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Regional income inequalities and public investments in rural India

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Abstract Regional inequalities in income levels in the agricultural sector have increased over time, but not as sharply as in the non-agricultural sectors. This article examines the effect of public investments on agricultural income inequalities across 17 major Indian states for the period 1981/82 to 2013/14 and for the pre- and post-liberalisation periods. The impact of conventional inputs and various types of public investments on income inequality is found to be significant but spending on education and health have larger adverse effects compared with spending on roads, energy, and irrigation over time. Land, labour, and private investment in irrigation also have only a modest impact. Among various categories of public investments contributing to regional income inequality, the contribution of education is estimated to be 32.2% nationally, and 50.8%, 38.5%, and 29.7%, respectively, in the low, middle, and high per capita income states. Results suggest that public investments should target roads, energy, irrigation, and agricultural research and development in the less-developed, more agriculture-dependent states to improve regional income equality, increase agricultural productivity, and alleviate rural poverty. The marginal returns to each of these investments, in terms of reducing income inequality, are generally higher in the low-income, agriculture-dominant states, implying the potential benefit of a location-specific expenditure policy.

Keywords Public investments, Inequalities, Agricultural growth, India

JEL classification D63, H53, O13, Q18

1 Introduction

Studies have shown that rural and agricultural growth have a more significant poverty-reducing impact than growth in other sectors of the economy (Ahluwalia 1978; Datt et al. 2016). Studies have also demonstrated the importance of public policies and strategies, in particular public spending in accelerating agricultural growth and reducing rural poverty (Barro 1990; Ravallion & Datt 1995; Sen 1997; Fan 2008). Nonetheless, several studies have found that various types of public investments have differential impacts on agricultural growth and rural poverty reduction (Fan et al. 2008; Mogues 2012; Mogues et al. 2015). Although the poverty effects of public expenditures vary across countries, studies report that investments in agricultural research and development (R&D), irrigation, education, and road infrastructure are more effective than other types of investments. In the case of India, some studies found higher marginal returns to public investment in these areas during the 1980s and 1990s (Fan et al. 1999; Fan et al. 2008). Bathla et al. (2017) showed a re-ordering of priorities over time, indicated by higher investments in education, health, agricultural R&D, and energy, resulting in a larger impact on agricultural growth and income levels.

Little attention has been paid to the impact of public investment on agricultural growth and poverty reduction within India. Based on higher returns from various social and economic services and select input

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subsidies, a few studies viz., Fan et al. (2000) and Bathla et al. (2017) supported the allocation of greater resources to the lagging eastern and rainfed regions of India. These issues have gained importance due to growing regional disparities in income levels and other social and development outcomes. Theoretically, high economic growth leads to increased income inequality, at least in the initial stages of development, but gaps subsequently narrow with progress in education, governance, and other conditions. In India, most of the states have been on a high growth trajectory, especially since the initiation of economic reforms in 1991. Income disparities have increased over time (Pal & Ghosh 2007; Kundu & Varghese 2010; Panagariya et al. 2014), but some of the poorer states have achieved higher growth rates in recent years, enabling them to narrow the gaps (Ghosh & Dasgupta 2017).

While a multitude of factors have been suggested to explain regional income inequalities in India,[1] scant literature focuses on the role of public resource allocation. Under India's constitution, responsibilities are (a) maintained at the federal level, (b) devolved to the states, or (c) jointly held by the federal and state governments. Revenues are allocated based on the responsibilities assigned. The states also generate their own revenues but are largely dependent on federal funding for transfers and loans. Considerable differences therefore exist across states in terms of their capacity to generate resources and invest in public goods—an important factor explaining the states' disparate performance levels. The high income and more well-developed states tend to invest more resources in rural areas compared with the less well-off states, whose populations are more dependent on agriculture for their livelihoods and employment. Unequivocally, policy on the allocation of expenditure is one of the important instruments[2] through which the government can achieve economic growth, which is crucial for increasing employment, mitigating poverty, and narrowing regional income gaps. Besides, public spending on education and health enhances human capacity and enables people to participate in higher living standards (Claus et al. 2014).

The empirical findings on this subject are mixed. A few studies show that government expenditure on roads has a positive impact on economic growth, but an ambiguous effect on regional income disparities (Martin 1999; Jacoby 2000). Other studies posit that public investments in road infrastructure and agricultural R&D have the largest impact in reducing income inequality because less favorable areas are more dependent on agriculture and have a greater concentration of poor people (Kanbur & Zhang 1999;Fan et al. 2002; Fan et al. 2008). In the context of China, Zhang & Fan (2004) found that additional investments in education and R&D in the lagging western region had a larger positive impact on inequality than investments in the relatively better off coastal and central regions.

This article examines the effect of various types of public investments on subnational inequalities in agricultural income levels in India. It includes an estimation of the marginal returns to increased investment under each category in states with low, middle, and high per capita income levels. It is intended that the findings presented will assist states in targeting key economic and social investments and in their efforts to achieve both higher and more equitable agricultural growth. The analysis is based on the hypothesis that differences in public investments may explain variations in income levels across the states. The analysis focuses on four economic services (roads/transport, energy, irrigation, and agricultural R&D[3]) and two social services (education and health/nutrition). The structure of the remainder of the article is as follows: Section 2 focuses on the empirical framework and data sources used to quantify the inter-linkages between public investment and income inequality.

[1] A large body of literature suggests that inter-state inequalities stem from various economic and policy factors, in turn influenced by socio-cultural and historical factors that shaped income and access to various services. The inequalities in agricultural income can also be explained by weak initial conditions, unfavorable climate and production conditions, market failure, and hence persistent gaps in economic and social amenities (Betz & Neff 2016; Dev 2017).

[2] Other instruments are taxation and direct income transfers that redistribute income from higher to lower income groups, governance and institutional reforms to level the playing field (Claus et al. 2014).

[3] Note that expenditures on agricultural R&D is expanded to include those related to soil conservation, crops and animal husbandry; expenditures on transport are included with expenditures on roads; and expenditures on medical and public health are broadly defined to include those related to social welfare and nutrition.

Section 3 begins with an estimation of inter-state inequality in agricultural and non-agricultural incomes, broadly taken to represent rural and urban incomes based on a Gini index. This is followed by an examination of temporal and spatial trends in public expenditures and their allocation to various social and economic services from 1981/82 to 2013/14. Trends in public spending are also shown during the pre- and post-liberalization periods to gauge changes stemming from the economic reforms of 1991. Section 4 presents the estimated results, and Section 5 the conclusions and policy implications.

2 Empirical framework and database

The contribution of public investments to regional income inequality is quantified using the regression-based inequality decomposition method. The approach is based on a specification of the Cobb-Douglas production function. As elucidated in Zhang & Fan (2004), agricultural output or income can be explained by conventional inputs that is, land, labour, capital, and public investments. The logarithmic form of the production function is given by:

$$y = a + \Sigma_{i=1}^{k} \beta_i x_i + \Sigma_{j=1}^{m} y_j p_j + \varepsilon \quad \ldots(1)$$

where, y is income, represented by gross state domestic product in agriculture and allied activities (GSDPA). It is explained by x_i - land, labour, rainfall, fertilizer use, private and public (capital) investment in irrigation, and p_j public investments in agricultural R&D, roads, energy, education, and health. The error-term, ε, represents stochastic shocks to income and is assumed to be unrelated to other variables. The production function is estimated using the pooled regression and random effect models for the aggregate period and separately for pre- and post-liberalization periods. State and year dummies are specified in each time period to determine state- and time-specific effects. The results appeared to be consistent in both the models; however, some variation was observed in the results with the inclusion of year dummies. Consequently, a fixed-effect model suggested a better fit.

The next step after estimating elasticities from the production function is to quantify the contribution of each input to income inequality. As described in Shorrocks (1982) and Fields & Yoo (2000), the variance of y is decomposed to estimate the inequality coefficient and calculate the contribution of each variable to inequality:

$$\sigma^2(y) = \Sigma_{i=1}^{k} \beta_i cov(y,x_i) + \Sigma_{j=1}^{m} y_j cov(y,p_j) + \sigma^2(\varepsilon) \ldots(2)$$

Where, $\sigma^2(y)$ is the variance of y, cov (y, x_i.) represents covariance of y with other variables (x_i) and cov (y, p_j) is covariance of y with public investment variables. Taking y in the logarithmic form, the sigma $\sigma(y)$ is the standard inequality measure, called the logarithmic variance. The covariance terms on the right hand side in Eq. (2) can be considered the contribution of the factor components to total inequality. The weighted GSDPA is used to estimate the inequality coefficient. Finally, the marginal effects of additional investments in terms of reduced inter-state income inequality are estimated using the elasticities obtained from the model.

The empirical exercise is undertaken for 17 states as a group; separately for low-income states (LIS), middle-income states (MIS), and high-income states (HIS) for the period 1981-2014; and separately for the pre- and post-liberalisation periods. The rationale for estimating the pre- and post-liberalisation time periods is that the economic reforms might have influenced government spending in each state and, hence, the outcomes.

2.1 Variables and data sources

The investment variables are specified as follows. Rural road density represents investment in rural roads, and agricultural electricity consumption represents investment in rural energy. The percentage net area irrigated by surface irrigation (public canals) represents public investment in irrigation, and the percentage net area irrigated by borewells represents private (farm-household) investment in irrigation. The rural infant mortality or survival rate is taken as a proxy for public investment on health/nutrition. Investment in education is proxied (a) by the rural literacy rate, and (b) by the number of years of schooling of the rural workforce. Public investment in agricultural R&D is measured as a stock variable, taking accumulated investment levels as of 1981/82, and adding each year investment starting from 1981, with a 10% depreciation allowance.

The data used in this article were compiled from a variety of sources. State-level time-series data on public expenditures in various social and economic categories

for the 1981 to 2014 period were extracted from the Finance Accounts (GoI various years [d]). The percentage net area irrigated by canals and groundwater sources, total gross state domestic product (GSDP), GSDPA, rural literacy rate, annual rainfall, and road density, were compiled from the Estimates of National Accounts Statistics (GoI various years [c]), and fertilizer consumption from Fertilizer Statistics of India (various years [f]). Agricultural energy consumption is taken from the Agricultural Statistics (GoI various years [a]). The series on rural infant mortality rate are from the Census Data (Ministry of Home Affairs, various years [g]). The number of years of schooling among the rural population is estimated and then interpolated for the 1981/82 to 2011/12 period based on the National Sample Survey (GoI various years [e]). Private investment in irrigation, mainly by the rural households, was estimated using the All India Debt and Investment Survey (GoI various years [b]). Time-series data on public expenditure, GSDP, GSDPA, and private investment, available in nominal terms, were converted into real terms using 2004/05 as a base, and GSDP income deflators from the National Accounts Statistics (GoI, various years [c]). The rural share of public expenditure on roads/transport was estimated based on the rural populations' share of the total population in each state. Similarly, rural energy consumption was estimated based on agriculture's share of total electricity consumption in each state.

In total, 17 major states covering more than 90% of the net sown area and population were included in the analysis. Low-income, middle-income, and high-income states were categorized based on annual average per capita income levels for the 2000/01 to 2013/14 period at 2004/05 prices. Levels fall in the range of Rs. 13,954 to 23,606 for the low-income states (LIS), Rs. 24,346 to 39,789 for the middle-income states (MIS), and Rs. 45,706 to 52,911 for high-income states (HIS). Average levels for all 17 states are estimated to be Rs. 31,284. The LIS included in the analysis are Bihar, Uttar Pradesh, Assam, Madhya Pradesh, and Jammu and Kashmir (J&K); the MIS included are Odisha, Rajasthan, West Bengal, Andhra Pradesh, and Karnataka; and the HIS included are Punjab, Kerala, Himachal Pradesh, Tamil Nadu, Gujarat, Maharashtra, and Haryana.[4] As expected, agriculture is dominant among LIS. These states have low levels of land and labor productivity, and a high incidence of rural poverty, although improvements have been identified in recent period. In contrast, industry is the main economic activity among HIS, with the tertiary sector strongly emerging from 1991. Although agriculture remains important in these states, the sector employs comparatively fewer people. The MIS comprise a mix of states, with agriculture dominating in some, and industry and services dominating in others.

3 Income inequality and public investments

3.1 Income inequality in the agricultural and non-agricultural sectors

Per capita GSDP increased almost four-fold, from Rs. 11,714 to Rs. 41,493, between the triennium ending (TE) 1983/84 and TE 2013/14 (table 1). While most states experienced a manifold increase in their per capita income levels, the income gap between the richest and poorest states (Maharashtra and Bihar, respectively) showed virtually no signs of declining. Even when analyzing per capita income levels by economic sector, the ratio between agricultural incomes in the richest and poorest states (Haryana and Bihar, respectively) remained at 3.4. In the case of non-agricultural income from industry and tertiary sectors, the ratio between Maharashtra and Bihar is much higher (6.7), although it declined marginally more recently.

The annual rate of GSDPA growth during the 2000s was impressive in most states, especially Assam, Rajasthan, Madhya Pradesh, Odisha, and Bihar, which are more dependent on agriculture. Non-agricultural GSDP (GSDPNA) also grew considerably in the 2000s, with the exceptions of Himachal Pradesh, Rajasthan, Bihar, and West Bengal. GSDPNA growth was concentrated in a few of the richer states: Andhra Pradesh, Haryana, Gujarat, Maharashtra, Tamil Nadu, and Karnataka. Similar trends have been reported in per capita consumption expenditure (Sen & Himanshu 2005; Anand et al. 2014). However, Panagariya et al. (2014) observed the distribution of rural income to be

[4] The public expenditures in the three newly created states (Chhattisgarh, Jharkhand, and Uttarakhand) are available from 2000/01 onward; data for these states were therefore merged with data from their respective parent states (Madhya Pradesh, Bihar, and Uttar Pradesh) to create a consistent series.

Table 1. Average per capita income and annual rate of growth by state (2004/05 prices)

	GSDP per capita (Rs.)				Compound annual growth rate (%)					
					Agricultural GSDP			Non-agricultural GSDP		
	TE 1983-84	TE 1993-94	TE 2003-04	TE 2013-14	1981-89	1990-99	2000-14	1981-89	1990-99	2000-14
Andhra Pradesh	14,078	16,688	25,357	50,239	1.4	2.4	4.7	5.5	6.5	9.3
Assam	14,061	16,182	17,886	26,135	2.3	0.9	2.6	3.7	3.3	6.6
Bihar	4,711	6,992	10,831	18,211	-1.9	4.7	6.1	8.2	9.3	10.6
Gujarat	15,553	20,607	32,327	68,754	4.0	1.9	3.7	8.1	6.6	10.1
Haryana	18,868	26,336	37,883	71,661	3.3	0.3	3.7	6.4	9.1	8.9
Himachal Pradesh	15,782	21,160	34,019	63,639	-1.1	4.1	1.8	3.5	4.9	6.6
Jammu and Kashmir	16,907	17,229	20,427	27,452	2.6	4.5	3.4	7.0	8.5	7.5
Karnataka	13,686	19,869	30,017	50,188	2.8	2.5	0.1	3.9	7.0	9.6
Kerala	14,430	19,754	31,841	66,037	3.8	4.8	4.3	6.5	7.5	9.3
Madhya Pradesh	7,927	11,648	17,456	30,121	3.4	1.4	3.7	7.7	5.9	9.5
Maharashtra	16,558	25,138	36,206	72,308	4.8	2.5	1.8	5.8	6.2	8.2
Odisha	11,007	13,350	16,867	32,497	2.4	3.5	5.6	8.3	8.1	8.1
Punjab	20,542	27,874	35,723	58,251	2.7	3.0	3.5	5.9	7.5	9.4
Rajasthan	10,538	14,307	19,871	33,059	7.1	5.4	2.2	4.0	7.5	7.7
Tamil Nadu	13,985	21,065	31,976	65,560	2.7	1.1	5.2	6.9	16.6	8.5
Uttar Pradesh	9,244	11,741	14,433	23,427	2.9	7.8	6.6	5.0	11.5	8.0
West Bengal	11,422	14,696	24,004	36,269	2.7	3.2	2.6	6.5	6.1	8.5
India	11,714	15,913	23,073	41,493	2.9	3.3	3.4	6.4	7.2	8.6

Source: GoI (various years) [c].
Notes: TE = triennium (three-year period) ending. GSDP = gross state domestic product. GSDPA= GSDP agriculture and allied activities.

more equitable compared with urban income; they further found that it had not undergone any significant change over time. The Gini index for both GSDPA and GSDPNA rose during the 1980s, fell in the subsequent decade, then increased again from 2000 onward (figure 1). The inequality between agricultural and non-agricultural incomes also widened during the 2000s.

3.2 Spatial and temporal trends in public expenditure

Public expenditure is broadly categorized as development and non-development expenditures, further broken down into (current) revenue and capital expenditures. Development expenditures include those allocated to economic development and social welfare activities, whereas non-development expenditures do not directly help in economic development –generally incurred to meet the cost of providing services. Agricultural and rural development expenditures are directly disbursed, whereas capital expenditures—for infrastructure, and so on—are drawn as loans. Spending on agriculture and irrigation is highly decentralized, with the central government channeling funds to the respective state governments. Central government funding is also directly disbursed to the states for a number of economic and social services, such as agricultural R&D, flagship programs relating to employment, food and fertilizer subsidies, and health initiatives. For the purposes of this analysis, disbursements by the central government are not considered in order to avoid the potential double counting.

Total public expenditure by the selected 17 states rose from Rs. 1,035 billion in 1981/82 to Rs. 9,288 billion in 2013/14, representing an annual growth rate of 6.7% (table 2). It is encouraging to note that development expenditures consistently outgrew population growth. Per capita development expenditures increased

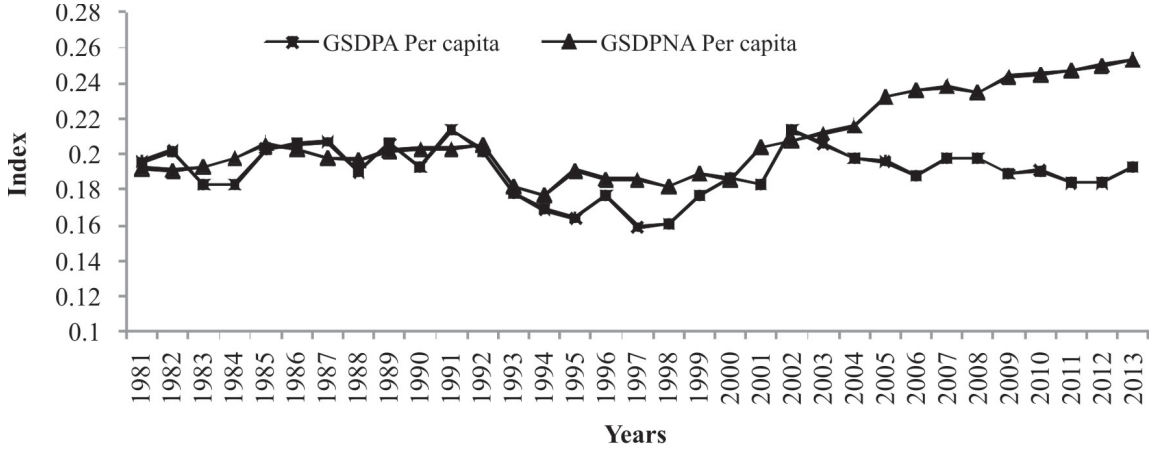

Figure 1. Inter-state income inequality in India (Gini index), 1981/82 -2013/14
Source: Estimates based on GoI [c].
Notes: GSDPA =gross state domestic product in agriculture and allied activities; GSDPNA = gross state non-agricultural domestic product.

Table 2. State government expenditure (Rs. billion at 2004-05 prices)

	TE 1983/84	TE 1993/94	TE 2003/04	TE 2013/14	1981-2014 (% rate of growth)
			Average (Rs. billion)		
Total expenditure	1,109	2,047	3,863	8,258	6.7
Developmental expenditure	834	1,402	2,251	5,502	6.1
Social services	409	689	1,203	3,123	6.5
Economic services	425	713	1,048	2,380	5.6
			Economic services (% share)		
Agriculture and allied services	21.2	22.9	17.3	19.0	4.6
Rural development	13.5	16.2	12.7	13.6	5.0
Irrigation and flood control	35.5	25.2	23.5	20.1	4.0
Rural energy	0.7	4.1	7.1	4.4	12.4
Rural roads/transport	11.0	8.0	9.7	12.2	6.6
			Social services (% share)		
Education, sports, arts, and culture	48.7	54.1	52.8	47.0	6.3
Medical and public health	18.3	16.4	14.0	12.3	5.0
Welfare of SCs, STs, and OBC	7.0	6.9	6.9	8.1	7.1
Social welfare and nutrition	10.8	9.2	11.4	16.9	8.3

Source: GoI (various years [d]).
Note: TE = the triennium (three-year period) ending; SCs, STs and OBC stand for scheduled caste, scheduled tribe and other backward class

from Rs. 1,513 in 1981/82 to Rs. 7,270 in 2013/14. Approximately 57% of development expenditures in 2013/14 were allocated to social services, mostly education and social welfare. Expenditures on economic services were further subdivided into several categories: during 1981 to 2014, nearly 25% was allocated to irrigation and flood control, followed by agriculture and allied activities (19.2%), rural development (14.0%), and rural roads (11.0%). Expenditures on rural energy were far less than those on rural roads, education, or health.

Although total expenditures more than doubled in the post-liberalisation period, expenditures on rural energy grew fastest, leading to an increase in rural infrastructure's share of total spending. On the other hand, the shares of agriculture, irrigation, and flood control fell drastically. The decline in spending on irrigation can also be attributed to extraneous forces, such as escalating irrigation costs, the impact of the environmental movement, and inter-state river disputes (Shetty 1990; Mishra & Chand 1995). Nevertheless, resurgence in investment levels in irrigation and rural roads was noted after 2004.The same cannot be said for spending on agriculture and allied activities, rural development, rural energy, and village industries.

Per capita, HIS spent a maximum of Rs. 922 on education, Rs. 708 on health, and Rs. 345 on rural roads (table 3). Public spending on irrigation per hectare (ha) was much higher and increased to about Rs. 3,000. It is important to note that not all expenditures result into

Table 3. Key categories of public expenditure by low-income, middle-income, and high-income state groupings (TE average)

	Unit	TE 1983/84	TE 1993/94	TE 2003/04	TE 2013/14
		Low-income states (average)			
Agricultural R&D	Rs. per ha	383	811	1,042	2,308
Irrigation	Rs. per ha	1,174	1,067	1,272	2,854
Rural roads/transport	Rs. per rural resident	115	113	138	299
Rural energy	Rs. per rural resident	8	51	77	51
Education	Rs. per rural resident	299	508	601	1,167
Health and nutrition	Rs. per rural resident	150	210	237	445
Private agriculture investment	Rs. per ha	390	449	522	1458
Share of irrigation investment in total agriculture investment	Share (%)	12.7	16.5	10.5	7.7
		Middle-income states (average)			
Agricultural R&D	Rs. per ha	189	348	413	1,541
Irrigation	Rs. per ha	933	1,157	1,689	3,844
Rural roads/transport	Rs. per rural resident	76	90	129	309
Rural energy	Rs. per rural resident	6	37	101	178
Education	Rs. per rural resident	288	427	625	1,095
Health and nutrition	Rs. per rural resident	142	177	250	446
Private agriculture investment	Rs. per ha	333	500	535	1,063
Share of irrigation investment in total agriculture investment	Share (%)	24.5	32.6	35.7	30.4
		High-income states (average)			
Agricultural R&D	Rs. per ha	618	1,294	1,221	2,800
Irrigation	Rs. per ha	1,160	1,476	2,006	3,300
Rural roads/transport	Rs. per rural resident	206	208	336	684
Rural energy	Rs. per rural resident	10	106	162	203
Education	Rs. per rural resident	426	652	967	1,853
Health and nutrition	Rs. per rural resident	216	277	373	745
Private agriculture investment	Rs. per ha	855	1,006	1,510	3,187
Share of irrigation investment in total agriculture investment	Share (%)	19.0	23.8	31.7	24.2

Source: Authors' calculations based on GoI [b, d].

Notes: TE = Triennium (three-year period) ending. Public expenditure is calculated as the sum of current and capital. Irrigation includes expenditure on minor, medium, and major irrigation infrastructure and command area development; it excludes expenditure on flood control. Capital investment varies between 27% and 85% of total expenditure across the states during TE 2013/14. Expenditure on agricultural R&D includes expenditure on soil conservation, crop and animal husbandry. Private investment corresponds to GoI National Sample Survey-AIDIS survey years.

investments. An average of 65% of total expenditure (revenue plus capital) on irrigation was allocated to developing new infrastructure. And within irrigation category, more than 60%of that amount was allocated to development of major or medium irrigation works, indicating meager investment in minor and micro irrigation infrastructure by the states. Notably, per ha expenditure on agricultural R&D was higher among both LIS and HIS compared with MIS (Rs. 1,038 and Rs.1,345 compared with Rs. 511, respectively). Per ha spending on agri R&D was highest in Himachal Pradesh and J&K (Rs. 5,400) and lowest in the agriculture-dominant state of Rajasthan (Rs. 537).

These data indicate an uneven pattern of rural spending across the states and on various services. Studies show that decisions on the allocation of agricultural and irrigation expenditures are determined by the states and are largely based on their fiscal status (revenues and expenditures), grants from the central government,[5] insufficient growth in agriculture, and the degree to which states prioritize development (Roy & Pal 2001; Bathla & Thorat 2006; Bathla 2014). Agricultural and rural development are undeniably neglected in India's public expenditure policy. This was evident in the decelerating rate of growth in agricultural and irrigation investment compared with other services during the 1980s and 1990s, which in turn adversely affected private agricultural investment, perhaps based on complementarity between the two.[6]

Private investment is largely undertaken by farm households, mainly on machinery, irrigation, transport, and livestock. The National Sample Survey (GoI various years [e]) reports an increase in private investment per ha from Rs.471 in 1981/82 to 1,645 in 2012/13, with similar trends among the states.[7] Private investment has always been higher among HIS—in fact, more than double the combined spending levels of the MIS and LIS. In 2012/13, private investment per ha among the states was the highest in Himachal Pradesh and Kerala (Rs.7,772 and Rs.5,447, respectively) followed by Punjab and Uttar Pradesh (Rs.2,799 each), J&K (Rs.2,273), Maharashtra (Rs.1,843), Gujarat (Rs.1,762), and Karnataka (Rs.1,659). A few states—Assam, Bihar West Bengal, and Odisha—recorded low levels of private investment compared with public investment. At the national level, private investment rose by 9.15% per annum during 2002 to 2012.Tubewells and other irrigation sources as a share of total farm investment also increased over time—at 5.05% per annum in last two rounds of the National Sample Survey (GoI various years [e]). In 2012/13, irrigation investment constituted 24% of total agricultural investments among HIS and 30% among MIS, compared with only 10% among LIS.[8] Agricultural households in the LIS depend more on canal irrigation, indicating a need for increased public investment in irrigation (table 3).

It is important to mention that a revival of public investment from 2003/04 triggered increased private investment, causing the rate of agricultural growth to show signs of recovery and rural poverty levels to fall.[9] Studies also reveal sharp differences in the magnitude and growth of public rural investment in the first and the second decades after liberalization, which may have had a significant bearing on the farm income. Although sharp differences in land and labor productivity continue, farm income levels in Andhra Pradesh, Rajasthan, Madhya Pradesh, and West Bengal caught up with levels in the more developed states.

Public spending fuels infrastructure development but with varying levels of effectiveness and efficiency (table 4). While the area under irrigation in each state rose between 1983/84 and 2013/14, the percentage area irrigated by canals (due to public investment) remained

[5] Although agriculture and irrigation are the responsibility of the states, the central government influences state-level policies through budgetary allocations, grants, and additional funds to "special category" states.

[6] Other factors that influence private investment in agriculture include credit, terms of trade, and savings (Bathla & Kumari 2017).

[7] The estimates of private agricultural investment presented are drawn from the AIDIS-National Survey Sample (GOI various years [b]) and hence are not comparable with official Estimates of National Accounts Statistics (GOI, various years [c]).

[8] In absolute terms, per ha irrigation investment by farm households during this period (at 2004/05 prices) increased from Rs. 162 to Rs 772 among HIS, from Rs. 82 to324 among MIS, and from Rs. 50 to 113 among LIS.

[9] Other factors instigating agricultural growth and poverty reduction included favorable terms of trade and an increase in public expenditure for the National Horticulture Mission and other flagship programs, such as the Mahatma Gandhi National Rural Employment Guarantee Program, the National Food Security Mission, and Rashtriya Krishi VikasYojna (Joshi et al. 2006; Chand & Parappurathu 2012).

Table 4. Key indicators of public investment (average)

	Unit	TE 1983/84	TE 1993/94	TE 2003/04	TE 2013/14
	Low-income states				
Canal irrigation	Share (%)	12.3	12.1	11.5	16.1
Road density	Kilometers per thousand km^2	559	614	724	1,212
Agricultural electricity consumption per ha	Kilowatt hours	67	235	222	337
Rural literacy rate	Share (%)	25.3	31.5	45.7	68.8
Schooling of rural population	Years	2	3	4	5
Rural infant mortality rate	Per thousand live births	111	89	71	54
	Other indicators				
Well irrigation	Share (%)	87.7	87.9	88.5	83.9
Fertilizer consumption per hectare	Tons	34	64	97	169
Agricultural GSDP	Rs. (billion)	988	1,308	1,696	2,588
Land productivity	Rs.per ha	31,273	37,722	46,123	68,295
	Middle-income states				
Canal irrigation	Share (%)	12.3	12.1	11.5	16.1
Road density	Kilometers per thousand square kilometers	533	715	889	1,482
Agricultural electricity consumption per ha	Kilowatt hours	53	325	608	1025
Rural literacy rat	Share (%)	27.3	34	51.6	69.2
Schooling of rural population	Years	2	3	4	5
Rural Infant mortality rate	Per thousand live births	102	87	72	45
	Other indicators				
Well irrigation	Share (%)	87.7	87.9	88.5	83.9
Fertilizer consumption per ha	Tons	37	84	121	187
Agricultural GSDP	Rs. (billion)	1,038	1,390	1,735	2,557
Land productivity	Rs. per ha	18,595	20,875	23,742	40,145
	High-income states				
Canal irrigation	Share (%)	13.5	14.1	13.5	13.7
Road density	Kilometers per thousand square kilometers	922	1,169	1,301	1,785
Agricultural electricity consumption per ha	Kilowatt hours	226	687	1,184	1,446
Rural literacy rate	Share (%)	41.8	48.7	62.1	79.9
Schooling of rural population	Years	3	4	5	6
Rural infant mortality rate	Per thousand live births	113	84	70	47
	Other indicators				
Well irrigation	Share (%)	86.5	85.9	86.5	86.3
Fertilizer consumption per ha	Tons	71	127	162	224
Agricultural GSDP	Rs. (billion)	968	1,350	1,706	2,421
Land productivity	Rs. per ha	32,748	46,495	59,918	81,668

Source: Authors' calculations based on GoI [a-f].
Note: TE = Triennium (three-year period) ending.

Table 5. Matrix of inequality in agricultural productivity and income, selected states, 1981 2014 average

		Per capita income		
		High	Middle	Low
Productivity	High	Haryana, Punjab, Kerala, Himachal Pradesh	West Bengal	Jammu and Kashmir
	Middle	Tamil Nadu	Andhra Pradesh	Assam, Bihar, Uttar Pradesh
	Low	Maharashtra, Gujarat	Rajasthan, Odisha, Karnataka	Madhya Pradesh

Source: Authors' compilation.

unchanged despite an enormous increase in expenditure on major and medium systems. Clearly, farm households depend more on borewells and tanks for irrigation than irrigation canals built with public funding. Only a few states (J&K, Haryana, Karnataka, Madhya Pradesh, and Punjab) recorded increase in area under public irrigation, and where increase occurred, the overall share remained less than 40%. This may reflect considerable time lags from the point at which investments are made to the point at which outcomes are attained, but it may also reflect inefficiencies in the use of public resources.

In the case of road networks, Kerala achieved the highest road density (3,758 km per thousand km^2) followed by Assam, Tamil Nadu, and Odisha. Rural road density is lowest in J&K and Rajasthan. Overall, density is lowest among LIS (776 km per thousand km^2) and highest among HIS (1,250 km per thousand km^2). The situation is equally discouraging for per ha agricultural electricity consumption among LIS (219 kWh compared with 847 kWh among HIS). Differences across states are more modest for the key indicator of health status, the rural infant mortality rate, and for the literacy rate and years of schooling among the rural population, both representing investment in education. Large inter-state differences in these indicators are a cause of concern. Health and education services generated with public spending are inadequate and call for policy interventions. The rural infant mortality rate significantly improved over the period under study, whereas rates of malnutrition and the health status of children and women are way behind in most of the states. Although rural literacy rates have risen steadily over the years, they remain below the national average in some of the poorer states. Of even greater concern, years of schooling among the rural population changed little over time, with the exception of the state of Kerala.[10]

Northern states with high per capita income levels have higher agricultural productivity, whereas less-developed states, mostly in eastern India have low levels of agricultural productivity. But the latter generally have low income-inequality (table 5). These trends emphasize the fact that uneven public investments – higher in northern and lower in eastern states - may have exacerbated inequalities in rural areas, in turn contributing to stagnating farm productivity and income growth in many states. The HIS generally spend more on education, health/nutrition, roads/transport, and agricultural R&D than they do on agriculture overall, energy, or irrigation services. Furthermore, the southern states performed better in many development indicators, such as health and education. All the states are lagging in their investment in nutrition outcomes, reflecting a need for policy initiatives that intend to promote equitable and inclusive growth.

4 Public investments and regional income inequality

Estimates obtained from the production function based on the conventional inputs and select public investments during pre- and post-liberalisation periods and across the three groups of states are presented in table 6. Alternate equations were estimated to address the problem of multicollinearity between road density and tubewell irrigation. A separate equation was specified to analyze the impact of education based on

[10] National Sample Survey data on employment-unemployment (GoI [e]) indicate that, as of 2011-12 only 6 % of India's population was educated above graduate level; the status could be shockingly low in rural areas.

Table 6. Elasticity estimates from production function based on pooled regression

	Pre-liberalisation (1981-1990)	Post-liberalisation (1991-2014)	Low-income states	Middle-income states	High-income states
Land	0.550*	0.470*	0.690*	0.320*	0.160
Labor	0.170	0.050**	0.090*	0.210***	0.180***
Capital					
Private irrigation (tubewells)	-0.220	0.300	0.770**	0.290	1.030*
Public irrigation (canals)	0.0001	0.080**	0.060***	0.070	0.098*
Road density	0.120	0.030***	0.0230	0.140*	0.094**
Electricity consumption	-0.001	0.060*	0.073*	0.080*	0.050
Education (literacy rate)	0.550*	0.330*	0.410*	0.460*	0.560*
Agricultural R&D	0.110***	0.090*	0.072*	0.180*	0.220*
Health (infant mortality rate)	1.60*	3.400*	1.800*	0.720	1.800*
Annual rainfall	0.140*	0.060*	0.031***	0.270*	0.170*
Fertilizer consumption	—	0.001*	0.001	0.060	0.270*
Adjusted R^2	0.960	0.970	0.980	0.980	0.960
No. of observations	170	391	165	165	231

Source: Authors' calculations.

Note: Variables are specified in log form. The model was estimated using pooled regression and random effects. The estimate for road density is from an alternate equation to address the multicollinearity problem. *, **, and *** indicate significance at the 1%, 5%, and 10% levels, respectively. GSDPA = gross state domestic product in agriculture and allied activities

the number of years of schooling among the rural population. The coefficient of multiple determination-adjusted R^2 in each equation is found to be high (nearly 0.97), implying that the explanatory variables taken in the production function aptly explain the variations. The coefficient for each variable bears the expected theoretical sign and is statistically significant. The coefficients for labour, irrigation, and road density are statistically insignificant during the pre-liberalisation period. The results tend to be similar across LIS, MIS, and HIS, with the exception of public irrigation and agricultural electricity consumption.

The variables land, labour, capital, and public investment show positive and significant impacts on agricultural income. The variable land is insignificant among HIS. The estimated elasticity is highest for health (1.8), followed by private irrigation (1.03), and education (0.56). The elasticity of labour is lower than that of land across all 17states, which confirms the presence of surplus agricultural labour. The coefficients for public and private irrigation differ substantially, with private irrigation being much larger. This suggests that the returns to private irrigation investment are higher. Across all public investment categories, health, education, and agricultural R&D have the largest elasticities. Even when rural literacy rate is replaced with years of schooling, the estimated elasticity is significantly high. The coefficients for roads and energy infrastructure have smaller values. The analysis also varies in the pre- and post-liberalisation periods, indicating statistical significance of investment in irrigation, roads, and electricity after liberalization.

The income inequality coefficient is estimated to be 0.014 for the overall period, and slightly higher in the post-liberalisation period (0.007) than the pre-liberalisation period (0.001) (table 7). These results confirm an increase in regional income inequalities following economic liberalization. As expected, income inequality increases with rising income levels. The estimated inequality coefficient is 0.015 among LIS, rising to 0.02 among MIS, and then to 0.023 among HIS. The contribution of each category of public investment to income inequality was quantified based on the elasticity estimates.

Table 7. Contribution of various factors to inter-state inequality in agricultural income (%)

	All					
	1981-2014	Pre-liberalisation 1981-1990	Post-liberalisation 1991-2014	Low-income states	Middle-income states	High-income states
Inequality coefficient	0.014	0.001	0.007	0.015	0.020	0.023
Land	8.28(6)	8.91 (4)	5.81 (5)	6.93 (5)	4.66 (5)	1.49 (7)
Labor	0.73(9)	5.88 (6)	1.02 (7)	1.34 (7)	2.32 (7)	-0.270 (9)
Capital (irrigation)						
Private	1.53(8)	0.76 (7)	0.85 (8)	5.49 (6)	-0.61 (10)	-1.88 (10)
Public	-1.91(10)	0.002 (8)	-1.38 (10)	-2.84 (10)	0.96 (9)	1.44 (8)
Electricity	16.97(2)	-0.83 (9)	5.99 (4)	7.36 (4)	17.13 (3)	7.91 (5)
Roads	3.31(7)	7.13 (5)	2.74 (6)	1.31(8)	12.57 (4)	3.72 (6)
Agricultural R&D	13.12(3)	19.27 (2)	16.36 (3)	10.55 (3)	18.70 (2)	22.47 (3)
Health	11.78(4)	17.21 (3)	23.67 (2)	17.10 (2)	3.66 (6)	8.55 (4)
Education	32.20(1)	36.03 (1)	40.94 (1)	50.83 (1)	38.46 (1)	29.67 (1)
Fertilizer consumption	10.31(5)	—	0.140 (9)	0.150 (9)	1.260 (8)	25.31 (2)

Source: Authors' calculations.
Notes: The figures in parentheses indicate ranking.

The contribution of land, labor, and private irrigation investment to income inequality is modest, at 8.28%, 0.73% and 1.53%, respectively (table 7). However, among various public investments, the contribution of irrigation to income inequality is negative, whereas the contribution of other services is positive, and highest for education. The ranking differs little during the pre- and post-liberalisation periods, indicating a key role of education, health and agricultural R&D investments towards regional income inequality. Irrespective of which education variable is used (that is, the literacy rate or years of schooling), the results remain unchanged. A much higher contribution of education to income inequality portrays large variations in the levels of educational attainment of people from primary to post graduation across the states. Further, such income inequalities are more apparent among LIS. Public investments in health and agricultural R&D ranked second and third in their contribution to income inequality during the post-liberalisation period (23.67% and 16.36%, respectively). The contribution of public investment in health is higher among LIS (17.10%) compared with either MIS or HIS (3.66% and 8.55%, respectively).

Investments in roads, electricity, and irrigation contributed less to income inequality over the period. Private irrigation, labor, and land rank lowest in terms of their contribution to income inequality. These findings sharply contrast those for China, where studies have found that land and labour inputs make higher contribution to regional income inequality compared with the contributions of public investments/services.[11] Zhang & Fan (2004) found that the contribution of agricultural R&D, electrification, and telephones during 1978 to 1995 increased inequality in China whereas investments in health and education led to a decline in inequality.

Estimates of the marginal impact of public investments on income inequality are based on the estimated elasticity from the production function and averages of each type of investment during 2013/14. The percentage change in inter-state inequality in agricultural income levels resulting from a 1% increase in public investment on various categories is reasonably high (table 8). The impact of additional investments in roads, electricity, agricultural R&D, and irrigation in reducing income inequality is somewhat higher than the impact of additional investments in education,

[11] The income inequalities due to land (owned and cultivated) have been identified within each state at the household level (Chakravarty et al. 2016; Bathla & Kumar 2018).

Table 8. % change in income inequality due to additional public investments (marginal returns)

	Change (%)				Ranking			
	All	Low-income states	Middle-income states	High-income states	All	Low-income states	Middle-income states	High-income states
Private irrigation tubewell	1.160	1.400	0.700	2.690	6	7	4	7
Public canal irrigation	1.180	0.620	0.910	1.620	7	5	5	6
Electricity	0.010	0.028	0.014	0.007	2	3	1	1
Roads/transport	0.003	0.003	0.018	0.012	1	1	2	2
Agricultural R&D	0.031	0.026	0.187	0.124	3	2	3	3
Health/nutrition	0.180	0.290	2.050	0.420	4	4	7	4
Education (literacy rate)	0.480	0.880	1.310	1.540	5	6	6	5

Source: Authors' calculations.
Note: Estimates indicate the percentage change in income inequality due to additional investments in 2013/14.

health, and private investment in irrigation. Furthermore, the marginal returns from each type of public investment are mostly higher among LIS. The elasticity is estimated to be 0.003% for roads, 0.026% for agricultural R&D, 0.028% for energy, 0.29% for health, and 0.62% for irrigation. These results indicate that additional investments in these services in poorer states would be more helpful in achieving income equality. The results substantiate literature on the differential effects of public investments in agriculture and infrastructure across the country's states and agro-ecological zones. A lopsided distribution of public investment to HIS would essentially worsen regional disparities, thereby suggesting to raise investments in low per capita income states, situated mainly in the eastern India.

5 Conclusions and implications

A significant change in public policy, apparent from 2003/04, has led to a substantial increase in public investment in agriculture and irrigation in India. As a result, private investment in agriculture, GSDPA, and land productivity steadily improved. Rapid overall economic and agricultural growth occurred in most Indian states in the post-liberalisation period, but especially among LIS. Nevertheless, this transformation failed to lessen inter-state disparities in agricultural income levels, as well as in key economic and social development indicators. Large inter-state variations in agricultural policies and in the type and magnitude of investments could explain differential productivity and growth.

Results reveal that agricultural income levels are strongly interrelated with the conventional inputs of land, labour, and capital, as well as with various types of public investment. Land, labour and private investment in irrigation have only a modest impact on regional income inequality. The contribution of public investments, however, is substantial, with significant variations across LIS, MIS, and HIS. Among various public investments, education and health have larger effects on inequality compared with rural energy, roads/transport, irrigation and agricultural R&D. This suggests that the states should prioritize investments in these four areas in order to maximize the equity effects. Importantly, the marginal returns to additional public investments (in terms of reducing income inequality) are generally higher in the less-developed, agriculture-dominant states with extreme poverty levels, implying the potential benefit of a location-specific expenditure policy. Increased public investment in the poorer states would also have a favorable impact in increasing agricultural productivity and reducing poverty through improved infrastructure and technology.

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References

Ahluwalia, M. S. (1978). Rural poverty and agricultural performance in India. Journal of Development Studies, 14(3), 298-324.

Anand, R., Tulin, V., & Kumar, N. (2014). India: defining and explaining inclusive growth and poverty reduction. Working paper 14/63, International Monetary Fund, Washington, DC.

Barro, J.R. (1990). Government spending in a simple model of endogenous growth. Journal of Political Economy, 20 (2), 221-247.

Bathla, S. (2014). Public and private capital formation and agricultural growth: state-wise analysis of inter-linkages during pre- and post-reform periods. Agriculture Economics Research Review, 27(1), 19-36.

Bathla, S., & Kumari, Y. (2017). Investment behaviour of farmers across Indian states: determinants and impact on agriculture income. In: Changing contours of Indian agriculture: Investment, income and non-farm employment (S. Bathla & A. Dubey, eds.), Springer Nature, Singapore.

Bathla, S., & Kumar, A. (2018). Income inequalities among agricultural households in India: state level assessment and contributing factors. In: India Social Development Report (Council for Social Development) Oxford University Press (forthcoming), New Delhi.

Bathla, S., & Thorat, S. K. (2006). Trends and determinants of public investment in agriculture at the regional level. Man and Development, 28 (2), 115-136.

Bathla, S., Joshi, P. K., & Kumar, A. (2017). Revisiting investment and subsidies to accelerate agriculture income and alleviate rural poverty in India. Discussion paper 1701, International Food Policy Research Institute, Washington, DC.

Bathla, S., Thorat, S. K., Joshi, P. K. & Bingxin, Y. (2017). Where to invest to accelerate agricultural growth and poverty reduction? Economic and Political Weekly, 52 (3), 36-45.

Betz, J., & Neff, D. (2016). Root causes of the varying performance of Indian states. In: seminar organized by Centre for the Study of Regional Development, Jawaharlal Nehru University, and German Institute of Global and Area Studies, Hamburg, Germany, 21-22 November.

Chakravarty, S., Chandrasekhar, S. & Naraparaju, K. (2016). Income generation and inequality in India's agricultural sector: the consequences of land fragmentation. Working paper 2016-028, Indira Gandhi Institute of Development Research. Mumbai.

Chand, R., & Parappurathu, S. (2012). Temporal and spatial variations in agricultural growth and its determinants. Economic and Political Weekly, 47(26/27), 55-64.

Claus, I., Martinez-Vazquez, J. & Vulovic, V. (2014). Government fiscal policies and redistribution in Asian countries. In: Inequality in Asia and the Pacific: Trends, drivers, and policy implications (R. Kanbur, C. Rhee, & J. Zhuang, eds.). Roultledge & Asian Development Bank.

Cowell F. (1995). Measuring inequality, 2nd edition. Hemel Hempstead: Harvester Wheatsheaf.

Datt, G., Ravallion, M., & Murgai, R. (2016). Growth, urbanization and poverty reduction in India. Working paper 21983, National Bureau of Economic Research, Cambridge, MA, USA.

Dev, M. S. (2017). The Problem of inequality. In: India's economy: pre-liberalisation to GST: essays in honour of Raj Kapila (Uma Kapila, eds.). Academic Foundation, New Delhi.

Fan, S., ed. (2008). Public expenditures, growth, and poverty: lessons from developing countries. Oxford University Press, New Delhi.

Fan, S., Kanbur, R., & Zhang, X. (2008). Regional inequality in China: an overview. Working paper No. 2008-18, Department of Applied Economics and Management, Cornell University.

Fan, S., Zhang, L., & Shang, X. (2002). Growth and poverty in rural China: the role of public investments. Report no. 125, International Food Policy Research, Washington, DC.

Fan, S., Hazell, P., & Thorat, S. K. (1999). Linkages between government spending, growth and poverty in rural India. Research report 10, International Food Policy Research Institute, Washington, DC.

Fan, S., Hazell, P. & Haque, T. (2000). Targeting public investments by agro-ecological zone to achieve growth and poverty alleviation goals in rural India. Food Policy, 25(4), 411-428.

Fan, S., Gulati, A., & Thorat, S. K. (2008). Investment, subsidies and pro-poor growth in rural India. Agricultural Economics, 39, 163-170.

Fan, S., Chan-Kang, C., Qian, K. & Krishnaiah, K. (2003). National and international agricultural research and rural poverty: the case of rice research in India and China. Discussion paper 109, International Food Policy Research Institute, Washington, DC.

Fields, G., & Yoo, G. (2000). Falling labour income inequality in Korea's economic growth: patterns and underlying causes. Review of Income Wealth, 46(2), 139–159.

Ghosh P. P., & Dasgupta, C. 2017. Uneven growth in India-inter- and intra-state disparities. Manak Publications, New Delhi.

GOI (Government of India).Various years [a]. Agricultural statistics at a glance. Ministry of Agriculture and Farmers' Welfare, New Delhi.

_____. Various years [b]. All India debt and investment survey. National Sample Survey, Central Statistical Organisation, Ministry of Statistics and Programme Implementation New Delhi.

_____.Various years [c]. National accounts statistics. Central Statistical Organisation, Ministry of Statistics and Programme Implementation, New Delhi.

_____.Various years [d]. Finance accounts. Comptroller and Auditor General of India, Ministry of Finance, New Delhi.

_____.Various years [e]. Employment unemployment. National Sample Survey office, Central Statistical Organisation, New Delhi.

Jacoby, H. (2000). Access to markets and the benefits of rural roads. Economic Journal, 110(465), 713–737.

Joshi, P. K., Birthal, P. S., & Minot, N. (2006). Sources of agricultural growth in India: role of diversification towards high value crops. Discussion paper 98, International Food Policy Research Institute, Washington, DC,

Kanbur, R., & Zhang, X. (1999). Which regional inequality?: the evolution of rural-urban and in-coastal inequality in China from 1983–1995. Journal of Comparative Economics, 27, 686–701.

Kundu, A., & Varghese, K. (2010). Regional inequality and inclusive growth in India under globalization: identification of lagging states for strategic intervention. Working paper Series-VI, Oxfam India, New Delhi.

Martin P. (1999). Public policies, regional inequalities and growth. Journal of Public Economics, 73, 85–105.

Ministry of Home Affairs. (Various years). Census data. New Delhi.

Mishra, S. N, & Chand, R. (1995). Public and private capital formation in Indian agriculture: comments on the complementarity hypothesis and others. Economic and Political Weekly, 30(25), A64–A79.

Mogues, T. (2012). What determines public expenditure allocations?: a review of theories and implications for agricultural public investment. Working paper 12-06, Food and Agriculture Organization of the United Nations, Rome.

Mogues, T., Fan, S., & Benin, S. (2015). Public Investments in and for agriculture. The European Journal of Development Research, 27, 337–352.

Pal, P., & Ghosh, J. (2007). Inequality in India: a survey of recent trends. Working paper 45, United Nations Department of Economics and Social Affairs, New York.

Panagariya, A., Chakraborty, P., & Rai, M. G. (2014). State level reforms, growth, and development in Indian states— studies in Indian economic policies. Oxford University Press, USA.

Ravallion, M., & Datt, G. (1995). Growth and poverty in rural India. Working paper 1405, World Bank, Washington, DC.

Roy, B.C., & Pal, S. (2001). Investment, agricultural productivity and rural poverty in India: a state-level analysis. In: Indian agriculture in the new millennium: changing perspectives and development policy (N. A. Majumdar & U. Kapila, eds.). Academic Foundation, New Delhi.

Sen A. (1997). Agricultural growth and rural poverty. In: Growth, employment, and poverty: change and continuity in rural India (G. K. Chadha & A. N. Sharma, eds.). Indian Society of Labour Economics, New Delhi.

Sen, A., & Himanshu. (2005). Poverty and inequality in India: getting closer to the truth. Economic and Political Weekly, 39(38), 4247–4263.

Shetty, S.L. (1990). Investment in agriculture: brief review of recent trends. Economic and Political Weekly, 25(7/8), 17–42.

Shorrocks, A. F. (1982). Inequality decomposition by factor components. Econometrica, 50(1), 193–211.

Zhang,X., & Fan, S. (2004). Public investment and regional inequality in rural China. Agricultural Economics, 30, 89–100.

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