Labour productivity in India: An analysis of regional and sectoral sources

Presentation at the 7th world KLEMS Conference, Manchester

October 13, 2022

Abdul A. Erumban, Sadhan K. Chattopadhyay,
Harendra Behera, Sreerupa Sengupta,
Shruti Joshi, and Suresh Aggarwal

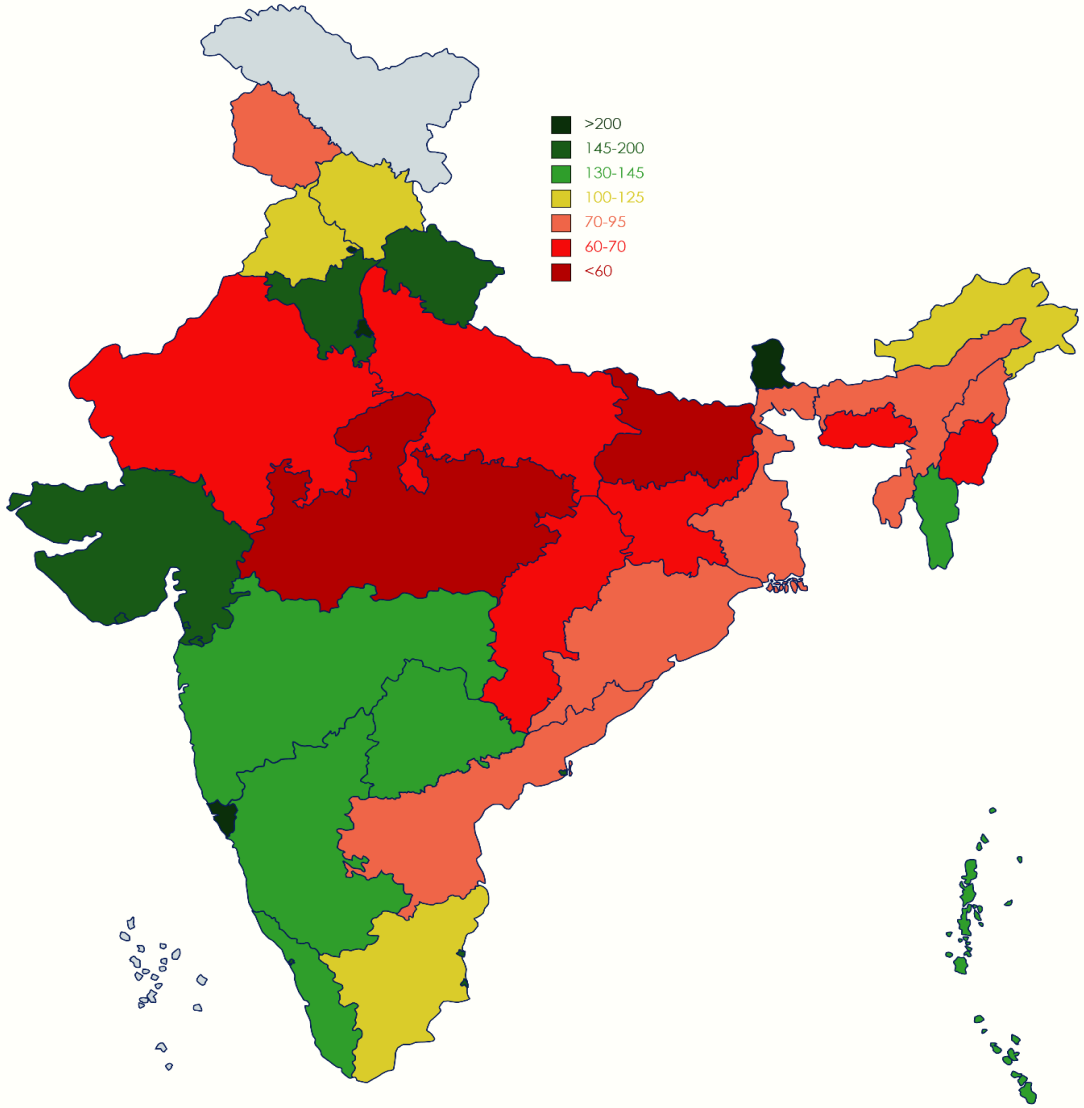
Content

Motivation and Research objective

- Labour productivity growth enhances welfare and living standard and is important for sustained long run growth

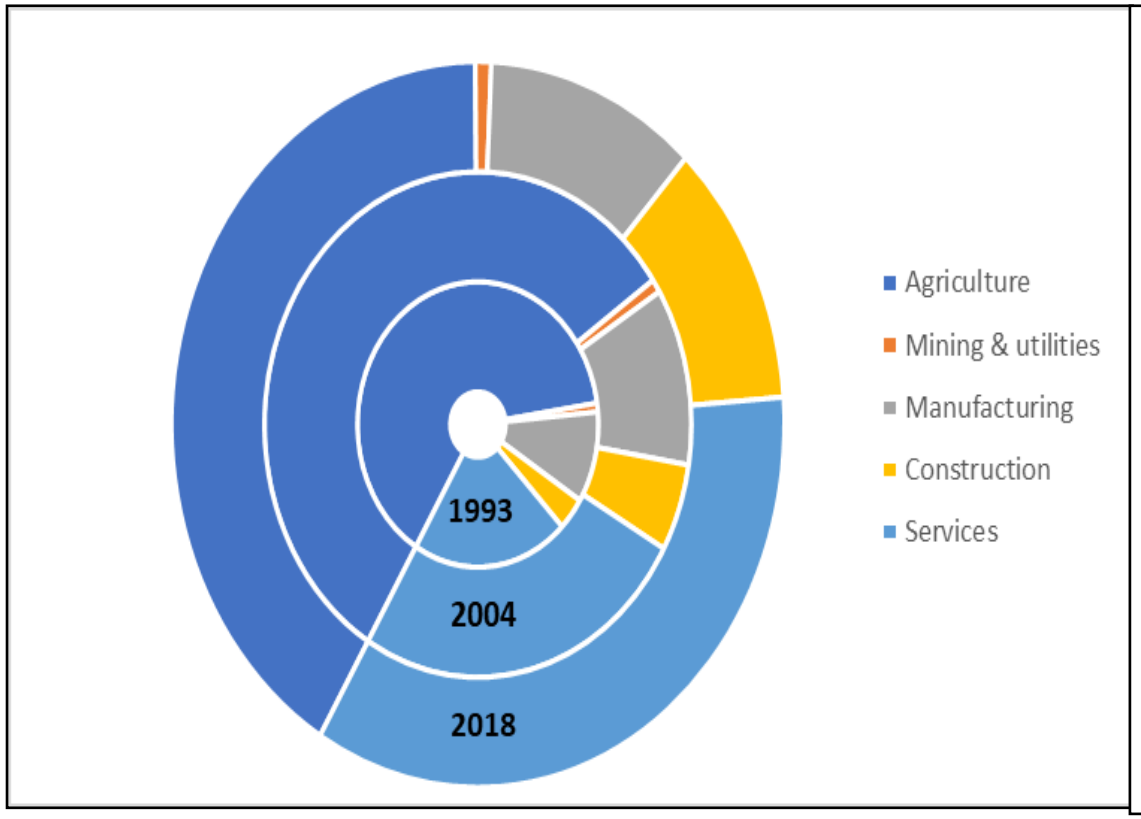
- Labour productivity continues to grow in India, at the national level.
- However, there is wide interstate disparity which motivates us to examine :
  - The role of within state and industry productivity growth, and worker reallocation effects
  - The factors that determine the (differences in) labour productivity across states

Relative Labour Productivity

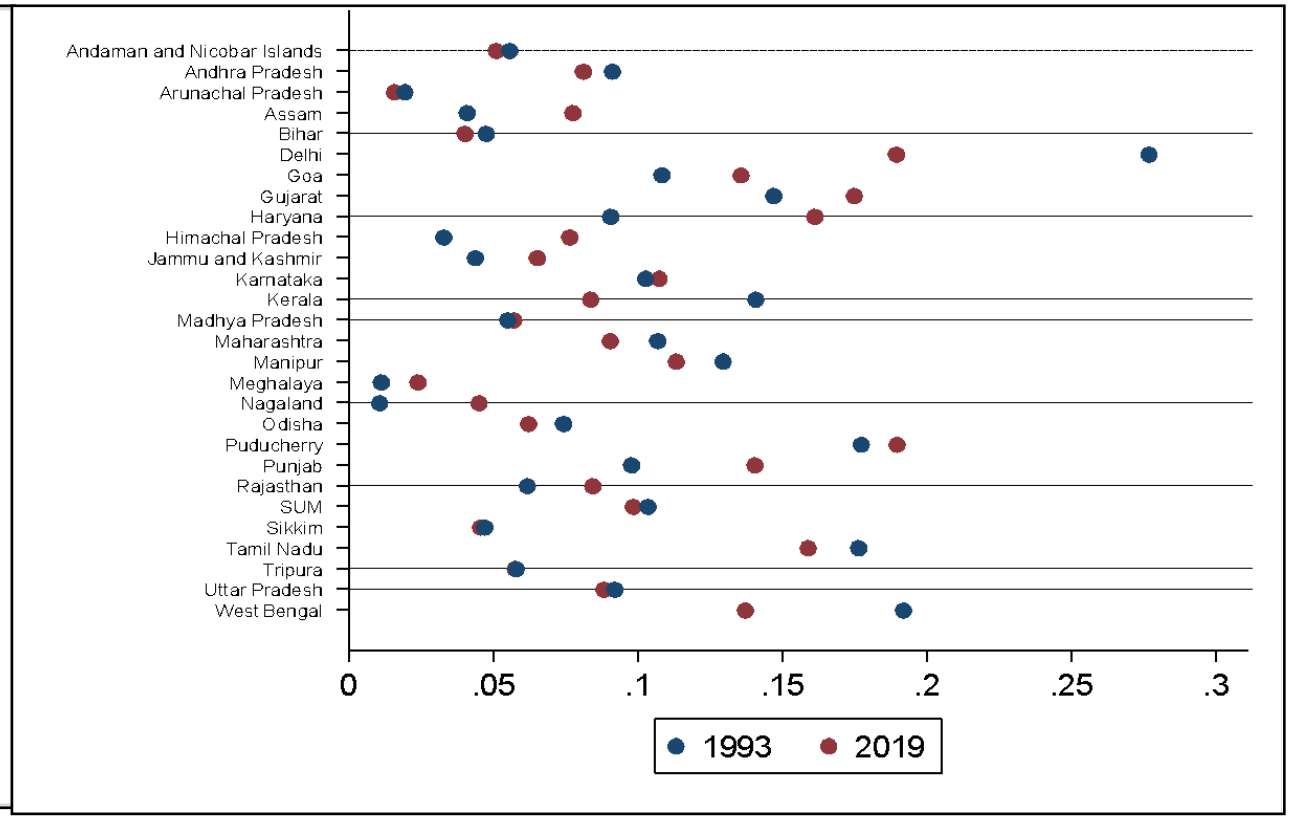


Stylized facts : Employment Structure in Indian States

Employment structure- All India national level



Manufacturing Employment share by State

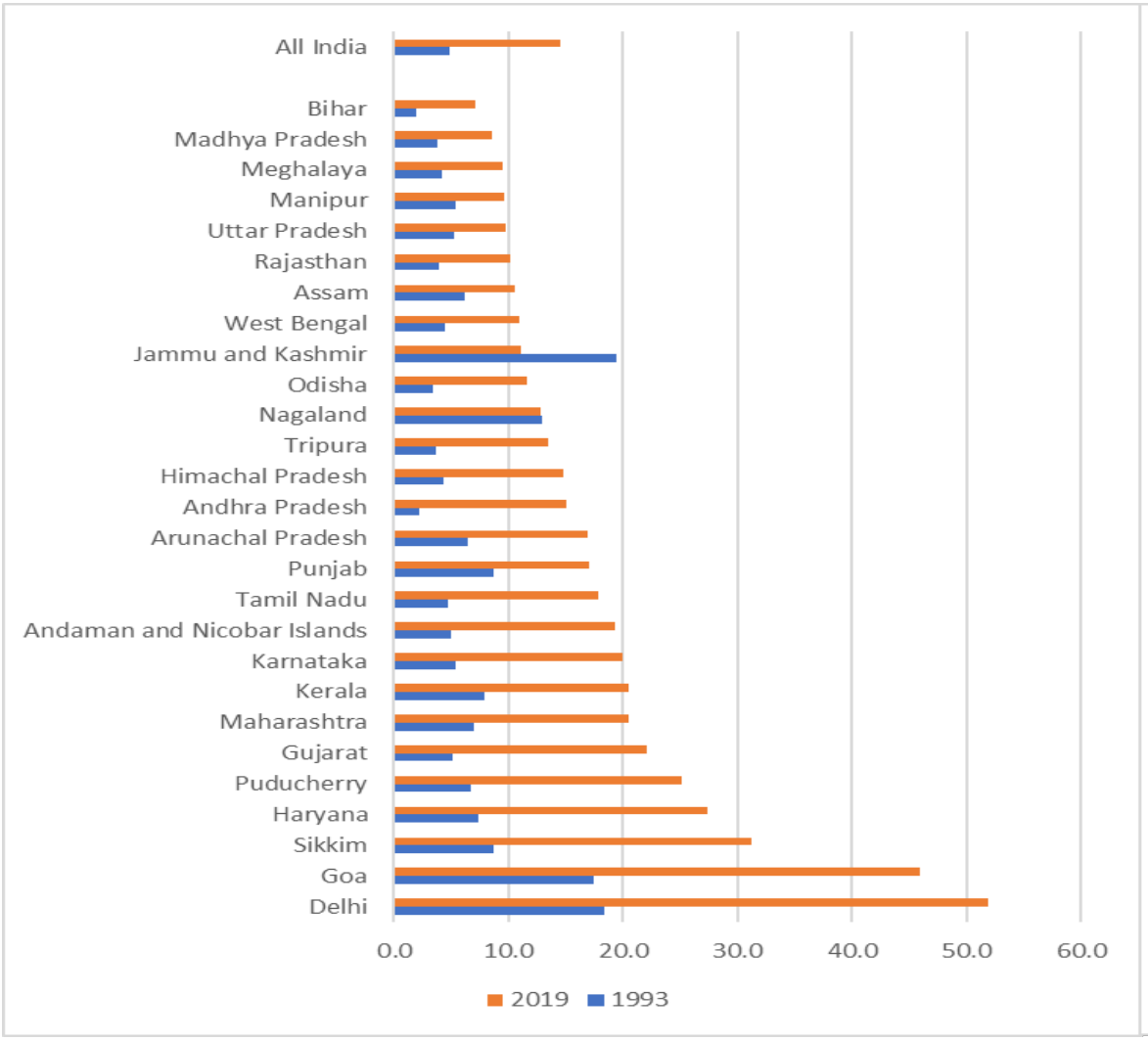


- Agriculture largest employer, stagnant manufacturing jobs
- Stagnation of manufacturing jobs –visible across states.

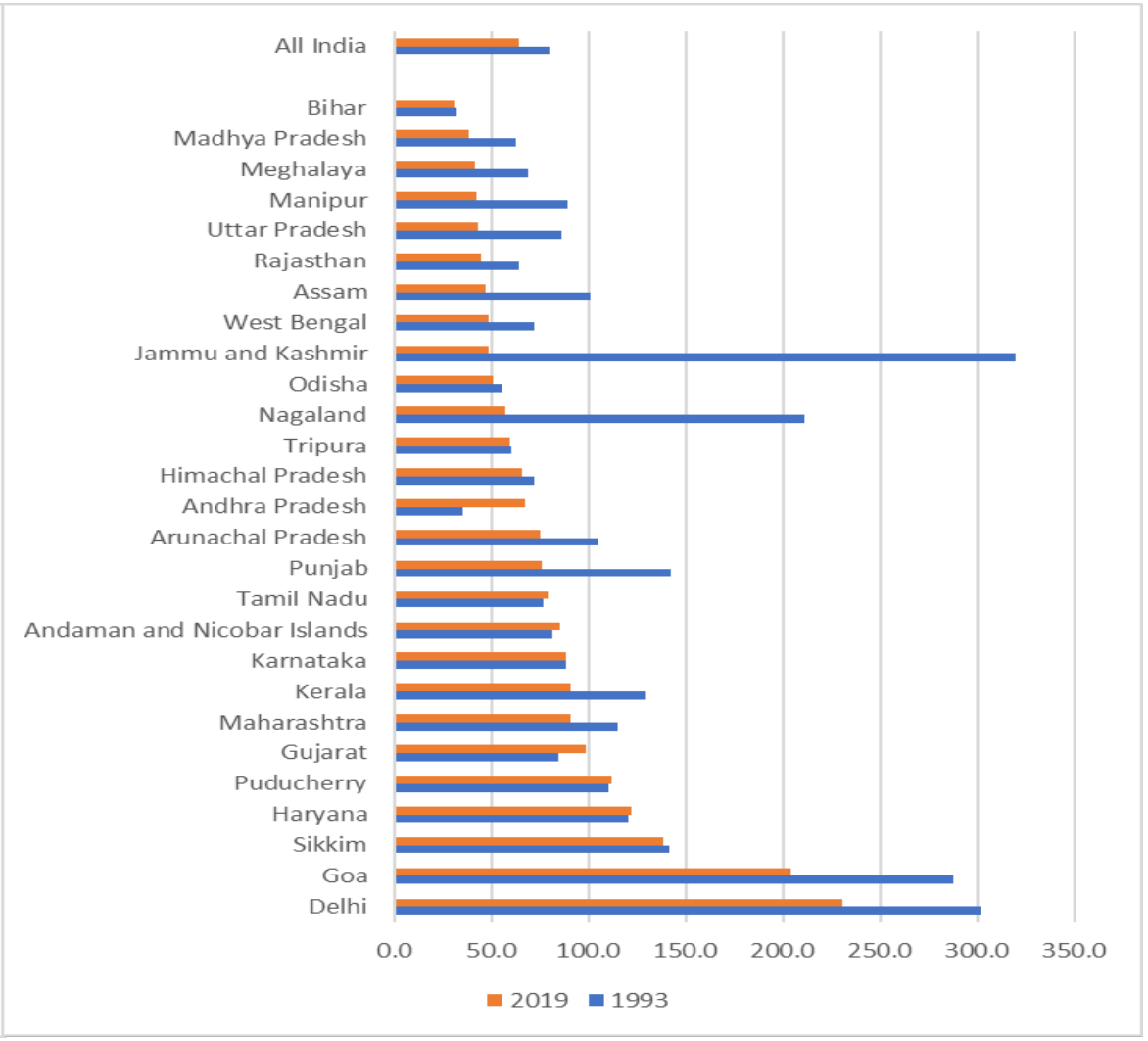
Stylized facts : Relative Labour Productivity

Relative labour productivity levels in Indian states (relative to US and China)

US=100



China =100



Labour Productivity and Worker reallocation

$$Y_t = \sum_{i=1}^{n} Y_{i,t} = \sum_{s=1}^{S} Y_{s,t} = \sum \quad Y_{i,s,t}$$

where Y_t is the aggregate real value added at the national level, Yi is the real value added in national sector i, Y_s is total real value added in state s, and$Y_{i,s}$ is the real value added in sector i in state s – all for year t.

Similarly, we can also obtain aggregate employment or the number of workers (L) as:

$$L_t = \sum_{i=1}^{n} L_{i,t} = \sum_{s=1}^{S} L_{s,t} = \sum \quad L_{i,s,t}$$

Now we define labour productivity (y_t) at different levels as:

Aggregate economy labour productivity at the national level: $y_t = \frac{Y_t}{L_t}$

Labour productivity for sector i in the national economy: $y_{i,t} = \frac{Y_{i,t}}{L_{i,t}}$

Aggregate economy labour productivity for state s: $y_{s,t} = \frac{Ys_{,t}}{L_{s,t}}$

Labour productivity for sector i in state state s: $y_{i,s,t} = \frac{Yi,s_{,t}}{L_{i,s,t}}$

we decompose the change in aggregate national labour productivity between periods t and t_0 into within sector and between sector using the standard shift-share approach as:

$$\Delta y_t = y_t - y_{t0} = \sum_i \Delta y_{i,t} \cdot v_{i,t-1} + \sum_i \Delta v_{i,t} \cdot y_{i,t-1} + \sum_i \Delta vu_{i,t} \cdot \Delta y_{i,t}$$

Within industry productivity contribution

static reallocation effect

Dynamic reallocation effect

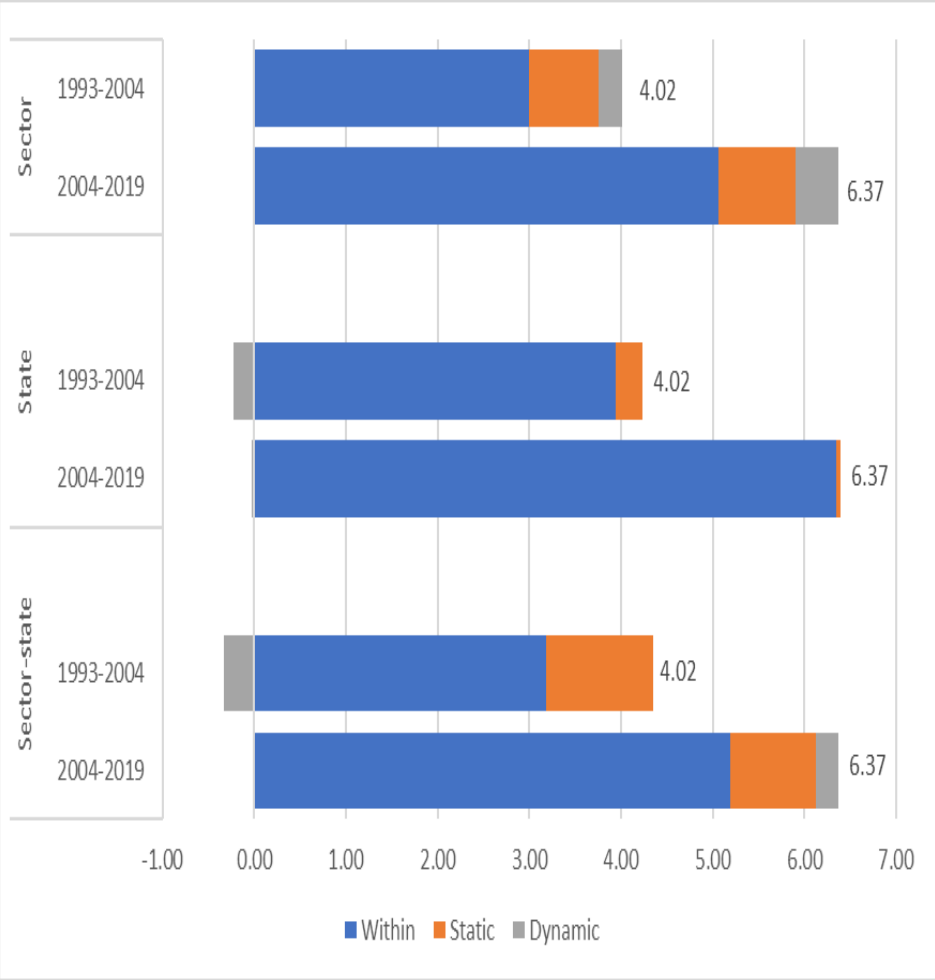
$\Delta y_t = y_t - y_{t0} = \sum_s \Delta y_{s,t} \cdot v_{s,t-1} + \sum_s \Delta v_{s,t} \cdot y_{i,t-1} + \sum_s \Delta vu_{s,t} \cdot \Delta y_{s,t} \Rightarrow$ **state productivity & inter-state reallocation in national economy**

$\Delta y_{i,t} = y_{i,t} - y_{i,t0} = \sum_s \Delta y_{i,s,t} \cdot v^i_{s,t} + \sum_s \Delta v^i_{s,t} \cdot y_{i,s,t-1} + \sum_s \Delta v^i_{s,t} \cdot \Delta y_{i,s,t} \Rightarrow$ **industry productivity & inter-industry reallocation within state**

$\Delta y_{s,t} = y_{s,t} - y_{s,t0} = \sum_i \Delta y_{i,s,t} \cdot v^s_{i,t} + \sum_i \Delta v^s_{i,t} \cdot y_{i,s,t-1} + \sum_i \Delta v^s_{i,t} \cdot \Delta y_{i,s,t} \Rightarrow$ **state-industry productivity & and reallocation across states and industries**

Decomposition Results

Aggregate labour productivity decomposition into sectoral and state reallocation effects



Decomposition of industry labour productivity growth into state contributions and reallocation across states within the industry

Productivity change by industry	Sectoral productivity growth (all India)		Productivity growth within states for the given industry		Static (Between states, within the industry)		Dynamic (between states, within the industry)	
	1993-2004	2004-2019	1993-2004	2004-2019	1993-2004	2004-2019	1993-2004	2004-2019
Agriculture	0.8	3.8	0.8	4.1	0.3	-0.1	-0.3	-0.2
Mining & utilities	6.0	6.6	7.8	7.5	1.5	0.8	-3.3	-1.6
Manufacturing	3.7	7.7	3.8	7.5	0.4	0.3	-0.5	-0.1
Construction	1.0	0.0	1.8	0.9	0.6	-0.2	-1.4	-0.7
Services	4.0	5.6	4.0	5.6	0.2	0.1	-0.2	-0.1
SUM*	4.0	6.4	3.9	6.4	0.3	0.0	-0.2	0.0

*Note: * SUM in the first column is the same as 'State' within productivity in the left panel Figure.*

Results

Shift share analysis: Summary Results

- ❑ Aggregate productivity growth is primarily coming from within industry productivity growth.
- ❑ The role of worker reallocation **across industries** is quite important as well; but the effect of **inter-state worker reallocation** effect is very trivial.
- ❑ Moreover, worker movement to states with low productivity growth led to dynamic losses in the recent period.
- ❑ Substantial variation across states in the structural change impact on productivity growth.
- ❑ Sizable productivity gaps between different sectors and states => significant potential to improve productivity.
- ❑ Supporting an efficient allocation of resources through removing market distortions and reducing regulatory compliance may help workers enter highly productive sectors and states.

Determinants of Labour Productivity –Econometric Analysis

Literature review on determinants of productivity

- Literature are abundant at aggregate economy level or cross-country level
- Few studies available using province level data – mostly confined to advanced economies and China
- In Indian context
  - Literature are based on aggregate level data
  - Studies use state level data are limited to manufacturing sector

Factors drive Labour Productivity:

- Education and public infrastructure had positive influence on labour productivity (Carline and Voith, 1992; Nelson and Phelps, 1996; Corvers, 1997; Smoluk and Andrews, 2005)
- Good health of workers are associated with increased labour productivity (Rivera and Currais, 2003; Ghatak, 2010; Bloom et al., 2003)
- Labour productivity is positively associated with net fixed asset per employee, ICT use and Innovation (Volagiris, 1999; Griliches, 1992; Brynjolfsson and Hitt, 1993; Arvanitis and Loukis, 2009; Ceccobelli et al., 2012)

Data and Variables for regression analysis

Data: Panel of 19 major Indian states over the period 2004 to 2019

Variable	Description	Data Source
Labour productivity	Gross State Domestic Product per worker	Handbook of Statistics on Indian States NSSO Employment Unemployment Surveys and Periodic Labour Force Surveys for Employment
Infrastructure	Index of per capita availability of power, per capita telephone connectivity, rail area and road area	Handbook of statistics of Indian States
Urbanization	Percentage of people living in urban area	Census
Education	Gross enrollment ratio in higher education	India Stat
Health	Infant mortality rate	Handbook of Statistics of Indian States
Capital stock per worker	Capital deepening	India KLEMS, Annual Survey of Industries
Manufacturing Share	Manufacturing share in total GVA	Handbook of statistics of Indian States

Methodology: determinants of state level labour productivity

- We use a multivariate production function of the following form:

$$y_{s,t} = \beta_1 + \beta_2 k_{s,t} + \beta_3 mfg_{s,t} + \beta_4 inf_{s,t} + \beta_5 ger_{s,t} + \beta_6 infra_{s,t} + \beta_7 urban_{s,t} + \varepsilon_{s,t}$$

Where subscript 's' stands for state and 't' refers to time and all the variables are in natural log form. $\varepsilon_{s,t}$ is idiosyncratic shocks to labour productivity of state 's' at time 't'.

- The estimation is performed by employing system generalised method of moments (GMM) approaches of Arellano-Bond-Bover (Arellano and Bover, 1995; and Blundell and Bond, 1998; Bond, 2002).

Static Regression Estimates: dependent variable = ln (labour productivity)

	Fixed Effect Model				Random Effect Model			
	Coef.	t-value	Coef.	t-value	Coef.	t-value	Coef.	t-value
$\ln k_{s,t}$	0.36***	13.16	0.40***	18.17	0.38***	14.48	0.37***	15.63
$\ln inf_{s,t}$	-0.49***	-7.07	-0.50***	-9.14	-0.48***	-8.71	-0.39***	-7.06
$\ln ger_{s,t}$	0.02	1.11	0.01	1.19	0.02	1.45	0.01	0.95
$\ln infra_{s,t}$	26.03***	11.96	16.21***	8.47	25.00***	12.79	24.38***	13.35
$\ln urban_{s,t}$			1.43***	12.51			0.56***	7.71
$\ln mfg_{s,t}$	0.07	1.56	0.13***	3.80	0.11***	2.85	0.08**	2.2
Constant	-112.06***	-11.07	-64.937	-7.26	-107.349	-11.87	-104.12***	-12.3
Number of obs.	304		304		304		304	
R-squared	0.97		0.98		0.92		0.89	

*Notes: ***,**,*: Significant at <1%; <5% and <10% levels. K/L is capital per worker, GER is the gross enrolment ratio*

Regression Results

Dynamic Panel Estimates: dependent variable = ln (labour productivity); cont…

	Difference GMM				System GMM			
	Coef.	t-value	Coef.	t-value	Coef.	t-value	Coef.	t-value
$L.\ln y_{s,t}$	0.78***	31.49	0.83***	39.43	0.81***	47.71	0.84***	48.53
$\ln k_{s,t}$	0.09***	6.30	0.07***	5.22	0.07***	5.83	0.06***	4.98
$\ln inf_{s,t}$	0.01	0.38	0.03	0.93	-0.05***	-3.30	-0.05***	-3.26
$\ln ger_{s,t}$	-0.01	-1.19	-0.01	-1.57	-0.01	-1.42	-0.01	-1.40
$\ln infra_{s,t}$	4.93***	5.65	4.96***	5.52	2.97***	4.50	1.91***	2.83
$\ln urban_{s,t}$	0.25***	3.85			0.09***	6.60		
$\ln mfg_{s,t}$	0.07***	4.59	0.07***	4.07	0.04***	4.14	0.08***	6.72
Constant	-20.85***	-5.23	-21.65***	-5.30	-12.01***	-4.07	-7.38***	-2.43
AR1	0.05		0.02		0.02		0.02	
AR2	0.80		0.74		0.61		0.43	
Sargan	1.00		1.00		1.00		1.00	

Notes: Sargan and autocorrelation test results are from two-step estimations while the coefficient estimates are based on one-step estimation. P-values are reported against various post-estimation tests. AR1 and AR2 are tests for first-order and second-order serial correlation, respectively. Sargan tests are for checking the overidentifying restrictions for the GMM estimators. ***,**,*: Significant at <1%; <5% and <10% levels.

Regression Results

Dynamic Panel Estimates: dependent variable = ln (labour productivity); cocld.

	Difference GMM		System GMM	
	Coef.	Coef.	Coef.	Coef.
Long-term coefficients				
$\ln k_{s,t}$	0.40	0.38	0.34	0.38
$\ln inf_{s,t}$	0.05	0.16	-0.24	-0.34
$\ln ger_{s,t}$	-0.03	-0.05	-0.04	-0.04
$\ln infra_{s,t}$	22.10	28.35	15.33	12.03
$\ln urban_{s,t}$	1.14		0.47	
$\ln mfg_{s,t}$	0.33	0.41	0.22	0.52
AR1	0.05	0.02	0.02	0.02
AR2	0.80	0.74	0.61	0.43
Sargan	1.00	1.00	1.00	1.00

Notes: Sargan and autocorrelation test results are from two-step estimations while the coefficient estimates are based on one-step estimation. P-values are reported against various post-estimation tests. AR1 and AR2 are tests for first-order and second-order serial correlation, respectively. Sargan tests are for checking the overidentifying restrictions for the GMM estimators. ***,**,*: Significant at <1%; <5% and <10% levels.

Conclusion

- Infrastructure, capital deepening, manufacturing share, urbanization and improvement in health of workers impact labour productivity positively
- Enrollment ratio is statistically insignificant across specifications implying negligible contribution of skills to labour productivity in India
- As manufacturing and service jobs are becoming skill intensive, upskilling the population would be essential to enhance mobility of workers across sectors
- Recent focus of government on Skill India Mission, New Education Policy and large investments in infrastructure may help improving India's labour productivity in future

Thank You

Decomposition Results