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An Alternative Approach for Projecting Own Tax Revenue of the Indian States

R. Kavita Rao

Sk Md Azharuddin

National Institute of Public Finance and Policy
New Delhi

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1. Introduction

The Finance Commission plays a pivotal role in allocation of resources between the Union and state governments in India. In addition to the constitutionally mandated requirement to provide recommendations on vertical and horizontal devolution of tax revenues and on the requirement for revenue deficit grants, the terms of reference of different Finance Commissions have included sector specific and macro-fiscal components.

In arriving at a framework for these recommendations, the commission undertakes a review of the finances of the Union and the states. Forecasts of receipts and expenditure form the basis for identifying resources available for devolution as well as the need for revenue deficit grants. The present paper examines the approach adopted for forecasting tax revenues of state governments in earlier FCs and proposes an alternative framework. In particular, the paper argues that tax revenue collections of states could depend not only on the level of GSDP of the state, but also on a number of other structural parameters. Using this approach, the paper seeks to propose an alternative method for forecasting tax revenues.

The paper is structured as follows: section 2 provides an overview of the approach adopted for forecasting tax revenues in the last five commissions. Section 3 discusses the significance of incorporating other structural factors alongside GSDP. The following section presents a brief overview of literature on using the stochastic frontier analysis (SFA) tool to estimate efficiency in revenue mobilisation. Using this framework for own tax revenue for Indian states, section 5 presents estimates for the frontier of revenues as well as efficiency of revenue collection. The section explores the recommendations of the 14th and 15th Finance Commissions in relation to tax efficiency considerations. Finally, it provides some suggestions for an alternative approach.

2. Own Tax Revenue Forecasts in Finance Commission Reports

Starting with the 11th Finance Commission (FC), instead of applying uniform growth rates to states' tax revenue, varying inter-state growth rates were considered based on differences in revenue potential. The 11th FC accounted for constraints stemming from diverse GSDP growth rates among states and their historical tax ratios. States were categorized by GSDP growth rates (12%, 13%, and 14%) and assigned tax buoyancies (1.10, 1.20, 1.30, and 1.35). Depending on their GSDP trends, states were classified normatively into higher or lower growth rate categories. Similarly, based on improvements or deteriorations in tax ratios compared to the past, states were placed normatively into higher or lower buoyancy groups.

The 12th Finance Commission established the relationship between nominal GDP growth rates and aggregate nominal GSDP growth rates. State-specific nominal growth rates were derived by adjusting each state's average annual GSDP growth rate to align with the target for aggregate nominal GSDP growth. The commission aimed to increase the aggregate OTR as a percentage of GDP from 5.91% in the base year to 6.75% in the terminal year, necessitating an annual OTR growth rate of 15%. Prescriptive buoyancy levels ranging from 1.1 to 1.35 were assigned normatively to states based on factors such as the average OTR/GSDP ratio achieved in 2000-03, improvement in the ratio from 1993-96 to 2000-03, and average per capita GSDP for 1999-2002.

13th Finance commission categorized states into groups based on projected real growth rates outlined in the Eleventh Five Year Plan. General category states are grouped according to their tax-GSDP ratios relative to the mean and standard deviation, aiming for realistic improvements and reduced inter-state variation. Meanwhile, special category states are projected to incrementally improve their ratios by the terminal year through annual adjustments aimed at achieving targeted improvements.

The 14th Finance Commission categorized states based on their OTR to GSDP ratio. States below the base year average of 8.26% (2014-15) were assigned normatively a buoyancy factor of 1.5, while those above received 1.05, reflecting average improvements in OTR-GSDP ratios. This led to an increase in the assumed aggregate tax-GSDP ratio from 8.26% to 9.00% by the award's terminal year (2019-20).

The 15th Finance Commission classified all Indian states into five groups based on per-capita revenue expenditure relative to the average, assigning each group different normative GSDP growth rates. States with per capita revenue expenditure of exceeding 40 percent of national average are assigned a higher growth in GSDP as well as higher buoyancy of taxes as well.

A comparison of the approaches adopted by the last five Finance Commissions suggests that all the reports relied on GSDP as the main determinant of the base for taxation. It is possible to argue that the apart from the size of the economy, a number of other structural features could influence the tax base and hence the potential to collect revenues. The following section explores this possibility in the context of own tax revenue of Indian states.

3. GSDP and Other Structural Factors

As discussed in section 2, earlier Finance Commission reports have relied on GSDP as the primary variable of interest in understanding the revenue performance of states. In addition, 15th Finance Commission also incorporated per capita revenue expenditure as a variable of interest. Structural features of the economy can also influence the tax base in different states. For instance, it is generally recognised that sectoral composition can play a critical role – higher share of agriculture can be associated with lower tax collections. To understand the influence of such structural variables alongside GSDP, a fixed effects panel data model has been

employed. [1]The model incorporates structural factors such as the ratios of Gross Value Added (GVA) from manufacturing, services, and mining sectors to agriculture (MAN_AGR, SER_AGR, MIN_AGR). Forest cover (FOREST) can place limits on the expansion of economic activity in the state, and by extension on the ability of the state to raise revenues. Furthermore, the model integrates the impact of a regime shift in the form of introduction of Goods and Services Tax (GST) regime using time dummy variables to capture both level (GST_D) and slope (GST_GSDP) effects over time. Additionally, it includes a time dummy variable (COVID_D) to account for the effects of the COVID-19 pandemic. The fixed effects framework accounts for state-specific and time-specific variations, providing a robust analysis of OTR determinants in the context of Indian states. The data for this analysis covers the period from 2011-12 to 2021-22.

The results of the fixed effect model are reported in Table 1. These results demonstrate that, in addition to GSDP, other factors do significantly influence the Own Tax Revenue (OTR) of Indian states. clearly, sectoral composition of GSDP, extent of forest cover as well as the introduction of GST emerge as statistically significant variables for determining own tax revenue. The model's overall significance is supported by the substantial F statistics. This suggests that projections of OTR should consider a broader range of factors beyond just GSDP.[2]

Table 1: Result of the Fixed effect model

Variable	Coefficients	Stand. Error	t-Statistics	p-value
LGSDP#	0.39	0.11	3.33	0.00*
MAN_AGR	-0.006	0.019	-0.34	0.73
SER_AGR	0.022	0.015	1.45	0.149
MIN_AGR	0.106	0.022	4.67	0.00*
GST_D	1.67	0.157	10.65	0.00*
GST_GSDP	-0.091	0.008	-10.55	0.00*
COVID_D	0.168	0.032	5.14	0.00*
FOREST	-0.021	0.006	-3.21	0.00*
CONSTANT	4.86	1.44	3.36	0.00*
F-Statistics: 209.60	P > F: 0.00*			

#LGSDP is natural logarithm of GSDP, * significant at 5% level.

Forecasts from a fixed effects panel model provide information on the average performance of states. Clearly, some states would perform better than the average, while others would be placed below the average. An alternative framework – Stochastic Frontier Analysis – helps estimate a

[1] Some of the taxes collected by states report stable behaviour while others are subject to excessive volatility. Most earlier commissions have chosen to focus on the own tax revenue collections as an aggregate, instead of analysing individual taxes. The same approach is adopted in this paper as well.

[2] Data description and sources are in appendix (A1)

frontier for each state along with an estimate of the "distance from the frontier", i.e., the efficiency of the state in revenue collection. The following section provides an overview of the literature using this tool in the context of tax revenue performance.

4. Stochastic Frontier Analysis and Efficiency: A Review

According to Alfirman (2003), Fenochietto and Pessino (2013), Jha et al. (1999), and Mukherjee (2019, 2020), efficiency in tax collection is a crucial factor that influences tax collection and Own Tax Revenue (OTR) projections, alongside other important factors.

Tax efficiency, defined as the ability of governments to collect taxes with minimal waste or inefficiency, has been a subject of extensive research employing Stochastic Frontier Analysis (SFA) across various countries. Stochastic Frontier Analysis (SFA) has proven to be a versatile tool employed in both cross-country and country-specific analyses to measure tax efficiency. This methodology allows researchers to simultaneously estimate the determinants of tax capacity and efficiency, accounting for both random noise and inefficiencies in tax collection processes.

In cross country studies, Pessino and Fenochietto (2010) developed a SFA across 96 countries from 1991 to 2006, distinguishing between OECD and non-OECD countries. They found factors such as income inequality, public education expenditures, corruption, and changes in consumer price index influenced tax inefficiencies. In a subsequent study by Fenochietto and Pessino (2013), they expanded their sample to 113 countries, distinguishing 17 resource-dependent countries. They found significant inefficiencies, with resource-dependent countries exhibiting higher inefficiency parameters compared to non-resource-dependent countries. Cyan, Martinez Vazquez, and Voluvic (2013) explored the economic rationale behind tax effort, comparing traditional regression and SFA approaches across 94 countries from 1970 to 2009. They concluded that a country's level of public expenditure, age dependency, agriculture and construction share in GDP value added, globalization and quality of governance provide additional insights into quantifying tax effort (in terms of share of the frontier) effectively along with per capita GDP.

The tool has been used to assess the performance of sub-national jurisdictions as well: Alfirman (2003) assessed Indonesian local governments' tax potential using the Aigner, Lovell, and Schmidt (1977) model, finding that local governments did not achieve their full potential. Barros (2005) employed a Cobb Douglas cost frontier model to measure efficiency of tax offices in Portugal, noting variability in efficiency across offices over time.

Several studies have explored the determinants of own tax revenue (OTR) capacity and tax efficiency across major Indian states over different periods using stochastic frontier analysis. Jha et al. (1999) measure the tax efficiency of fifteen major Indian states (Andhra Pradesh, Assam, Bihar, Haryana, Gujarat, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Orissa, Punjab, Rajasthan, Tamil Nadu, Uttar Pradesh, and West Bengal) from 1980-81 to 1992-93. Their study allows tax efficiency to vary across both time and states. The SFA model considers variables like agriculture share in state domestic product, state level dummies, time and time

squared, and per capita real rural consumption expenditure and the share of central government grants in total state government expenditure alongside GSDP. Garg et al. (2014) measures the tax capacity and tax effort of 14 major Indian states from 1992-93 to 2010-11 using Stochastic Frontier Analysis. Results show significant variations in tax effort index across states, and this variation is increasing over time. Results of their analysis reveals that economic and structural factors significantly impact tax capacity. Specifically, per-capita Gross State Domestic Product positively influences own tax revenue, while a larger agricultural sector has a negative effect. Karnik and Raju (2015) analyse the tax effort of seventeen Indian states from 2000-01 to 2010-11 to explore fiscal space creation. They study four state-level taxes—stamp duty and registration fees, state sales tax, state excise duty, and motor vehicle tax—along with total own tax revenue using Stochastic Frontier Analysis (SFA) models. Their findings indicate that technical inefficiency is the primary reason states fail to achieve their revenue potential. The study identifies significant budgetary room for states to increase revenues from existing taxes, but notes a concerning decline in average tax effort over time. Mukherjee (2019)[3] examines tax capacity and efficiency under the VAT system from 2001–2016, finding a positive association between tax capacity and the scale of economic activity (GSDP), as well as the structural composition of the economy. Factors such as the price changes of mineral oils and the presence of infrastructure like seaports and refineries also played significant roles. In another study, Mukherjee (2020) uses a time-variant truncated panel Stochastic Frontier Analysis (SFA) to estimate GST capacity across Indian states. The analysis incorporates variables such as gross state value added, the ratios of mining, manufacturing, services, and industry GVA to agriculture GVA, along with relevant GST-related dummy variables.

5. The Frontier and Efficiency in Indian States

Considering the importance of efficiency, this study employs a time-invariant Stochastic Frontier Analysis (SFA) for 28 Indian states to model Own Tax Revenue (OTR) alongside significant structural variables, such as the ratios of Gross Value Added (GVA) from manufacturing, services, and mining sectors to agriculture. The model also includes a COVID-19 dummy, GST level and slope dummies, and a dummy to distinguish between general category states and special category states. The study covers annual data from 2011-12 to 2022-23. Forest cover data is excluded due to its discontinuous series, necessitating interpolation, and the latest available data only extending to 2021-22. Including forest cover would result in dropping one year of observations for all other variables. Additionally, data without forest cover, extending to 2022-23, provides better model fits, as indicated by a higher gamma-efficiency parameter value.

Various alternative formulations of the SFA allow for estimating time variant as well as time invariant efficiency estimates. The paper uses the time invariant method – it features a simpler model specification by assuming that inefficiency effects do not change over time, facilitating easier interpretation of results and a focus on long-term efficiency (Kumbhakar et al., 2015).

[3] He utilized Battese and Coelli's (1995) methodology to simultaneously estimate tax capacity and efficiency, highlighting non-linear relationships between per capita income and tax efficiency.

The estimation process is also less complex, leading to more robust and stable parameter estimates, especially in smaller samples (Greene, 2005). Additionally, by focusing on long-term efficiency, time-invariant SFA provides a clearer picture for strategic decision-making, useful for benchmarking and policy analysis (Fried et al., 2008). Furthermore, it reduces the risk of overfitting, offering a more parsimonious framework that captures essential efficiency differences without unnecessary complexity (Coelli et al., 2005).

Table 2 presents the results of the stochastic frontier analysis. The paper identifies an overall tax buoyancy of 1.05 across all states. The study highlights those structural variables, particularly the GVA of services and mining as a share of agriculture, have a positively impact on OTR collection. The introduction of GST exhibits a positive intercept effect but a negative slope effect. The positive intercept signifies an increase in OTR levels following GST implementation, while the negative slope indicates a decrease in OTR buoyancy after the introduction of GST. Additionally, the COVID-19 pandemic negatively affects OTR collections. Special category states are at a disadvantage in OTR collection compared to general category states indicated by a negative coefficient of the special category dummy (SPC). The parameter Gamma in the SFA estimation represents the proportion of variation in the composite error that is due to inefficiency. It ranges from 0 to 1, where a value of 0 indicates that all variations in the composite error are due to random noise, and a value of 1 indicates that all variations are due to inefficiency. For our model, Gamma value of 0.94 indicates that most of the variations in OTR of the states are due to inefficiency. The efficiency of OTR collection varies among states. Table 3 provides the time-invariant efficiency scores for the 28 Indian states.

Table 2: Results of the Stochastic Frontier analysis

Variable	Coefficients	Std. Error	z-Statistics	p-value
LGSDP	1.05	0.031	33.26	0.00*
MAN_AGR	-0.015	0.014	-0.98	0.33
SER_AGR	0.019	0.011	1.69	0.09**
MIN_AGR	0.09	0.023	3.79	0.00*
GST_D	1.23	0.104	11.86	0.00*
GST_GSDP	-0.091	0.008	-10.55	0.00*
COVID_D	-0.095	0.018	-2.09	0.03*
SPC	-0.29	0.066	-4.39	0.00*
CONSTANT	-3.33	0.427	-7.80	0.00*
Gamma	0.94	0.13*		
sigma_u^2	0.18	0.39*		
Sigma_v^2	0.012	0.001*		

* significant at 5% level, ** significant at 10 % level.

Table 3: Efficiency scores of Indian states

States	FY	OTR Frontier (Rs. Crore)	Efficiency	Rank
Himachal Pradesh	2021-22	9472.264	0.98	1
Uttar Pradesh	2021-22	129880.3	0.98	2
Madhya Pradesh	2021-22	72687.59	0.96	3
Telangana	2021-22	79052.94	0.96	4
Uttarakhand	2021-22	14699.76	0.95	5
Chhattisgarh	2021-22	29929.38	0.93	6
Andhra Pradesh	2021-22	76891.21	0.93	7
Goa	2021-22	6574.599	0.93	8
Punjab	2021-22	42296.92	0.93	9
Tamil Nadu	2021-22	140469.3	0.92	10
Karnataka	2021-22	137073.1	0.91	11
Haryana	2021-22	59446.34	0.88	12
Meghalaya	2021-22	2349.271	0.88	13
Assam	2021-22	23583.22	0.88	14
Maharashtra	2021-22	213730	0.87	15
Rajasthan	2021-22	80483.38	0.85	16
Kerala	2021-22	71814.58	0.85	17
Odisha	2021-22	48106.55	0.83	18
Gujarat	2021-22	126858.2	0.82	19
Bihar	2021-22	45510.5	0.79	20
West Bengal	2021-22	90535.47	0.74	21
Arunachal Pradesh	2021-22	2083.141	0.73	22
Tripura	2021-22	3687.362	0.72	23
Jharkhand	2021-22	26359.96	0.70	24
Sikkim	2021-22	2114.943	0.65	25
Manipur	2021-22	2170.479	0.64	26
Nagaland	2021-22	1924.496	0.54	27
Mizoram	2021-22	1750.203	0.51	28
Efficiency	Average GCS	0.88	Average SCS	0.75

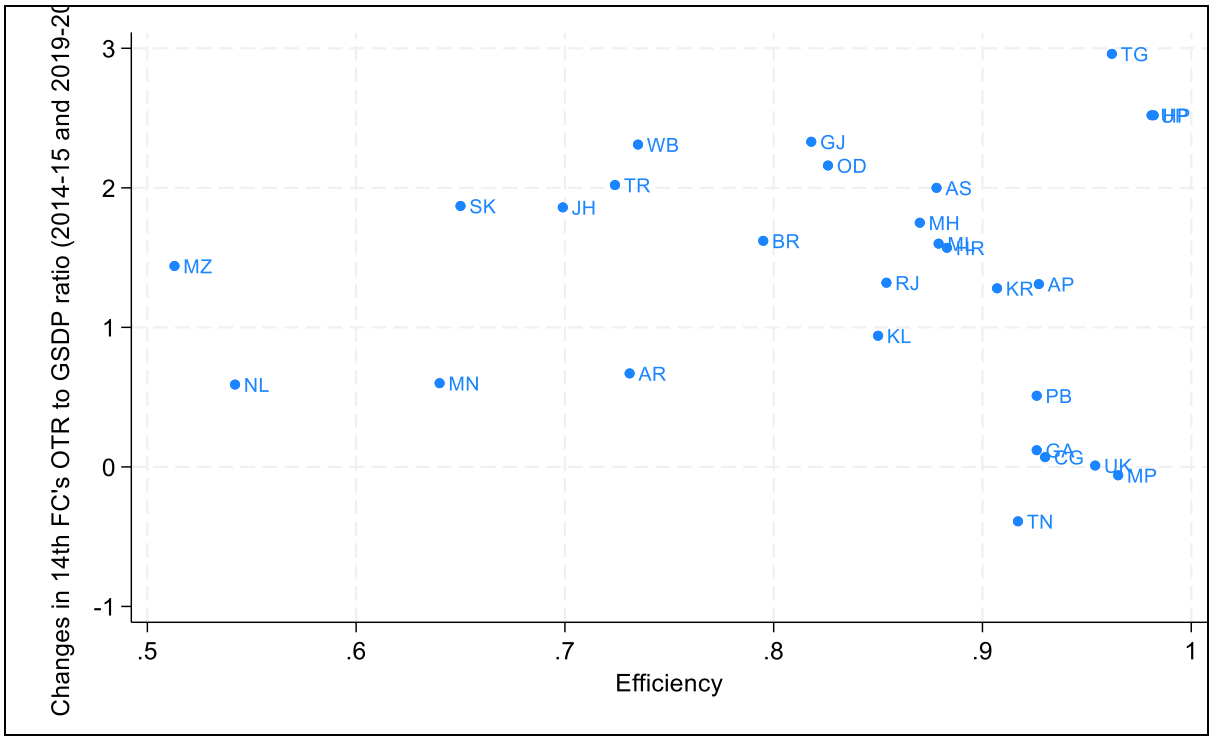
This framework suggests that additional revenue that a state can raise could be related to the efficiency of the state. The stochastic frontier of the state represents the potential revenue the state can collect and states with relatively lower efficiency can be nudged to raise more.

Using this framework and the estimates of efficiency, the paper analyses the forecasts of the last two finance commissions.

The 14th Finance Commission (FC) forecasts of tax revenue classified states into two categories based on their tax to GSDP ratio – states with ratios higher than national average and those below. The latter were normatively assigned a higher buoyancy of 1.5 while the latter were

assigned a buoyancy of 1.05. These assumptions implied differences in the proposed increment in tax to GSDP ratio over award period. Figure 1 presents these proposed increments against the estimated efficiency of the state. These is no evident correlation between the proposed increments and the efficiencies, suggesting that the normative assumptions might not be related to realisable potential of the state.

Figure 1: Scatter plot-14th FC's OTR-GSDP ratio projection and efficiency



The 15th Finance Commission (FC) categorized all Indian states into five different groups based on per-capita revenue expenditure as a percentage of the average per-capita revenue expenditure[4], assigning normatively different GSDP growth rates to the states. States with per capita revenue expenditure more than 40% above the average were recommended higher growth rates and higher buoyancy, on the premise that states with higher expenditure must have higher earnings to sustain their expenses.[5]

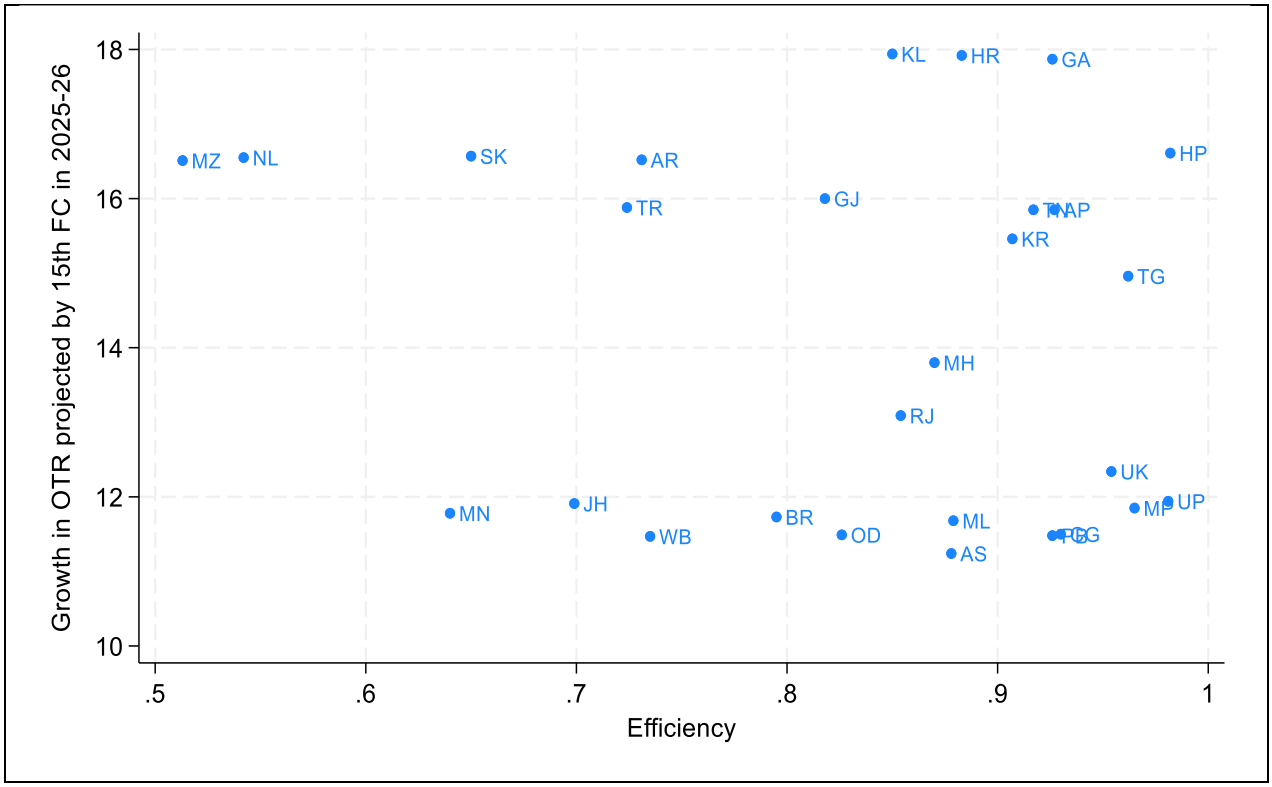
Since the normative assumptions in the case of 15th Finance Commission relate more to GSDP growth, in assessing the relation between the differences in normative forecasts of revenue and efficiency, Figure 2 presents projected growth in own tax revenue for the terminal year of the

[4] Averaged for 2017-18 and 2018-19.

[5] In order to explore the implies normative relation between per capita revenue expenditure and GSDP growth or tax buoyancy, Granger non-causality test was performed for these pairs of variables. The test suggests there is no causal relation between per-capita revenue expenditure and buoyancy or between per-capita revenue expenditure and GSDP growth rates. (Appendix -A2)

award period against estimated efficiency. Once again, there is no observed correlation between these two variables.

Figure 2: Scatter plot- 15th FC's projected growth rates and efficiency



6. Suggestions for An Alternative Approach

Improving the states' own tax revenue (OTR) is crucial for enhancing fiscal autonomy and ensuring sufficient funding for development initiatives. The potential for increasing OTR lies in either implementing significant policy changes or improving the efficiency of tax collection. Given that tax policies across Indian states are generally similar, differences in performance of states can be attributed to modest differences in tax regimes and differences in tax collection efficiency.

In the framework of Stochastic Frontier Analysis, the estimates for the frontier can be a good reference point for the potential tax a state can collect. Given the model presented in section 5, the only variables which might vary significantly over the duration of the award period is GSDP. Given the forecast for GSDP, the model can provide estimates of the frontier for different years of the award period. With this approach, sharper improvements in revenue performance would be expected from states with lower efficiency.

Two potential adjustments can be undertaken to this estimate. First, some of the states could report actual collections above the estimated frontier values in the reference – for these states,

the estimated buoyancy from the stochastic frontier equation can be used to generate a forecast. Second, for states with considerably lower efficiency, if a case is to be made for gradual improvements in efficiency, suitable adjustments can be incorporated.

Finance Commissions often provide suggestions on policy changes for improving tax revenue collections. The potential impact of such proposed changes would need to be factored in, as an increment over and above the estimates provided by the frontier.

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Appendix

A1. Data Description and Sources:

Variables	Description	Sources
OTR	Own Tax Revenue	RBI States Finances, RBI
GSDP	Gross State Domestic Product	MOSPI, GOI
LGSDP	Natural logarithm of GSDP	
LOTR	Natural logarithm of OTR	
MAN_AGR	Ratio of Manufacturing GVA to Agriculture GVA.	MOSPI, GOI
SER_AGR	Ratio of Services GVA to Agriculture GVA.	MOSPI, GOI
MIN_AGR	Ratio of Mining GVA to Agriculture GVA.	MOSPI, GOI
GST_D	Intercept dummy for GST introduction	
GST_GSDP	Interactive dummy between GST and LGSDP	
COVID_D	Dummy to represent COVID-19 period	
FOREST	Forest cover as a percentage of total Land area	Forest Survey of India
SPC	Dummy for Special category states	

A2. Granger Non-causality Test

The Granger non-causality test between per capita revenue expenditure and buoyancy shows no causal relation from per-capita revenue expenditure to buoyancy, questioning the normatively assigned higher buoyancy for states with higher per-capita revenue expenditure. Furthermore, no Granger causality (Juodis, Karavias and Sarafidis (2021)/JKS Granger Non-Causality test) is found from per-capita revenue expenditure to GSDP, again challenging the 15th FC's rationale for assigning higher GSDP growth rates to states with higher per-capita revenue expenditure.

Table 4: Granger non-causality test between per-capita revenue expenditure and buoyancy

Variable	Coefficient	Std. Error	Z-Value	P-Value
LPREVEX	-19.53	14.74	-1.32	0.19
HPJ Wald Test: 1.74 p-Value: 0.19				
H_0: LPREVEX does not Granger-cause Buoyancy of OTR				
H_1: LPREVEX does Granger-cause Buoyancy of OTR				

Table 5: Granger non-causality test between per-capita revenue expenditure and growth rate of GSDP

Variable	Coefficient	Std. Error	Z-Value	P-Value
LPREVEX	0.04	0.05	0.83	0.40
HPJ Wald Test: 0.68 p-Value: 0.40				
H_0: LPREVEX does not Granger-cause growth rate of GSDP				
H_1: LPREVEX does Granger-cause growth rate of GSDP				