown in Appendix. By solving the LPP constructed for the State "Andhra Pradesh", the Self Efficiency of Andhra Pradesh was obtained as Maximum Z = 0.7311222525. By proceeding this way, we obtained the optimal weight for inputs and outputs and the self-efficiency scores for all the remaining 14 States and are shown in Table A1.

Calculation of Cross-Efficiency: Using the optimal weights of Andhra Pradesh, the derivation of Cross Efficiency of the State 'Kerala' was obtained using the formula shown in Section 2. Using the values of Input and Output variables of 'Kerala', the Cross-Efficiency of Kerala with Andhra Pradesh as reference DMU was calculated to be 0.8494631. In the same way, the Cross efficiency of Assam with Andhra Pradesh as Reference DMU was found to be exactly 1. Similarly, by taking each State as reference DMU, the Cross Efficiency scores of other States have been calculated in the same way and are shown in Table A2.

Calculation of Peers: For each Reference State, the corresponding other States with Cross Efficiency values as one are considered as Peers of the Reference State. Peers can be considered as performing in an efficient manner with respect to the Reference State (Reference DMU). From the Cross Efficiency values given in Table A2, we obtained the Peers for each Reference State and are shown in Table A3.

Calculation of Peer Counts: Using Table A3, we count the number of times a particular State is regarded as a Peer for other States. A State which acts as Peer for more States has 'Relative best performance' and hence "Peer Counts" serve as an indicator of its relative efficiency. The Table A4 shows the Peer Counts for each Reference State.

States and their Ranks: Based on the peer counts and the self-efficiency scores, the states have been ranked and the corresponding result is shown in Table 6.1.

Table 6.1. States and their Ranks based on their Peer Counts and Self Efficiency using Original Data

S. No.	State	Rank
1	Andhra Pradesh	15
2	Assam	2
3	Bihar	4
4	Gujarat	7
5	Haryana	2
6	Karnataka	13
7	Kerala	9
8	Madhya Pradesh	2
9	Maharashtra	5
10	Orissa	10
11	Punjab	8
12	Rajasthan	6
13	Uttar Pradesh	11
14	West Bengal	12
15	Tamil Nadu	14

The Peers of a State derived by using the Cross Efficiency can be verified by solving the Dual LPP of that State. In the corresponding dual problem, Peers alone will have non-zero solution. That is, the states for which the solution is non-zero will be the Peers for the Reference DMU. This dual property is verified in the case of Andhra Pradesh by solving the dual LPP of Andhra Pradesh.

The dual LPP corresponding to Andhra Pradesh was formulated and solved, and the corresponding result showed that the Self Efficiency of Andhra Pradesh is 0.7311222525 (i.e., Minimum Z*), which coincides with Maximum Z obtained by solving the corresponding Primal LPP. For the Primal problem, the Peers given in Table A3 for the State "Andhra Pradesh" are Assam, Bihar, Haryana and Madhya Pradesh. For the corresponding dual problem, the solution is non-zero only for the states Assam, Bihar, Haryana and Madhya Pradesh, while the solution becomes zero for the other States. This property provides an alternative approach for finding the peers of a State (DMU). This clearly shows that the ranking of states obtained by solving Primal LPP will the same as the rankings obtained by solving the corresponding Dual problem.

Data Reduction using PCA Technique

The Principal Component Analysis is a technique of data reduction. That is, if there are 'n' records each with 'm' variables then, the PCA reduces the 'm' variables into 'k' ($k<n$) linear combinations of the original 'm' variables. These linearly transformed variables retain a considerable variation of the data (n x m - values). In Section 5, the states were ranked using their 7 Inputs and 2 Outputs. In this Section, the 7 Inputs and 2 Outputs are reduced to Single Input and Single Output using Principal Component Technique. The results of this PCA showed that in both Input and Output reductions, the 1st Principal Component takes into account a considerable amount of variation. Therefore, our study is restricted to the 1st Principal Component in both the cases - i.e., Input Reduction and Output Reduction. Using the First Principal Component, we obtained the Single Reduced Input and Single Reduced Output for all the 15 States, and this reduced data is shown in Table A5. Then the 15 States were ranked based on these reduced Input and Reduced Output by using the same analysis used in Section 5 and the corresponding result showed that the Self Efficiency of Andhra Pradesh is Minimum Z^* = 0.5724932105, which coincides with Maximum Z obtained by solving the corresponding Primal LPP. For the Primal problem, the Peers for the State Andhra Pradesh were found to be 'Bihar'. For the corresponding Dual problem, the solution is non-zero only for the State Bihar, while the solution is zero for the other States. The ranking of 15 states based on this reduced data is shown in Table A6.

Conclusion

The ranking of States based on 7 inputs and 2 outputs is considerably varied from the ranking of States obtained by Single Reduced Input and Single Reduced Output. This is an indication of the fact that in this case, the number of Inputs and Outputs cannot be reduced by adopting Principal Component

Analysis. This implies that there may exists some Inputs and/or Outputs, though having less variance, can alter the rankings because of their high sensitivity, when processed through LPP optimization. It is suggested from the results of this study that instead of reducing the data dimension using Principal Component Technique (which has been established as a failure), other measures of influence can be devised for each Input and Output variables and there by the data volume can be reduced with the same relative rankings.

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Appendix

The LPP for the State "Andhra Pradesh" has been formulated and is presented below:

$$\text{Max } Z = 5849398\, m_{1,1} + 911042\, m_{1,2}$$

Subject to the constraints

$$13164\, l_{1,1} + 2712037\, l_{1,2} + 3214547\, l_{1,3} + 770522\, l_{1,4} + 214354\, l_{1,5} + 910356\, l_{1,6} + 337197\, l_{1,7} = 1$$

$$-13164\, l_{1,1} - 2712037\, l_{1,2} - 3214547\, l_{1,3} - 770522\, l_{1,4} - 214354\, l_{1,5} - 910356\, l_{1,6} - 337197\, l_{1,7} + 5849398\, m_{1,1} + 911042\, m_{1,2} \leq 0$$

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$$-6373\, l_{1,1} - 1740738\, l_{1,2} - 1797696\, l_{1,3} - 462666 l_{1,4} - 258194\, l_{1,5} - 588968\, l_{1,6} - 377712\, l_{1,7} + 3485892\, m_{1,1} + 573679\, m_{1,2} \leq 0$$

$$-20249\, l_{1,1} - 3750517\, l_{1,2} - 4722285\, l_{1,3} - 888350\, l_{1,4} - 312910\, l_{1,5} - 1103970\, l_{1,6} - 515876\, l_{1,7} + 9459777\, m_{1,1} + 1479535\, m_{1,2} \leq 0$$

where $m_{1,j} \geq 0$, j = 1, 2 and $l_{1,j} \geq 0$, j = 1, 2, 3, 4, 5, 6, 7

The solution of the above LPP is given below:
The optimal weights for inputs are
$l_{11} = 0.0000136645$
$l_{12} = 0$
$l_{13} = 0.0000000956$
$l_{14} = 0$
$l_{15} = 0$
$l_{16} = 0$
and $l_{17} = 0.0000015203$

The optimal weights for outputs are m_{11} = 0.0000000719 and m_{12} = 0.0000003406. The Self Efficiency of Andhra Pradesh is Maximum Z = 0.7311222525.

Proceeding as above, we obtained the optimal weight for inputs and outputs and self-efficiency scores for all the remaining 14 States and are presented in Table A1.

Table A1. Self Efficiency of the States

S.No.	State	Optimal Weights									Self Efficiency
		Inputs							Outputs		
		IP1	IP2	IP3	IP4	IP5	IP6	IP7	OP1	OP2	
1	Assam	0	0	0.0000025821	0	0	0	0.0000023092	0	0.0000058894	1
2	Bihar	0	0	0.0000044804	0	0	0	0	0.0000014992	0	1
3	Gujarat	0	0.00000002	0.00000002	0.00000024	0.0000008	0	0.00000074	0.00000002	0.00000039	0.9583112118
4	Haryana	0	0	0.0000004081	0	0	0.0000008704	0	0.0000002249	0	1
5	Karnataka	0.0000251081	0	0.0000000207	0.0000000536	0.0000030229	0	0.0000008225	0	0.0000009433	0.7874051830
6	Kerala	0.0000460608	0	0.0000008703	0	0	0	0	0.0000003996	0	0.9935795518
7	Madhya Pradesh	0	0	0.0000002081	0	0	0.0000006919	0.0000020872	0.0000002268	0	1
8	Maharashtra	0	0	0.0000000786	0	0	0.0000002423	0	0.0000000259	0.0000001532	1
9	Orissa	0.0002693074	0	0	0	0	0	0.0000068008	0	0.0000034978	0.9354655385
10	Punjab	0	0.0000003269	0	0.0000010836	0	0	0.0000024600	0.0000002617	0	0.9991956927
11	Rajastan	0	0.0000000548	0.0000000742	0	0.0000032392	0.0000008075	0.0000024732	0.0000000757	0.0000014550	1
12	Uttar Pradesh	0	0.0000000491	0	0.0000003620	0.0000023068	0	0.0000007967	0.0000000180	0.0000007083	0.8346662850
13	West Bengal	0.0000330604	0	0.0000004391	0	0	0	0	0.0000000923	0.0000008121	0.7877515204
14	T_N	0.0000090333	0	0.0000000632	0	0	0	0.0000010051	0.0000000476	0.0000002252	0.7830422600

Table A2. Cross Efficiency of the States

	AP	Assam	Bihar	Gujarat	Haryana	Karnataka	Kerala	M p	Maharashtra	Orissa	Punjab	Rajasthan	UP	W. Bengal	TN
AP	0.731123196	1	1	0.87118	1	0.68796524	0.8494631	1	0.927013	0.700674	0.976876	0.866471	0.738503	0.535449	0.783043
Assam	0.590991445	1	1	0.51184	0.743041618	0.53131505	0.8173701	0.524965	0.797657	0.53471	0.771104	0.572211	0.475792	0.61274	0.651021
Bihar	0.608869138	0.736033179	1	0.486887	0.820053818	0.42816491	0.9320333	0.639816	0.676222	0.371335	0.842964	0.500571	0.4422	0.648829	0.670288
Gujarat	0.651920696	0.987090028	0.992224193	0.958311	0.988093967	0.73716265	0.7184162	0.981023	0.985323	0.773962	0.957722	0.969498	0.805206	0.439385	0.755087
Haryana	0.625342279	0.718626358	1	0.65995	1	0.53608827	0.8902667	0.844858	0.864026	0.483865	0.940454	0.659778	0.576353	0.629213	0.736845
Karnataka	0.630144496	1	0.809270814	1	0.967633398	0.78740477	0.6275376	1	1	0.891551	0.821333	1	0.823829	0.412068	0.689492
Kerala	0.686705657	0.810150879	1	0.609867	1	0.52896878	0.9935788	0.816722	0.834407	0.47226	0.931882	0.605858	0.542753	0.749711	0.749688
MP	0.662485151	0.76268369	1	0.815383	1	0.58694451	0.8337326	1	0.84779	0.549057	0.989814	0.799928	0.685059	0.503606	0.75996
Maharashtra	0.615482745	0.833757842	1	0.717809	1	0.62623369	0.8360131	0.815595	1	0.618926	0.918208	0.742663	0.628082	0.627773	0.739048
Orissa	0.545806279	0.847500923	0.621819114	0.920202	0.895494006	0.75581952	0.5719795	1	1	0.935466	0.67001	0.828254	0.72443	0.46828	0.577474
Punjab	0.600166632	0.733491779	1	0.764422	1	0.55506885	0.7968811	1	0.825148	0.493301	1	0.674625	0.644044	0.456298	0.716082
Rajasthan	0.667067287	1	1	0.984916	1	0.75026095	0.7311993	1	1	0.793796	0.965034	1	0.82341	0.443836	0.767599
UP	0.638896351	1	0.962455295	0.996761	1	0.76067857	0.6771452	1	1	0.805151	0.939842	1	0.834667	0.408211	0.743731
WB	0.693140585	1	1	0.654615	1	0.63399882	0.949754	0.771909	0.981437	0.62708	0.902648	0.676655	0.58866	0.787753	0.756514
TN	0.731122864	1	1	0.871178	1	0.6879641	0.8494628	1	0.927011	0.700672	0.976876	0.86647	0.738502	0.535448	0.783043

Table A3. Peers for Reference States

S. No.	Reference state	Peers
1	Andhra Pradesh	Assam, Bihar, Haryana, M_P
2	Assam	Assam
3	Bihar	Bihar
4	Gujarat	Assam, Gujarat
5	Haryana	Haryana
6	Karnataka	Assam, M_P, Maharashtra, Rajasthan
7	Kerala	Bihar, Haryana
8	Madhya Pradesh	M_P
9	Maharashtra	Maharashtra
10	Orissa	M_P, Maharashtra
11	Punjab	Bihar, Haryana, M_P
12	Rajasthan	Rajasthan
13	Uttar Pradesh	Assam, Haryana, M_P, Maharashtra ,Rajasthan
14	West Bengal	Assam, Bihar, Haryana
15	Tamil Nadu	Assam, Bihar, Haryana, M_P

Table A4. Peer Counts for Reference States

S. No.	Reference state	Peers count
1	Andhra Pradesh	0
2	Assam	7
3	Bihar	6
4	Gujarat	1
5	Haryana	7
6	Karnataka	0
7	Kerala	0
8	Madhya Pradesh	7
9	Maharashtra	4
10	Orissa	0
11	Punjab	0
12	Rajasthan	3
13	Uttar Pradesh	0
14	West Bengal	0
15	Tamil Nadu	0

Table A5. Reduced Input and Reduced Output for 15 States

S. No.	States	Reduced Input	Reduced Output
1	Andhra Pradesh	7694723.704	6746919.12
2	Assam	824755.138	945494.222
3	Bihar	505513.952	774239.418
4	Gujarat	15976738.12	13755128.61
5	Haryana	3718005.385	5085595.426
6	Karnataka	6906419.221	5075018.622
7	Kerala	2186168.775	2843577.448
8	Madhya Pradesh	4404503.924	4962666.776
9	Maharashtra	18508573.58	21548839.95
10	Orissa	2241536.138	1447203.792
11	Punjab	3188585.678	4368195.102
12	Rajasthan	4329014.996	3520415.06
13	Uttar Pradesh	9289799.136	7113394.7
14	West Bengal	4934390.252	4051451.858
15	Tamil Nadu	10648112	10917433.38

Table A6. States and their Ranks based on their Peer Counts and Self Efficiency Using Reduced Data

S. No.	State	Rank
1	Andhra Pradesh	9
2	Assam	6
3	Bihar	1
4	Gujarat	10
5	Haryana	3
6	Karnataka	14
7	Kerala	4
8	Madhya Pradesh	7
9	Maharashtra	5
10	Orissa	15
11	Punjab	2
12	Rajasthan	12
13	Uttar Pradesh	13
14	West Bengal	11
15	Tamil Nadu	8

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