Natural Resources Revenue Buoyancy in India: Empirical Evidence From State-specific Mining Regime

Chakraborty, Lekha S and Thomas, Emmanuel and Gandhi, Piyush

NIPFP, JNU, Oxford University

2019

Natural Resources Revenue Buoyancy in India:
Empirical Evidence
From State-specific Mining Regime

Lekha Chakraborty[1]
Emmanuel Thomas
Piyush Gandhi

Abstract

The dynamics of natural resources revenue – the payment due to the sovereign owner (government) in exchange for the right to extract the mineral substance – is complex, how it is fixed and paid. It is controversial and significant, as it is a revenue that is unique to the resources sector and also that has been fixed and paid in multiple extractive tax regimes, sometimes on the measures of profitability, but more often based on ad valorem (value based) or the unit of the mineral extracted. We try to analyse how dynamic revenue from natural resources across the States in India , within a comparative framework with other (direct and indirect) taxes. Using the ARDL methodology, we have tried to estimate the revenue buoyancy within States and between the States in a panel, and analysed the short run and long run coefficients and their speed of adjustment. Using HP filter, we tried to estimate the potential GDP, and also analysed the cyclicality of revenue buoyancy using output gap variable across states. Our findings revealed that revenue from natural resources is a buoyant source of revenue, though there is distinct State-specific differentials. The policy implication of our study for the natural resources sector is the rate rationalisation as higher rates revised upward every three years through Royalty Study Group by Government of India can affect the revenue augmentation if Laffer Curve starts operating and in turn it affects the firm level competitiveness. The decision of shifting the mining regime from tonnage regime to ad-valorem regime for non-atomic non-ferrous is welcome, as it is market-linked.

Keywords: Natural resources taxation, Buoyancy, ARDL, Mining regime

---

[1] The authors respectively are Professor at NIPFP; Doctoral Fellow at JNU; and MPhil scholar at Oxford University and former intern, NIPFP. This is the revised and extended version (incorporating more time series) of "tax buoyancy analysis" presented by Pinaki Chakraborty in the NIPFP Annual State Finance Conference August 2018, at India International Centre, New Delhi. The authors sincerely acknowledge the technical assistance from Divy Rangan, former NIPFP intern.

Introduction

The dynamics of natural resources revenue – the payment due to the sovereign owner (government) in exchange for the right to extract the mineral substance – is complex, how it is fixed and paid. This is a controversial realm, as the revenue from natural resources is unique and also that has been fixed and paid in multiple extractive industrial regimes, sometimes on the measures of profitability, but more often based on ad valorem (value based) or the unit of the mineral extracted.

In the context of reforms/amendments related to the ways in which natural resources sector is regulated and taxed, there is a growing recognition to examine the responsiveness of the natural resource taxation to the GDP in comparison with other taxes. This paper is confined to the analysis of buoyancy of the mining taxation *vis a vis* other direct and indirect taxes in the context of India across its 28 States. The buoyancy is defined as the responsiveness of revenue to a change in the GDP. We confine our analysis to mining, as we do not have any other significant source of revenue from natural resources augmenting the States' revenue and in intergovernmental fiscal transfers mechanism in India, unlike other federations, the revenue from natural resources has not yet been designed or integrated within the divisible pool of tax sharing with the other sources of revenue including direct taxes and GST.

The paper is organised into sections. Section 1 looks into the natural resources sector specific dynamics, with special emphasis on mining sector. Section 2 analyses the existing literature on tax buoyancy. Section 3 presents the data sources and methodology. Section 4 presents the buoyancy estimates of mining taxation in comparison with other direct and indirect taxes across major states in India. Section 5 concludes.

I. Dynamics of Natural Resources sector and Mining Regime in India

Globally, the global mining arrangements are broadly categorized into three: unit based, ad-valorem based or profit based. The unit based royalty is the royalty is determined with reference to the volume of production, or is determined with reference to gross revenues. It is also referred to as tonnage-based royalty or unit-based royalty. The ad valorem royalty is calculated by applying a percentage rate to the gross sale value. It is also referred to as value-based royalty. This is usually 'ex-mine' or pithead value (sale realisation) less allowable expenditure. The Profit-based royalty, where the royalty is calculated as a percentage of gross/net profit.

Mining royalty regime varies widely between countries and minerals. Minerals include coal, metallic minerals and non-metallic minerals. As mentioned earlier, there are three types of royalty tax systems in the world namely: Unit Based, Ad valorem (value based) and Profit based. India follows both tonnage and as valorem based royalty rates. India is having the highest royalty rates in the world. Apart from royalty, almost all countries rely on profit (income) based taxes and Value Added Tax (VAT) for revenue argumentation. While designing the income tax system, though a policy maker can grapple with two key elements, the tax rate, and the tax base that the rate is applied to, empirical evidence suggests that in most nations, income tax policy is mainly implemented through manipulation of the tax base rather than through the tax rate. Broadly the tax rate is either uniform for all tax-payers, or for all tax payers at a given level of profit. While some countries impose a flat rate on all commercial taxpayers, a few have a progressive tax scheme that imposes higher tax rates on taxpayers with higher levels of profit.

Even the royalty rates in India are at the highest level. The rate of royalties on iron ore is 15% and that on coal is 14% which is way more than the other countries of the world. The rate of royalties on iron ore and coal in South Africa is in the range of 0.5% to 7% and has dependent on whether the mineral is refined or unrefined. In Philippines, the rate of royalties is at least 55 per cent of the market value of gross output of the minerals extracted. The rate has also been decided by the company and the indigenous cultural community but the rate should not be less than 1%.

Mining taxation regime in India is in a state of flux. Particularly, the current methodology of royalty estimation for mining sector requires a relook. The mining royalty regime in India is onerous. India has one of highest royalty rates in the world. Though there has been an increasing trend in the regime shift in mining royalty away from the tonnage royalty regime to ad valorem, the rationalization of rates to internationally competitive rates has not yet materialized. Every three years, the royalty rates are revised upwards in India.

In ferrous royalty regime, though there has been a shift from tonnage to ad valorem, the base estimation suffers from discretion in deciding the grade content (ʎ1,2,3…n) in the following formula) of the extracted ore in arriving at royalty calculations.

$$RROM = [ʎ_{1,2,3\ldots n}\ ROM] * \Upsilon_{ore}$$

where

RROM	=	Royalty revenue from metal contained in Fe ore
$ʎ_{1,2,3\ldots n}$	=	Grade percent of Metal in the different types of extracted iron ore
ROM	=	Tonnage of Run of Mine (ROM) Ore Treated
Υ_{ore}	=	Prevailing Royalty Rate on the Fe ore

There is a regime shift in ferrous royalty since 2012. Prior to 2012, the Fe royalty was estimated on the basis of tonnage method.

$$RROM = [ʎ * ROM] * [\alpha\ PIBM] * \Upsilon ore$$

RROM	=	Royalty revenue from metal contained in the ore
ʎ	=	Grade percent of Metal in the extracted ore
ROM	=	Tonnage of Run of Mine (ROM) Ore Treated
PIBM	=	IBM Fe Prices
ϒore	=	Prevailing Royalty Rate on the Fe ore

The grade percent was different for ore lumps and fines, and also within each category. The recent royalty rate for iron is as high as 15 per cent ad valorem of national benchmark (IBM) price.

II. Tax Buoyancy : Conceptual and Empirical Issues

Effective fiscal consolidation path is through better tax buoyancy than expenditure compression. There is an increasing recognition of the role of government spending in enhancing economic growth, however whether rising economic growth would raise enough sufficient tax revenue to maintain fiscal deficit GDP threshold to 3 per cent across States needs to be examined. The answer to whether increase in economic growth will raise tax revenue so as to maintain fiscal deficit to GDP threshold ratio fiscal balances depends on an important ingredient of a tax system, the "tax buoyancy", the measure of how tax revenues responds to changes in GDP (Dudine Paolo and Joao Tovar Jalle, 2017, Blanchard, Dell'Aricia and Mauro, 2010).

A tax buoyancy of one would imply that an increase in GDP by one percent of GDP would increase tax revenue also by one percent, thus leaving the tax-to-GDP ratio unchanged. From the perspective of meeting the FRBM targets, a tax buoyancy exceeding one is required. When the tax buoyancy exceeds one, tax revenue increases more than GDP. If tax buoyancy is below unity, tax revenues are not increasing as much the increase in GDP.

Why tax buoyancy is crucial in fiscal policy practices? First, tax buoyancy reflects the role of revenue policy in fiscal consolidation efforts in India. The responsiveness of tax to economic growth is crucial for fiscal sustainability in the long run. Tax buoyancy reflects both the structural policies and automatic stabilisers. The responsiveness of tax to fluctuations in output (output) at the state level is crucial for long term fiscal frameworks of subnational governments. Second, tax buoyancy gives indication to the government, whether effective tax mobilization efforts can increase the revenue in concomitant with economic growth. The tax buoyancy estimates help the fiscal authorities to be certain about the sustained increase in tax revenue in line with GDP growth. Three, it helps in designing the structural policies relate to tax regime, and also in forecasting macro-fiscal variables towards fiscal consolidation.

In this paper we ask four questions. How the natural resource tax buoyancy varies across Indian States vis a vis other taxes, both over short run and long run and the speed of adjustment towards long run equilibrium? How tax buoyancy varies across the panel of high income, low income and middle income States in India? Do natural resource tax buoyancies remain the same during the different periods in India? How tax buoyancy responds to the cyclicality in output gaps of subnational governments in India?

III. Data and Methodology

We analyse the tax buoyancy for the period 2000-01 to present and specifically for the period 2011-12 to 2018-19. The data for macro-fiscal variables are organized from State Finance Accounts and Budget documents. The state wise GSDP variables collated from CSO. The data for GSDP is made comparable over the period of analysis using splicing method.

The tax buoyancy is calculated using the following formula:

Log (T) = a + b_1 log (GSDP) + u

Where b_1 is the tax buoyancy

T = tax revenue

GSDP = Gross State Domestic Product

We have used time series techniques to deal with the constraints of the short time series. The short run buoyancy and long run buoyancy estimates are reported with the speed of adjustment.

We used ARDL to estimate the dynamic time series.

Equation 1

$$\Delta \ln y_{it} = \varphi_i y_{it-1} + \beta_i' x_{it-1} + \sum_{j=1}^{p-1} \lambda_{ij} \Delta \ln y_{it-j} + \sum_{q=1}^{q-1} \gamma_{ij}' \Delta \ln x_{it-j} + \mu_i + \xi_{it},$$
$$i = 1,2,\ldots,N; t = 1,2,\ldots,T$$

where y_{it} is the natural logarithm of tax revenue variable, x_{it} is the natural logarithm of GDP . We have not used a set of potential controls in the regression in the initial round. The coefficient on the $\varphi_i y_{it-1}$lagged dependent are the other explanatory variables, $\varphi_i y_{it-1}$are scalar coefficients on lagged first-differences of dependent variables.

$\sum_{j=1}^{p-1} \lambda_{ij} \Delta \ln y_{it-j}$coefficient vectors on first-differences of explanatory variables and their lagged values. ξ_{it}, is independently distributed across *i* and *t*, with zero means and constant variances. Equation (1) translates that change in tax revenue can be determined by a distributed lag of order p of the dependent variable (tax), and a distributed lag of order q of GDP.

Assuming that $\theta_i' < 0$ for all i, there exists a long-run relationship between y_{it} and x_{it} :

Equation 2

$$\ln y_{it} = \theta_i' \ln x_{it} + \eta_{it}, i = 1,2, \dots, N; t = 1,2, \dots, T$$

Equation (1) can then be rewritten as:

Equation 3

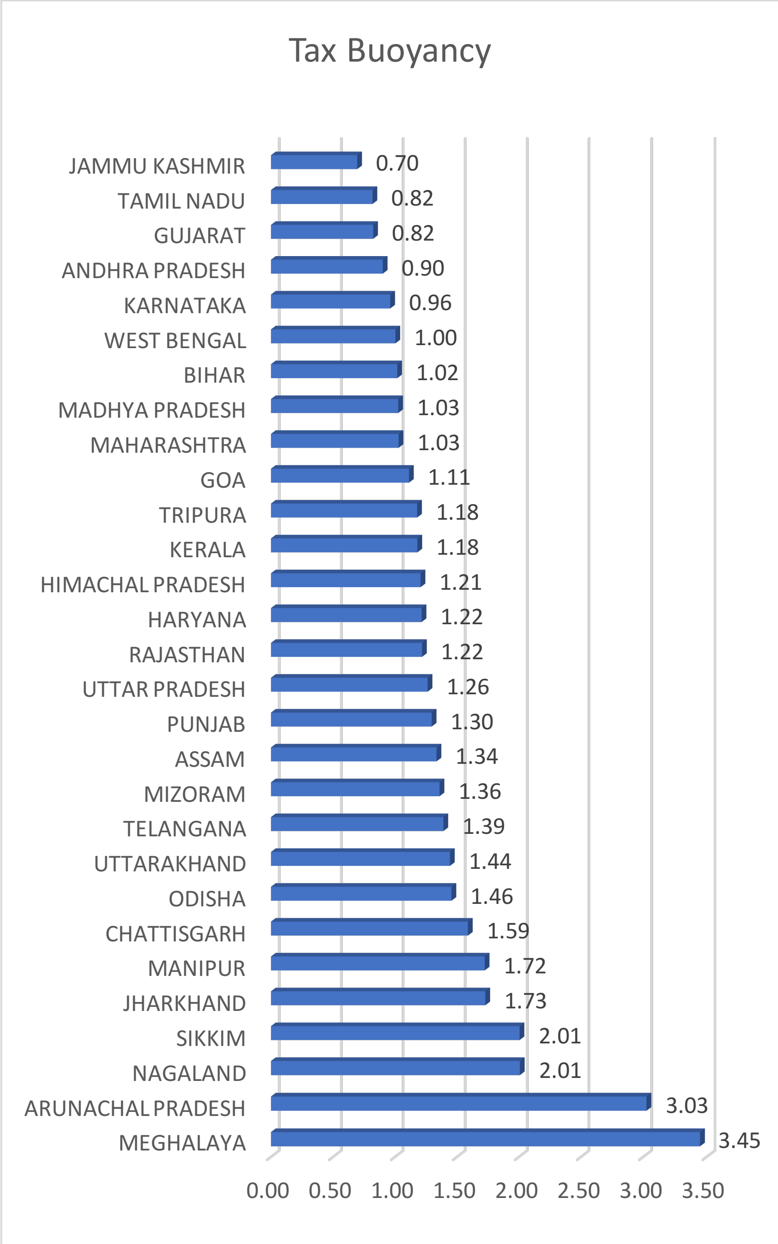
$$\Delta \ln y_{it} = \varphi_i \eta_{it-1} + \sum_{j=1}^{p-1} \lambda_{ij} \Delta \ln y_{it-j} + \sum_{q=1}^{q-1} \gamma_{ij}' \Delta \ln x_{it-j} + \mu_i + \xi_{it},$$
$$i = 1,2, \dots, N; t = 1,2, \dots, T$$

where η_{it-1} is the error correction term (that is, the deviation of variables at a certain point in time from their long run equilibrium), and φ_{i_i} is measures the speed of adjustment towards the long-run equilibrium. This specification allows capturing the idea that an equilibrium relationship links revenue and GDP in the long-run, but that the dependent variable may deviate from its equilibrium path in the short-run (due, e.g., to shocks that may be persistent) (Dudine , Paolo and Joao Tovar Jalles , 2017).

IV Tax Buoyancy Estimates: Time Series Estimates of Individual States

The tax buoyancy estimates for the period 2011-12 to 2018-19 showed that all States except Jammu Kashmir, Tamil Nadu, Gujarat, Andhra Pradesh and Karnataka has tax buoyancy exceeding unity.

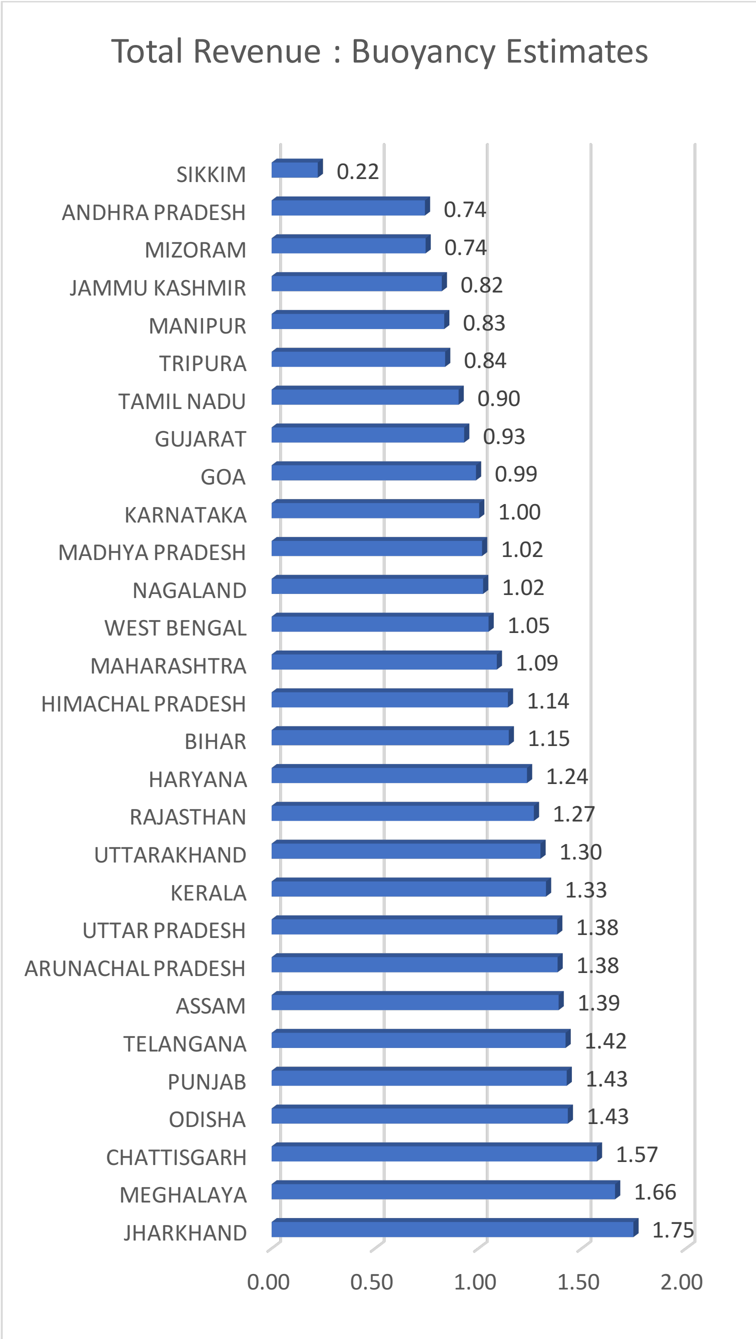
Figure 1: Tax Buoyancy across States of India, 2011-12 to 2018-19



Source: Finance Accounts of States (various years), State Budget documents (various years) and CSO (various years)

The revenue (tax plus nontax revenue) buoyancy is also calculated across states for comparison purposes (Figure 2). The total revenue buoyancy across States show that except Sikkim (0.2), Andhra Pradesh (0.74), Mizoram (0.74), Jammu Kashmir (0.82), Manipur (0.83), Tripura (0.84), Tamil Nadu (0.90), Gujarat (0.93) and Goa (0.99), all other states have revenue buoyancy exceeding unity.

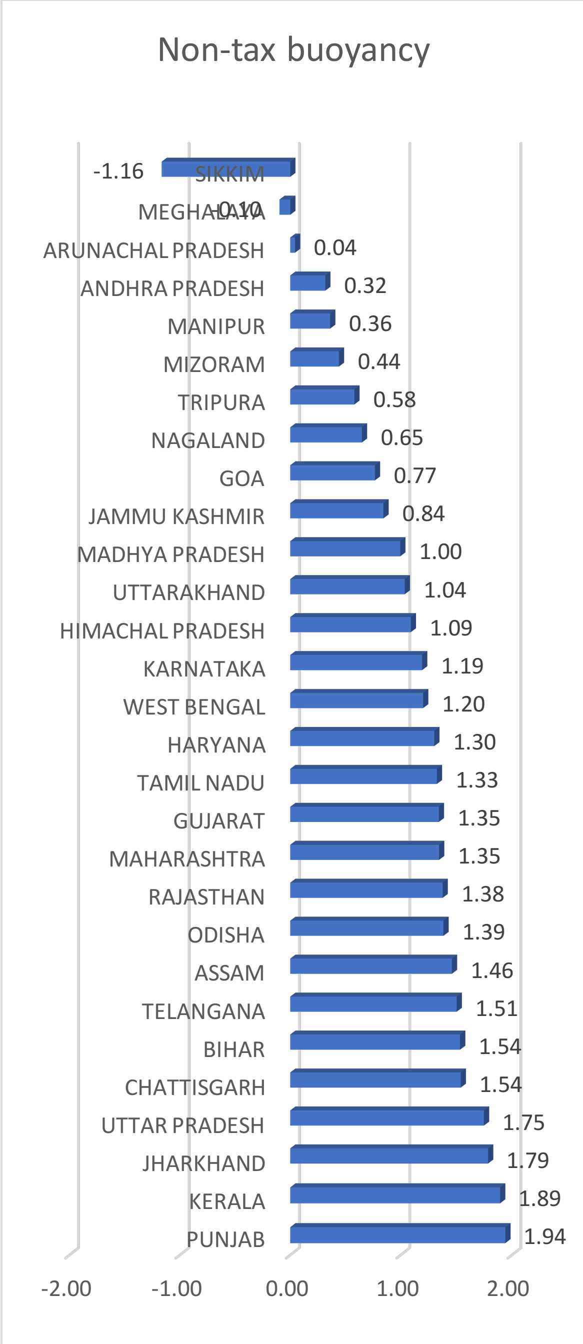
Figure 2: Total Revenue Buoyancy across States of India, 2011-12 to 2018-19



Source: Finance Accounts of States (various years), State Budget documents (various years) and CSO (various years)

The non-tax revenue buoyancy of the States revealed that except Goa, Andhra Pradesh and a few North Eastern States, all other States have non-tax buoyancy greater than one. Punjab (1.94) and Kerala (1.89) top the scale. The mining States like Jharkhand, Chhattisgarh, Odisha, and Rajasthan are also among the top States with regard to non-tax revenue buoyancy.

Figure 3: Non-Tax Revenue Buoyancy across States of India, 2011-12 to 2018-19



Source: Finance Accounts of States (various years), State Budget documents (various years) and CSO (various years)

IV.1. Tax Buoyancy: ARDL Estimates

Often, fiscal stimulus is launched through the tax side than expenditure side assuming that the buoyancy of the former will ensure minimum fiscal slippage, while shoving the economy out of a glut. The general idea is that a reduction in rates will increase the tax base and compliance. This along with its positive impact on growth would lead to higher tax buoyancy. The fiscal stimulus programme announced by finance minister is also premised on similar idea. An IMF working paper titled *'How buoyant is the tax system? New evidence from a large heterogeneous panel'* by Paulo Dudine and Joao Tovar Jalles, published in 2017 finds that tax buoyancies are generally equal to unity or greater for developed as well as for less developed economies.

In our economy, the tax-GDP ratio has hovered around 14-17% for the last few decades, which is the combined figure for the Union and the States. Direct and indirect taxes contribute almost equally to the total tax revenue although the share of direct taxes is slightly higher at 52% during 2017-18. Union collects about 10% of GDP as tax revenue and the rest is by all the States together. The finance minister's stimulus package is premised on the buoyancy of these taxes. Hence, it is imperative to look at the tax buoyancy factor both at the Union and States level during the recent past.

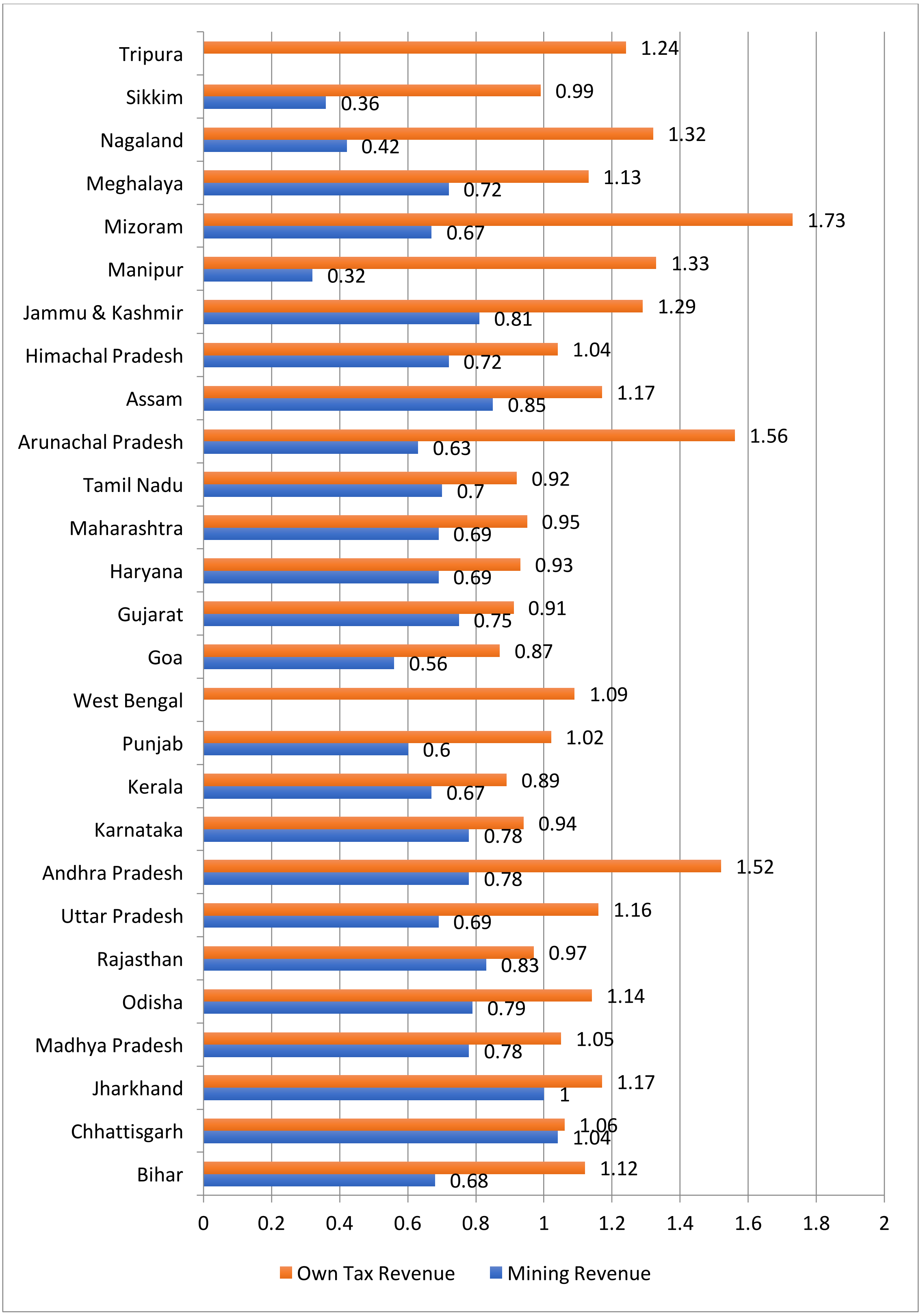
Tax buoyancy measures the response of tax revenue to a change in national income and the tax policy. Economists generally define it as the ratio of percentage change in tax revenue to a percentage change in income. Buoyancy can be estimated for the long term as well as for the short term. Short-term buoyancy above unity signifies that the tax system acts as an automatic stabiliser. Here, the tax system itself would automatically leave a greater proportion of income with the taxpayers during a slowdown dampening the fall in demand. Similarly, during a boom, the system would automatically take away more income through taxes consequently slowing down the growth of demand. Such a tax system has a built-in-stabiliser in it. In other words, the short run buoyancy measures the instantaneous effect of a change in GDP on the tax revenue.

Long-run buoyancy is important in gauging the impact of long-run growth of the economy on fiscal sustainability. Long run buoyancy above unity would mean that faster growth would lead to better fiscal balance through the revenue side. This would be an important guiding principle while considering counter cyclical fiscal measures, meaning, an increased fiscal deficit would trigger growth, which can in turn generate more tax revenue, leading to the easing of fiscal pressure.

Auto Regressive Distributed Lag (ARDL) model allows us to estimate the long-run and short-run buoyancy along with the speed of adjustment. Speed of adjustment tells us how fast the buoyancy converges to the long run equilibrium value. The estimates for the period, 2001-2017, show that the long-run and short-run buoyancy are 1.05 and 1.74, respectively, for total tax (Union and states combined). The high short-run buoyancy will mean that the current slow down would have an amplified negative impact on tax revenue in the short-run. The slow down will have a heavy impact on the Union tax revenue which has an overall short-run buoyancy coefficient which is very high. The very high short-run buoyancy of direct taxes will escalate the fiscal pressure emanating from the recent cut in corporation taxes. This will also have a deleterious effect on the fiscal health of the States as the shareable kitty will shrink substantially. Now with the 15th Finance Commission (FC) asked to consider the impact of the award of 14th FC on Union Finances, any fall in the share of the States would adversely affect the State finances.

Relatively low buoyancy for States' taxes (1.04 for the long run and 1.19 for short run) will mean a reduced adverse impact of the slowdown on States as a whole. But the effect on individual States will depend on their buoyancies and the extent of deceleration of gross state domestic product of respective States. Short run buoyancy is found to be either equal to or less than unity for all the States. Bihar, Goa, Haryana, Jharkhand, Odisha and Sikkim will be the States that would be least affected in the short run, with a buoyancy factor less than unity. For the long term, all States have buoyancies either equal to unity or greater than unity. Goa, Gujarat, Haryana, Karnataka, Madhya Pradesh, Maharashtra, Odisha, Punjab, Rajasthan, Tamil Nadu, West Bengal, Assam, Nagaland and Sikkim have long-run buoyancy equal to one making them less vulnerable in the long run. Interestingly, most of the richer States fall in this category.

Figure 4: Buoyancy of Tax and Natural Resources Revenue



Source: Finance Accounts of States (various years), State Budget documents (various years) and CSO (various years)

More detailed analysis of buoyancies of individual taxes including GST (where we have only a short time series) is essential. Though we have incorporated the optimal parameterisation in the models by choosing the apt lag lengths, the estimates can be refined further by incorporating variables like inflation, structural variables, political factors and business cycles in the tax buoyancy estimation models. At disaggregate level analysis, it is also important to see whether the buoyancy of divisible pool taxes is greater than States' own taxes. Along with these, an understanding of how tax buoyancies behave in different phases of business cycle (output gap) will throw more light on the effectiveness of such polices.

Table 1: Buoyancy of Own Tax Revenue of States

	State	**Long-Run Buoyancy**			**Short-Run Buoyancy**			**Speed of Adjustment**
		<1	**1**	**>1**	**<1**	**1**	**>1**	
	Bihar		1.12*** (0.12)		0.42** (0.22)			-0.21* (0.11)
	Chhattisgarh			1.06*** (0.02)	0.81*** (0.18)			-0.97*** (0.05)
	Jharkhand			1.17*** (0.04)	0.47** (0.21)			-0.91*** (0.1)
Low Income	Madhya Pradesh		1.05*** (0.04)			0.75* (0.39)		-0.55** (0.24)
	Odisha			1.14*** (0.05)	0.07 (0.17)			-0.23** (0.09)
	Rajasthan		0.97*** (0.07)		0.25* (0.14)			-0.16 (0.1)
	Uttar Pradesh			1.16*** (0.03)		0.65** (0.28)		-0.41*** (0.13)
	Andhra Pradesh		1.52*** (0.37)		0.05 (0.15)			-0.07 (0.07)
	Karnataka	0.94*** (0.03)			0.47*** (0.12)			-0.26* (0.15)
Middle Income	Kerala	0.89*** (0.04)			0.39** (0.14)			-0.27* (0.13)
	Punjab		1.02*** (0.05)			0.63 (0.39)		-0.41** (0.17)
	West Bengal		1.09*** (0.16)		0.41 (0.29)			-0.12 (0.08)
	Goa	0.87*** (0.1)			0.1 (0.15)			-0.22*** (0.07)
	Gujarat	0.91*** (0.05)			0.62*** (0.21)			-0.22* (0.12)
High Income	Haryana		0.93***		-0.09 (0.29)			-0.18 (0.11)
	Maharashtra	0.95*** (0.02)			0.56*** (0.14)			-0.47*** (0.15)
	Tamil Nadu	0.92*** (0.03)			0.53*** (0.16)			-0.39** (0.15)
	Arunachal Pradesh			1.56*** (0.07)		0.41 (0.42)		-0.37** (0.17)

Special Category	Assam			1.17*** (0.08)		0.65** (0.25)		-0.19 (0.11)
	Himachal Pradesh		1.04*** (0.04)		0.44* (0.22)			-0.27*** (0.12)
	Jammu & Kashmir			1.29*** (0.03)		0.64** (0.26)		-0.63*** (0.19)
	Manipur			1.33*** (0.1)		0.56* (0.3)		-0.25* (0.12)
	Mizoram			1.73*** (0.29)	-0.31 (0.25)			-0.09* (0.04)
	Meghalaya		1.13*** (0.09)		0.3 (0.19)			-0.17*** (0.07)
	Nagaland			1.32*** (0.13)		0.58** (0.26)		-0.22** (0.08)
	Sikkim		0.99*** (0.08)		0.19 (0.19)			-0.23* (0.13)
	Tripura			1.24*** (0.08)	0.04 (0.14)			-0.16** (0.16)

Note: *** p<0.01, ** p<0.05 and * p<0.1; GDP and GSDP data are from RBI database
Source: (Basic data), NIPFP database of Finance Accounts (various years).

Table 2: Categorisation of States as per Buoyancy

Buoyancy of Own tax Revenue		**States**
Short-run Buoyancy	**<1**	Bihar, Goa, Haryana, Jharkand, Odisha, Sikkim
	=1	Andhra Pradesh, Chattisgarh, Gujarat, Himachal Pradesh, Jammu & Kashmir, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Rajasthan, Tamil Nadu, Uttar Pradesh, West Bengal, Arunachal Pradesh, Assam, Manipur, Meghalaya, Nagaland, Mizoram, Thripura
Long-run Buoyancy	**>1**	Andhra Pradesh, Bihar, Chhatisgarh, Himachal Pradesh, Jammu & Kashmir, Jharkand, Kerala, Uttar Pradesh, Arunachal Pradesh, Manipur, Meghalaya, Mizoram, Thripura.
	=1	Goa, Gujarat, Haryana, Karnataka, Madhya Pradesh, Maharashtra, Odisha, Punjab, Rajasthan, Tamil Nadu, West Bengal, Assam, Nagaland and Sikkim

Source: (Basic data), NIPFP database of Finance Accounts.

Table 3: Revenue Buoyancy of Natural Resources, By States

	State	**Long-Run Buoyancy**			**Short-Run Buoyancy**			**Speed of Adjustment**
		<1	**1**	**>1**	**<1**	**1**	**>1**	
Low Income	Bihar	0.68*** (0.07)				1.44** (0.84)		-0.21* (0.11)
	Chhattisgarh		1.04*** (0.09)		0.13 (0.53)			-0.67*** (0.14)
	Jharkhand		1.00*** (0.06)		-0.06 (0.32)			-0.78*** (0.13)

	Madhya Pradesh	0.78*** (0.01)			-0.07 (0.35)			-0.35*** (0.10)
	Odisha	0.79*** (0.02)				0.96*** (0.28)		-0.14*** (0.04)
	Rajasthan	0.83*** (0.07)			0.34 (0.26)			-0.05* (0.02)
	Uttar Pradesh	0.69*** (0.04)				1.97** (0.81)		-0.14 -(0.04)
Middle Income	Andhra Pradesh	0.78*** (0.03)			-0.56 (0.53)			-0.21** -(0.07)
	Karnataka	0.78*** (0.06)			0.05 (0.35)			-0.08*** (0.02)
	Kerala	0.67*** (0.05)				-0.94 (0.85)		-0.15** 0.06
	Punjab	0.6*** (0.12)			0.22 (1.08)			-0.09 (0.07)
	West Bengal		-			-		-0.12 (0.08)
High Income	Goa	0.56*** (0.15)						-0.22*** (0.07)
	Gujarat	0.75*** (0.01)				1.29*** (0.39)		-0.56*** (0.18)
	Haryana	0.69*** (0.07)			-0.54 (0.93)			-0.27** (0.13)
	Maharashtra	0.69*** (0.03)			1.25*** (0.28)			-0.16** (0.06)
	Tamil Nadu	0.7*** (0.02)			-0.22 (0.64)			-0.44*** (0.14)
Special Category	Arunachal Pradesh	0.63*** (0.07)				1.75** (0.62)		-0.15* (0.08)
	Assam	0.85*** (0.13)					2.36 (1.77)	-0.77 (0.22)
	Himachal Pradesh	0.72*** (0.03)				1.36 (0.94)		-0.29** (0.10)
	Jammu & Kashmir	0.81** (0.39)						
	Manipur	0.32*** (0.06)				0.56* (0.3)		-0.68*** (0.19)
	Mizoram	0.67 (0.42)						-0.17* (0.09)
	Meghalaya	0.72*** (0.05)				1.48 (1.2)		-0.43*** (0.16)
	Nagaland	0.42*** (0.06)				1.78 (2.18)		-0.57*** (0.17)
	Sikkim	0.36*** (0.03)				1.11 (1.27)		-0.70*** (0.18)
	Tripura	-	-		-	-	-	

Notes: *** p<0.01, ** p<0.05 and * p<0.1
GSDP data are from RBI database
Source: Mining revenue data is from NIPFP database of Finance Accounts.

IV. 2 Tax Buoyancy: Panel Group Estimates across Category of States

We have estimated dynamic panel coefficients for three categories of States – high income, middle income and low income States for the macro-fiscal variables under concern. (table 1)

Table 4: Dynamic Panel Buoyancy Estimates using Output Gap

Variables	Low Income States	High Income States	Middle Income States	All States
Tax	1.105 (0.0314) [0.0000]	0.908 (0.049) [0.0000]	1.036 (0.0336) [0.0000]	0.932 (0.03) [0.000]

Note: The figures in bracket refers to Standard Error. The figures in square parentheses refer to Probability.
Source: (basic data) , Finance Accounts of States (various years), State Budget documents (various years) and CSO (various years)

The dynamic panel estimates show that the overall buoyancy of all states over the period 2011-12 to 2018-19 is less than unity at 0.98. With the categories of the states based on income, the tax buoyancy of low income states was 1.105 while the tax buoyancy of middle income states was 1.04. The tax buoyancy of high income states was relatively lower at 0.908 during this period. The output gap is estimated using the following formula.

OG=[(Actual GDP-Potential GDP)/Potential GDP] *100

This is also known as the "economic activity index" (Congdon 1998; Tanzi 1985; Chakraborty, 2016). It can be seen from equation that the "output gap," or the index of economic activity, is defined as the difference between the actual and trend/potential level of national output as a percentage of trend/potential output. Definitionally speaking, the potential level of output would be higher than the actual, as the resource utilization is maximized at the potential level. However, it is argued that cyclical factors, such as a recession or boom, could cause the actual to be below or above the potential output, respectively (Tanzi 1985). The major problem of estimation of the "output gap" lies on the estimation of potential level of output.[2]

The Hodrick-Prescott filter (HP filter) is the method used for the derivation of the potential output. The idea of this filter is to decompose a nonstationary time series, such as actual output, into a stationary cyclical component and a smooth trend component (Y_t and Y_t^* denote the logarithms of actual and trend/potential output respectively) by minimizing the variance of the cyclical component subject to a penalty for the variation in the second difference of the trend component. This results in the following constrained least-square problem:

$$Min \sum_{t=1}^{T} (Y_t - Y_t^*)^2 + \lambda \sum_{t=2}^{T-1} [(Y_{t+1}^* - Y_t^*) - (Y_t^* - Y_{t-1}^*)]^2$$

The first term in the equation is a measure of fit. The second term is a measure of smoothness. The Langrange multiplier (λ) is associated with the smoothness constraint and must be set a priori. As a weighting factor, it determines how smooth the resulting output series is. The lower the λ, the closer potential output follows actual output.

Table 5: Dynamic Panel Estimates_ Buoyancy of Natural Resource Revenue and Own Tax revenue – All States Analysis

[2] Theoretically, the "production function method" estimates the trend/potential output by determining the quantity and productivity of inputs, viz., labor and capital. The relative importance of the two inputs are determined by assuming that their return is determined by their marginal products and their share in the national output is equal to their quantity multiplied by the return (Adams and Coe 1990; Congdon 1998). Trend output estimation through the "production function method" requires data on labor force and capital stock. If data on one or both of these series are not available, one has to search for other methods of estimation of trend output. One of the most commonly used methods of estimation of trend output is the "moving average method." Another method, known as "trend through peaks" (hereafter, TTP), was developed by Klein with Wharton Econometric Forecasting Associates. The steps involved in estimation are delineated below. The first step is to plot the data on GDP adjusted for price fluctuations and identify the peaks. Second, it is assumed that identified peaks in the series are the points where resources in the economy are used at 100 percent of their capacity. The third step is to intrapolate between the major peaks, including the first and last observation. The strong assumptions beneath the TTP method itself deterred us from using it as a tool for estimating potential output.

VARIABLES	Mineral Royalty	Own Tax Revenue
Lagged Mineral Royalty	0.427*** (0.0273)	
Gross State Domestic Product	0.655*** (0.0276)	0.541*** (0.0151)
Lagged Own Tax Revenue		0.481*** (0.0183)
Constant	-5.745*** (0.436)	-1.754*** (0.145)
Observations	700	700
Number of states	28	28

Notes: Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1
Source: (basic data) , Finance Accounts of States (various years), State Budget documents (various years) and CSO (various years)

We observe highly significant effects for lagged values of Mineral Royalty and Own Tax Revenue on their current values, showing that a persistent series. The revenue buoyancy of natural resources is to the tune of 0.65, whereas own tax revenue for the period in consideration stands at 0.54. The buoyancy of mining revenue is slightly higher than the own tax revenue.

V Conclusion

Using the ADRL methodology, we have tried to estimate the revenue buoyancy within States and between States in a panel , and analysed the short run and long run coefficients and their speed of adjustment. Using HP filter, we tried to estimate the potential GDP, and also analysed the cyclicality of tax buoyancy using output gap variable across states. Our findings revealed that natural resource taxation is a buoyant source of revenue comparable to the buoyancy coefficients of other taxes across States, though the coefficients are always not above unity across States. The policy implication of our study for the natural sector is the rate rationalisation as higher rates revised every three years can affect the revenue augmentation.

References

Adams & David T. **Coe**, **1990**. "A Systems Approach to Estimating the Natural Rate of Unemployment and Potential Output for the United States," IMF Economic Review (**1990**) 37: 232.

Belinga, V., Benedek, D., Mooij, d. R., & Norregaard, J. 2014. Tax Buoyancy in OECD Countries. Working Paper, International Monetary Fund, Fiscal Affairs Department.

Congdon, Tim (**1998**) 'Did **Britain** have a **Keynesian** Revolution? In Clarke, Peter, 1998 The **Keynesian Revolution** and its Economic Consequences (Cheltenham, Glos.; Northampton, Mass., **1998**).

Chakraborty, Lekha 2016 , Fiscal Consolidation, Budget Deficit and Macroeconomy, Sage Publications, UK and New Delhi.

Dudine Paolo and Joao Tovar Jalle, 2017, Blanchard, Dell'Aricia and Mauro, 2010).

Dutta, R., Sreedhar, R., & Ghosh, S. 2012. India: Development at a Price. Working Paper, Revenue Watch Institute.

Government of India, 2018-19. Annual Report. Ministry of Mines.

Government of India, 2019. National Mineral Policy. Ministry of Mines.

Paolo, D., & Jalles, J. T. 2017. How Buoyant is the Tax System? New Evidence from a Large Heterogenous Panel. Working Paper, International Monetary Fund, Fiscal Affairs Department.

Pesaran, M., & Shin, Y. 1999. An Autoregressive Distributed Lag Modelling Approach to Cointegration Analysis. In S. Strom, Econometrics and Economic Theory in the 20th Century: The Ragnar Frisch Centennial Symposium, Chapter 11. Cambridge University Press.

Rajaraman, I., Goyal, R., & Khundrakpam, J. K., 2006. Tax Buoyancy Estimates for Indian States. *Economic and Political Weekly* (April 22).