Social Demographics and Health Achievements

An Ecological Analysis of Institutional Delivery and Immunization Coverage in India

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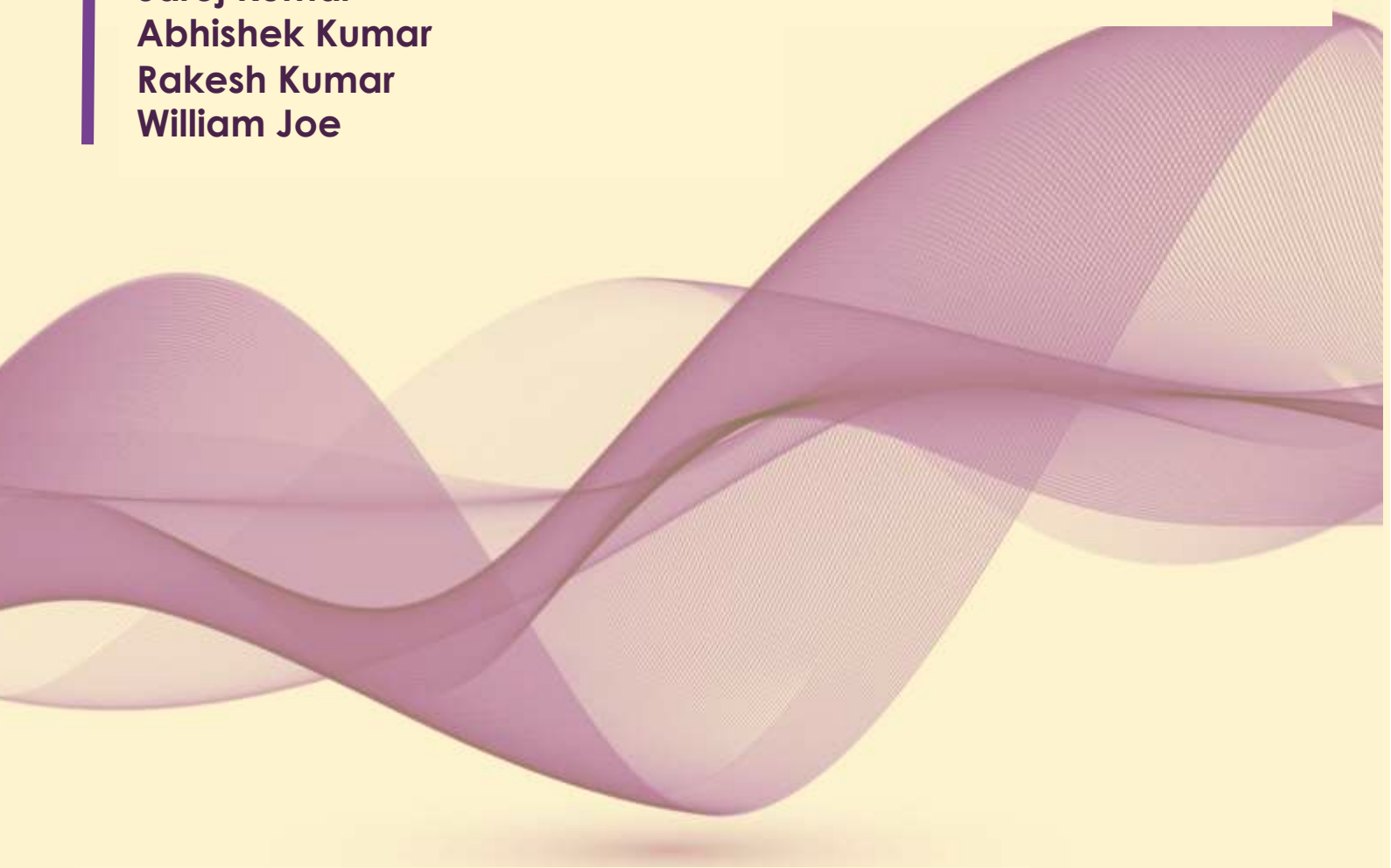

2021

IEG Working Paper No. 427

April 2021

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An Ecological Analysis of Institutional Delivery and Immunization Coverage in India

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ABSTRACT

The National Rural Health Mission of India was expected to have two broad kinds of impacts on institutional delivery and immunization coverage. First, to significantly increase institutional delivery and immunization coverage levels across all districts and, second, to enhance equity by reducing utilization gaps between districts with higher and lower share of marginalised population. This paper adopts a lens of social demography and presents an ecological analysis of poor performing districts in nine high focus States of India. We find that between year 2007-08 and 2012-13 there has been considerable progress in institutional delivery across all the districts but improvements in full immunization coverage has been slow and many districts are failing to sustain progress in immunization coverage. Econometric analysis reveals that districts with higher shares of Muslims display slowest progress. The association is robust even in models adjusted for district-level clustering. Districts with greater availability of specialists in public health facilities have a favorable impact on institutional births whereas female literacy levels have significant influence on immunization. In concluding, we discuss the need for policy debiasing as more than a uniform approach is necessary to facilitate rapid progress in immunization across districts.

Keywords: Social demography, Immunization, Institutional births, District Level Household Survey (DLHS), National Health Mission (NHM)

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Introduction

The National Rural Health Mission (NRHM) – a flagship programme of the Government of India - was launched in 2005 to achieve faster and equitable improvements in maternal and child health outcomes in the country (Planning Commission of India, 2011). The NRHM recommended almost uniform set of strategies and interventions across states and districts to ensure universal coverage of maternal and child health care services. The states were entrusted to prepare the programme implementation plans for strengthening supply-side factors such as availability and quality of health infrastructure and human resources across districts. Also, on an unprecedented scale, the Mission rolled out demand-side financing scheme by providing direct monetary incentives to the beneficiaries to promote institutional births (conditional cash transfer programme, *Janani Suraksha Yojana,* JSY). Furthermore, under *Janani Shishu Suraksha Karyakram,* (JSSK) provisions were made for free drugs, diagnostics and drop-back facilities for pregnant women and mothers to promote uptake of maternal and child health care services.

Community engagement was identified as an integral part of the programme strategies to achieve greater mobilization and support from local level institutions such as Panchayats and schools. The Mission developed a network of community health workers (named as Accredited Social Health Activists, ASHAs) to improve health awareness and promote linkages between communities and the public health system. These efforts, along with JSY, contributed towards an overall increase in utilization of maternal health care services with

particularly favourable impact on institutional delivery that increased from 39% in 2005-06 to 79% in 2015-16 (IIPS, 2015-16; Vellakkal, 2017a, 2017b; Powell-Jackson et al. 2015; Lim et al., 2010). However, in case of childhood immunization (44% 2005-06 to 62% in 2015-16) India failed to experience improvements of similar magnitude (IIPS, 2015-16; Dasgupta et al. 2014). Progress notwithstanding, the representativeness of national achievement in institutional delivery and immunization coverage is also questionable because of huge inter-district disparities across states and regions (ORGI & IEG, 2016). This assumes critical relevance because districts are identified as the key unit for planning, administration and programme implementation. Against this backdrop, this paper presents an ecological analysis of dissimilar health progress across selected Indian districts and highlights issues for policy debiasing for greater effectiveness.

The analysis adopts a social demographic perspective that is regarded as an important theoretical approach to understand such spatial disparities in health and health care progress (Arcaya et al. 2015; Kawachi, 2002; Krieger, 2001; Williams, 2001; Curtis & Jones, 1998). In particular, spatial disparities in health and health care achievements are linked to differences in socioeconomic profile of the place. Such disparities are expected because of both compositional and contextual effects associated with a place (Curtis & Jones, 1998). The former type of effect is attributable to the variations in the distribution of type of people whose individual characteristics influence health and health care whereas the latter effect embodies the influence of the social and physical environment in shaping health and achievement. In fact, segregation based on such compositional effects is argued to be an important determinant of quality of health care provisioning with significant disadvantages for the marginalized subgroups (William & Collins, 2001). Even in the Indian context, it is noted that regions with greater concentration of historically marginalized social groups

(Scheduled Caste or Scheduled Tribe, SC or ST) suffer from high incidence of poverty, illiteracy and health deprivations (Thorat et al. 2016; Thorat & Dubey, 2012; Baru et al. 2010; Sengupta et al. 2008; Desai & Kulkarni, 2008). Similarly, regions with higher share of Muslim population depict poor social and economic development (Sachar, 2006). Entailing such an ecological approach assumes salience in policymaking and offers vital insights regarding the associations between contextual, structural and sociological dimensions of public health (Curtis & Jones, 1998; Susser, 1994; Schwartz, 1994).

Figure 1: A typology of base-level and progress relationship

		Progress	
		Low	High
Base level	Low	(Low, Low)	(Low, High)
	High	(High, Low)	(High, High)

Before proceeding further, it is critical to account for an elementary inverse association between base level of health indicator and the progress thereon (Waage et al. 2010; Easterly, 2009; Prennushi et al. 2002; Dasgupta, 1990; Sen, 1981). In fact, it is widely acknowledged that regions with higher base-levels are more likely to demonstrate slower progress than those with lower base-levels (Fukuda-Parr et al. 2013; Kakwani, 1993). A simple two-way classification of districts in terms of base-level and progress further illustrates this concern. Figure 1 shows that districts can be categorised into those with higher and lower base-levels and, similarly, those with higher and lower progress. Thus, a mutually exclusive classification of districts is possible whereby the threshold cut-off point can be defined based

on specific policy benchmarks or distributional measures such as mean or median. Given the underlying non-linear dynamics of health care progress, situations where base-levels were lower and absolute progress is higher (Low, High) and where base-levels were higher and absolute progress is lower (High, Low) are more expected. Situation (High, High) is perhaps an interesting case worth being highlighted as a best practice for policy and governance. However, from a policy perspective, the districts under (Low, Low) category defy the logic of progress dynamics and can be clearly identified and prioritised for policy action. This framework is rather desirable for governments and organizations that rely on ecological inferences for policy implementation and appraisals and more often refer to classifications such as high-focus districts or areas for accelerated improvements.

This paper illustrates such an approach to understand the dynamics of progress in institutional delivery and immunization coverage across 284 districts from nine high-focus states of India (Assam, Bihar, Chhattisgarh, Jharkhand, Madhya Pradesh, Odisha, Rajasthan, Uttarakhand and Uttar Pradesh). We examine the progress made during 2007-08 and 2012-13 and hypothesise that a socio-demographic lens can provide valuable insights to understand the deviation of districts from the expected path of health care progress. Moreover, a deviation from this general pattern presents a case for debiasing policies with particular focus across such districts. Thus, we essentially motivate the idea that improvements from both demand and supply side are necessary to ensure rapid health progress. In fact, NRHM displays a predominant supply side focus but it is also critical to develop policy tools that can further influence the demand side. Therefore, in concluding, we argue for improved understanding of individual behaviour (bounded rationality) across such districts and at the same time consider promoting choice across health care providers and settings as an effective alternative (Schlesinger, 2010) to improve health system performance across such districts.

Data and methods

The analysis is based on 284 districts from nine States of India namely Assam, Bihar, Chhattisgarh, Jharkhand, Madhya Pradesh, Odisha, Rajasthan, Uttar Pradesh and Uttarakhand. These States have relatively high fertility and child mortality rates and account for about one-half of the total population of India (ORGI, 2016). The district level information regarding institutional delivery and full immunization coverage obtained from the District Level Household Survey (DLHS) 2007-08 factsheets (IIPS 2008) and Annual Health Survey (AHS) 2012-13 factsheets (RGI 2014) are used to understand progress during this period (IIPS, 2007-08; ORGI, 2012-13). Although, NRHM was launched in 2005, but this analysis considers 2007-08 estimates as the base period for this analysis. The year 2012-13 provides sufficient time gap for the programme to make a comprehensible impact on these health care indicators.

The district level shares of SC, ST and Muslim population is available from Census of India 2001 and 2011. As we aim to examine whether there is a significant difference in levels of institutional delivery and full immunization coverage across districts with higher share of vulnerable social groups viz. SC, ST, Muslims, therefore, we use a threshold of 25% population share to categorize districts on the basis of socio-demographic composition as high SC, high ST or high Muslim population district. The distribution of districts across these States as well as information regarding number of districts with greater concentration (more than 25%) of ST, SC and Muslim population is available in Supplementary Table S1. Overall, about one-fifth of the 284 districts have a greater concentration of ST population. Madhya Pradesh, Odisha and Chhattisgarh have 15, 14 and 11 districts respectively with higher concentration of ST population. Uttar Pradesh has a large number of districts with

greater concentration of the SC population (16 and 14 in 2001 and 2011, respectively). More than 10% of the districts have a higher concentration of Muslim population. In particular, Assam, Uttar Pradesh and Bihar have more districts with higher proportion of Muslim population than others.

During the NRHM period, there have been other developmental changes which could have directly or indirectly contributed to improvements in institutional delivery and immunization coverage. Therefore, we also include certain key developmental variables to discern their influence on progress between 2007-08 and 2012-13. In particular, we use the region-specific poverty headcount ratios for the years 2004-05 and 2011-12 to proxy the income deprivation levels across districts in the respective time-periods (Chauhan et al. 2015). Census of India information regarding male and female literacy rates for the years 2001 and 2011 is used to capture social development across districts. District level household electrification information from Census of India 2001 and 2011 is used to proxy infrastructure improvements. We also use classification of the districts as Left-Wing Effected (LWE) core and adjoining areas based on secondary information available from www.indiastats.com. About one-fifth of the 284 districts are classified as left-wing extremism affected (LWE) core or adjoining districts.

We also explore the role of availability of human resources in public health facilities, particularly at district hospitals (DHs) and community health centres (CHCs) as this can significantly influence service uptake by the community and also improve overall monitoring and performance at the sub-district level. For this purpose, we use the human resources information collected through DLHS 2012-13 public health facility surveys and generate a district level human resource score which is defined as a sum of total number of specialists in

the DHs and CHCs of a given district. The information regarding availability of the following specialists at the DH level and CHC level is considered: Obstetrician & Gynaecologist, Paediatrician, Anaesthetist, Radiographer and availability of ultrasound facility. The components are added to arrive at district level human resources score (Cronbach's alpha: 0.70).

We present statistical summaries of district-level progress in institutional delivery and full immunization coverage. A simple difference-in-differences method is used to test whether there is a statistically significant difference in average level of health care utilization levels across the different types of districts. From this analysis, we seek to infer whether there have been any reductions in the disparities over the years for districts classified on the basis of sociodemographic composition of marginalized social groups. It is worthwhile to mention that the change in outcomes for the comparison districts serves as the counterfactual here. This analysis of change in levels of institutional delivery and full immunization coverage across these districts is further complemented by adjusting for influence of other factors over these health care indicators. For this purpose, we use random-effects multilevel regression model to examine the association between share of vulnerable population subgroups and district-level progress in health care utilization. The regression model also includes interaction terms for time period and type of district to discern whether certain districts performed exceptionally different from others.

Finally, we use the generalized ordered logit model to assess whether districts with higher concentration of certain marginalized social groups are more likely to deviate from the expected progress dynamics. For this purpose, following Figure 1, the districts are classified into three ordered-categories: 1) LL districts, 2) HL or LH districts and 3) HH districts. LL

refers to districts with lower base level health achievement than average level across districts and the progress in health achievement also being lower than average progress across districts. HL refers to districts with base level health achievement above average level across districts but progress in health achievement is noted to be below average progress across districts. LH refers to districts with base level health achievements below the average level across districts but progress in health achievement is found to be above average progress across districts. HH refers to districts whose base level health achievement is higher than average level across districts and progress in health achievement is also greater than average progress across districts. Given the categories, the generalized ordered logit could be written as follows (Williams, 2006):

$$P(Y_i > j) = g(X\beta_j) = \frac{\exp(\alpha_j + X_i\beta_j)}{1 + \{\exp(\alpha_j + X_i\beta_j)\}}, j = 1, 2, \dots, K-1$$

Where, Y is the dependent variable with K categories and X is the vector of explanatory variables with coefficients β_j. The generalized ordered logit essentially relaxes the parallel lines constraint underlying the simple ordered logit model. More specifically, in a simple ordered logit β values are same for all values of K categories of dependent variable (hence the parallel lines assumption) whereas in the generalized ordered model the β's are allowed to vary across the K categories of dependent variable. The results are based on a partial proportional odds model whereby we use a Wald test to check the parallel lines assumption for variables (William, 2006; Long & Freese, 2014). Following (William, 2006), the results are reported using gamma (γ) parameterization such that each of the explanatory variable has one β coefficient (interpreted as the constant component of log odds ratio across cut-off points) with γ coefficients (interpreted as the increment at the cut-off point) being reported only for those explanatory variables that violate the parallel lines assumption.

Results

Table 1 reports the average institutional delivery and full immunization coverage across districts for the selected states in 2007-08 and 2012-13. It is noted that there is significant increase in average institutional delivery levels across districts. In particular, districts from Madhya Pradesh, Odisha and Rajasthan have attained faster average progress. The coefficient of variation (CV) suggests a reduction in inter-district disparities in institutional delivery across states (Supplementary Table S2). Full immunization coverage also shows considerable improvements both in terms of levels as well as reductions in inter-district disparities. But Odisha is a clear exception with much poor progress in immunization coverage (61.9% in 2007-08 and 64.4% in 2012-13).

Table 1: Average levels of institutional delivery (%) and full immunization coverage (%) across districts by state and demographic characteristics, 2007-08 and 2012-13

	Institutional delivery (%)				Full immunization coverage (%)			
	2007-08		2012-13		2007-08		2012-13	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Districts from								
Assam	37.2	11.4	66.0	14.8	52.2	14.0	64.7	9.8
Bihar	28.6	11.7	57.2	13.9	42.0	10.8	70.2	11.1
Chhattisgarh	18.3	5.2	42.4	12.8	59.8	9.9	75.5	9.9
Jharkhand	20.1	11.1	44.1	12.7	54.9	16.2	67.9	12.6
Madhya Pradesh	47.9	12.9	81.7	10.6	37.8	15.8	64.1	12.5
Odisha	43.5	17.4	78.7	12.2	61.9	15.6	64.4	18.0
Rajasthan	44.9	10.6	77.7	11.6	51.1	16.7	73.1	13.0
Uttar Pradesh	26.6	10.6	57.5	10.1	31.7	10.7	53.6	11.3
Uttarakhand	29.5	9.8	56.7	9.7	63.9	7.2	82.5	7.9
Districts with								
ST < 25%	34.9	15.4	64.8	17.3	44.0	16.8	64.6	14.4
ST > 25%	31.2	14.8	64.6	17.8	51.9	18.5	67.2	14.9
SC < 25%	35.0	15.4	65.2	17.6	46.5	17.4	65.5	14.4
SC > 25%	24.9	10.8	59.5	13.2	34.4	12.5	60.2	16.2
Muslim < 25%	35.5	15.3	66.5	16.9	46.6	17.7	66.3	14.3
Muslim >25%	22.9	10.1	51.5	15.0	36.9	11.5	56.6	13.4
Non-LWE areas	35.0	15.2	65.7	17.2	44.5	17.2	64.8	14.3
LWE areas	26.4	14.4	55.5	16.5	56.4	15.4	68.8	16.3

Source: Computed by Author

Table 1 also reports similar information for districts classified on the basis of social demographic composition with specific focus on districts having greater share of marginalized population subgroups (ST, SC and Muslim). Although, there have been improvements in levels of institutional delivery and immunization coverage across all districts but districts with higher shares of Muslim population display lower average health achievement.

Figure 2: District-level progress (absolute values in 2011-12 and change since 2007-08) in institutional delivery and full immunization coverage vis-a-vis base levels in 2007-08

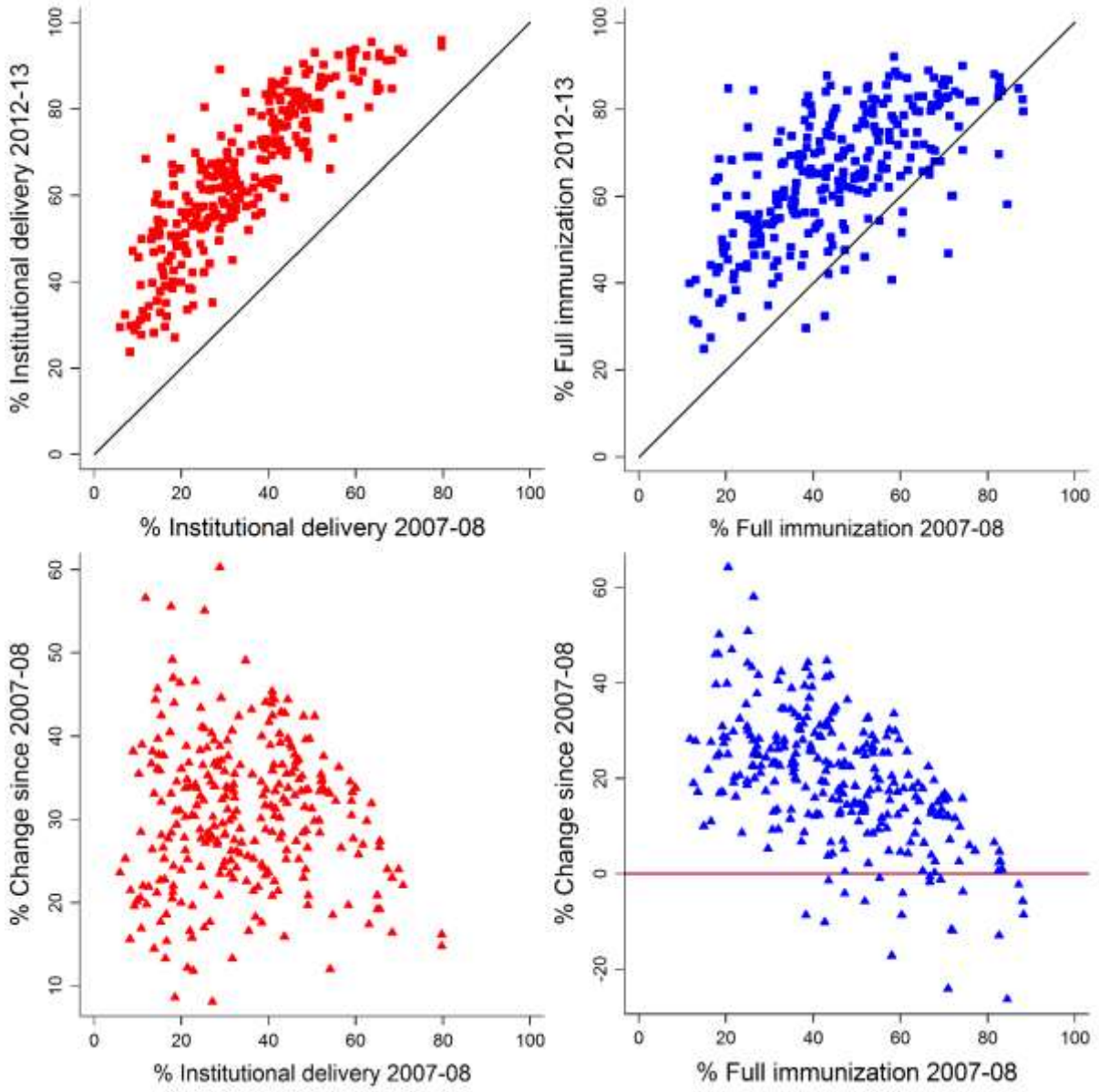


Figure 2 depicts the association between base-level (2007-08) averages and progress in institutional delivery and immunization coverage across districts. In the top panel, x-axis plots the base level of the indicator, y-axis plots the coverage reported in 2012-13 and the diagonal represents the line of no change. In case of institutional delivery all the districts are found above the diagonal indicating that all the districts registered a positive change in institutional delivery. However, in case of immunization there are a number of districts where the coverage has shrunk between 2007-08 and 2012-13. The bottom panel in Figure 2 presents a comparison of district-level progress vis-à-vis base level of the indicator. In case of immunization coverage, it is noted that most of the districts with very low or negative progress had higher base levels. But greater variations are observed in case of progress in institutional delivery. In particular, despite lower base levels, a large number of districts were unable to achieve greater progress in institutional delivery.

Supplementary Figures S1 and S2 explore the association between share of marginalized population and levels of institutional delivery and immunization coverage, respectively, across districts for both periods. It is observed that the levels of institutional delivery across districts do not share any significant association with proportion of SC or ST population. But districts with higher concentration of Muslim population display lower levels of institutional delivery. Moreover, the patterns have remained unchanged between 2007-08 and 2012-13. In case of full immunization coverage, it is observed that districts with higher proportion of ST population have higher immunization levels whereas districts with higher SC or Muslim population have lower immunization coverage.

But between 2007-08 and 2012-13, progress has been slower in districts with higher ST population whereas greater absolute progress is noted in districts with higher SC population.

Associations between social demographic profile and developmental indicator are further explored in Supplementary Figures S3 and S4 (poverty headcount ratio and female literacy, respectively). But as shown in Supplementary Figure S5, there is not much influence of district level change in these developmental variables on change in institutional delivery or immunization coverage.

Table 2: Comparison of mean institutional delivery and full immunization across districts and over time using difference-in-differences method

		Institutional delivery		**Full immunization**	
	Districts with	**Mean**	**Std. err.**	**Mean**	**Std. err.**
2007-08	ST Pop. < 25%	34.9	1.0	44.0	1.1
	ST Pop. > 25%	31.2	2.0	51.9	2.5
	Difference	-3.8*	2.1	7.8***	2.5
2012-13	ST Pop. < 25%	64.8	1.1	64.6	1.0
	ST Pop. > 25%	64.6	2.4	67.2	2.0
	Difference	-0.2	2.7	2.6	2.2
	Diff-in-diff	*3.6*	*3.4*	*-5.2**	*3.4*
2007-08	SC Pop. < 25%	35.0	1.0	46.5	1.1
	SC Pop. > 25%	24.9	2.3	34.4	2.7
	Difference	-10.1***	2.3	-12.2***	2.8
2012-13	SC Pop. < 25%	65.2	1.1	65.5	0.9
	SC Pop. > 25%	59.5	2.9	60.2	3.5
	Difference	-5.7**	2.9	-5.3	3.3
	Diff-in-diff	*4.4*	*3.8*	*6.8*	*4.2*
2007-08	Muslim Pop. < 25%	35.5	1.0	46.6	1.1
	Muslim Pop. > 25%	22.9	1.9	36.9	2.1
	Difference	-12.6***	2.1	-9.7***	2.8
2012-13	Muslim Pop. < 25%	66.5	1.1	66.3	0.9
	Muslim Pop. > 25%	51.5	2.6	56.6	2.3
	Difference	-15.0***	3.0	-9.7***	2.6
	Diff-in-diff	*-2.4*	*3.8*	*-0.0*	*3.3*
2007-08	Non-LWE core area	35.0	0.9	44.5	1.1
	LWE core area	26.4	2.8	56.4	3.0
	Difference	-8.6***	3.2	11.9***	2.7
2012-13	Non-LWE core area	65.7	1.1	64.8	0.9
	LWE core area	55.5	3.2	68.8	3.2
	Difference	-10.2***	3.4	4.0	3.6
	Diff-in-diff	*-1.6*	*4.8*	*-7.9**	*4.2*

Source: Computed by Author

A simple difference-in-differences approach is used to examine whether there has been a significant increase in the mean levels of institutional delivery and immunization coverage across districts segregated on the basis of demographic composition (Table 2). In 2007-08 there was a significant difference ($p<0.1$) in institutional delivery levels of districts with low (34.9%) or high (31.2%) ST population but this difference has disappeared in 2012-13. We observe a significant difference in average institutional delivery across districts with low or high SC population in both the years. In 2007-08 the difference in averages was about 10.1% ($p<0.01$) whereas it has reduced to 5.7% ($p<0.05$) in 2012-13. However, the insignificant difference-in-differences statistic suggests that there is still considerable gap between districts with high and low share of SC population. It is also noted that the difference in average institutional delivery across district with high and low share of Muslim population has increased from 12.6% ($p<0.01$) in 2007-08 to 15.0% ($p<0.01$) in 2012-13. The LWE core districts also show lower averages than those non-LWE districts in both the years.

In case immunization coverage, in 2007-08 there was a significant average gap of 7.8% ($p<0.01$) among districts with higher and lower share of ST population but it has disappeared because of greater improvements in districts with lower ST population. A significant difference-in-differences statistic of 5.2 ($p<0.1$) confirms the reduction. Similar reduction across districts with high and low SC population is observed but the effect is statistically insignificant. However, there is no evidence of diminishing gap (9.7% in both periods) between districts with higher and lower shares of Muslim population. Nevertheless, there has been a significant bridging of differences in immunization coverage between LWE affected and non-LWE districts partly because of slow improvements in LWE affected districts.

Table 3: Multilevel random-effects linear regression results for factors associated with institutional delivery and full immunization coverage across districts, 2007-08 and 2012-13

Variables	Institutional delivery (%)				Full immunization (%)			
	Model 1		Model 2		Model 3		Model 4	
	Coef.	*s.e*	Coef.	*s.e*	Coef.	*s.e*	Coef.	*s.e*
ST population (%)	-0.01	0.07	-0.01	0.07	-0.00	0.09	-0.00	0.09
SC population (%)	-0.00	0.13	-0.01	0.13	-0.33**	0.17	-0.34**	0.16
Muslim population (%)	-0.31***	0.08	-0.28***	0.08	-0.23**	0.10	-0.23**	0.10
District ST pop. > 25%	-0.93	2.49	-2.37	2.57	0.91	3.12	3.07	3.28
District SC pop. > 25%	-1.00	2.14	-2.61	2.36	1.50	2.75	-0.12	3.17
District Muslim pop. > 25%	2.47	2.70	4.81*	2.82	2.39	3.48	4.10	3.74
LWE core districts	1.70	2.01	1.90	2.01	2.15	2.47	2.19	2.47
LWE adjoining districts	1.52	1.71	1.55	1.71	-3.48*	2.11	-3.53*	2.11
Urban population (%)	0.23***	0.05	0.24***	0.05	0.02	0.06	0.02	0.06
Poverty headcount ratio (%)	-0.12**	0.05	-0.13**	0.05	-0.08	0.07	-0.08	0.07
Female literacy rate	0.02	0.18	0.01	0.17	0.40	0.24	0.31	0.24
Male literacy rate	0.32**	0.15	0.38**	0.15	0.11	0.20	0.18	0.20
Male/Female ratio	0.88	4.18	1.54	4.07	0.80	5.99	-0.37	5.96
HH with electricity (%)	0.05	0.04	0.03	0.04	0.03	0.05	0.03	0.05
DH CHC HR Score	0.40***	0.11	0.40***	0.11	0.26*	0.14	0.27*	0.14
Bihar (reference)	-		-		-		-	
Madhya Pradesh	8.51***	2.81	9.04***	2.80	-16.59***	3.57	-16.91***	3.57
Chhattisgarh	-26.44***	3.26	-26.03***	3.25	-2.32	4.09	-2.61	4.09
Odisha	7.16***	2.64	7.33***	2.63	-3.65	3.29	-3.64	3.29
Rajasthan	3.16	3.13	3.25	3.13	-3.45	3.96	-3.97	3.96
Uttar Pradesh	-9.41***	2.09	-9.54***	2.09	-19.10***	2.59	-19.28***	2.59
Uttarakhand	-18.93***	3.52	-18.83***	3.51	-0.10	4.44	-0.28	4.43
Jharkhand	-16.39***	2.67	-16.71***	2.68	-0.38	3.31	-0.69	3.31
Assam	6.89***	2.79	6.69***	2.79	-8.47**	3.50	-8.21**	3.49
Period (2012-13 = 1)	25.90***	1.22	25.32***	1.33	12.57***	1.66	13.79***	1.84
Interaction: District with ST pop. > 25% x Period	-		3.87***	1.37	-		-4.33*	2.10
Interaction: District with SC pop. > 25% x Period	-		3.78*	2.10	-		3.83	3.21
Interaction: District with Muslim pop. > 25% x Period	-		-5.04***	1.81	-		-2.94	2.76
Constant	11.79	10.79	7.65	10.75	36.48**	14.70	36.51**	14.74
Variance partition coef.	0.471		0.501		0.299		0.310	

Source: Computed by Author

*Note: *** p<0.01, ** p<0.05, * p<0.1*
N: 568 districts

A two-level random-effects linear regression is used to understand the role of various factors (including poverty, literacy, social demographics) in influencing level of institutional delivery

and immunization coverage across districts. Specifically, two separate models are used for each of the dependent variables whereby the second model also estimates an interaction effect between year and district social demographics to discern whether there was a differential impact across these districts. A period dummy variable is included to comment on the potential influence of NRHM between 2007-08 and 2012-13. The model accounts for clustering at the district-level. The regression results are presented in Table 3. A positive and significant coefficient of the period dummy indicates that NRHM can be attributed with significant increase (about 25.0%, $p < 0.01$) in the level of institutional delivery across districts. A favourable impact (about 13.0%, $p < 0.01$) is also noted in case of immunization coverage though the magnitude of the coefficient is smaller than institutional delivery. Compared to others, districts with higher Muslim population display significantly lower institutional delivery and immunization coverage. In fact, 1% increase in share of Muslim population is associated with about 0.3% ($p < 0.01$) and 0.2% ($p < 0.05$) lower levels of institutional delivery and immunization coverage, respectively. No such association can be noted for ST population but a similar disadvantage is noted for SC population, particularly in immunization coverage.

The interaction term for time period and districts with higher shares of marginalized population reveals that, post 2007-08, districts with higher ST population have registered significant increment (3.9%, $p < 0.01$) in institutional delivery but these districts also registered a significant decline in immunization coverage (4.3%, $p < 0.1$). Districts with higher proportion of SC population also experienced significant increment (3.8%, $p < 0.1$) in institutional delivery post NRHM but no such gains are noted in immunization coverage. But districts with higher Muslim population registered slower progress (5.0%, $p < 0.01$) in institutional delivery post 2007-08 and also failed to experience any significant gains in immunization coverage. In fact, additional regressions suggest that change in levels of

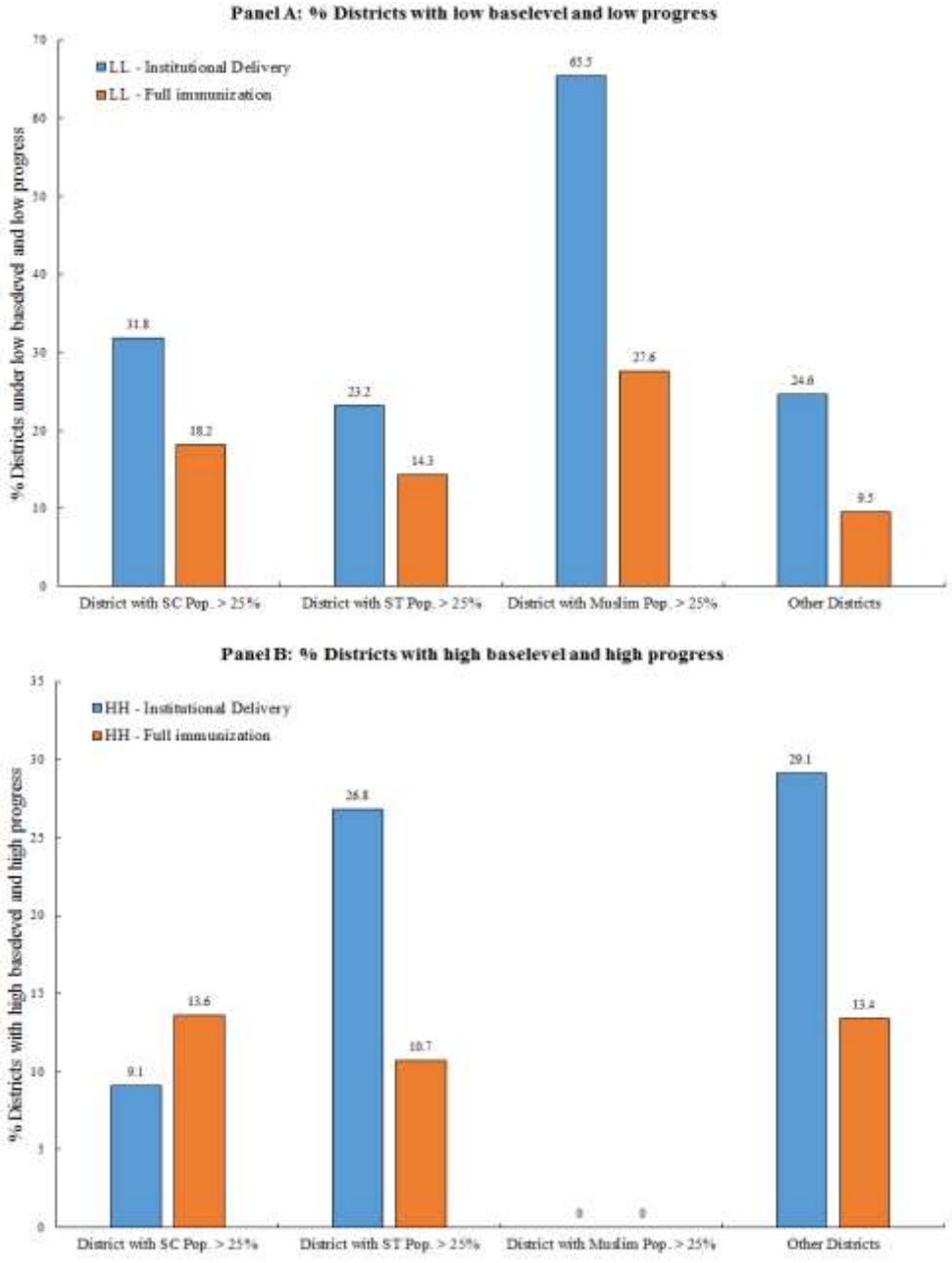
institutional delivery and immunization coverage is also slower in districts with higher share of Muslim population (Supplementary Table S3).

Among other variables, better availability of human resources at the CHCs and the DHs had a favourable impact on district level institutional delivery (0.4%, $p < 0.01$) and immunization coverage (0.3%, $p < 0.1$). Higher urban population had a positive influence (0.2%, $p < 0.01$) on institutional delivery but no such impact is observed on immunization coverage. Similarly, districts with higher poverty headcount ratio were likely to have lower institutional delivery levels. Interestingly, female literacy rates had no significant impact on levels of institutional delivery or immunization coverage though districts with higher male literacy showed higher levels of institutional delivery. Average district level outcomes varied considerably across states with Madhya Pradesh, Odisha and Assam recording much better levels of institutional delivery than Bihar most of the states performed poorly in immunization coverage during this period.

Finally, we examine the socio-demographic features of districts that have deviated from the expected progress dynamics. Supplementary Table S4 reports the distribution of districts categorised based on the sociodemographic composition and typology presented in Figure 1. Specifically, we present the relative share of districts from each socio-demographic composition and observe that districts with higher share (> 25% population) of Muslim population are more likely to have poor progress despite having lower base levels (LL category). In fact, it is apparent that none of districts with higher share of Muslim population have higher base levels and higher progress - the HH category. For further insights, a generalized ordered logit model is employed that adjusts for key developmental indicators while assessing the socio-demographic particulars of districts that are more likely to be poor

performers – the LL category. For each outcome (institutional delivery and immunization), we specify two alternate models. The first model focuses on the district categorization as per the population share of marginalized social groups whereas in the second model we also include the respective population share of these groups.

Figure 3: % Districts with LL and HH type progress performance in institutional delivery and full immuniztion by sociodemographic categorization of districts, 2007-08 and 2012-13



In case of institutional delivery, the *beta* (β) estimates (constant component of log odds ratio at both cut-off points) for Model 1 suggests that districts with more than 25% ST population (log OR: 2.34, $p < 0.05$) have significantly higher chances of being in HL, LH or HH category whereas those with over 25% Muslim population have lower likelihood (log OR: -1.19, $p < 0.05$). Model 2 further shows that higher share of Muslim population is associated with lower likelihood (log OR: -0.07, $p < 0.05$) of witnessing expected progress (LL vs HL, LH or HH) in institutional delivery. It is worth noting that districts with greater than 25% ST population are also less likely to demonstrate good progress when it is adjusted for share of ST population. But concentration of SC population across districts did not reveal any significant impact on odds of progress in institutional delivery across categories.

Further, from the Table 4, the *gamma* (γ) parameterization (increment in log odds ratio at cut-off point LL, HL, LH vs HH) reveals that despite being better performers districts with higher ST population were particularly less likely to be in the HH category (incremental log OR: -2.77, $p < 0.05$). Among other factors, districts with higher urban population had greater chances of demonstrating good progress but at the same time this district were less likely to be in the HH category and is revealed by a negative coefficient for increment at cut-off point (LL, HL, LH vs HH).

Districts with high poverty headcount ratio were more likely to be found in the HL, LH category but were less likely to be in HH category. Model 2 also shows that the district level availability of human resources at the CHCs and DHs had a favourable impact (log OR: 0.07, $p < 0.05$) on progress in institutional delivery. Interestingly, districts from Madhya Pradesh, Rajasthan and Assam were more likely to have the HH category districts in institutional delivery.

Table 4: Log odds ratios for generalized ordered logit model for progress in institutional delivery and immunization coverage across nine states, India 2007-08 and 2012-13

Variables	Institutional delivery				Full immunization			
	Model 1		Model 2		Model 3		Model 4	
	Coef.	s.e	Coef.	s.e	Coef.	s.e	Coef.	s.e
Beta: Constant component of ln(OR) across cut-off points (HH, HL, LH vs LL) for all variables								
District with ST Pop. > 25%	2.34**	1.06	-1.67**	0.84	-0.04	0.50	0.46	0.84
District with SC Pop. > 25%	-0.03	0.57	0.27	0.69	0.53	0.58	1.06	0.78
Dist. with Muslim Pop. > 25%	-1.19**	0.54	0.26	0.95	-0.88	0.54	0.23	0.93
Scheduled tribe Pop. (%)	-		0.13***	0.03	-		-0.03	0.02
Scheduled caste Pop. (%)	-		-0.01	0.04	-		-0.06	0.05
Muslim Pop. (%)	-		-0.07**	0.03	-		-0.06*	0.03
Urban Pop. (%)	0.05**	0.02	0.06***	0.02	0.00	0.01	0.01	0.02
Poverty headcount ratio (%)	0.08**	0.04	-0.01	0.02	-0.04*	0.02	-0.08***	0.03
Change in poverty HCR	-0.14***	0.05	-0.01	0.02	0.01	0.03	0.02	0.03
Female literacy rate (%)	0.01	0.02	0.03	0.02	0.05**	0.02	0.06**	0.03
Change in female literacy rate	-0.05	0.05	-0.03	0.05	0.02	0.05	0.12**	0.06
LWE core districts	0.42	0.62	-0.11	0.68	-0.77	0.64	-0.72	0.65
LWE adjoining districts	0.57	0.55	0.33	0.57	0.03	0.52	1.88	1.22
DH CHC HR score	0.05	0.03	0.07**	0.03	-0.00	0.04	0.00	0.04
Bihar (reference)	-		-		-		-	
Chhattisgarh	-7.18***	1.51	-9.18***	1.82	0.14	0.89	0.44	0.97
Jharkhand	-4.83***	1.15	-6.08***	1.39	-0.36	0.85	0.01	0.92
Madhya Pradesh	3.41***	0.76	-0.31	1.25	-1.73**	0.72	-1.50*	0.83
Odisha	2.32***	0.85	1.31	0.91	-1.41*	0.75	-0.86	0.93
Rajasthan	2.51***	0.83	-0.98	1.09	-1.28	0.86	-0.97	0.94
Uttar Pradesh	-0.75	0.58	-1.07*	0.62	-2.83***	0.66	-2.87***	0.73
Uttarakhand	0.06	0.97	-2.93***	0.99	-0.48	0.88	0.43	1.06
Assam	-1.11	0.90	-1.45	1.04	-2.13**	0.90	-1.54	1.03
Gamma: Increment at cut-off point (HH vs HL, LH &LL) for variables violating parallel lines assumption								
District with ST Pop. > 25%	-2.77**	1.16	-		-		-	
Scheduled tribe Pop. (%)	-		-0.11***	0.03	-		-	
Urban Pop. (%)	-0.09***	0.02	-0.10***	0.03	-		-	
Poverty headcount ratio (%)	-0.10***	0.03	-		-		0.08**	0.03
Change in poverty HCR	0.13***	0.05	-		-		-	
Female literacy rate (%)	-		-		-		-0.07**	0.03
Change in female literacy rate	-		-		-		-0.17**	0.07
LWE adjoining districts	-		-		-		-2.78**	1.37
Madhya Pradesh	-		3.16***	1.17	-		-	
Rajasthan	-		3.08***	0.95	-		-	
Assam	2.96***	0.81	2.95***	0.96	-		-	

Source: Computed by Author

*Note: *** p<0.01, ** p<0.05, * p<0.1*

N: 284 districts

HH refers to districts with base level health achievement above average level across districts and progress in health achievement also above average progress across districts. HL refers to districts with base level health achievement above average level across districts but progress in health achievement below average progress across districts. LH refers to districts with base level health achievement below average level across districts but progress in health achievement above average progress across districts. LL refers to districts with base level health achievement below average level across districts and progress in health achievement also below average progress across districts.

In case of immunization coverage, no such social demographic specific (dis)advantages are apparent but Model 4 reveals that districts with higher share of Muslim population are less likely (log OR: -0.06, $p < 0.1$) to deviate from the expected progress dynamics. Districts with high poverty head count ratio are also less likely to be good performers in immunization coverage. Importantly, districts with higher female literacy rate and change in female literacy demonstrated good progress in immunization coverage. Besides, districts from Uttar Pradesh had significantly higher likelihood of being poor performers in immunization coverage.

Discussion

Following the launch of NRHM, there has been substantial increase in public health investments across states (Choudhury & Amar Nath, 2012). The focus of NRHM is on promoting universal health care coverage in basic maternal and child health care services with particular emphasis on institutional delivery and full immunization coverage. These investments were expected to bridge inter-state and intra-state disparities in utilization of basic health care services. Based on the analysis of 284 districts across nine high focus states, we find that between 2007-08 and 2012-13 there has been considerable progress in institutional delivery across all the districts but improvements in full immunization coverage has been slow and below programme potentials. Especially, there is rather mixed performance in immunization coverage among districts that had relatively high levels of immunization coverage during 2007-08. In fact, a number of districts register a decline in overall immunization coverage when compared to the base reference year, 2007-08 (Dasgupta et al. 2014). This clearly is a policy concern as it brings out the difficulties in sustaining progress in immunization coverage across districts.

We adopted a social demographic perspective to examine how progress in institutional delivery and immunization coverage varies across districts with differing concentration of marginalized social groups. Social group affiliations are crucial in assessing human development in India (Majumdar & Subramanian, 2001; Dreze & Sen, 1999). Although, it is noted that marginalized social groups (SC, ST and Muslims) have poor health outcomes (Thorat et al. 2016; Sachar, 2006; Dreze & Murthi, 2001) but our findings further demonstrate that districts with higher concentration of such marginalized social groups are also less likely to experience faster progress and at the same time more likely to deviate from the expected progress dynamics. In particular, regression analysis suggests that districts with higher share of Muslim population had significantly lower progress in both institutional delivery and immunization coverage. The associations are robust even after adjusting for district-specific random effects. Besides, it is also revealed that LWE affected core districts had lower average achievements in both immunization and institutional delivery but the gap in district level averages has decreased in recent years.

There can be two broad ways to understand causes of slow progress in districts with higher concentration of marginalized population. The first explanation is that marginalized groups often reside in disadvantaged areas (including LWE core areas) and have been isolated from mainstream developmental process (Sachar, 2006; Dreze & Sen, 1999; Mathew, 2012). For instance, income poverty is one of the major forms of deprivation among marginalized groups in India and marginalized communities like SC, ST and Muslims are unable to experience faster reductions in poverty (Sengupta et al. 2008). In fact, NRHM policies such as JSY that aimed at improving the demand-side of services have shown favorable impact (Powell-Jackson, 2015; Lim et al. 2010) and our results further confirm that districts with higher poverty are more likely to demonstrate better progress (HL or LH category). Similarly,

utilization of health services may be affected by social concerns such as literacy, gender bias and women empowerment (Murthi et al. 1995; Jejeebhoy, 1997). In particular, female literacy is found to be a significant determinant of district-level fertility and child mortality (Dreze & Murthi, 2001). Our results also suggest that female literacy levels have a particularly influential impact on progress in immunization coverage across districts whereas in case of institutional delivery effects of high male literacy is more prominent. This also highlights the leveraging effect of female literacy in case of immunization coverage.

A second set of explanation revolves around efficacy of programme implementation and management (Husain, 2011; Duggal, 2009; Ashtekar, 2008). The deployment of medical staff and development of health infrastructure has been an overarching concern that deters rapid progress (Rao et al. 2011; Rao et al. 2012). For instance, shortage of human resource, particularly clinical staff including medical doctors, gynecologists and surgeons, is a chronic problem of the Indian public health system. Our findings lend credence to this explanation as it is noted that districts with better staffed CHCs and DHs have better health care utilization, particularly institutional births. In fact, we note significant correlation across districts such that understaffed locations also have higher shares (> 25%) of ST and Muslim population. The public health system in India has been grappling with such distributional inefficacies (Hazarika et al. 2013) and should be accounted for while discussing the role of social factors in influencing health care outcomes. Besides the quality of community mobilization services including efficacy of community health workers (ASHAs or members of VHSNCs) is rather varied and perhaps is underperforming in regions with diverse social composition (Gopalan et al. 2012).

Overall, such inequitable distribution of benefits of developmental policies and programmes across districts with varying socio-demographic profile reiterates the need for effective policies for mainstreaming (Thorat & Neuman, 2012). While the overarching NRHM policy framework had substantial contribution but the status of health care indicators makes it clear that there are diminishing benefits in recent years (IIPS, 2015-16; ORGI, 2016). At this juncture, there is an urgency to engage in policy debiasing as at this juncture more than a uniform approach will be necessary to facilitate rapid progress among backward districts and marginalized groups (McGinnis et al. 2002). In this regard, it is worth noting an increased support among policymakers and practitioners for policy debiasing of health promoting social norms (Trujillo et al. 2015). Given the trend, there is considerable scope for debiasing in the context of immunization policies and to overcome potential cognitive and socio-cultural biases that adversely influence the programme outcomes (Laskowski, 2016; Balarajan et al. 2011; Paul et al. 2011; Jolly & Douglas, 2014). In particular, debiasing should aim to address intersectional inequalities in immunization across marginalized groups, particularly those residing in disadvantaged locations including urban hotspots as well as peri-urban areas (Dasgupta et al. 2014; Joe, 2015). Debiasing in case of immunization coverage can draw motivation from the success of JSY but an equal emphasis on debiasing the cognitive and information environment is also necessary. Also, it is likely that externalities of such cognitive debiasing may be larger and can ensure sustained behavior. In fact, going forward, ensuring and sustaining universal immunization coverage can be a major challenge for India as even developed countries such as the United States is finding it difficult to swim against the tide of anti-vaccine conspiracy theories (Laskowski, 2016).

Before concluding, it is important to list the limitations of the study. First, the analysis is based on 284 districts from nine states of India but nevertheless the results are of

considerable relevance because these states are regarded as high policy focus states and also account for over 50% of total population and over 60% of total births in India. Second, between Census 2001 and Census 2011 a few district boundaries were redefined and to that extent this may have marginally affected the enumeration of proportion of population from different social groups. However, we do not expect these limitations to alter our major conclusions.

Conclusion

This paper reveals that despite uniform policy strategies across India, the progress in institutional delivery and immunization coverage varied across districts with much slower pace of improvements in areas with higher representation of marginalized social groups, particularly the STs and the Muslims. These districts were also more likely to display low progress despite lower base levels and thus deviate from the expected dynamics of progress. Moreover, when compared to institutional delivery, the observed pace of improvements in immunization coverage across these districts leaves much to be desired. The challenges of experiencing higher progress or sustaining higher immunization coverage thus calls for further policy debiasing with specific attention on cognitive and information environment to achieve the sustainable development goal (SDG) related to universal coverage in basic health services. Debiasing is also warranted to strengthen programme management or deployment of medical personnel in deprived areas.

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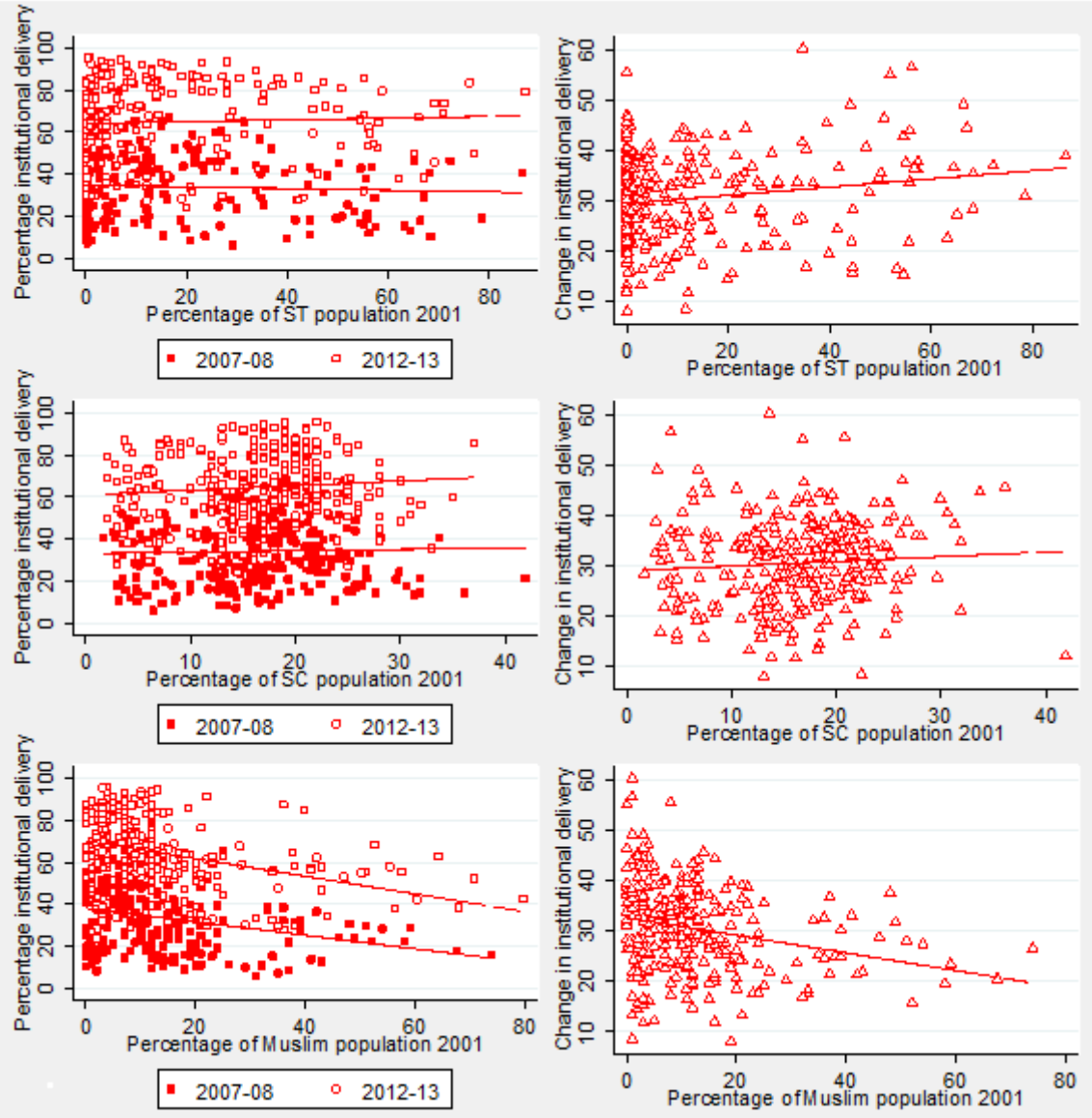
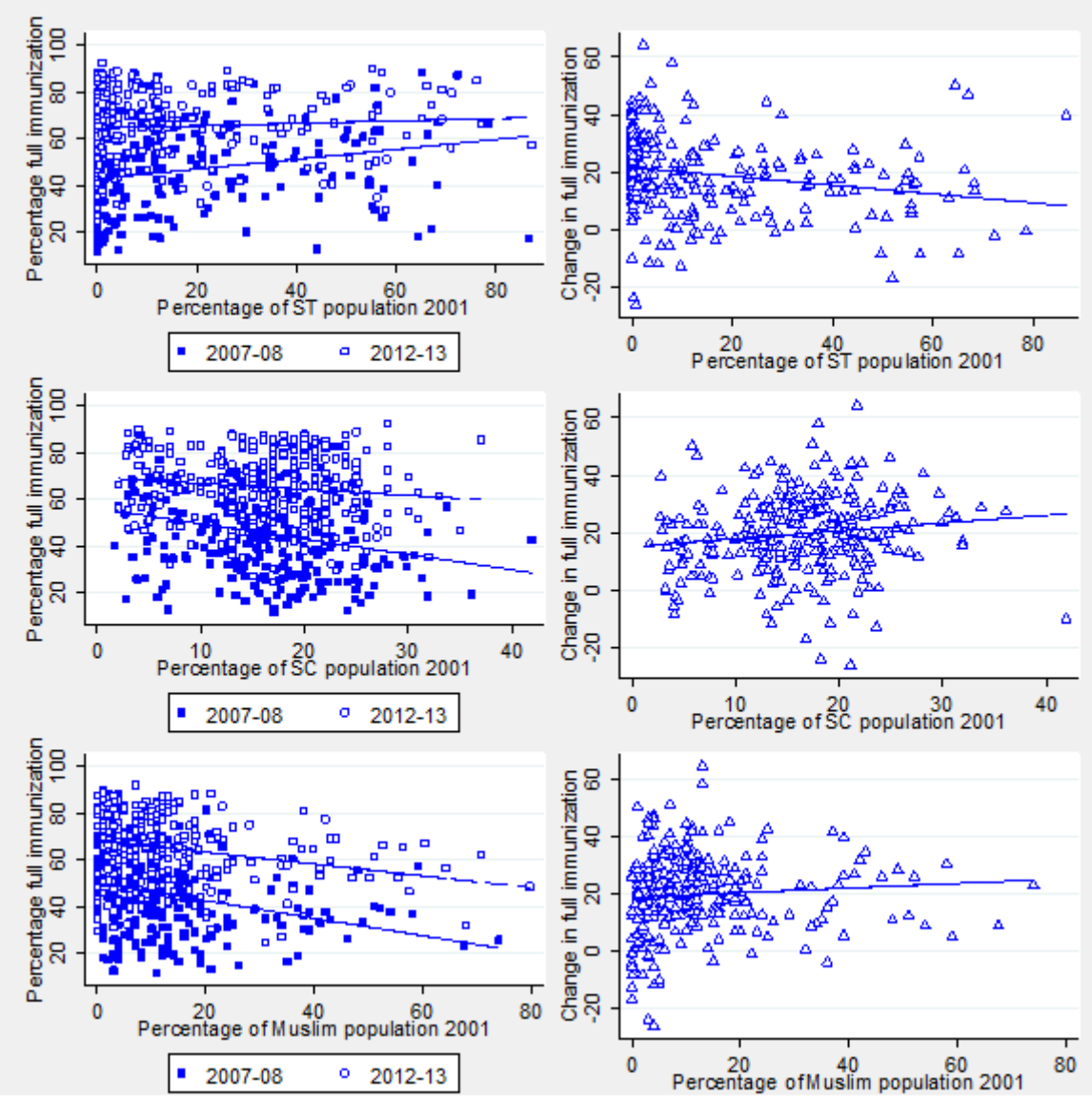
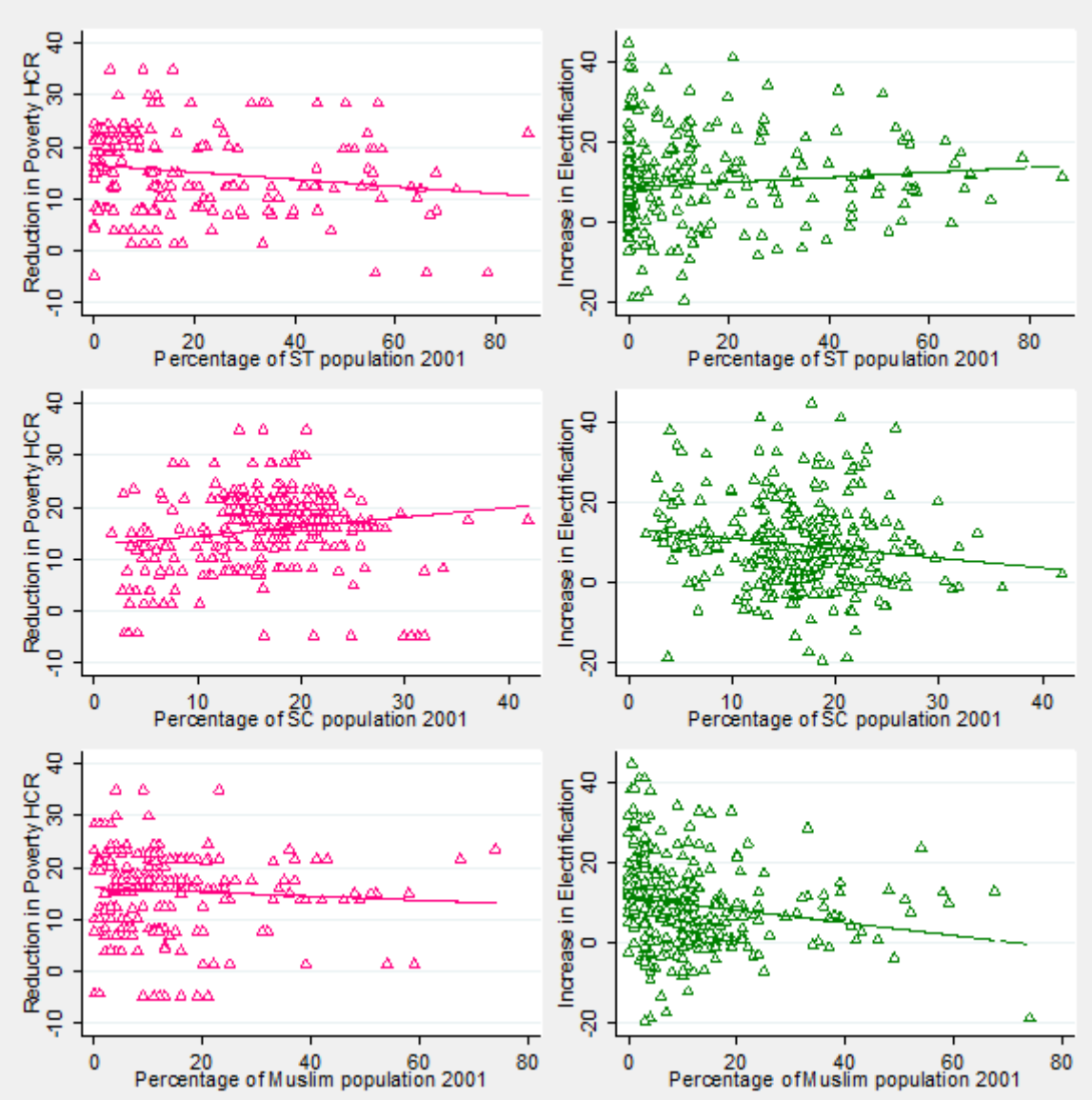
Supplementary Figure S1: Association of district-level shares of marginalized population subgroups with levels of institutional delivery and changes between 2007-08 and 2012-13



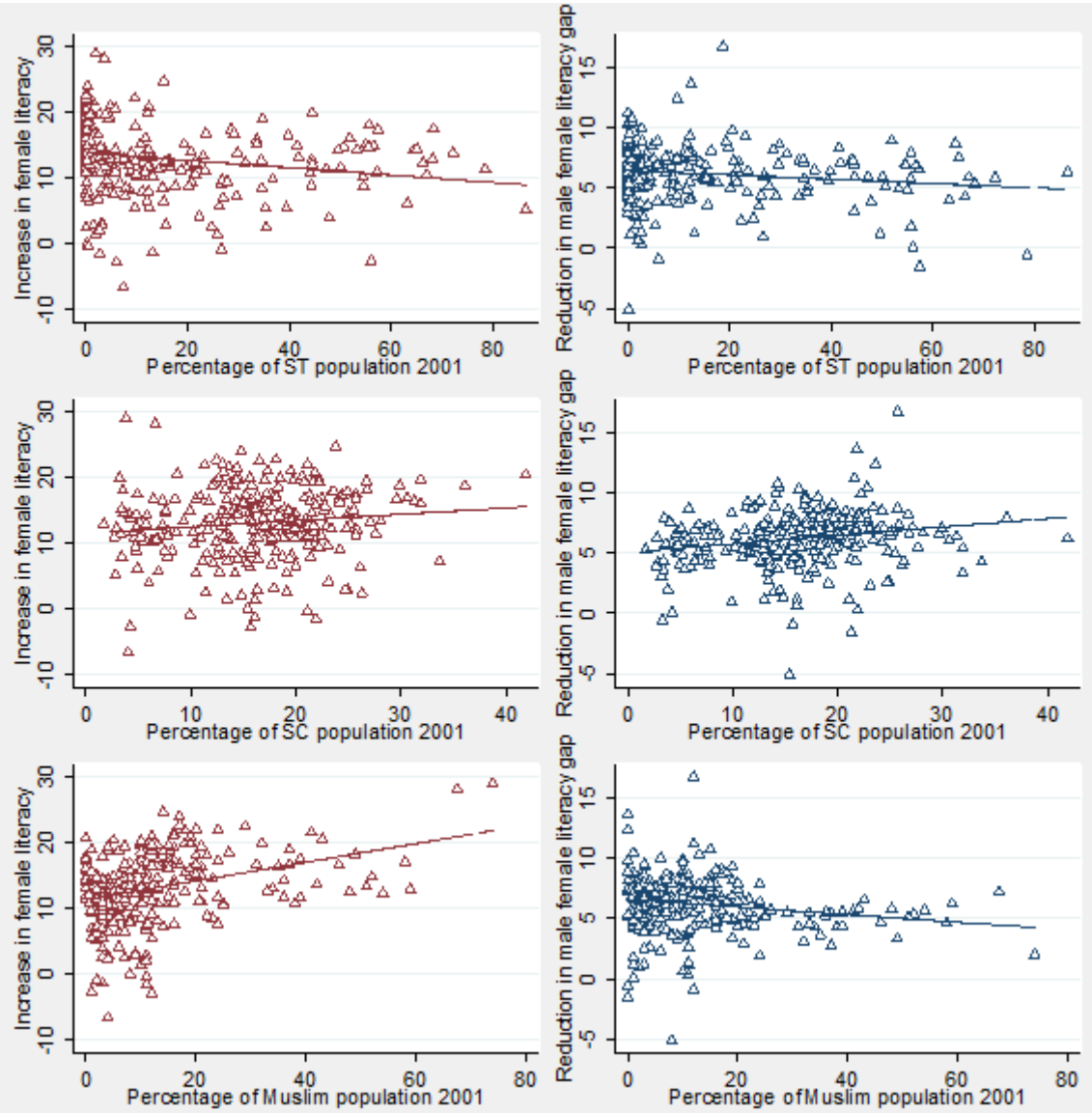
Supplementary Figure S2: Association of district-level shares of marginalized population subgroups with levels of immunization coverage and changes between 2007-08 and 2012-13



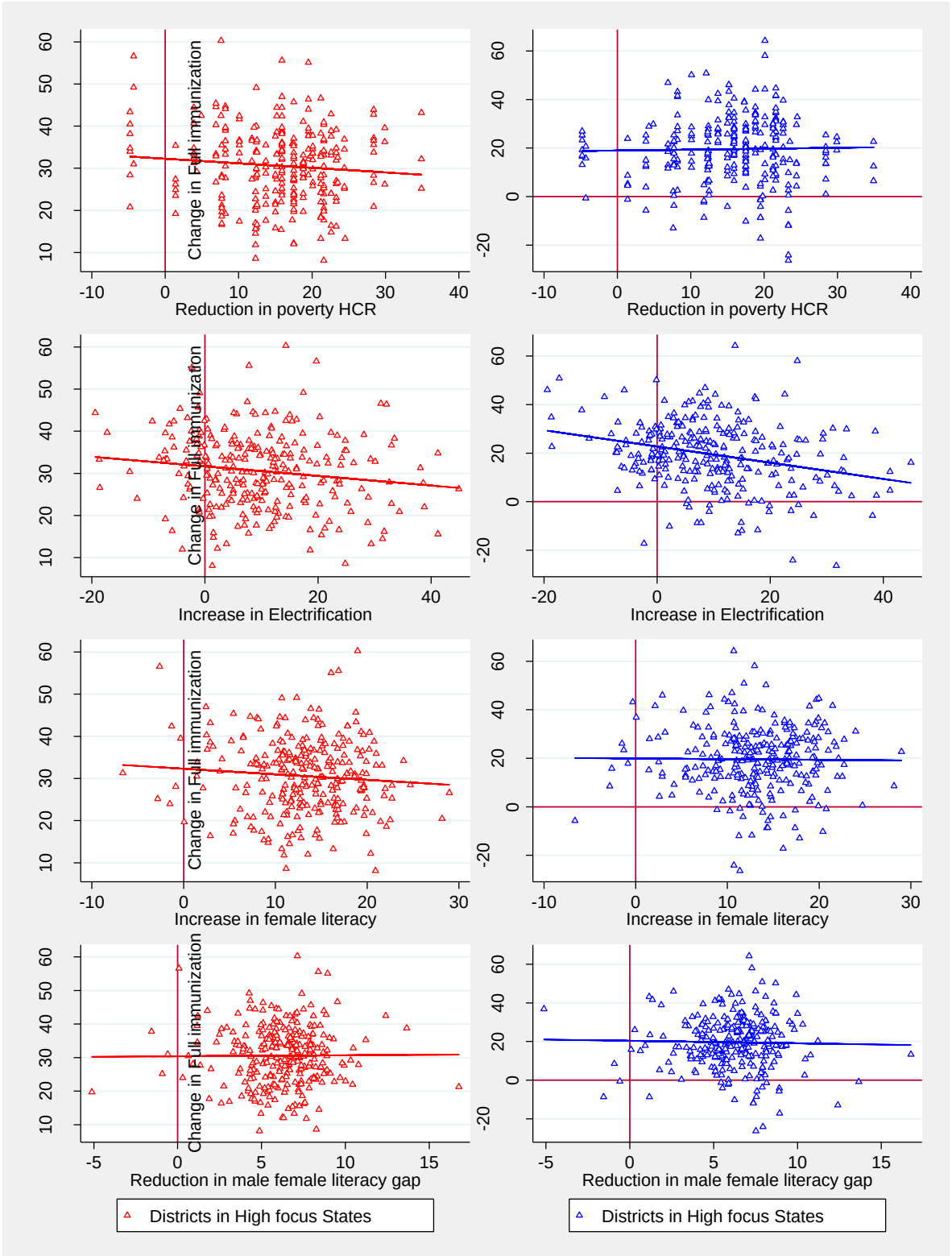
Supplementary Figure S3: Association of district-level shares of marginalized population subgroups with reductions in poverty headcount ratio (2004-05 and 2011-12) and increase in electrification (2001-2011) across households



Supplementary Figure S4: Association of district-level shares of marginalized population subgroups with increase in district level female literacy rates (2001-2011) and reductions in male-female literacy gap (2001-2011)



Supplementary Figure S5: Association of changes in institutional delivery and immunization coverage with changes in economic and social developmental profile of the districts



Supplementary Table S1: Number of districts by population share of marginalized social groups and identification as left-wing core or adjoining districts by States, 2001-2011

State	All		ST Population > 25%		SC Population > 25%		Muslim Population > 25%		Leftwing (LEA, 2009-10)	
	2001	2011	2001	2011	2001	2011	2001	2011	Core	Adjoining
Assam	23	23	4	4	-	-	10	13	-	-
Bihar	37	37	-	-	1	1	4	4	5	9
Chhattisgarh	16	16	11	11	-	-	-	-	5	6
Jharkhand	18	18	8	8	2	2	2	2	9	4
Madhya Pradesh	45	45	15	15	-	1	-	-	1	3
Odisha	30	30	14	14	-	-	-	-	5	9
Rajasthan	32	32	4	5	2	2	-	-	-	-
Uttar Pradesh	70	70	-	-	16	14	12	13	1	2
Uttarakhand	13	13	-	-	1	1	1	1	-	-
Total	**284**	**284**	**56**	**57**	**22**	**21**	**29**	**33**	**26**	**33**

Source: Computed by Author

Note: Count of the sample number of districts is presented where share of ST population or SC population or Muslim population is greater than 25% of the total district population. Count of core and adjoining left-wing extremist affected (LEA) districts is based on Ministry of Rural Development (2009-10).

Supplementary Table S2: Coefficient of variation (CV) of institutional delivery (%) and full immunization coverage (%) across districts by state and demographic characteristics, 2007-08 and 2012-13

	Institutional delivery (%)		Full immunization coverage (%)	
	CV: 2007-08	**CV: 2012-13**	**CV: 2007-08**	**CV: 2012-13**
Districts from				
Assam	0.31	0.22	0.27	0.15
Bihar	0.41	0.24	0.26	0.16
Chhattisgarh	0.28	0.30	0.17	0.13
Jharkhand	0.55	0.29	0.29	0.19
Madhya Pradesh	0.27	0.13	0.42	0.19
Odisha	0.40	0.15	0.26	0.28
Rajasthan	0.24	0.15	0.33	0.18
Uttar Pradesh	0.40	0.18	0.34	0.21
Uttarakhand	0.33	0.17	0.11	0.10
Districts with				
ST > 25%	0.47	0.28	0.36	0.22
SC > 25%	0.44	0.22	0.37	0.27
Muslim >25%	0.44	0.29	0.31	0.24

Source: Computed by Author

Supplementary Table S3: Regression results for association between change in covariates and changes in institutional delivery and full immunization coverage between 2007-08 and 2012-13

Variables	Change in institutional delivery		Change in full immunization	
	Coefficient	***Std. Err.***	**Coefficient**	***Std. Err.***
District with SC population > 25%	1.62	*1.93*	-2.08	*2.69*
District with ST population > 25%	3.46**	*1.54*	-2.73	*1.72*
District with Muslim pop. > 25%	-6.20***	*1.59*	-4.53*	*2.46*
LWE core districts	-3.34	*2.14*	-0.21	*2.61*
LWE adjoining districts	-2.39	*1.69*	2.41	*1.94*
Change in urban population	0.24	*0.15*	0.05	*0.15*
Change in poverty headcount ratio	-0.06	*0.07*	0.06	*0.08*
Change in female literacy rate	0.12	*0.23*	-0.26	*0.32*
Change in male literacy rate	-0.30	*0.30*	-0.19	*0.40*
Change in household electrification	-0.14***	*0.04*	-0.00	*0.07*
Institutional delivery level, 2007-08	-0.08*	*0.04*		
Full immunization level, 2007-08			-0.50***	*0.04*
Constant	36.46***	*3.04*	47.04***	*3.43*

Source: Computed by Author

*Note: *** p<0.01, ** p<0.05, * p<0.1*

Supplementary Table S4: Distribution of districts by socio-demographic composition and observed progress dynamics in full immunization and institutional delivery, 2007-08 and 2012-13

Districts	Full Immunization (Number of Districts)					Institutional Delivery (Number of Districts)				
	LL	**LH**	**HL**	**HH**	**All**	**LL**	**LH**	**HL**	**HH**	**All**
District with SC population > 25%	4	13	2	3	22	7	11	2	2	22
District with ST population > 25%	8	14	28	6	56	13	19	9	15	56
District with Muslim pop. > 25%	8	14	7	0	29	19	6	4	0	29
Other Districts	17	70	68	24	179	44	37	46	52	179
All	37	110	104	33	284	81	73	61	69	284
Districts	**Full Immunization (% of Districts)**					**Institutional Delivery (% of Districts)**				
	LL	**LH**	**HL**	**HH**	**All**	**LL**	**LH**	**HL**	**HH**	**All**
District with SC population > 25%	18.2	59.1	9.1	13.6	100.0	31.8	50.0	9.1	9.1	100.0
District with ST population > 25%	14.3	25.0	50.0	10.7	100.0	23.2	33.9	16.1	26.8	100.0
District with Muslim pop. > 25%	27.6	48.3	24.1	0.0	100.0	65.5	20.7	13.8	0.0	100.0
Other Districts	9.5	39.1	38.0	13.4	100.0	24.6	20.7	25.7	29.1	100.0
All	13.0	38.7	36.6	11.6	100.0	28.5	25.7	21.5	24.3	100.0

Source: Computed by Author

Note: **HH** refers to districts with base level health achievement above average level across districts and progress in health achievement also above average progress across districts. **LH** refers to districts with base level health achievement below average level across districts but progress in health achievement above average progress across districts. **HL** refers to districts with base level health achievement above average level across districts but progress in health achievement below average progress across districts. **LL** refers to districts with base level health achievement below average level across districts and progress in health achievement also below average progress across districts.

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