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Fiscal Performance of Indian States – A Comparison of Convex and Non-Convex Frontier Approaches

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Abstract

The present study is based on the unevenness in financial performance of Indian states. While it is generally agreed upon that the States require more authority in the matter of mobilization of financial resources and perhaps, more generous attitude of the Central government regarding transfer of funds from the Centre to the States, analysis of the internal strength and weaknesses of the States is also equally important. In the past one decade, the central government also linked its assistance to the state governments with the accomplishment of institutional reforms in area of fiscal operations. Against this backdrop, the present study benchmarks the performance of general category states for the period 2009-10 to 2014-15 using DEA, FDH, Order-m and Order-alpha. In the next stage, the impact of outstanding liability and gross capital formation (on the efficiency performance) is estimated in terms of censored regression.

Keywords: Financial Performance, Governments, DEA, FDH, Capital, Formation

Introduction

In India, just as different regions/states exhibit considerable disparity in terms of economic development, the fiscal performance of the states also reveal significant variations. On the revenue side, the fiscal unevenness arises because of wide variations in tax base as well as owing to considerable variations in tax mobilization efforts. On the expenditure side also, there are considerable heterogeneity in respect of the nature and quality of expenditure incurred by the states. While it is generally agreed upon (in the Indian context) that the States require more authority in the matter of mobilization of financial resources and perhaps, more generous attitude of the Central government regarding transfer of funds from the Centre to the States, analysis of the internal strength and weaknesses of the States from the fiscal point of view is also equally important. In order to promote efficiency, the central government, in the past one decade, has linked its assistance to the state governments with the accomplishment of institutional reforms in area of fiscal operations. In this context, the present study benchmarks the performance of non-special category states for the years 2009-10 to 2014-15 using full and partial

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frontier approaches and tries to assess the impact of indebtedness and gross capital formation on the performance of the states.

Organisation of the Paper

The paper is organized in to five sections and proceeds as follows. Section 1 provides an overview of state finances in India. Section 2 discusses the related literature. Section 3 discusses the methodological issues connected with benchmarking of performance in a non-parametric setting and assessment of the impact of contextual variable on the efficiency scores. Section 4 presents and discusses the results. Finally, section 5 concludes.

Fiscal Scenario of Indian States

It is a common knowledge that there are inherent asymmetries in the Indian fiscal structure which led to vertical as well as horizontal imbalances in the fiscal imbalances.

Vertical imbalance implies asymmetric revenue mobilisation power between the central government and the state governments. In India, relative to the central government,states have limited resource mobilisation capacity. The central government retains the entire tax revenue collected from important sources like corporate income. Thus, the central government retains major portion of the tax revenue collected. For example, during 2014-15, Central Government share in the combined revenue of central and state governments was 63% while all states taken together had a share of about 37%. On the other hand, the share of the Indian states in total expenditure was 60%.

Similarly, there are considerable variations in key fiscal indicators across the states implying the presence of horizontal imbalance. Table-1 provides the descriptive statistics (for 2014-15) relating to four important fiscal indicators of the non-special category Indian states:own revenue to total revenue expenditure, development expenditure to total expenditure, interest payments to revenue receipts and committed expenditure to total expenditure. The table shows that the ratio of best performing state to worst performing state is 2.74 in respect of own revenue to revenue expenditure and 1.57 in respect of development expenditure to aggregate expenditure. On the other hand the ratio of worst performing state to best performing state is 5.68 for interest payment to revenue receipts and 2.34 for committed expenditure to revenue expenditure.

Table-1: Descriptive Statistics of Key Fiscal indicators of Indian Non-Special Category States (2014-15)

Descriptive Statistics	Own Revenue/ Revenue Expenditure	Development Expenditure/ Aggregate Expenditure	Interest Payments/ Revenue Receipts	Committed Expenditure/ Revenue Expenditure
Mean	59.5	65.8	12.4	29.8
Median	58.2	67.2	11.3	30.1
Maximum	84	76.2	25	47
Minimum	30.7	48.5	4.4	20.1
Variance	185.2	57.1	29.4	37.9

Source: RBI(2017): State Finances:A Study of Budgets of 2016-17

Fiscal Performance of Indian States-A Review of Literature

Related Research Work

There are relatively fewer number of studies devoted to the fiscal performance of Indian states. Further, a majority of them considered the revenue side only.

Jha, Mohanty, Chatterjee, Chitkara (1999) used stochastic frontier analysis for estimating tax efficiency of fiffteen major Indian states for the time span 1980-81 to 1992-93. The study found that devolution of greater quantum of resources as grants tend to reduce the tax efficiency of states. Thus less poor states are more efficient in respect of tax mobilisation. The tax efficiency rankings of states for the period do not imply convergence. The study computed an index of aggregate tax efficiency and this index has been stagnating over the observed years. The study advocated in favour of increasing the weight placed on tax effort in the formula determining central grants to state governments in order to improve tax efficiency of state governments.

Coondoo, Majumder, Mukherjee and Neogi (2001) compared the relative tax performance of 16 states in India (as measured by tax/SDP ratio) for the period 1986-87 to 1996-97 using a quantile regression approach. On the basis of their study they classified the in-sample states in to four categories: best, medium, declining and worst. Their study showed that the states in southern and western part of India display a superior tax performance relative to the rest. This might be due to a variety of factors such as relatively larger taxable capacity of these states, relatively greater tax effort made by these states or some deep-seated political-economic characteristics shared by them.

Dholakia (2005) provided an alternative to the Fiscal Self Reliance and Improvement Index recommended by the Eleventh and Twelvth Finance Commissions for measuring fiscal discipline of the Indian states. She developed a composite index of performance which she termed as Fiscal Performance Index which was constructed out of three indices-a Deficit Index, an Own Revenue Effort Index and an Expenditure and Debt Servicing Index. Dholakia used the Fiscal Performance Index to rank the performance of Indian states for the period 1990-91 to 2002-03.

Mundle, Chowdhury and Sikdar (2016) compared the governance performance of major Indian states for the years 2001-02 and 2011-12 from the stand points of services,infrastructure,social services, fiscal performance, justice,law and order and quality of legislature. For judging fiscal performance, two indicators were considered: proportion of development expenditure to total expenditure and the ratio of own tax revenue to total tax revenue. They found three high income states (Gujarat, Tamil Nadu and Haryana), two middle income states (Karnataka and Andhra Pradesh) and one low income state (Chattisgarh) as the best performers in the area of fiscal performance.

Garg,Goyal and Pal (2017) estimated the tax capacity and tax effort of 14 major Indian states for the period 1992-92 to 2010-11 applying Stochastic Frontier Analysis. The study applied the Battese-Coelli (1995) model for estimating tax mobilisation efficiency of Indian states. In the model used in the study, the inefficiency term is a linear function of a set of explanatory variables. The study

considered fiscal, administrative and governance, structural and political variables which seek to explain the tax inefficiency of Indian states. The study confirmed the presence of large variations in tax effort indices across states and which increased over time. The econometric analysis used in the study suggested that economic and structural variables have significant influence on the tax capacity.

Research Gaps and Objective of the Study

The existing literature relating to the comparative fiscal performance of Indian states mostly used weighted ratio approach. Only one study used the quantile regression methodology. The objective of the present study is to provide an alternative approach for constructing a comprehensive fiscal performance index based on robust methodology. For constructing the index, four alternative approaches have been considered: Data Envelopment Analysis, Free Disposal Hull Approach, Order-m and Order-alpha.

Methodology

Evaluation of Performance - The Distance Function Approach

For estimating the performance of decision making units, it is essential to formalize the relationship between inputs and outputs. Following Debreu (1951) and Koopmans (1951), the production technology (P_T) is characterized by a set of inputs $X = (x_1, x_2, \ldots\ldots, x_n) \in R_+^n$ which are required to produce a set of outputs $Y = (y_1, y_2, \ldots\ldots, y_n) \in R_+^m$. The inputs and outputs can be functionally related as: $Y = f(X)$ and $X = l(Y)$.

In the present context, Shephard's (1953,1970) distance function approach provides theoretical basis for the derivation of performance evaluation rules. The input set is characterised by the input distance function.The output set is characterised by the output distance function. The efficiency of a productive unit is defined as a distance between the quantity of observed input and output and the quantity of input and output required for the best practice frontier.An input distance function is defined as $D_i = \frac{\|x\|}{\|dx\|} = \frac{1}{\lambda}$ Thus an input distance function indicates the smallest radial contraction of the producer's input vector without making the (producible) output vector infeasible. The reciprocal λ can be considered as the radial measure of input oriented technical efficiency.

In an analogous fashion, the output distance function is defined as: $D_o = \frac{\|x\|}{\|\mu x\|} = \frac{1}{\mu}$. Intuitively speaking, an output distance function gives the maximum amount by which the producer's output vector can be inflated and yet remain feasible for a given input vector. The radial measure of output oriented technical efficiency coincides with the output distance function.

Estimation of the Distance Function

While both parametric and non-parametric methods can be used for the estimation of distance function, we prefer the non-parametric approach over the parametric approach because of the following reasons:

- non-parametric methods can easily handle multiple outputs. While a parametric framework can be used for relating multiple outputs with the inputs, estimation can be done by using mathematical programming methods.

- non-parametric methods do not require knowledge about the parametric functional specification of the relationship between input and output indicators.

In the present context,four non-parametric methods have been used for the estimation of state performance: Data Envelopment Analysis, Free Disposal Hull Approach, Order-m Approach and Order-alpha Approach.

Data Envelopment Analysis is a non-parametric method based on mathematical programming. DEA is frequently used for comparing the relative performances of economic units with two prior assumption on input-output relation: free disposability of inputs and outputs and convexity. The DEA approach constructs a convex efficiency frontier of productive units. Thus using DEA the output oriented efficiency of a productive unit is computed by comparing the observed output (input) with the best practice output (input). The applicable linear program for the output oriented case is:

$$\text{Max } \varphi$$
$$\text{subject to } \varphi y_o \leq \lambda Y, X_o \geq \lambda X, \Sigma \lambda_j = 1, \lambda_j \geq 0$$
$$\textbf{T}\text{echnical Efficiency (VRS)} = 1/\varphi$$

The Free Disposal Hull approach was developed by Deprins, Simar and Tulkens (1984). Like the DEA approach, FDH retains the free disposability of input and outputs. However, unlike the DEA approach, the FDH frontier is not convex. The distinguishing feature of the FDH approach is that efficiency evaluations are based on actual observations only and not on the convex combinations of actual observations. Thus the relative linear program for the output oriented case is:

$$\text{Max } \varphi$$
$$\text{subject to } \varphi y_o \leq \lambda Y, X_o \geq \lambda X, \Sigma \lambda_j = 1, \lambda_j \in \{0,1\}$$
$$\textbf{T}\text{echnical Efficiency} = 1/\varphi$$

The Order-m approach was introduced by Cazals, Florens and Simar (2002). In the input oriented Order-m approach, a decision making unit (x_0,y_0) is benchmarked against the average minimal input used by m peers randomly drawn from the population of decision making units producing at least y_0. The Order-m lower boundary of the input vector X is defined as the expected value of the minimum of m random variables $X_1, X_2,\ldots..,X_m$ drawn from the distribution function of X. Thus mathematically speaking, $\varphi_{m(input)} = E[\min(X_1, X_2,\ldots..,X_m)]$. The value m represents the number of m potential firms (drawn randomly from the population of firms) producing at least the output level of y against which we want to benchmark the observed firm. As m goes to infinity, the Order-m frontier converges to the full frontier.

In a similar manner, in the output oriented approach, benchmarking is done against the average maximal output used by m peers randomly drawn from the population of decision making units using inputs less than or equal to x_0. The Order-m upper boundary of the output vector Y is defined as the expected value of the maximum of m random variables $Y_1, Y_2,\ldots..,Y_m$ drawn from the distribution function of Y. Thus mathematically speaking, $\varphi_{m(output)} = E[\max(Y_1, Y_2,\ldots..,Y_m)]$.

As an alternative to the Order-m frontier, Aragon, Daouia and Thomas-Agnan (2005) introduced the Order-α frontier which is based on conditional quantiles of an appropriate distribution associated with the production process. Here a productive firm (x,y) is benchmarked against 100α firms producing an output level ≥y and using an input level≤ x. The value of α lies between 0 and 1. As α goes to 1, the Order- α frontier converges to the full rontier.

Impact of Contextual Variable on the Performance Scores

An important objective of the study is to assess the influence of contextual/ environmental variable on the efficiency estimates and this is done in terms of econometric analysis. However, since the efficiency scores are bounded (the lower and upper bounds being 0 and 1), regression method can be applied only by imposing restriction on the dependent variable..The censored regression model is effectually an extension of the standard Tobit model. The dependent variable can be either left-censored, right-censored, or both left-censored and right-censored, where the lower or upper limit of the dependent variable can be any number. The censored regression model can be represented as:

$$y^*=z'\beta+u$$

$$y=m \text{ if } y^*\leq 0, y=y^* \text{ if } m<y^*<n \text{ and } y=d \text{ if } y^*\geq 0$$

Where y* is a latent (unobserved) variable and y is the observed variable. z is a vector of explanatory variables. m and n are the lower and upper limits of the dependent variable. β is a vector of unknown parameters and u represents the disturbance term.

Censored regression models are usually estimated by the Maximum Likelihood method. Under the assumption that the disturbance term u is normally distributed with expectation 0 and variance σ^2, the log-likelihood function may be written as:

$$Log\,L = \sum[Im \log\varphi(\frac{m - x'\beta}{\sigma}) + In \log\varphi(\frac{x'\beta - n}{\sigma}) + (1 - Im - In)\{\log\theta(\frac{y - x'\beta}{\sigma}) - \log\sigma\}]$$

where $\varphi(.)$ and $\theta(.)$ denote the cumulative distribution and probability density function respectively of the standard normal distribution and Im & In are the indicator functions with Im =1 if y=m and Im =0 if y>m and In =1 if y=n and In =0 if y>n.

Framework of Study, Results and Discussion

Inputs and Outputs and Model Orientation

Benchmarking of state performance requires specification of input and output indicators. In the previous section a simple framework of analysis was used which showed that the level of income is positively related to government revenue, government spending and therevenue-spending ratio. Taking cue from this, we now make use of three output indicators and one input indicator for the purpose of multi-criteria performance evaluation (Table-4). On the output side, three indicators are taken: own tax revenue, development depending and fiscal performance ratio (total receipts net of fresh borrowing) /total expenditure). Mobilisation of own tax resources is an important indicator of the intention to have fiscal discipline. The quality of spending, on the other hand, is found to be an important facilitator of growth and development and consequently development expenditure has been taken as a proxy for the quality of expenditure undertaken by the states. The numerator of the last output indicator (index of fiscal discipline) includes the total resources mobilized for state from not debt sources including both tax and non-tax sources and consequently depends on the aggregate income of the concerned state. On the input side, GDP is considered. In the second stage, the efficiency scores are regressed on two contextual variables (Outstanding liabilities to State GDP ratio and Log of Gross Capital Formation). Estimation of efficiency is made using

the output oriented approach and under the assumption of operation of variable returns to scale. Computations were made using 'R'.

Table-2: Input and Output Indicators (and Contextual Variable) for Performance Benchmarking

Particulars	Variables
Input	State GDP
Output	own tax revenue, development expenditure & fiscal performance ratio
Contextual variables	Outstanding liabilities to GSDP ratio, Log of Gross Capital Formation

Period of Analysis, Sample Observations and Data Source

The present study is based on observations relating to 16 non-special category States for the period 2009-10 to 2013-14 and for 17 states relating to 2014-15. Data relating to the variables included in the study have been collected from the RBI and Government of India reports. To be specific, data relating to the output and input indicators have been collected from various sources including Report on State Finances (R.B.I.) and Economic Survey (Government of India).

Mean Technical Efficiency Scores

Tables-3 and 4 present the mean technical efficiency scores corresponding to DEA, FDH, Order-m and Order-Alpha Frontier for the period 2009-10 to 2013-14. To be specific, Table-3 presents the outcomes from the two full frontier approaches of estimation (DEA and FDH) whereas Table-4 presents the outcomes corresponding to the two partial frontier approaches (Order-m and Order-alpha).The state wise technical efficiency scores obtained from the estimation (DEA, FDH, Order-m and Order-alpha) are provided in appendix tables.

Table-3: Mean Technical Efficiency scores for DEA and FDH (2009-10 to 2014-15)

Particulars	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15
DEA	0.9249	0.9335	0.9471	0.9500	0.9079	0.9631
FDH	0.9631	0.9229	0.9896	0.9933	0.9695	0.9805

Source: Calculated

Figure-1: Mean efficiency of in-sample states – DEA and FDH

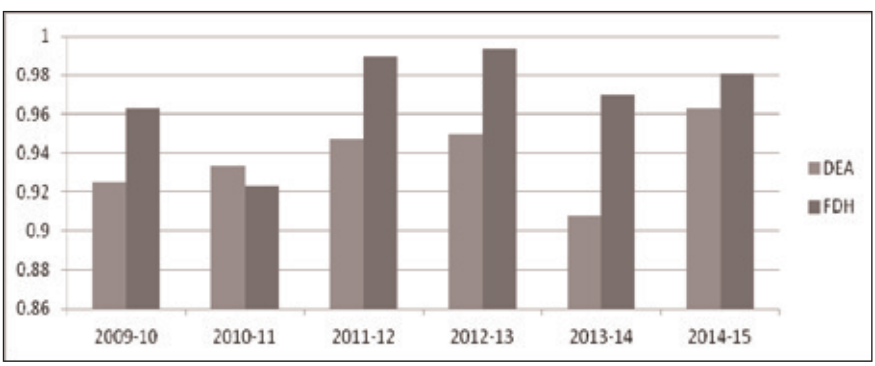


Table-4: Mean Technical Efficiency scores for order-m and order-alpha (2009-10 to 2013-14)

Particulars	Percentage of observations included	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15
Order-m	25	1.0846	1.1728	0.9896	0.9883	0.9705	1.0023
	50	0.9744	0.9624	0.9896	0.9875	0.9695	0.9848
	75	0.9744	0.9624	0.9896	0.9875	0.9695	0.9848
Order-alpha	25	1.3959	1.5726	1.3972	1.4318	1.5631	1.4241
	50	1.1833	1.1872	1.1789	1.2114	1.2579	1.1842
	75	1.0684	1.0378	0.9896	1.0437	1.0186	1.0303

Source: Calculated

Figure-2: Mean efficiency of in-sample states – Order-m and Order-m (First Quartile)

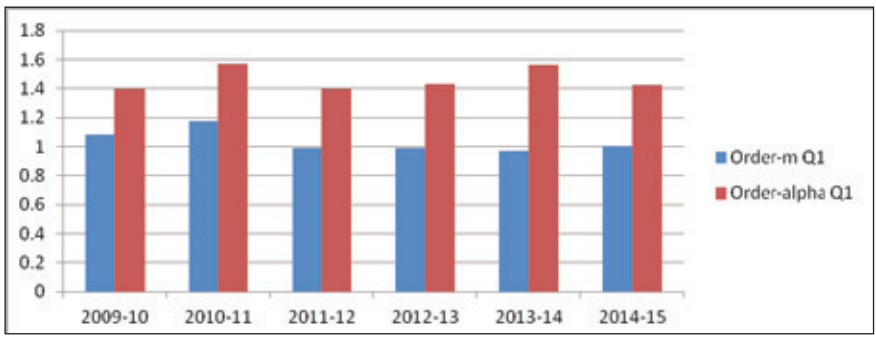


Figure-3: Mean efficiency of in-sample states – Order-m and Order-m (Second Quartile)

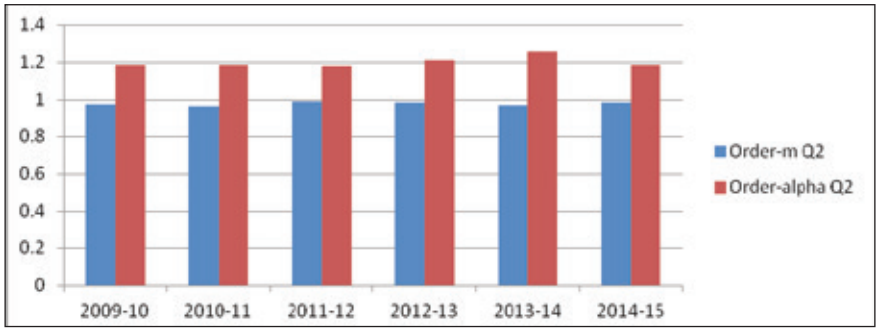
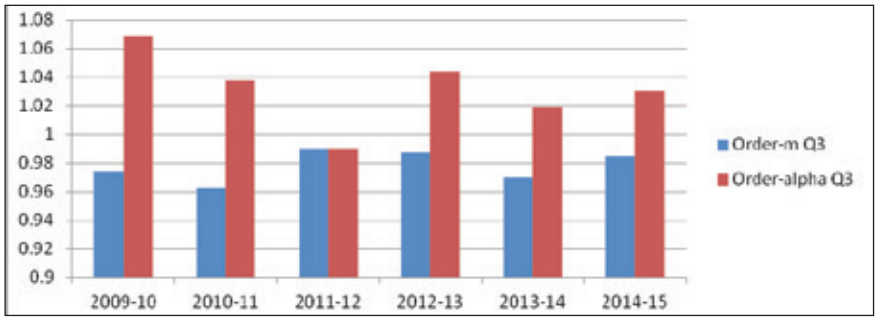


Figure-4: Mean efficiency of in-sample states – Order-m and Order-m (Third Quartile)



Returns to Scale (RTS) Characteristics

Table-5 provides summary information relating to returns to scale exhibited by the states under consideration for the period 2009-10 to 2014-15. The table shows that during the period under consideration, the number of states exhibiting constant returns to scale varied between 3 to 5. For two years (2011-12 and 2012-13) none of the states exhibited increasing returns to scale while for the remaining three years the number varied between 2 and 3. What is worrysome is that most of the states exhibited decreasing returns to scale for the period under consideration. For state wise information consult appendix tables A1 to A24.

Table-5: RTS Classification of Indian States – 2009-10 to 2014-15

Particulars	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15
Number of states exhibiting CRS	5	5	3	4	3	5
Number of states exhibiting IRS	3	2	0	0	2	0
Number of states exhibiting DRS	8	9	13	12	11	12

Source: Calculated

Impact of Indebtedness and Gross Capital Formation

The influence of contextual variables on the efficiency performance of the Indian states is estimated using a censored regression framework. Since we have observations for Telengana for only 1 year, the same were dropped for estimation purposed. As indicated earlier, DEA, FDH, Order-m and Order-alpha efficiency scores are taken as the dependent variables and the total outstanding liabilities to State GDP ratio as well as log of gross capital formation are taken as the two contextual variables. However, for estimation purposes, the order-m and order-alpha estimates encompassing 25% and 50% observations have not been considered because they are based on only on a small number of observations. The results (presented in Table-6 through 9) show that in all the cases, the influence of the outstanding liability ratio is significant. However, the influence of gross capital formation on the efficiency performance is significant only in cases of DEA and order-alpha efficiency scores.

Table-6: DEA efficiency and Outstanding Liability-GSDP Ratio

Particulars	Coefficient	Standard Error	Coefficient/ Standard Error	Probability of Type I Error
Intercept	1.21713	0.1688	7.2093	<0.00001
Outstanding Liability-GSDP ratio	-0.0085	0.0029	-2.8717	0.0041
Log Gross Capital Formation	0.0012	0.0099	0.1238	0.9015
Cross-section dummy	0.00009	0.0035	0.0254	0.9798
Time series dummy	-0.0031	0.0111	-0.2756	0.7829

Source: Calculated

Table-7: FDH Efficiency and Outstanding Liability-GSDP Ratio

Particulars	Coefficient	Standard Error	Coefficient/ Standard Error	Probability of Type I Error
Intercept	3.7212	1.06641	3.4894	0.0005
Outstanding Liability-GSDP ratio	-0.0263	0.0102	-2.5787	0.0099
Log Gross Capital Formation	-0.1539	0.0636	-2.4185	0.0156
Cross-section dummy	0.0116	0.0096	1.2190	0.2228
Time series dummy	-0.0095	0.0244	-0.3869	0.6988

Source: Calculated

Table-8: Order-m Efficiency and Outstanding Liability-GSDP Ratio

Particulars	Coefficient	Standard Error	Coefficient/ Standard Error	Probability of Type I Error
Intercept	1.05575	0.0365	28.8883	<0.00001
Outstanding Liability-GSDP ratio	-0.0021	0.00097	-2.1195	0.03404
Log Gross Capital Formation	-0.00241	0.0018	-1.3634	0.1728
Cross-section dummy	-0.0004	0.0010	-0.3908	0.6960
Time series dummy	0.0035	0.0029	1.1755	0.2398

Source: Calculated

Table-9: Order-alpha Efficiency and Outstanding Liability-GSDP Ratio

Particulars	Coefficient	Standard Error	Coefficient/ Standard Error	Probability of Type I Error
Intercept	0.9759	0.10021	9.7386	<0.00001
Outstanding Liability-GSDP ratio	-0.0043	0.0022	-1.9663	0.0493
Log Gross Capital Formation	0.0154	0.0081	1.8925	0.0584
Cross-section dummy	0.0039	0.0027	1.4394	0.1500
Time series dummy	-0.0169	0.0090	-1.8823	0.0598

Source: Calculated

Section 5: Conclusion

The present study attempts to provide efficiency performance of Indian non-special category states (based on several non-parametric tools) for six consecutive financial years. According to DEA based estimates,technical efficiency exhibited an upward trend between 2009-10 to 2012-13 but declined in 2013-14 and again bounced back in 2014-15. The non-convex approaches (FDH, Order-m and Order-alpha) indicate decline in mean efficiency score for 2010-11 (instead of an improvement as suggested by DEA based estimate). However, the rest results are similar.

The study includes a second stage analysis: assessment of the influence two contextual variables on the efficiency score. As indicated earlier, the coefficients of outstanding liability to State GDP is significant across the four approaches used for the estimation of efficiency. This indicates the importance of past borrowings on the efficiency performance. The impact of gross capital formation is, however, contingent on the method chosen for efficiency estimation.

Limitations of the Study and Scope for Future Research

The present study is based on observations for six financial years. In order to get a long term picture, extension of study to a longer period is essential. Secondly, the performance indices generated from the exercise can be made more broad based by including other performance indicators. Finally, more contextual variables can be accommodated.

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Appendix 1: State wise Efficiency Scores: (DEA, FDH, Order-m and Order-α)

Table-A1: State wise DEA Efficiency Scores (2009-10 to 2014-15)

State	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15
Andhra Pradesh	1	1	1	1	1	1
Bihar	0.8872	0.9328	0.9438	0.9548	0.9145	0.9873
Chhattisgarh	1	1	1	1	1	1
Gujarat	0.7849	0.8429	0.9271	0.9245	1	0.9576

State	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15
Haryana	0.6751	0.7892	0.8769	1	0.7779	0.8521
Jharkhand	0.9171	0.8124	1	1	1	1
Karnataka	0.9970	1	0.9657	1	1	1
Kerala	1	0.9161	0.8556	0.8318	1	0.9711
Madhya Pradesh	1	1	1	0.9503	0.7128	1
Maharashtra	1	1	1	1	1	1
Odisha	0.9767	1	1	1	0.7548	1
Punjab	1	1	0.8312	0.8172	1	0.9051
Rajasthan	0.8776	0.9481	0.9460	0.9343	0.6750	0.9360
Tamil Nadu	1	0.9359	1	0.9674	1	0.9695
Telengana	-	-	-	-	-	0.9389
Uttar Pradesh	1	1	1	1	1	1
West Bengal	0.6826	0.7582	0.8076	0.8193	0.6916	0.8548

Source: Calculated

Table-A2: State wise FDH Efficiency Scores (2009-10 to 2014-15)

State	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15
Andhra Pradesh	1	1	1	1	1	1
Bihar	1	1	1	1	1	1
Chhattisgarh	1	1	1	1	1	1
Gujarat	0.5741	0.5229	0.9818	0.9804	1	0.8010
Haryana	1	0.6835	1	1	1	0.9892
Jharkhand	0.9875	0.9831	1	1	1	1
Karnataka	1	1	0.9983	1	1	1
Kerala	1	1	1	1	1	1
Madhya Pradesh	1	1	1	1	1	1
Maharashtra	1	1	1	1	1	1
Odisha	1	1	1	1	1	1
Punjab	1	1	1	1	1	1
Rajasthan	1	1	0.9879	1	0.7429	1
Tamil Nadu	1	1	1	1	1	1
Telengana	-	-	-	-	-	1
Uttar Pradesh	1	1	1	1	1	1
West Bengal	0.8480	0.5768	0.8656	0.9124	0.7685	0.8777

Source: Calculated

Table-A3: Order-m efficiency scores (25%) (2009-10 to 2014-15)

State	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15
Andhra Pradesh	1.1966	1.4762	1	1.0008	1.0008	1.0217
Bihar	1.0590	1.0671	1	1	1	1.0009
Chhattisgarh	1	1	1	1	1	0.9124
Gujarat	0.9726	1.0248	0.9818	0.9818	1.0001	1.0020
Haryana	1.0354	0.9389	1	1	1	0.9457
Jharkhand	0.9353	0.8522	1	1	1	1
Karnataka	1.2487	1.5016	0.9983	0.9984	1.0017	1.0570
Kerala	1.1160	1.0706	1	1	1.0001	1.0010
Madhya Pradesh	1.1285	1.2651	1	1.0003	1.0003	1.0240
Maharashtra	1.3550	1.5999	1	1.0089	1.0085	1.0925
Odisha	1.0082	1.0177	1	1	1	1

State	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15
Punjab	1.0501	1.1297	1	0.9662	1	1
Rajasthan	1.0508	1.1639	0.9879	0.9879	0.7435	1.0084
Tamil Nadu	1.1660	1.2621	1	1.0019	1.0015	1.0356
Telengana	-	-	-	-	-	1.0028
Uttar Pradesh	1.2001	1.3750	1	1.0014	1.0017	1.0180
West Bengal	0.8313	1.0208	0.8656	0.8656	0.7698	0.9173

Source: Calculated

Table-A4: Order-m Efficiency Scores (50%) (2009-10 to 2014-15)

State	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15
Andhra Pradesh	1	1	1	1	1	1
Bihar	1	1	1	1	1	1.0000
Chhattisgarh	1	1	1	1	1	0.9039
Gujarat	0.8781	0.8899	0.9818	0.9818	1	0.9911
Haryana	1	0.8489	1	1	1	0.9436
Jharkhand	0.9350	0.8217	1	1	1	1
Karnataka	1	1	0.9983	0.9983	1	1
Kerala	1	1	1	1	1	1
Madhya Pradesh	1	1	1	1	1	1
Maharashtra	1	1	1	1	1	1.0001
Odisha	1	1	1	1	1	1
Punjab	1	1	1	0.9662	1	1
Rajasthan	1	1	0.9879	0.9879	0.7429	1
Tamil Nadu	1	1	1	1	1	1
Telengana	-	-	-	-	-	1
Uttar Pradesh	1	1	1	1	1	1
West Bengal	0.7776	0.8373	0.8656	0.8656	0.7685	0.9026

Source: Calculated

Table-A5: Order-m Efficiency Scores (75%) (2009-10 to 2014-15)

State	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15
Andhra Pradesh	1	1	1	1	1	0.9039
Bihar	1	1	1	1	1	0.9911
Chhattisgarh	1	1	1	1	1	0.9436
Gujarat	0.8781	0.8899	0.9818	0.9818	1	1
Haryana	1	0.8489	1	1	1	1
Jharkhand	0.9350	0.8217	1	1	1	1
Karnataka	1	1	0.9983	0.9983	1	1
Kerala	1	1	1	1	1	1
Madhya Pradesh	1	1	1	1	1	1
Maharashtra	1	1	1	1	1	1
Odisha	1	1	1	1	1	1
Punjab	1	1	1	0.9662	1	1
Rajasthan	1	1	0.9879	0.9879	0.7429	1
Tamil Nadu	1	1	1	1	1	1
Telengana	-	-	-	-	-	0.9026
Uttar Pradesh	1	1	1	1	1	0.9039
West Bengal	0.7776	0.8373	0.8656	0.8656	0.7685	0.9911

Source: Calculated

Table-A6: Order-alpha Efficiency Scores (25%) (2009-10 to 2014-15)

State	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15
Andhra Pradesh	2.0371	2.1744	2.5404	2.7354	2.9345	2.0539
Bihar	1.4721	1.2086	1	1.4613	1.7456	1.1111
Chhattisgarh	1	1	1	1	1	0.9796
Gujarat	1.0914	1.6965	1.6029	1.9128	1.8105	1.5564
Haryana	1.0884	1.1406	1.5687	1	1.3480	1.0102
Jharkhand	0.9350	1	1	1	1	1
Karnataka	1.8635	2.2912	1.7683	2.1094	2.1981	1.9192
Kerala	1.4643	1.2906	1.0216	1.5671	1.3462	1.7769
Madhya Pradesh	1.9232	1.9142	1.8571	1.7955	1.7568	1.7623
Maharashtra	1.7483	2.0647	1.6990	1.6483	1.5551	1.8758
Odisha	1	1	1	1	1	1
Punjab	1	1.5040	1.5157	1.0128	2.1069	1
Rajasthan	1.0195	1.6343	1.0405	1.0363	1.0694	1.1177
Tamil Nadu	2.1164	2.2306	1.4441	1.1899	1.4337	1.9958
Telengana	-	-	-	-	-	1.1429
Uttar Pradesh	1.5759	1.9895	1.3333	1.4406	1.4752	1.8820
West Bengal	1	1.1342	0.9629	1	1.2290	1.0259

Source: Calculated

Table-A7: Order-alpha Efficiency Scores (50%) (2009-10 to 2014-15)

State	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15
Andhra Pradesh	1.2734	2.1074	2.0626	1.9581	2.1350	1.3077
Bihar	1	1.0108	1	1	1	1
Chhattisgarh	1	1	1	1	1	0.9422
Gujarat	1	0.9446	0.9834	1	1.4671	1.4393
Haryana	1.0676	0.8575	1	1	1	1
Jharkhand	0.9350	0.8217	1	1	1	1
Karnataka	1.7707	1.7960	1	1.1089	1.4646	1.6467
Kerala	1.4643	1.0140	1.0216	1.5671	1.3462	1
Madhya Pradesh	1	1	1.8571	1.7955	1.7245	1.6250
Maharashtra	1.7447	1.8145	1.6185	1.5787	1.4807	1.5513
Odisha	1	1	1	1	1	1
Punjab	1	1	1	1	1	1
Rajasthan	1.0195	1.0101	1	1.0053	1	1.0769
Tamil Nadu	1.3099	1.1555	1.3091	1.1353	1.2050	1.3333
Telengana	-	-	-	-	-	1
Uttar Pradesh	1.5603	1.4627	1.1429	1.3069	1.3425	1.2092
West Bengal	0.7867	1	0.8670	0.9260	0.9615	1

Source: Calculated

Table-A8: Order-alpha Efficiency Scores (75%) (2009-10 to 2014-15)

State	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15
Andhra Pradesh	1.2734	1.2766	1	1	1	1
Bihar	1	1	1	1	1	1
Chhattisgarh	1	1	1	1	1	0.9302
Gujarat	0.9859	0.8972	0.9818	1	1.0017	1
Haryana	1	0.8489	1	1	1	0.9436

State	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15
Jharkhand	0.9350	0.8217	1	1	1	1
Karnataka	1	1	0.9983	1.1089	1	1
Kerala	1	1	1	1	1	1
Madhya Pradesh	1	1	1	1	1	1
Maharashtra	1.6802	1.5703	1	1.4519	1.4153	1.4629
Odisha	1	1	1	1	1	1
Punjab	1	1	1	1	1	1
Rajasthan	1	1	0.9879	1	0.7429	1
Tamil Nadu	1.1952	1.0585	1	1.1022	1.0988	1.1208
Telengana	-	-	-	-	-	1
Uttar Pradesh	1.2376	1.1458	1	1.1109	1.0777	1.0569
West Bengal	0.7867	0.9865	0.8656	0.9260	0.9615	1

Source: Calculated

Table-A9: State wise Efficiency Performance

State	DEA	FDH	Order-m	Order-alpha
Andhra Pradesh	1	1	0.9840	1.0917
Bihar	0.9367	1	0.9985	1
Chhattisgarh	1	1	0.9906	0.9884
Gujarat	0.9062	0.8100	0.9553	0.9778
Haryana	0.8285	0.9455	0.9748	0.9654
Jharkhand	0.9549	0.9951	0.9595	0.9595
Karnataka	0.9938	0.9997	0.9994	1.0179
Kerala	0.9291	1	1	1
Madhya Pradesh	0.9439	1	1	1
Maharashtra	1	1	1	1.4301
Odisha	0.9553	1	1	1
Punjab	0.9256	1	0.9944	1
Rajasthan	0.8862	0.9551	0.9531	0.9551
Tamil Nadu	0.9788	1	1	1.0959
Telengana	0.9389	1	0.9026	1
Uttar Pradesh	1	1	1	1
West Bengal	0.7690	0.8082	0.8510	0.9211

Source: Calculated

Table-A10: State wise returns to scale (2009-10 to 2014-15)

State	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15
Andhra Pradesh	Constant	Constant	Constant	Constant	Constant	Constant
Bihar	Increasing	Decreasing	Decreasing	Decreasing	Increasing	Decreasing
Chhattisgarh	Constant	Constant	Constant	Constant	Constant	Decreasing
Gujarat	Decreasing	Decreasing	Decreasing	Decreasing	Decreasing	Constant
Haryana	Decreasing	Decreasing	Decreasing	Constant	Decreasing	Constant
Jharkhand	Increasing	Decreasing	Constant	Constant	Increasing	Constant
Karnataka	Increasing	Constant	Decreasing	Decreasing	Decreasing	Decreasing
Kerala	Constant	Increasing	Decreasing	Decreasing	Decreasing	Decreasing
Madhya Pradesh	Constant	Constant	Decreasing	Decreasing	Decreasing	Decreasing
Maharashtra	Decreasing	Decreasing	Decreasing	Decreasing	Decreasing	Decreasing

State	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15
Odisha	Decreasing	Constant	Decreasing	Decreasing	Decreasing	Decreasing
Punjab	Constant	Increasing	Decreasing	Decreasing	Constant	Decreasing
Rajasthan	Decreasing	Decreasing	Decreasing	Decreasing	Decreasing	Decreasing
Tamil Nadu	Decreasing	Decreasing	Decreasing	Decreasing	Decreasing	Decreasing
Telengana	-	-	-	-	-	Decreasing
Uttar Pradesh	Decreasing	Decreasing	Decreasing	Decreasing	Decreasing	Constant
West Bengal	Decreasing	Decreasing	Decreasing	Decreasing	Decreasing	Decreasing

Source: Calculated

Table-A11: Order-m-super-efficiency- parameter(m) relationship (values of m)

Percentage of observations included	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15
25	8	4	132	55	55	21
50	196	164	292	228	228	134
75	356	356	420	356	368	320

Source: Calculated

Table-A12: Order-alpha-super-efficiency- parameter(alpha) relationship

Percentage of observations included	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15
25	0.75	0.66	0.75	0.75	0.74	0.71
50	0.84	0.80	0.85	0.85	0.84	0.84
75	0.90	0.90	0.92	0.90	0.91	0.90

Source: Calculated

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