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FISCAL PERFORMANCE BENCHMARKING OF INDIAN STATES - A ROBUST FRONTIER APPROACH

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Abstract:

Aim: The objective of the paper is to construct an index of fiscal performance of Indian states using DEA. The reason behind using non-parametric methods for the purpose of construction of index is that the traditional ratio approach is incapable of handling multiple input and output indicators.

Design / Research methods: The present study uses a two stage approach. In the first stage, DEA is deployed to evaluate the performance of Indian states for five consecutive years. The input and output indicators used for DEA have been selected on the basis of a simple theoretical model. Further, in order to tackle the problem of estimation bias (due to sampling variations) bootstrapped DEA is applied. In the second stage ,impact of indebtedness on the performance of the states has been assessed using a censored regression framework.

Conclusions / findings: The major outcome of the study is the construction of a fiscal performance index based on multiple indicators. Moreover, the second stage results indicate that state performance is significantly influenced by their degree of indebtedness.

Originality / value of the article: The present study is perhaps the first attempt to assess the performance of sub-national units in terms of both convex and non-convex mathematical programming methods.

Implications of the research (if applicable): The approach (with suitable modifications) can be effectively used to benchmark state performance which can serve as a basis for resource transfer from the central government to the states.

Keywords: robust frontier, Indian states, non-parametric approach

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1. Introduction

In spite of the existence of a federal structure of administration (in which the financial powers and responsibilities are shared between the Centre and the State), it is commonly agreed that Indian states enjoy relatively much less administrative and financial power compared to the Central government. In this context, reexamination of Centre-State financial relations and possible initiation of reforms in the relationship are undoubtedly of interest to the researchers and policy makers. The primary motivation for the present paper, however, emanates from a different source- 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 non-special category states (these are the states which do not enjoy any special tax concession or additional central assistance) for the years 2009-10 to 2013-14 using data envelopment and also tries to assess the impact of indebtedness on the efficiency performance of the states.

The paper is organized in to five sections and proceeds as follows. Section 2 provides an overview of state finances in India. Section 3 discusses the received literature relating the evaluation of fiscal performance of Indian states. Section 4 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 5 presents and discusses the results. Finally, section 6 concludes.

2. Fiscal scenario of Indian states

While both the central and the state governments in India have independent revenue raising and spending powers, there are inherent asymmetries in the federal structure resulting in both vertical and horizontal fiscal imbalances. The vertical fiscal imbalances exist because compared to the centre, the state governments in India have limited power to mobilise resources through taxes. The central government retains the entire tax revenue collected from important sources like corporate income or customs. The states have limited opportunities to mobilise direct taxes. Although due to the more liberal sharing of tax collection with the state governments, their share has increased over the last few decades, the central government share in the combined revenue is still about 43%. Table 1 provides the trend relating to the relative share of the central government and the states in the combined revenue between 1990-91 and 2013-14.

Table 1. Relatives tax shares of central and state governments in the combined tax revenue

Category	1990-91	2000-01	2005-06	2009-10	2013-14
Central Government Share (after devolution of state share)	49.06	44.8	45.98	48.3	43.08
State Government Share	50.94	55.2	54.02	51.7	56.92

Source: Indian Public Financial Statistics, various years, Ministry of Finance.

With limited resources at their disposal, the state governments have to have to shoulder a significant burden of expenditure relating to the social sector. In particular, education and provision of medical services and public health are the important social sector activities taken up by the state governments. Table 2 provides the trend in social sector expenditure incurred by the state governments for the span 2009-10 to 2013-14.

Table 2. Social sector expenditures of Indian states (2009-10 to 2013-14) (Amount in Rs billion)

State Category	2009-10	2010-11	2011-12	2012-13	2013-14
Non-Special Category States	3,558.2	4,106.3	4,763.7	5,518.2	6,208.5
Special Category States	371.3	412.9	472.2	511.4	583.6
Total	3,929.4	4,519.4	5,235.7	6,029.4	6,792.0

Source: State Finances – A Study of Budgets of 2015-16, RBI, Mumbai.

The Indian constitution provides for the transfer of resources from the Central to the state governments to bridge the gap between resources required by states to meet their assigned responsibilities and their own resources. Effectively, the transfer system is a three tier transfer system: the Indian central government transfers funds via Finance Commission, Planning Commission and various union ministries and agencies (discretionary transfers). Recently, the Planning Commission has been replaced by the Niti Ayog (The National Institution for Transforming India – policy think tank established by the Central Government). Table 3 provides a snapshot view of the transfer of resources from the Centre to the states.

Table 3. Devolution & transfer of resources from the Central government (Amount in Rs billion)

Particulars	2009-10	2010-11	2011-12	2012-13	2013-14
States' share in central taxes	1650.1	2194.9	2555.9	2915.3	3182.7
Grants from the Centre	1509.7	1635	1864.2	1886.3	2059.7
Gross Loans from the Centre	81.1	94.8	99	112	108.7
Total (Gross Transfer)	3240.9	3924.8	4519.1	4914.2	5351

Source: State Finances – A Study of Budgets of 2015-16, RBI, Mumbai.

In spite of the financial support from the Central Government (beyond the sharing of taxes), conditions of state finances in India deteriorated sharply from the eighties and this condition persisted for two decades. In order to ensure better fiscal governance, 28 states have passed Fiscal Responsibility and Budgetary Management (FRBM) Acts between 2003-2010 aiming at phased and time bound reductions in revenue and fiscal deficits (as a percentage of GSDP) to prudent levels and putting ceilings on total outstanding liabilities (as a percentage of GSDP).

In the post-FRBM phase, fiscal indicators have improved for the states in general. However, substantial inter-state variations in fiscal scenario continue to exist across the states due to variations in revenue mobilisation capacity, composition and quality of expenditure and outstanding liablities. There are also many idiosyncratic factors at play. For example, two states may have similar GSDP (Gross Domestic State Product) levels. Yet the potential and actual revenue mobilisation may differ widely between them depending on the relative presence of the organised manufacturing and service sectors in them. States also differ considerable in terms of outstanding liabilities. The objective of the present study is to focus on this horizontal imbalance in the post-FRBM phase.

3. Fiscal performance of Indian states-a review of literature and research gaps

3.1 Literature Review

Several research studies attempted to assess the fiscal performance of Indian states in the context of intergovernmental transfer of resources. The present section includes the important studies undertaken in Indian context which had a sub-national perspective.

Rao and Singh (1998) examined the fiscal situation of Indian states for the period 1955-56 to 1993-94 in terms of vertical and horizontal fiscal imbalances. As indicated earlier, vertical fiscal imbalance prevails due to the gap between expenditures and revenues at different levels of government while horizontal/lateral fiscal imbalance exists due to the gap between revenue and expenditure levels within a particular level of government.

Bajpai and Sachs (1999) reviewed the deteriorating fiscal position of the Indian states in the nineties and identified several reasons for the worsening position: a stagnating tax-GDP ratio, increasing proportion of non-development expenditure in the total expenditure, large quantum of clandestine subsidies, rising financial burdens of state enterprises and rising demand for public services.

Coondoo et al. (2001) considered the comparative 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.

Rao (2002) reviewed the situation of Indian state finances for the period 1980-2000. The study noticed worsening scenario in state finances during the nineties – as evidenced by sharp upswings in primary, revenue and fiscal deficits, growth in indebtedness and contingent liabilities, and downward trends in capital and maintenance expenditures. Low buoyancy of fiscal transfers from the central government and the contagion effect of central pay revisions had an adverse bearing on state finances. However, the own fiscal performance of the relative states has also seen sharp decline especially due to their failure to increase the tax base.

Dholakia (2005) provided an alternative to the Fiscal Self Reliance and Improvement Index recommended by the Eleventh and Twelfth 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.

Roy and Roy Chowdhury (2009) used a theoretical model to determine optimum fiscal policy of the state governments in India and then compared the actual revenue and expenditures with the optimum policy for 1981-2001. The comparison of actual own revenue and expenditure policies of the observed states to the optimum policy shows that states are spending at a higher level than estimated optimum level and collecting lesser revenue relative to the optimum.

Chakraborty and Dash (2013) considered the impact of introduction of fiscal rules by the states via Fiscal Responsibility Acts (FRBM). While they found that the introduction of fiscal rules have prompted the states to reduce revenue and fiscal deficits in the post-FRBM phase, inter-state disparities in per capita expenditure has increased during the recent years. Further, it was evidenced that fiscal targets under FRBM were achieved through cut backs in discretionary development spending.

Mundle et al. (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.

3.2 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, Data Envelopment Analysis (DEA) has been used. The composite indices developed as proxies for fiscal performance of states in studies like Dholakia (2005) used a priori and researcher assigned weights. Compared to this, DEA is a data driven approach which assigns weights to inputs and outputs in manner such that the units under observation are evaluated in the most favourable manner. Thus the approach used in the present study is more scientific than the weighted ratio based indices introduced earlier.

Another important advantage of the present study is the computation of interval estimates of performance through bootstrap which was not possible under the conventional methodology. For each in-sample year, we have only 16 observations. For small samples, DEA estimates of efficiency contain upward bias which can be corrected through bootstrap. The objective of performing bootstrap DEA is to obtain unbiased efficiency estimates.

Further, it is a known fact that the Indian states are dependent on borrowings for financing their activities to a significant extent. Thus in the second stage, the present study performs censored regression for exploring the influence of outstanding liability ratio (in terms of gross state domestic product) on point and bias corrected estimates of efficiency.

4. Performance benchmarking: the conceptual and methodological issues

4.1 A brief outline of the conceptual framework

In the present day context, a state has an important role to play in promoting economic growth and development. In order to see how economic growth is related to state finances, let us consider a very simple static macroeconomic framework. Consider a hypothetical state with the following income and budgetary identities:

$$Y_t = C_t + X_t + I_t + G_t \quad (1)$$

$$G_t = R_t + F_t - rB_t \quad (2)$$

Where Y_t stands for GSDP (Gross Domestic State Product), C_t for private aggregate consumption, X_t for net exports to other regions/states, I_t for private investment and G_t for government spending. R_t represents the total non-debt resources of the state and includes four components: own tax revenues, non-tax revenues share of central government taxes and transfers from central government under various heads. Bt stands for the outstanding debt in period t. Finally, r represents the rate of interest payable on the borrowed amount.

We further assume that It is dependent on government development spending: $It = mGt\ d$, 0<m<1. Finally, $Ft = f\ t$, f stands for the incremental debt-GSDP ratio. From equations (1) and (2) we get the following relationship:

$$Y_t = \frac{C_t + X_t + mG_t^d + R_t - (rB_t + G_t^n)}{[1-f]} \quad (3)$$

Where 0<f<1.

Equation (3) shows that apart from, consumption expenditure and exports to other regions, the level of income (and its growth rate) depends positively on (non-debt)resources mobilized, government development spending. Since a state do not have discretionary power over other sources of revenue, own tax revenue (mobilized by the state) is an important variable from the perspective of the state. Similarly, development spending is also a facilitator for income generation and growth.

4.2 Evaluation of performance-the distance function approach

In the present study we follow a multi-criteria approach for performance evaluation. In this context, Shephard's (1953, 1970) distance function approach gives a sound theoretical basis for the derivation of performance evaluation rules. The idea emanates from a multi-input multi-output production system where distance function provide a functional interpretation of the production technology. The production technology encompasses an input and an output set. The input set is characterized by the input distance function. The output set is characterized 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.

In order to explain the concept of input and distance function, we consider a technology T_g utilizing a nonnegative vector of inputs $X=(x_1,x_2,......,x_n)\in R^n_+$ to produce a nonnegative vector of outputs $Y=(y_1,y_2,......,y_m)\in R^m_+$. They can be functionally related as: Y=P(X) and X=L(Y). These two functions relates inputs and outputs from the output and input perspectives respectively. P(X) refers to the output set (set of all output vectors) and L(Y) refers to the input requirement set (set of all combinations of inputs that will produce y).

An input distance function can thus be defined as $D_{input}= \text{Max}[\lambda:X/\lambda \in L(Y)]$.Intuitively speaking, an input distance function gives the maximum amount by which the producer's input vector can be radially contracted and yet remain feasible for the output vector it produces. The reciprocal of the input distance function can be considered as the radial measure of input-oriented technical efficiency.

In an analogous fashion, the output distance function is defined as: $D_{output}= \text{Min}[\mu:Y/\mu \in P(X)]$. Intuitively speaking, an output distance function gives the minimum amount by which the producer's output vector can be deflated and yet remain feasible for a given input vector. The radial measure of output-oriented technical efficiency coincides with the output distance function

4.3 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 because of the following reasons:

(i) non-parametric methods can easily handle multiple outputs which is not the case for parametric approaches.

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

As mentioned earlier, DEA has been used in the present study for estimating efficiency. DEA 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. Efficiency can be computed from both input perspective (input-oriented model) and output perspective. In the input-oriented model (under the assumption of variable returns to scale), the linear program for efficiency estimation is:

$$\text{Min } \theta$$

$$\text{Subject to } \theta x \geq \lambda X, y \leq \lambda Y, \lambda \geq 0, \sum \lambda = 1$$

$$\text{Efficiency} = \theta$$

Similarly, in the output-oriented model, the relative linear program is

$$\text{Max } \theta$$

$$\text{Subject to } x \geq \lambda X, \mu y \leq \lambda Y, \lambda \geq 0, \sum \lambda = 1$$

$$\text{Efficiency} = 1/\theta$$

4.4 The purpose of undertaking bootstrap

Banker (1993), while providing a formal statistical foundation for DEA, showed that DEA estimators of the best practice monotone increasing and concave production function would be maximum likelihood estimators if the deviation of actual output from the efficient output is regarded as a stochastic variable with a monotone decreasing probability density function. However, For a finite sample size, the best practice frontier estimator would lie below the theoretical frontier implying the existence of an upward bias in the constructed frontier. In practical application of DEA, statistical estimators of the frontier are obtained from finite samples. Consequently, the corresponding efficiency estimates are sensitive to the sampling variations of the obtained frontier. Korostelev et al. (1995a, 1995b) have shown that DEA estimators satisfy consistency property under very weak general conditions. However, the obtained rates of convergence are very slow. Bootstrap analysis facilitates the correction of such upward bias.

4.5 Bootstrap efficiency estimation:

Efron (1979) introduced the concept of bootstrap which involves resampling from an original sample of data via computer-based simulations to getting the sampling properties of random variables. The beginning of any bootstrap procedure is a sample of observed data points X = $\{x_1, x_2, . . . , x_n\}$ randomly drawn from a population with an probability distribution f (unknown). The premise of the bootstrap method is that the random sample actually drawn "mimics" its parent population.

The sample statistic $\hat{\theta} = \theta(X)$ computed from this state of observed values is merely an estimate of the corresponding population parameter $\theta = \theta(f)$. Since the researcher has access to only one sample rather than multiple samples drawn from the same population, it is not possible to get sampling distribution of the statistic. Under the circumstances, if one draws a random sample with replacement from the observed values in the original sample, it can be treated like a sample drawn from the underlying population.

The bootstrap method suggested by Efron (1979) involves drawing of sample (with replacement) directly from the observed data and is known as naive bootstrap. In this case the bootstrap sample is effectively drawn from a discrete population which fails to recognize the fact that the underlying population density function f is continuous. Simar and Wilson (1998) suggested that the problem could be overcome by resorting to smoothed bootstrap which involves resampling via a fitted model. The smoothed bootstrap methodology involves the use of Kernel estimators as weight functions. If we write the naive bootstrap sample as $X_{nbs} = \{x_1^*, x_2^*, ..., x_n^*\}$

and the smoothed bootstrap sample as X_{sbs} ={x_1**, x_2**,......, x_n**} then the elements of the two are related to each other in the following manner: $x_i^{**}=x_i^{*}+h\epsilon \sim f$, where h is the smoothing parameter for the density function while x_i^* and x_i^{**} represent the i^{th} elements of the naive and smoothed bootstrap samples.

In case of bootstrapping, every time when we replicate the bootstrap sample, we get a different sample X**, we will also get a different estimate of $\theta^* = \theta(X^{**})$. Thus, we need to select a large number of bootstrap samples, B, in order to extract as many combinations of x_j (j = 1, 2, . . . , n) as possible. The steps followed in bootstrapping are briefly as follows:

(a) Compute the technical efficiency θ from the observed sample X.

(b) Select r^{th} (r = 1, 2, . . . ,B) independent bootstrap sample X^*_r, which comprises of n data values drawn with replacement from the observed sample X. From this, compute the naïve bootstrap.

(c) Compute the statistic $\theta_{sb} = \theta(X^{**}_{sb})$ from the rth bootstrap sample X^{**}_b

(d) Construct pseudo-data from the smoothed bootstrap efficiency scores and compute technical efficiency

(e) Repeat steps (b),(c) and (d) a large number of times (say, N times).

(f) Calculate the average of the bootstrap estimate (θ_e).

4.6 Computation of bias corrected efficiency

One important objective for applying bootstrap analysis in the context of small samples is to get rid of the upward bias existing in the estimated frontier. The bias correction procedure is now spelt out in brief:

A measure of the accuracy of an estimator θ_e of the parameter θ is the bias measure $E(\hat{\theta})-\theta$. The bias-corrected estimator is: $\theta_{bc}=\hat{\theta}$-bias. In our case, we compute bias $=\theta_e-\theta$.

Thus the bias corrected estimated technical efficiency is :$\theta_{bc}=2\hat{\theta}-\theta_e$

However, as Simar and Wilson (2000) pointed out, this bias correction might generate additional noise. To check for this, the sample variances of the bootstrap values (σ^2_{bs}) are to be calculated. Bias correction is to be made only if : bias/σ_{bs} >$\sqrt{3}$.

4.7 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), ordinary least square method can not be applied without any kind of data transformation. In the present study, censored regression has been used in lieu of data transformation.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:

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

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

Where y* is a latent (unobserved) variable and y is the observed variable. x is a vector of explanatory variables. c and d 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:

$$LogL = \sum[Ia \log\varphi(\frac{a - x'\beta}{\sigma}) + Ib \log\varphi(\frac{x'\beta - b}{\sigma}) + (1\text{-}Ia\text{-}Ib)\{\log\theta(\frac{y - x'\beta}{\sigma}) - \log\sigma\}]$$

where $\varphi(.)$ and $\theta(.)$ denote the cumulative distribution and probability density function respectively of the standard normal distribution and Ia & Ib are the indicator functions with Ia=1 if y=a and Ia=0 if y>a and Ib=1 if y=b and Ib=0 if y>b.

5. Framework of study, results and discussion

5.1 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 the revenue-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, two indicators are taken: Own Tax Revenue and Development Spending Mobilization 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. On the input side, Gross State Domestic Product is considered. Estimation of efficiency is made using the output-oriented approach. DEA efficiency scores were computed under variable returns to scale. Computations were made using 'R'.

Table 4. Input and output indicators (and contextual variable) for performance benchmarking

Particulars	Variables
Input	Gross state domestic product
Output	Own tax revenue, development spending
Contextual variable	Level of indebtedness

Source: Author's own elaboration.

5.2 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. In India, there are two categories of states: special and non-special. Out of the 29 states in India, eleven are special category states which have not been included in the present analysis because they enjoy special benefits in terms of tax concessions and Additional Central (Government) Assistance. Out of the 18 non-special category states, two small states (Delhi and Goa were excluded).The period has been chosen out of the interest to compare the states for the post-FRBM phase only. 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).

5.3 Results and discussion

Table 5 presents the descriptive statistics of technical efficiency scores for the period 2009-10 to 2013-14. The state wise mean technical efficiency scores and standard deviation of efficiency scores are provided in appendix tables (A2 through A6). Table 5 indicates an alternating trend in mean efficiency scores across the time period.

Table 5. Mean Technical Efficiency scores of the in-sample states (2009-10 to 2013-14)

Particulars	2009-10	2010-11	2011-12	2012-13	2013-14
Mean Efficiency	0.8726	0.8528	0.8265	0.8419	0.8096
Standard Deviation	0.1624	0.1868	0.1850	0.1734	0.1997

Source: Author's own elaboration.

5.3.1. Bootstrap based interval estimates of performance:

In case of small samples point DEA estimates of efficiency contain upward bias. Table 6 provides the bias corrected mean efficiency scores, mean lower and upper bounds of efficiency relative to the in-sample states for the period under observation. The state wise such scores are provided in appendix tables A2 through A7. Kindly note that the tables contain upper bounds of efficiency scores (as reported by the software) which are greater than 1. These may be truncated to 1.

Table 6. Bootstrap DEA Estimates

Descriptive Statistics	2009-10	2010-11	2011-12	2012-13	2013-14
Mean Bias Corrected Technical Efficiency	0.7780	0.6342	0.6082	0.6455	0.5804
Mean Lower Limit of Confidence Interval	0.6991	0.4943	0.4758	0.5198	0.4407
Mean Upper Limit of Confidence Interval	0.9566	0.8469	0.8173	0.8518	0.8015

Source: Author's own elaboration.

5.3.2. Estimation of returns to scale

It is of interest to have information about the returns to scale characteristics of the in-sample states for the five year period. Table 7 presented below provides the summary information regarding the returns to scale. The table shows that most of the states exhibited decreasing returns to scale after 2009-10. Appendix Table A 7 provides the state wise information about returns to scale.

Table 7. Returns to scale

Descriptive Statistics	2009-10	2010-11	2011-12	2012-13	2013-14
No states exhibiting constant returns to scale	9	5	3	4	5
No states exhibiting increasing returns to scale	1	2	0	0	1
No states exhibiting decreasing returns to scale	6	9	13	12	10

Source: Author's own elaboration.

5.3.3. Efficiency variations across income groups

In the present study, performance of sixteen non-special category Indian states has been evaluated for 2009-10 to 2013-14 from the stand point of fiscal management. The efficiency score corresponding to a state is a composite index of efficiency. Now, for understanding the difference in efficiency performance across the affluent and not so affluent states, the in sample states have been categorized in to three categories on the basis of per capita Gross State Domestic Product The sixteen states include four high income states (Maharashtra, Gujarat, Haryana and Tamil Nadu), five middle income states (Kerala, Punjab, Karnataka, Andhra Pradesh and West Bengal) and seven low income states (Rajasthan, Jharkhand, Chhattisgarh, Madhya Pradesh, Odisha, Uttar Pradesh and Bihar). Table 8 represent the average performances across the three groups for the observed years. The categorization provides some interesting results. In the first two years under observation, high income states produced below average performance while the other two categories had above average result. However, there was a role reversal in the subsequent three years.

Table 8. Mean DEA efficiency across income groups

State	2009-10	2010-11	2011-12	2012-13	2013-14
High Income States	0.7537	0.7557	0.8311	0.9487	0.8248
Middle Income States	0.8728	0.8989	0.7397	0.7733	0.7530
Low Income States	0.9404	0.8754	0.8857	0.8298	0.8413
Overall	0.8726	0.8528	0.8265	0.8419	0.8096

Source: Author's own elaboration.

5.3.4. Impact of indebtedness

As indicated earlier, the influence of indebtedness of the Indian states on their efficiency performance is estimated using a censored regression framework. The DEA efficiency is taken as the dependent variable and the total outstanding liabilities to GSDP ratio (proxy for indebtedness) is taken as the independent variable. The year wise outstanding liability ratios for the in-sample states for the five year period are provided in appendix Table A 8. The results presented in Table 8 show that the influence of the outstanding liability ratio is significant provided we consider the point estimates of efficiency.

Table 8. DEA efficiency and Outstanding Liability-GSDP ratio

Particulars	Coefficient	Standard Error	Coefficient/ Standard Error	Probability of Type I Error
Intercept	1.3487	0.1668	8.0860	<0.00001
Outstanding Liability-GSDP ratio	-0.0123	0.0048	-2.5960	0.0094
Cross-section dummy	-0.0028	0.0063	-0.4485	0.6538
Time series dummy	-0.0276	0.0221	-1.2480	0.2120

Source: Author's own elaboration.

However, if we consider the bias corrected scores (refer Table 9), then this linkage is not supported by empirical evidence. This is quite an interesting result: the states which are relatively more indebted may not have done that badly in terms of current performance. In fact, high degree of indebtedness is a legacy of the past.

With the on set of FRBM regulations, states have been compelled to restrict their borrowings for maintaining the FRBM upper limits.

Table 9. Bias corrected efficiency and Outstanding Liability-GSDP ratio

Particulars	Coefficient	Standard Error	Coefficient/ Standard Error	Probability of Type I Error
Intercept	0.8158	0.0802	10.1722	<0.00001
Outstanding Liability-GSDP ratio	-0.0017	0.0025	-0.6685	0.5038
Cross-section dummy	-0.0002	0.0034	-0.0731	0.9417
Time series dummy	-0.0402	0.0110	-3.6570	0.0003

Source: Author's own elaboration.

6. Conclusions

The present study attempts to provide robust estimates of fiscal performance indices based on non-parametric tools for five consecutive financial years. If we look at the DEA results, then we find that mean technical efficiency had an alternating trend. Mean efficiency improved in 2010-11 and then experienced a decline in 2011-12, further picked up in 2012-13 and declined again in 2013-214. This alternating trend is likely because of instability in the mobilization of own tax revenues and undertaking development spending. As mentioned earlier, middle and low per capita income states have performed better than the high income states during 2009-10 and 2010-11 but the trend was reversed during 2011-12 to 2013-14. For inefficient states, inefficiency can arise due to shortfalls in performance relative to the benchmark in respect of own tax revenue, development expenditure or index of fiscal discipline. Decomposition of inefficiency shows that the inefficiency of high and middle income states is mainly due to shortfalls in development expenditure. On the other hand, the low income states mainly lagged on account of poor mobilization of own tax revenues. Further, the alleged inverse linkage between indebtedness and efficiency performance does not hold good if we remove biases in efficiency estimates.

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Appendix: State wise efficiency scores

Table A1. State wise efficiency Scores (2009-10 to 2013-14)

State	2009-10	2010-11	2011-12	2012-13	2013-14
Andhra Pradesh	1.0000	1.0000	1.0000	1.0000	1.0000
Bihar	0.8872	0.6348	0.9438	0.7933	0.9145
Chhattisgarh	1.0000	1.0000	1.0000	1.0000	1.0000
Gujarat	0.6004	0.6234	0.7433	0.8647	0.8579
Haryana	0.5061	0.4635	0.5811	1.0000	0.4658
Jharkhand	0.9171	0.7420	1.0000	1.0000	1.0000
Karnataka	0.9855	1.0000	0.8238	1.0000	1.0000
Kerala	0.8934	0.9001	0.6061	0.7419	0.6066
Madhya Pradesh	1.0000	1.0000	1.0000	0.7626	0.6454
Maharashtra	1.0000	1.0000	1.0000	1.0000	1.0000
Odisha	0.9534	1.0000	0.7287	0.6348	0.6957
Punjab	0.8949	1.0000	0.6240	0.5709	0.6207
Rajasthan	0.8249	0.7513	0.5277	0.6182	0.6336
Tamil Nadu	0.9082	0.9359	1.0000	0.9300	0.9754
Uttar Pradesh	1.0000	1.0000	1.0000	1.0000	1.0000
West Bengal	0.5901	0.5943	0.6446	0.5538	0.5379

Source: Author's own elaboration.

Table A2. Bootstrap efficiency scores (2009-10)

State	Bias corrected mean efficiency	Lower limit (2.5%)	Upper limit (97.5%)
Andhra Pradesh	0.8648	0.7474	1.0319
Bihar	0.8339	0.7958	0.8969
Chhattisgarh	0.7553	0.5301	1.4544
Gujarat	0.5390	0.4894	0.6605
Haryana	0.4649	0.4324	0.5234
Jharkhand	0.8139	0.7254	1.2113
Karnataka	0.8996	0.8298	1.0336
Kerala	0.8365	0.7958	0.9019
Madhya Pradesh	0.9285	0.8760	1.0141
Maharashtra	0.8068	0.6317	1.2490
Odisha	0.8686	0.8032	0.9959
Punjab	0.8323	0.7865	0.9051
Rajasthan	0.7687	0.7280	0.8440
Tamil Nadu	0.8318	0.7722	0.9381
Uttar Pradesh	0.8664	0.7498	1.0318
West Bengal	0.5363	0.4930	0.6143

Source: Author's own elaboration.

Table A3. Bootstrap efficiency score (2010-11)

State	Bias corrected mean efficiency	Lower limit (2.5%)	Upper limit (97.5%)
Andhra Pradesh	0.7285	0.5517	0.9199
Bihar	0.5096	0.4410	0.6106
Chhattisgarh	0.6232	0.3372	1.2354
Gujarat	0.4736	0.3807	0.6166
Haryana	0.3701	0.3195	0.4485
Jharkhand	0.5617	0.4479	0.7736
Karnataka	0.7874	0.6698	0.9656
Kerala	0.7356	0.6559	0.8548
Madhya Pradesh	0.7372	0.5639	0.9298
Maharashtra	0.6468	0.3869	1.0705
Odisha	0.6721	0.4350	1.0141
Punjab	0.7481	0.5924	0.9280
Rajasthan	0.5959	0.5115	0.7293
Tamil Nadu	0.7366	0.6224	0.9051
Uttar Pradesh	0.7488	0.5896	0.9649
West Bengal	0.4723	0.4037	0.5833

Source: Author's own elaboration.

Table A4. Bootstrap efficiency score (2011-12)

State	Bias corrected mean efficiency	Lower limit (2.5%)	Upper limit (97.5%)
Andhra Pradesh	0.6713	0.4477	0.9490
Bihar	0.7462	0.6437	0.9128
Chhattisgarh	0.6268	0.3558	1.0890
Gujarat	0.5999	0.5323	0.7140
Haryana	0.4419	0.3641	0.5616
Jharkhand	0.6241	0.3526	1.1671
Karnataka	0.6284	0.5192	0.7885
Kerala	0.4627	0.3825	0.5898
Madhya Pradesh	0.7548	0.6122	0.9401
Maharashtra	0.6304	0.3675	1.0435
Odisha	0.5631	0.4741	0.6921
Punjab	0.4902	0.4222	0.6144
Rajasthan	0.4085	0.3446	0.5059
Tamil Nadu	0.7833	0.6684	0.9493
Uttar Pradesh	0.7818	0.6664	0.9432
West Bengal	0.5186	0.4597	0.6166

Source: Author's own elaboration.

Table A5. Bootstrap efficiency score (2012-13)

State	Bias corrected mean efficiency	Lower limit (2.5%)	Upper limit (97.5%)
Andhra Pradesh	0.7059	0.4957	0.9903
Bihar	0.6607	0.5923	0.7871
Chhattisgarh	0.7353	0.5531	1.0102
Gujarat	0.7112	0.6302	0.8419
Haryana	0.6719	0.4288	1.0504
Jharkhand	0.6599	0.4055	1.1726
Karnataka	0.8018	0.6876	0.9684
Kerala	0.5925	0.5055	0.7440
Madhya Pradesh	0.6103	0.5206	0.7716
Maharashtra	0.6813	0.4466	1.0405
Odisha	0.5248	0.4677	0.6218
Punjab	0.4570	0.3916	0.5670
Rajasthan	0.4944	0.4229	0.6122
Tamil Nadu	0.7599	0.6688	0.9211
Uttar Pradesh	0.8108	0.7041	0.9886
West Bengal	0.4512	0.3962	0.5411

Source: Author's own elaboration.

Table A6. Bootstrap efficiency score (2013-14)

State	Bias corrected mean efficiency	Lower limit (2.5%)	Upper limit (97.5%)
Andhra Pradesh	0.6416	0.3961	0.9506
Bihar	0.7150	0.6155	0.8820
Chhattisgarh	0.6237	0.3558	1.0221
Gujarat	0.6696	0.5738	0.8283
Haryana	0.3440	0.2717	0.4612
Jharkhand	0.5646	0.2422	1.1839
Karnataka	0.7610	0.6320	0.9593
Kerala	0.4644	0.3881	0.6074
Madhya Pradesh	0.4794	0.3825	0.6463
Maharashtra	0.6085	0.3294	0.9659
Odisha	0.5291	0.4403	0.6579
Punjab	0.4830	0.4133	0.6128
Rajasthan	0.4774	0.3918	0.6251
Tamil Nadu	0.7517	0.6368	0.9396
Uttar Pradesh	0.7663	0.6450	0.9696
West Bengal	0.4069	0.3362	0.5114

Source: Author's own elaboration.

Table A 7. Returns to scale (State wise results)

State	2009-10	2010-11	2011-12	2012-13	2013-14
Andhra Pradesh	Constant	Constant	Constant	Constant	Constant
Bihar	Increasing	Decreasing	Decreasing	Decreasing	Constant
Chhattisgarh	Constant	Constant	Constant	Constant	Constant
Gujarat	Decreasing	Decreasing	Decreasing	Decreasing	Decreasing
Haryana	Decreasing	Decreasing	Decreasing	Constant	Decreasing
Jharkhand	Constant	Decreasing	Constant	Constant	Increasing
Karnataka	Constant	Constant	Decreasing	Decreasing	Decreasing
Kerala	Constant	Increasing	Decreasing	Decreasing	Decreasing
Madhya Pradesh	Constant	Constant	Decreasing	Decreasing	Decreasing
Maharashtra	Decreasing	Decreasing	Decreasing	Decreasing	Decreasing
Odisha	Constant	Constant	Decreasing	Decreasing	Constant
Punjab	Constant	Increasing	Decreasing	Decreasing	Constant
Rajasthan	Constant	Decreasing	Decreasing	Decreasing	Decreasing
Tamil Nadu	Decreasing	Decreasing	Decreasing	Decreasing	Decreasing
Uttar Pradesh	Decreasing	Decreasing	Decreasing	Decreasing	Decreasing
West Bengal	Decreasing	Decreasing	Decreasing	Decreasing	Decreasing

Source: Author's own elaboration.

Table A 8. Indebtedness of Indian states: outstanding liabilities to GSDP ratio (%)

State	2009-10	2010-11	2011-12	2012-13	2013-14
Andhra Pradesh	25.9	23.9	22.5	23.0	22.9
Bihar	36.5	31.2	27.9	26.4	25.8
Chhattisgarh	16.4	14.3	12.4	13.0	14.0
Gujarat	28.6	27.4	25.3	25.7	24.6
Haryana	18.3	17.8	19.0	19.8	20.5
Jharkhand	26.8	22.2	23.1	23.1	21.9
Karnataka	25.0	22.8	23.3	21.6	22.6
Kerala	32.5	31.8	30.3	31.6	31.7
Madhya Pradesh	29.8	28.7	26.5	24.8	22.2
Maharashtra	23.8	22.0	21.0	21.3	20.5
Odisha	28.1	23.8	21.7	19.6	18.5
Punjab	34.3	33.1	32.3	32.4	32.2
Rajasthan	34.5	29.4	25.7	25.2	24.8
Tamil Nadu	21.2	19.6	19.6	20.5	21.0
Uttar Pradesh	39.4	38.3	35.6	31.3	30.9
West Bengal	44.0	41.9	40.4	39.1	36.7

Source: Author's own elaboration.

Benchmarking kondycji fiskalnej indyjskich stanów – podejście oparte na odporności granicy

Streszczenie

Cel: Artykuł ma na celu skonstruowanie indeksu kondycji fiskalnej indyjskich stanów w oparciu o metodę DEA. Uzasadnieniem wykorzystania metod nieparametrycznych w celu opracowania indeksu jest niezdolność tradycyjnego podejścia współczynnikowego do uwzględnienia wskaźników wielokrotnych nakładów i wyników.

Metodyka badań: Badanie oparto na dwuetapowym podejściu. W pierwszym etapie wykorzystano metodę DEA do oceny kondycji indyjskich stanów w pięciu kolejnych latach. Wskaźniki nakładów i wyników użyte w DEA ostały wybrane na podstawie prostego modelu teoretycznego. Następnie, aby rozwiązać problem błędu szacunkowego (ze względu na wariacje doboru próby), zastosowano samoczynną DEA. W drugim etapie oceniono wpływ zadłużenia na kondycję stanów, wykorzystując cenzurowane modele regresji.

Wnioski: The major outcome of the study is the construction of a fiscal performance index based on multiple indicators. Moreover, the second stage results indicate that state performance is significantly influenced by their degree of indebtedness.

Wartość artykułu: Głównym wynikiem badań jest opracowanie indeksu kondycji fiskalnej opartym na wielokrotnych wskaźnikach. Co więcej, wyniki z drugiego etapu badań wskazują, że kondycja stanów znajduje się pod istotnym oddziaływaniem stopnia ich zadłużenia.

Ograniczenia: Niniejsze badanie to prawdopodobnie pierwsza próba oceny kondycji jednostek subnarodowych pod względem zarówno wypukłych, jak i niewypukłych metod programowania matematycznego.

Implikacje: Zaprezentowane podejście (z odpowiednimi modyfikacjami) może być z powodzeniem stosowane do benchmarkingu kondycji stanów, co może służyć jako podstawa transferu zasobów od rządu centralnego do stanów.

Słowa kluczowe: odporność granicy, indyjskie stany, metoda nieparametryczna

JEL: H 17, D 21, C 61