

Estimation, Decomposition and Convergence of Human Development Index and Gender Development Index in the States of India

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Abstract: The aim of this paper is to examine the trends in Human Development Index (HDI) and Gender Development Index (GDI) and decompose the HDI by its dimensions in the states/union territories of India. The HDI of India has increased from 0.456 in 2001 to 0.571 in 2016. Decomposition of HDI by its dimensions suggests that education accounts for the largest contribution to the improvement in HDI (42%) followed by income (33%) and health (18%). The contribution of education and income to the change in HDI was found largest in 18 and 16 states/union territories respectively. Similarly, the GDI in India has increased from 0.764 in 2001 to 0.824 in 2016. A strong and positive association of state level HDI and GDI was observed. Despite large interstate variations, the states are converging both in HDI and GDI.

Keywords: HDI, GDI, India, State, Decomposition, Convergence.

Introduction

Over the last twenty-five years, the Human Development Index (HDI) has been used extensively among the academia, national and regional governments, and developmental agencies. The global human development reports disseminate the annual estimates of HDI at the country-level. While the estimation of global HDI is an annual feature, national and local governments are estimating and using HDI at the sub-national level. Though the concept of human development is broad, complex and comprehensive, the measurements rely on three key dimensions, namely, health, knowledge and standard of living, which capture the average progress in these domains of a population. The rationale of including these three dimensions is on the ground that if these three dimensions are taken care of, all other needs can be taken care of. Sub-national estimates of HDI suffer from data constraints and are often not compatible with the recommended global methodology.

The variables and methodology used in measuring HDI have undergone changes over the years. In 2010, the United Nations Development Programme (UNDP) recommended a revised set of indicators and methodology in estimating the HDI. For example, in the educational domain, adult literacy rate and gross school enrolment rate were replaced by mean years of schooling and school life expectancy respectively (UNDP, 2010). While life expectancy at birth remained unchanged, the Gross Domestic Product (GDP) per capita (in PPP\$) was replaced by Gross National Income (GNI) per capita (UNDP, 2010). While both GDP per capita and GNI per capita are macroeconomic measures, the GNI per capita is broader than GDP per capita. For meaningful comparison, GNI per capita at purchasing power parity (PPP) is used to compare different economies. The new HDI uses a multiplicative model in place of the additive model that was used earlier. The multiplicative

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model is said to have advantages over the additive model as it can be decomposed by dimensions and indicators (UNDP, 2010).

During the last two decades, India has made significant improvements in the state of human development. The HDI has increased from 0.428 in 2001 to 0.624 in 2015 (UNDP, 2016). In the education domain, there has been a spectacular increase in literacy level and some upgradation in educational attainment. The mean years of schooling has increased from 4.4 years in 2001 to 5.8 years in 2016 (IIPS & ICF, 2017) for population aged 25 and above. While the country has sustained economic growth of over 5 percent of GDP, the percentage of population living below poverty line declined from 39.2 percent in 2009-10 to 29.5 percent in 2011 (Planning Commission of India, 2014). The inequality-adjusted human development index (IHDI) for India was estimated at 0.34 (Suryanarayana *et al.*, 2017). In the health domain, there has been a significant improvement in life expectancy at birth, childhood mortality and maternal mortality (ORGI, 2016). The National Health Mission has been successful in improving the state of maternal and child health (IIPS & ORC Macro International, 2000, 2007; IIPS & ICF, 2017). The national progress in these dimensions conceals large disparities across the states. While some states recorded high economic growth, their social development has been persistently low alongside increasing economic inequality.

A number of studies in India had estimated the HDI at the national and sub-national levels (Planning Commission, 2007, 2014; UNDP 1990, 1991, 2005, 2006, 2009, 2010, 2011, 2016; Suryanarayana *et al.*, 2011, 2017; Mohanty and Ram, 2004; IAMR, 2011; Mohanty and Dehury, 2012) using different data sources and varying methodology. The general inference from these studies suggests general improvement over time but wide disparities in human development across the states. However, no attempt has been made to understand the contribution of each of the dimensions to the state of human development. Besides, the estimates of GDI are less frequently published for the states of India. In this paper, we estimate the trends in human development in India and decompose the contribution of human development indices by its dimensions. The relative contribution of health, knowledge and income in the overall development is estimated. State-level GDI estimates are provided for a period of fifteen years. The specific objectives of this paper are

- i. To estimate the temporal variation in HDI across the states of India.
- ii. To decompose the change of HDI by its dimensions.
- iii. To estimate the temporal variation in GDI across the states of India.
- iv. To examine the convergence of HDI & GDI in the states of India.

Data

Data from multiple sources such as Census of India (2001, 2011), Sample Registration System (SRS), four rounds of National Family and Health Survey (1992-2016)(NFHS 1-4), India Human Development Survey II (IHDS2) (2011-12), District Level Household and Facility Survey (DLHS 1-4)(1998-2013) (IIPS, 2006; 2010), Annual Health Survey 2012-13 (AHS) and Reserve Bank of India were used in the analyses. Most of these are large-scale population based national-level surveys, providing reliable estimates on social, economic, health and demographic aspects of human population. We have used data at four time points - 2001, 2006, 2011 and 2016. For the newly formed states within the study period, we have used the data corresponding to the parent state. For example, data corresponding to Madhya Pradesh was used for Chhattisgarh for 2001. For the analyses, 35

states and union territories were considered. Table 1 provides the data sources, variables and methodology in estimating the human and gender development indices.

The life expectancy at birth that represents the health dimension was obtained from the Sample Registration System (SRS). In cases where it was not available for a state, the estimates were derived from states having similar estimates of infant mortality rate. A list of states for which we have used the life expectancy of a similar state is given in Appendix 1. In case of education, two key indicators, namely, mean years of schooling and school life expectancy were used. Mean years of schooling were taken from NFHS and the school life expectancy of 2011 and 2016 were computed from the Census of India. The State Domestic Product Per Capita (SDPP) was used to measure the economic dimension. The SDPP was obtained from the Reserve Bank of India at constant prices (RBI, 2018). The base year was adjusted to 2011-12 and the SDPP was presented at constant prices (World Bank Data, 2014). The share of economically active population was computed from the Census of India, 2001 and 2011. The estimates were interpolated for 2006 and extrapolated for 2016. At the national level, the economically active female population in 2001 was 33.3 percent and 31.7 percent in 2011. We assumed that the share of female and male wage remained constant for all periods, which was calculated using IHDS 2 (Desai *et al.*, 2011-12). The female to male wage ratio was taken as 0.8 as recommended by UNDP (2010).

Table 1: Data Sources and Goal Posts used for Computing HDI and GDI

<i>Variables/Time</i>	<i>Data Source</i>	<i>Maximum Value</i>	<i>Minimum Value</i>
Life expectancy at birth	Sample Registration System	85	20
Life expectancy at birth-Male	Sample Registration System	82.5	17.5
Life expectancy at birth-Female	Sample Registration System	87.5	22.5
Expected years of schooling	Census, 2001, 2011	18	0
Mean years of schooling	NFHS 2, 3, 4, IHDS 2, DLHS 2	15	0
State Domestic Product per capita at constant prices (SDPP\$)	RBI	75000	100

The SDPP was converted to purchasing power parity, 2011-12, using national conversion factor of 3.27 (GDPPCI=1738 \$ & GDPPCIPPP=5688 \$ from the World Bank) and an exchange rate of 67.21 per Dollar.

Methods

We have used the methods recommended by the United Nations Development Program (UNDP) in constructing the HDI and GDI (UNDP, 2010). In the first step, the dimensional indices were computed and the HDI was computed as the geometric mean of dimensional indices. The dimensional index was computed using the formula

$$Dimension\ Index\ (I_a) = \frac{actual\ value - minimum\ value}{maximum\ value - minimum\ value}$$

Here I_a stands for the dimensional index of dimension a. In the case of educational index, the average of mean years of schooling and expected years of schooling were used.

The HDI is the geometric mean of the three-dimension indices:

$$HDI = (I_{Health} \times I_{Education} \times I_{Income})^{1/3} \dots\dots\dots(1)$$

Estimation of Gender Development Index (GDI)

For computing the GDI, we estimated the female and male per capita as recommended by UNDP. As the first step, income earned by females and males was estimated using female and male wage rate, female share in economically active population and the SDPP. The female share of the wage bill (S_f) was calculated as follows:

$$S_f = \frac{(W_f/W_m) \cdot EA_f}{(W_f/W_m) \cdot EA_f + EA_m} \dots \dots \dots (2)$$

Where W_f/W_m is the ratio of female to male wage.

EA_f is the female share of an economically active population and EA_m is the male share of an economically active population.

If there is no wage differential, i.e. $W_f/W_m=1$, then $S_f = \frac{EA_f}{EA_f + EA_m}$

Again, if gender is not taken into account, the work force participation rate, $S_f = 0.5$.

The male share of the wage bill was calculated as:

$$S_m = 1 - S_f \dots \dots \dots (3)$$

Estimated female earned income per capita $GNIpc_f$ was obtained from GNI per capita $GNIpc$, first multiplying it by the female share of wage bill, S_f and then rescaling it by the female share of the population, $P_f = N_f/N$:

$$GNIpc_f = GNIpc \cdot S_f / P_f \dots \dots \dots (4)$$

Estimated male earned income per capita was obtained in the same way:

$$GNIpc_m = GNIpc \cdot S_m / P_m \dots \dots \dots (5)$$

In the second step, we normalized the indicators using the goal posts given below. The dimensional indices were computed as

$$Dimension\ Index = \frac{actual\ value - minimum\ value}{maximum\ value - minimum\ value}$$

For education, the dimension index was first obtained for each of the two subcomponents and then the underweighted arithmetic mean of the two resulting indices was taken. In the third step, the female and male HDI values were estimated. The female and male HDI values are the geometric means of the three dimensional indices for each gender:

$$HDI_f = (I_{Health_f} \times I_{Education_f} \times I_{Income_f})^{1/3} \dots \dots \dots (6)$$

$$HDI_m = (I_{Health_m} \times I_{Education_m} \times I_{Income_m})^{1/3} \dots \dots \dots (7)$$

Lastly, GDI was computed as the ratio of the female HDI to male HDI

$$GDI = HDI_f / HDI_m \dots \dots \dots (8)$$

Decomposition of HDI

The change in HDI over the period, 2001-2016 has been decomposed by each of its components. First, the values of HDI, as well as the indicators were normalised and were converted to a scale between 0-100. The changes in HDI were computed as follows:

$$HDI_{2001} = (I_{Health_{2001}} \times I_{Education_{2001}} \times I_{Income_{2001}})^{1/3} \dots\dots\dots(9)$$

$$HDI_{2011} = (I_{Health_{2011}} \times I_{Education_{2011}} \times I_{Income_{2011}})^{1/3} \dots\dots\dots(10)$$

$$\text{Proportional change during 2001-2011 in HDI (phd}_i) = (HDI_{2011}/HDI_{2001}) - 1 \dots\dots\dots(11)$$

Similarly, proportional changes in health, education and income have been computed. Thus, proportional change in human development is the sum of proportional change in each component and an interaction term. All the proportional changes have been expressed as percentile proportional changes for the purpose of easy interpretation. The contribution of each of the components has been computed as the ratio of proportional change in each index to the proportional change in the human development index multiplied by 100.

Convergence of HDI & GDI

In addition, we have used (β) convergence model to understand the convergence of HDI across the states of India. The mathematical form of the model is given as

$$\ln(Y_{jn}/Y_{j0})/T = \alpha + \beta(Y_{j0}) + e_j \dots\dots\dots(12)$$

- where ln is the natural log,
- Y_{j0} is the value of HDI/GDI corresponding to the year 2001,
- Y_{jn} is the value of HDI/GDI corresponding to the year 2016
- T is the number of years between 2001 and 2016
- β is the convergence coefficient
- α is the constant, and
- e is the error term.

The subscript j is the j th state, 0 is the base year (2001), and n is the final year (2016).

A negative β means lagging states are converging (catching up with leading states), and a positive β means lagging states are diverging (falling farther behind) (diverging). β convergence occurs when the rate of decline among states with a high level of human development is greater than the rate of decline among those with a low level of human development.

Empirical Findings

Human Development in India, 2001-2016

Table 2 presents the state-wise HDI values of India for the years corresponding to 2001, 2006, 2011 and 2016 along with their relative ranks. Appendix 2 presents the input values used for computation of HDI in the states of India. The HDI value for India was 0.456 in 2001; 0.498 in 2006, 0.543 in 2011 and 0.571 in 2016. The annual increase (average) in HDI for India was 0.008 during the last 15 years. The interstate variation in human development was enormous at all the time periods. The coefficient of variation in HDI across the states of India was 13.4 percent in 2001, 12.4 percent in 2006, 11.1 percent in 2011 and 9.9 percent in 2016 suggesting that the state variation in human development has reduced over time. In 2016, 12 states, namely, Bihar, Uttar Pradesh, Assam, Odisha, Madhya Pradesh, Chhattisgarh, Rajasthan, Jharkhand, Meghalaya, Arunachal Pradesh, West Bengal and

Manipur showed below national level human development. The HDI was highest in the state of Goa over time (0.612 in 2001 and 0.721 in 2016) and lowest in Bihar (0.335 in 2001 and 0.483 in 2016).

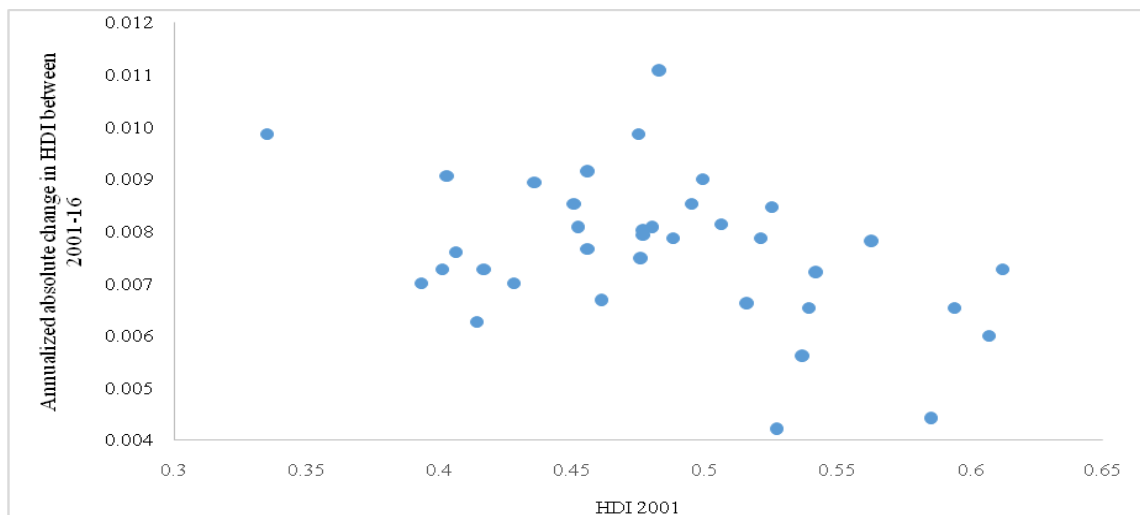
Table 2: Human Development Indices and their Relative Ranks in the States of India, 2001-2016

State	HDI 2001	HDI 2006	HDI 2011	HDI 2016	Rank in 2001	Rank in 2016	Annualized Absolute Change in HDI during 2001-16
Andaman & Nicobar Islands	0.542	0.584	0.613	0.650	6	7	0.007
Andhra Pradesh	0.451	0.497	0.54	0.579	26	24	0.009
Arunachal Pradesh	0.436	0.486	0.572	0.570	27	26	0.009
Assam	0.414	0.454	0.492	0.508	30	33	0.006
Bihar	0.335	0.380	0.441	0.483	35	35	0.010
Chandigarh	0.585	0.630	0.649	0.651	4	6	0.004
Chhattisgarh	0.417	0.452	0.496	0.526	29	30	0.007
Dadra & Nagar Haveli	0.475	0.517	0.612	0.623	22	13	0.010
Daman & Diu	0.495	0.545	0.570	0.623	15	14	0.009
Goa	0.612	0.652	0.712	0.721	1	1	0.007
Gujarat	0.480	0.525	0.571	0.601	18	18	0.008
Haryana	0.506	0.546	0.593	0.628	13	12	0.008
Himachal Pradesh	0.539	0.579	0.607	0.637	7	10	0.007
Jammu & Kashmir	0.456	0.509	0.561	0.593	24	21	0.009
Jharkhand	0.403	0.442	0.508	0.539	32	28	0.009
Karnataka	0.476	0.517	0.554	0.588	21	23	0.007
Kerala	0.563	0.609	0.652	0.68	5	4	0.008
Lakshadweep	0.525	0.574	0.633	0.652	10	5	0.008
Madhya Pradesh	0.406	0.439	0.484	0.520	31	31	0.008
Maharashtra	0.521	0.573	0.615	0.639	11	9	0.008
Manipur	0.527	0.553	0.599	0.59	9	22	0.004
Meghalaya	0.452	0.497	0.562	0.573	25	25	0.008
Mizoram	0.477	0.523	0.589	0.596	20	20	0.008
Nagaland	0.537	0.565	0.637	0.621	8	15	0.006
NCT of Delhi	0.594	0.636	0.660	0.692	3	3	0.007
Odisha	0.401	0.445	0.484	0.510	33	32	0.007
Puducherry	0.607	0.636	0.683	0.697	2	2	0.006
Punjab	0.516	0.549	0.586	0.615	12	16	0.007
Rajasthan	0.428	0.461	0.504	0.533	28	29	0.007
Sikkim	0.483	0.532	0.618	0.649	17	8	0.011
Tamil Nadu	0.499	0.551	0.600	0.634	14	11	0.009
Tripura	0.488	0.526	0.582	0.606	16	17	0.008
Uttar Pradesh	0.393	0.428	0.468	0.498	34	34	0.007
Uttarakhand	0.477	0.520	0.563	0.597	19	19	0.008
West Bengal	0.461	0.498	0.533	0.561	23	27	0.007
India	0.456	0.498	0.543	0.571	-	-	0.008

The pace of change in human development during 2001-16 was highest in Sikkim (with an average annual change in HDI by 0.011) followed by Bihar and Dadra & Nagar Haveli (0.01) and was slowest in Manipur (with an average annual change in percentage in HDI of 0.417) (Table 2). Many of the states with a higher level of human development in

2001 had made slower progress, while states with a lower level of HDI made higher progress over time. Bihar, with the least rank of HDI value in both the time periods, had made the highest increase. States having low HDI (0.45-0.55) in 2001 showed higher changes in HDI than those with higher HDIs in 2001 (Figure 1).

Figure 1: Association of annualized absolute changes in HDI 2001-16 with HDI 2001

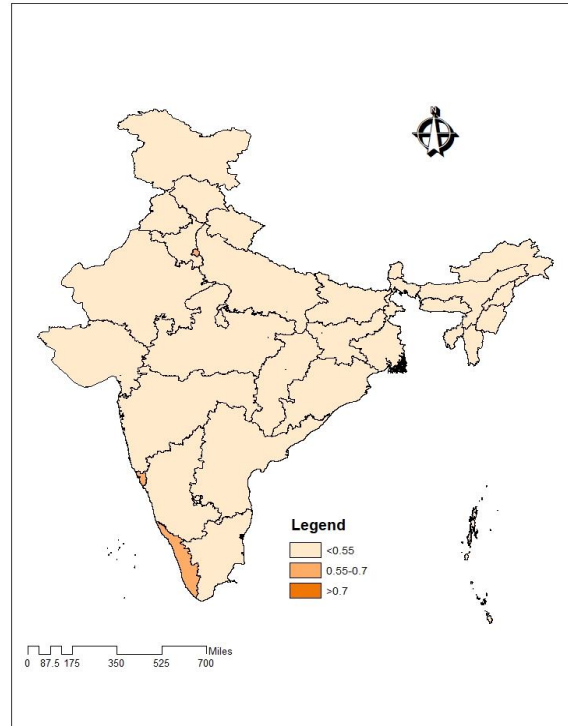


Maps 1(a-b) present the HDI for the states of India for 2001 and 2016 respectively. The cut-off points for human development have been chosen in accordance with the global HDR. The HDI value lower than 0.55 implies ‘low’ level of development, those between 0.55 and 0.70 are classified as ‘medium’ level of human development and above 0.70 are ‘high’ level of human development. Based on the HDI values, 30 states in 2001 were classified as having low HDI. However, the remaining five, namely, Chandigarh, Goa, Kerala, NCT of Delhi and Puducherry had medium HDI. In 2001, the spatial pattern of human development was rather uniform showing low human development. However, in 2016, the central region encompassing the states of Rajasthan, Uttar Pradesh, Madhya Pradesh, Chhattisgarh, Bihar, Jharkhand and Odisha and Assam continued to have low human development. Goa was the only state to achieve a high level of human development.

Decomposition of Human Development Index, 2001-16

Figure 2 presents the results of decomposition of HDI by its components during 2001-16. At the national level, education contributes the highest to change in human development (41.9%), followed by income (33.3%) and health (17.8%). The proportional change in education, income and health dimensions at the national level were estimated to be 10.6 percent, 8.4 percent and 4.5 percent respectively. Improvement in the education index has been the greatest in the educationally backward and poorer states of Uttar Pradesh, Rajasthan, Odisha, Madhya Pradesh, Chhattisgarh, Jharkhand, Bihar and a few other states. The contribution of education to the change in HDI was highest in 19 states, whereas the contribution of income was highest in 16 states. The maximum contribution of education in HDI was observed in Jammu & Kashmir (50.7%) followed by Arunachal Pradesh (47.4%), while the minimum was observed in Uttarakhand (21.2%). The contribution of income in HDI was the highest in Uttarakhand (57%) and the lowest in Arunachal Pradesh (18.5%). In general, education contributed to considerable improvement in HDI in many states of India while health subscribed the least.

Map 1a: Human Development Index in States of India, 2001



Map 1b: Human Development Index in States of India, 2016

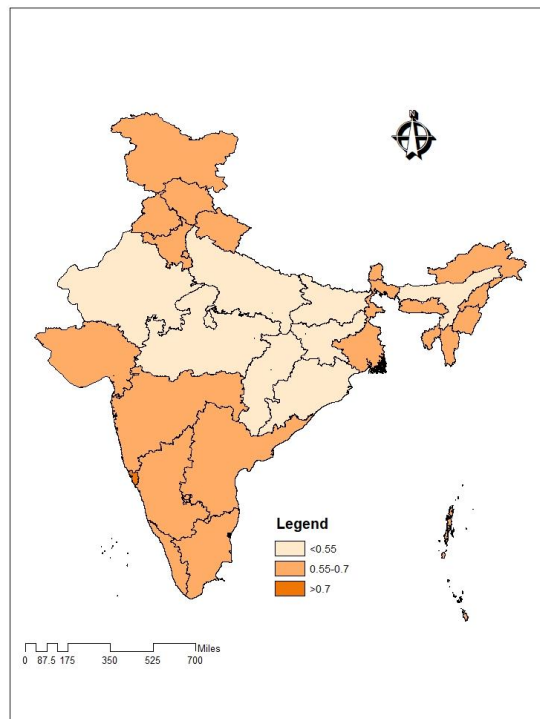
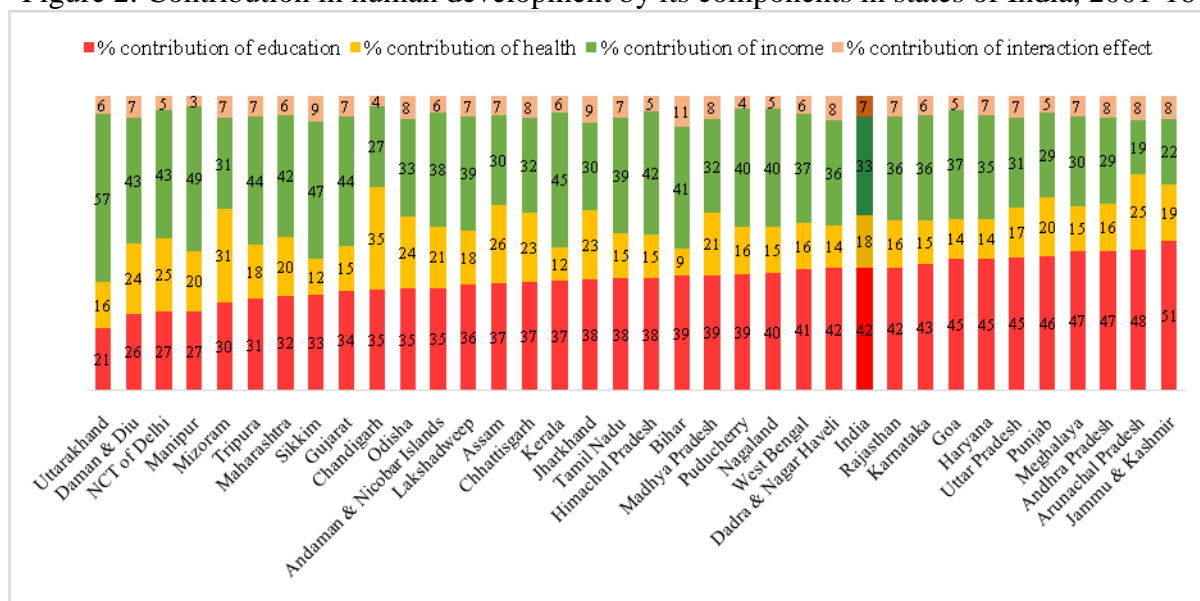


Figure 2: Contribution in human development by its components in states of India, 2001-16



Convergence of HDI and GDI over time

Table 3 presents the results of state-level beta convergence of HDI and GDI in India at different time periods. The coefficients are consistently negative over time. The negative β coefficients implied that the lagging states were growing faster than the better performing states in both HDI and GDI. Thus, it implied that the degree of inter-state variation in HDI and GDI had declined over time and states are exhibiting absolute β convergence.

Table 3: Absolute β convergence for HDI and GDI among the states of India, 2001-16

Time period	HDI				GDI			
	β coefficient	t-statistic	Constant	Adjusted R square	β coefficient	t-statistic	Constant	Adjusted R square
2001-2006	-0.035	-5.19	0.034	0.436	-0.065	-5.41	0.058	0.66
2001-2011	-0.044	-5.53	0.039	0.426	-0.064	-5.85	0.056	0.728
2006-2011	-0.052	-3.92	0.046	0.252	-0.071	-4.47	0.063	0.525
2006-2016	-0.044	-5.58	0.036	0.532	-0.044	-3.66	0.038	0.354
2011-2016	-0.046	-4.92	0.035	0.294	-0.008	-0.52	0.006	0.007
2001-2016	-0.042	-6.74	0.035	0.612	-0.05	-5.91	0.043	0.608

Table 4: Gender Development Index and their Relative Ranks in the States of India, 2001-2016

State	GDI 2001	GDI 2006	GDI 2011	GDI 2016	Rank in 2001	Rank in 2016
Andaman & Nicobar Islands	0.820	0.828	0.821	0.824	11	20
Andhra Pradesh	0.804	0.833	0.854	0.859	17	12
Arunachal Pradesh	0.801	0.830	0.856	0.863	18	10
Assam	0.754	0.773	0.804	0.805	28	27
Bihar	0.512	0.599	0.691	0.715	36	36
Chandigarh	0.802	0.832	0.830	0.814	13	24
Chhattisgarh	0.770	0.801	0.850	0.868	24	8
Dadra & Nagar Haveli	0.791	0.790	0.850	0.810	22	26
Daman & Diu	0.735	0.761	0.764	0.734	31	34
Goa	0.879	0.883	0.875	0.876	6	6
Gujarat	0.793	0.806	0.820	0.814	19	23
Haryana	0.789	0.798	0.807	0.795	21	29
Himachal Pradesh	0.866	0.881	0.896	0.914	5	3
Jammu & Kashmir	0.750	0.774	0.788	0.791	29	30
Jharkhand	0.702	0.737	0.794	0.813	34	25
Karnataka	0.812	0.833	0.849	0.852	14	14
Kerala	0.876	0.873	0.868	0.847	2	15
Lakshadweep	0.801	0.804	0.815	0.754	20	33
Madhya Pradesh	0.742	0.784	0.818	0.841	30	17
Maharashtra	0.817	0.841	0.856	0.861	11	11
Manipur	0.866	0.875	0.898	0.893	7	5
Meghalaya	0.859	0.881	0.884	0.893	3	4
Mizoram	0.874	0.877	0.888	0.873	1	7
Nagaland	0.898	0.920	0.931	0.938	4	1
NCT of Delhi	0.759	0.787	0.790	0.797	27	28
Odisha	0.720	0.772	0.802	0.821	33	22
Puducherry	0.851	0.853	0.849	0.834	9	18
Punjab	0.808	0.799	0.792	0.767	16	32
Rajasthan	0.724	0.768	0.806	0.831	32	19
Sikkim	0.851	0.876	0.910	0.916	8	2
Tamil Nadu	0.826	0.851	0.867	0.868	10	9
Tripura	0.820	0.834	0.852	0.852	15	13
Uttar Pradesh	0.617	0.660	0.709	0.724	35	35
Uttarakhand	0.761	0.803	0.835	0.841	26	16
West Bengal	0.777	0.786	0.800	0.785	23	31
India	0.764	0.793	0.821	0.824	-	-

Gender-related Development in India, 2001-2016

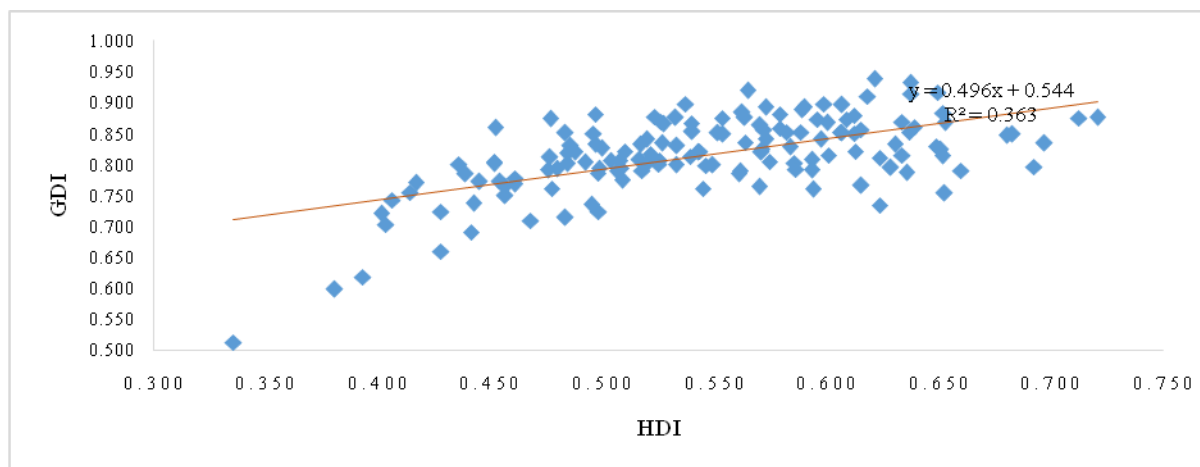
While the HDI measures the average progress, the GDI reflects the inequalities in human development by sex. For India, the estimated value of GDI was 0.764 in 2001, 0.793 in 2006, 0.821 in 2011 and 0.824 in 2016 (See Table 4). Appendices 3 and 4 present the input values in computing the state-level GDI for India. In 2001, GDI was highest in Mizoram (0.886), followed by Kerala (0.876) and was lowest in Bihar (0.512). In 2016, Himachal Pradesh (0.914) experienced the highest GDI. Bihar continued to exhibit the lowest GDI throughout 2001-2016 (varying from 0.599 in 2006 to 0.691 in 2011 and 0.715 in 2016). The high performing states in human development such as Kerala, Lakshadweep and Punjab showed a decline in gender-related development over time, while there was no further

gender-related improvement in Mizoram, Bihar and Uttar Pradesh which had a low GDI (<0.7) in 2001. Most of the states including the northern, central, western, eastern and parts of the north-eastern states had GDI within 0.7-0.85 and continued to showcase similar patterns in 2016. Himachal Pradesh in the north, Kerala and Goa in the south and north-eastern states such as Sikkim, Meghalaya, Nagaland, Manipur and Mizoram exhibited high GDI>0.85 in 2001. By 2016, all the southern and north-eastern (except Assam) states and union territories experienced a high GDI (>0.85).

Association between HDI and GDI

Figure 3 presents the scatter plot of HDI and GDI for all the states of India between 2001 and 2016. A strong positive association was found between HDI and GDI. However, the figure also suggested that a few states exhibited a low level of HDI and GDI, and their association with GDI was also low (but positive).

Figure 3: Association of HDI and GDI during 2001-2016



Discussion and Conclusion

The changes in methodology and inclusion of new indices of human development as recommended by the UNDP in 2010 aimed at providing a more comprehensive overview of growing inequality in the state of HDI within and across countries. These indices are advantageous for cross-country comparison but are sparse due to availability of limited data at sub-national levels. To our knowledge, this is the first systematic study which provides the estimates of HDI and GDI for all the states and union territories of India (excluding Telangana) corresponding to four time points, 2001, 2006, 2011 and 2016 over the last 15 years. The uniform methodology and recommended variables make the estimates consistent with global HDI and comparable among the states of India over time. Estimates obtained from earlier studies are non-comparable over time due to the changing methodology and incomplete coverage of states and union territories of India. Second, it also decomposes HDI into its component domains to understand their relative contribution. We examined whether there is a converging pattern of the states in terms of human development and gender-related development during 2001-2016. Third, it provides the estimates of GDI which are also globally comparable.

Results discern that India has recorded considerable improvement in human development across the states. However, the general pattern has remained unchanged. While Goa topped in the state of human development, Bihar was found to be lagging. The patterns of both the human development and gender-related development remained similar over time. However, the inequalities in HDI and GDI between the lagging states and the better-off states seemed to be decreasing over time. Bihar, ranking lowest at all the time periods, recorded the second largest increase in human development after Sikkim. The decomposition of human development across its dimensions suggests that education contributes largest to the change in human development, while health contributes to the least. Low human development is associated with low gender development in most cases. However, GDI has improved notably across all the states and union territories of India suggesting a reduction in gender inequality over time.

The present study could not provide the temporal estimates of HDI and GDI for the newly formed state of Telangana carved out from Andhra Pradesh. Most of the data sources do not provide sufficient scope to mark out portions of Telangana from Andhra Pradesh. For example, SRS, NFHS 2 and 3 render only state level estimates. Although rounds of DLHS and NFHS 4 provide district level estimates, we cannot get a consolidated estimation for Telangana over time (which was available only for 2016). Thus, it was excluded from the analysis. However, the present trends in HDI and GDI delineate that while the states of India are showing huge improvement in socio-economic development, there is further scope of improvement in some of the backward states.

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Notes

The information on life expectancies at birth for the bigger states are available from the Sample Registration System (SRS).

School Life expectancy: In the domain of knowledge, the school life expectancy for the age group 6-24 was computed. The state-level school life expectancy for 2001 and 2011 were estimated from the Census of India. For 2006 and 2011, the state-level estimates were interpolated and extrapolated respectively. Here, we assumed that the growth of school life expectancy follows a linear trend.

Mean Years of Schooling: The mean years of schooling for 25 years and above were computed using NFHS II (corresponding to 2001), III (corresponding to 2006) and IHDS II (corresponding to 2011)

and NFHS 4 (corresponding to 2016) data. For those states not covered in NFHS, data from DLHS were computed and used.

State Domestic Product Per capita: The SDPP at constant prices was obtained from the Reserve Bank of India. The estimates were deflated and stated at 2004-05 prices. Further, we converted the SDPP using purchasing power parity 2011-12 (factor of 3.27) and the 2016 exchange rate (1 US\$=67.21). The average exchange rate was computed using daily exchange rate of RBI. SDPP was not available for Daman & Diu, Dadra & Nagar Haveli and Lakshadweep. Thus, they were replaced by the values of their neighbouring states. For instance, the SDPP of Gujarat was taken for the estimates of Daman & Diu and Dadra & Nagar Haveli; the SDPP of Kerala was used for Lakshadweep.

Appendix Table 1: IMRs of States with No Estimates of Life Expectancies and States with Similar Levels of Infant Mortality Rates (IMRs)

State	IMR 2015	State	IMR 2015
Andaman & Nicobar Islands	20	Tamil Nadu	19
Arunachal Pradesh	30	Jharkhand	32
Chandigarh	34	Uttaranchal	34
Dadra & Nagar Haveli	21	Maharashtra	21
Daman & Diu	18	Tamil Nadu	19
Goa	9	Kerala	12
Lakshadweep	20	Maharashtra	21
Manipur	9	Kerala	12
Meghalaya	42	Bihar	42
Mizoram	32	Jharkhand	32
Nagaland	12	Kerala	12
NCT of Delhi	18	Tamil Nadu	19
Puducherry	11	Kerala	12
Sikkim	18	Tamil Nadu	19
Tripura***	20	Maharashtra	21

Estimation, Decomposition and Convergence of HDI and GDI in the States of India

Appendix Table 2: Indicators used in computing HDI in the States of India, 2001-2016

State	2001			2006				2011				2016				
	Life expectancy at birth	Mean years of schooling	Expected years of schooling	SDP P \$	Life expectancy at birth	Mean years of schooling	Expected years of schooling	SDP P \$	Life expectancy at birth	Mean years of schooling	Expected years of schooling	SDP P \$	Life expectancy at birth	Mean years of schooling	Expected years of schooling	SDP P \$
Andaman & Nicobar Islands	66.2	6.2	11.2	1743	68.2	6.9	12.1	2312	70.2	6	13	3326	72.2	7.5	13.9	3538
Andhra Pradesh	63.9	3.4	9.6	1089	65.9	3.8	10.9	1450	67.9	4.2	12.3	1876	70.2	5.2	13.6	2052
Arunachal Pradesh	58.6	3.7	9.2	1129	63.2	4	11	1346	67.7	7.2	12.7	1729	68.4	5.3	14.4	1752
Assam	58.6	4.3	9.1	734	61	5.6	9.8	855	63.3	6.3	10.5	1058	65.9	5.8	11.2	1138
Bihar	64	3.5	6.7	341	65.9	3.5	8.6	426	67.7	3.7	10.6	640	69.6	4.1	12.5	754
Chandigarh	60.1	8.9	12.2	2921	62	9.9	13	4154	63.8	10.5	13.7	3931	65	9.4	14.4	4028
Chhattisgarh	58.8	4.1	9.2	783	61.3	3.7	10.2	1050	63.8	4.5	11.3	1322	66.4	5.1	12.3	1380
Dadra & Nagar Haveli	66.7	5.4	7.8	1215	69	4.5	9.5	1876	71.3	8.1	11.2	2755	73.2	6.3	13	3073
Daman & Diu	66.2	5.4	9.8	1215	68.2	6.3	10.1	1876	70.2	5.6	10.4	2755	75.2	7.6	10.8	3073
Goa	72.5	6.4	11.7	3245	73.7	7.2	12.7	4197	74.8	9.1	13.7	6296	76.4	8.1	14.7	6685
Gujarat	65	5	9.2	1215	66.6	5.2	10.1	1876	68.2	5.8	11	2755	70.3	6.3	12	3073
Haryana	65.7	4.7	10.5	1543	67	4.9	11.6	2161	68.2	5.8	12.7	3003	70.3	6.7	13.8	3272
Himachal Pradesh	69.1	5.1	12.6	1394	70.1	6.2	13.1	1858	71	6.4	13.6	2394	73.2	7.4	14.1	2651
Jammu & Kashmir	66	4	9.5	946	69	5	11.1	1137	72	6	12.8	1401	74.4	6.1	14.5	1530
Jharkhand	58.6	4.4	8	731	63.2	4	9.7	848	67.7	4.6	11.5	1229	68.4	4.8	13.2	1405
Karnataka	65.4	4.7	9.5	1147	67	5	10.6	1555	68.5	5.3	11.7	2019	70.2	6.2	12.8	2239
Kerala	72.5	6.8	12.4	1294	73.7	7.6	13.2	1854	74.8	8.5	14	2569	76.4	9.1	14.8	2869
Lakshadweep	66.7	5.9	11.6	1294	69	6.6	12.5	1854	71.3	8.5	13.5	2569	73.2	8.1	14.4	2869
Madhya Pradesh	58.8	3.6	9.1	732	61.3	4	10.2	831	63.8	4.3	11.3	1132	66	5	12.4	1306
Maharashtra	66.7	5.2	11.2	1469	69	6	11.9	2218	71.3	6.7	12.6	2981	73.2	6.9	13.3	3362
Manipur	72.5	6.4	13.2	796	73.7	7.2	13.2	937	74.8	10.3	13.2	1079	76.4	8.1	13.2	1170
Meghalaya	64	3.9	9.5	990	65.9	4.8	10.7	1239	67.7	7.1	12	1666	69.6	5.9	13.2	1808
Mizoram	58.6	5.9	11.1	1095	63.2	6.8	12	1280	67.7	8.3	12.8	1845	68.4	7.4	13.7	1999
Nagaland	72.5	4.7	11.6	1427	73.7	5.3	12	1706	74.8	9.3	12.3	2255	76.4	6.6	12.7	2431
NCT of Delhi	66.2	8.2	11.4	2686	68.2	8.7	12.4	3709	70.2	7.6	13.3	5190	72.2	8.4	14.2	5761
Odisha	59.7	3.7	8.6	690	62.3	3.9	9.4	983	64.8	4.7	10.2	1194	68.1	5.1	11	1213
Puducherry	72.5	7	12	2507	73.7	7.5	12.9	2975	74.8	8.9	13.8	3917	76.4	7.9	14.7	4612
Punjab	67.6	5.2	10.3	1500	69.4	5.7	11.2	1804	71.1	6.3	12	2254	73.3	7	12.8	2410
Rajasthan	63.8	3.3	9	844	65.7	3.5	9.9	1038	67.5	3.9	10.9	1441	69.1	4.7	11.8	1549
Sikkim	66.2	4.2	11	1072	68.2	5	12.1	1474	70.2	6	13.2	3586	72.2	6.4	14.3	4064
Tamil Nadu	66.2	4.8	10.7	1257	68.2	5.4	11.8	1906	70.2	6	12.8	2778	72.2	6.9	13.9	3034
Tripura	66.7	5.1	10.4	1015	69	5.4	11.3	1341	71.3	6.6	12.2	1927	73.2	6.3	13	2299
Uttar Pradesh	60.1	3.8	8.7	585	62	4.2	9.9	693	63.8	4.6	11.2	876	65.7	5.2	12.4	936
Uttarakhand	60.1	6	11.5	947	62	5.8	12.2	1491	63.8	5.5	13	2559	65	6.8	13.7	2878
West Bengal	66.2	4.5	8.9	980	68.1	4.9	9.9	1236	69.9	5.1	10.9	1565	71.1	5.5	11.9	1766
India	63.4	4.4	9.3	1026	65.5	4.8	10.4	1366	67.5	5.3	11.5	1851	69.5	5.8	12.6	1941

Appendix Table 3: Indicators used in computing GDI in the States of India, 2001-06

State	2001										2006									
	Life expectancy at birth		Mean years of schooling		Expected years of schooling		GNIpc (\$)		HDI		Life expectancy at birth		Mean years of schooling		Expected years of schooling		GNIpc (\$)		HDI	
	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F
Andaman & Nicobar Islands	64.8	67.6	7	5.4	11.3	11.2	2540	800	0.579	0.475	66.5	70	7.5	6.2	12.2	12.1	3471	966	0.619	0.513
Andhra Pradesh	61.7	66.3	4.7	2.1	10.4	8.7	1427	743	0.495	0.398	63.6	68.4	5.2	2.6	11.6	10.2	1901	992	0.538	0.449
Arunachal Pradesh	58.2	59.2	4.8	2.4	10	8.4	1399	827	0.479	0.383	62.8	63.6	5.2	2.9	11.6	10.3	1676	987	0.528	0.438
Assam	58.2	59.2	5.4	3.2	9.5	8.7	1030	416	0.461	0.348	60.1	62.2	6.9	4.3	10.1	9.6	1224	465	0.501	0.387
Bihar	64.6	63.4	5.2	1.6	7.9	5.3	504	163	0.411	0.21	66	65.7	5.4	1.9	9.6	7.6	629	205	0.452	0.271
Chandigarh	60	60.2	10.3	7.5	12	12.6	4278	1175	0.631	0.506	61.3	62.7	10.6	9.1	12.8	13.2	6221	1559	0.668	0.556
Chhattisgarh	58.1	59.4	5.6	2.5	10.2	8.1	980	584	0.466	0.359	60.2	62.5	5.6	2.2	10.9	9.5	1312	785	0.5	0.401
Dadra & Nagar Haveli	65	68.6	6.7	3.9	8.7	6.8	1569	778	0.521	0.412	67.2	71	6	2.6	10.1	8.8	2535	1045	0.564	0.445
Daman & Diu	64.8	67.6	7.2	3.8	9.9	9.6	1742	472	0.545	0.4	66.5	70	7.8	4.8	10	10.4	2722	601	0.587	0.447
Goa	69.7	75.3	7.5	5.5	12	11.5	4499	1941	0.645	0.567	70.8	76.6	8.2	6.4	12.8	12.6	6081	2249	0.684	0.604
Gujarat	63	67.2	6.3	3.6	10	8.4	1674	715	0.525	0.417	64.5	68.9	6.6	3.9	10.8	9.4	2670	1014	0.572	0.461
Haryana	64.4	67.2	6.3	3	11.2	9.6	2081	918	0.556	0.439	65.1	69.1	6.7	3.4	12.1	10.9	3076	1109	0.597	0.476
Himachal Pradesh	67.1	71.4	6.7	3.6	13.1	12.2	1692	1085	0.576	0.499	68.1	72.3	7.9	4.8	13.4	12.8	2269	1435	0.615	0.542
Jammu & Kashmir	64.4	68	5.5	2.3	10.4	8.5	1309	538	0.51	0.382	67.5	71	6.5	3.6	11.8	10.3	1616	599	0.561	0.434
Jharkhand	58.2	59.2	6	2.6	9.2	6.7	1006	439	0.463	0.325	62.8	63.6	5.8	2.3	10.7	8.8	1154	524	0.501	0.369
Karnataka	63	68	6	3.3	10.1	8.8	1558	722	0.519	0.421	64.7	69.4	6.3	3.8	11.1	10.1	2132	960	0.558	0.465
Kerala	69.7	75.3	7.4	6.3	12.4	12.3	1830	789	0.593	0.52	70.8	76.6	8.1	7.3	13.3	13.1	2775	995	0.641	0.559
Lakshadweep	65	68.6	7.3	4.6	12.3	10.9	1843	716	0.573	0.459	67.2	71	7.8	5.6	12.9	12.1	2835	819	0.62	0.499
Madhya Pradesh	58.1	59.4	5.1	2	10.2	7.9	954	490	0.458	0.34	60.2	62.5	5.4	2.6	10.9	9.4	1085	555	0.486	0.381
Maharashtra	65	68.6	6.7	3.6	11.8	10.6	1972	922	0.566	0.463	67.2	71	7.6	4.6	12.4	11.4	3000	1373	0.617	0.518
Manipur	69.7	75.3	8.1	4.7	13.7	12.6	950	638	0.563	0.487	70.8	76.6	9	5.7	13.6	12.7	1128	742	0.588	0.515
Meghalaya	64.6	63.4	4.5	3.4	9.5	9.5	1228	745	0.484	0.415	66	65.7	5.3	4.4	10.6	10.8	1560	912	0.526	0.464
Mizoram	58.2	59.2	6.7	5.1	11.3	10.9	1308	866	0.507	0.443	62.8	63.6	7.6	6.2	12.2	11.8	1583	963	0.555	0.487
Nagaland	69.7	75.3	5.6	3.6	11.9	11.3	1699	1125	0.562	0.505	70.8	76.6	6.1	4.5	12.1	11.8	2029	1354	0.586	0.539
NCT of Delhi	64.8	67.6	9.7	6.7	11.4	11.4	4258	770	0.641	0.487	66.5	70	9.8	7.6	12.4	12.3	5980	1019	0.678	0.534
Odisha	58.7	60.7	5.1	2.2	9.5	7.7	975	397	0.456	0.328	61.3	63.3	5.3	2.8	10.1	8.8	1380	575	0.495	0.382
Puducherry	69.7	75.3	8.2	6	12.4	11.6	3680	1336	0.646	0.55	70.8	76.6	8.5	6.7	13.2	12.6	4560	1420	0.675	0.575
Punjab	66.3	68.9	6.1	4.2	10.4	10.2	2169	737	0.557	0.45	67.7	71.2	6.7	4.7	11.2	11.1	2741	746	0.591	0.473
Rajasthan	62.3	65.5	5.1	1.5	10.5	7.3	1097	570	0.487	0.352	63.9	67.8	5.4	1.8	11.2	8.5	1329	724	0.515	0.395
Sikkim	64.8	67.6	5.2	3	11.1	10.9	1355	748	0.516	0.439	66.5	70	6	4	12	12.1	1875	1020	0.563	0.493
Tamil Nadu	64.8	67.6	6.2	3.5	11	10.3	1680	829	0.542	0.448	66.5	70	6.7	4.4	12	11.5	2600	1206	0.592	0.504
Tripura	65	68.6	6.2	4	11	9.8	1363	647	0.529	0.434	67.2	71	6.4	4.4	11.8	10.8	1845	813	0.567	0.473
Uttar Pradesh	60	60.2	5.6	2	9.7	7.5	877	260	0.461	0.284	61.3	62.7	6.1	2.4	10.7	9.1	1048	301	0.492	0.325
Uttarakhand	60	60.2	8.1	3.8	12.3	10.7	1270	611	0.535	0.407	61.3	62.7	7.7	4.2	12.8	11.7	2033	928	0.572	0.459
West Bengal	64.8	67.8	5.8	3.2	9.4	8.5	1379	553	0.508	0.395	66.7	69.7	6.1	3.7	10.2	9.7	1818	617	0.544	0.428
India	62.3	64.6	5.8	2.9	10.1	8.4	1417	607	0.507	0.388	64.1	67	6.3	3.4	11	9.8	1910	785	0.548	0.434

Estimation, Decomposition and Convergence of HDI and GDI in the States of India

Appendix Table 4: Indicators used in computing GDI in the States of India, 2011-16

State	2011										2016									
	Life expectancy at birth		Mean years of schooling		Expected years of schooling		GNIpc (\$)		HDI		Life expectancy at birth		Mean years of schooling		Expected years of schooling		GNIpc (\$)		HDI	
	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F
Andaman & Nicobar Islands	68.2	72.3	7.1	5	13	13	5139	1255	0.653	0.536	70.8	74.1	8.1	6.9	13.89	13.85	5628	1196	0.689	0.568
Andhra Pradesh	65.5	70.4	5.6	3	12.9	11.7	2460	1288	0.579	0.494	68.8	72.3	6.5	3.8	14.09	13.18	2692	1412	0.621	0.533
Arunachal Pradesh	67.3	68	8.6	6	13.1	12.3	2160	1268	0.614	0.526	68.7	68.6	6.3	4.1	14.58	14.24	2202	1286	0.609	0.526
Assam	61.9	65.1	7.2	5.3	10.6	10.5	1543	551	0.533	0.428	65.2	67.3	6.6	4.9	11.17	11.34	1693	566	0.549	0.442
Bihar	67.3	68	5.3	2.3	11.2	9.9	944	309	0.502	0.347	70.2	69.4	5.9	2.5	12.83	12.16	1112	365	0.546	0.39
Chandigarh	62.5	65.2	11.2	9.6	13.6	13.9	6023	1373	0.685	0.569	64.2	66.3	10.3	8.5	14.33	14.59	6318	1304	0.693	0.564
Chhattisgarh	62.3	65.5	6	3.1	11.6	11	1649	991	0.534	0.454	65.3	67.9	6.5	3.8	12.32	12.39	1721	1037	0.561	0.487
Dadra & Nagar Haveli	69.4	73.4	8.8	7.3	11.5	10.9	3879	1304	0.647	0.549	72	75	7.7	4.8	12.92	13.02	4489	1197	0.666	0.54
Daman & Diu	68.2	72.3	7.1	4.2	10.1	11.2	4037	684	0.608	0.465	70.8	74.1	8.7	6.1	10.14	11.97	4537	525	0.646	0.474
Goa	71.8	77.8	10.5	7.8	13.7	13.7	9514	2989	0.748	0.655	73.9	79.3	9	7.3	14.56	14.89	10518	2774	0.754	0.66
Gujarat	66	70.5	7.1	4.6	11.6	10.4	4042	1356	0.615	0.504	68.6	72.7	7.5	5	12.45	11.39	4642	1366	0.648	0.528
Haryana	65.8	70.9	7.5	4.2	13.1	12.2	4497	1302	0.64	0.517	68.6	73	8.2	5	14.11	13.54	5144	1165	0.678	0.539
Himachal Pradesh	69	73.1	7.9	5.3	13.8	13.5	2940	1832	0.639	0.573	70.8	76.3	8.7	6.3	14.08	14.12	3275	2011	0.665	0.608
Jammu & Kashmir	70.6	74	7.4	4.6	13.3	12.2	2041	680	0.613	0.483	72.9	77.2	7.6	4.6	14.83	14.04	2284	680	0.644	0.509
Jharkhand	67.3	68	6.1	3	12.1	10.8	1654	781	0.559	0.444	68.7	68.6	6.4	3.2	13.54	12.89	1870	918	0.59	0.48
Karnataka	66.4	70.8	6.5	4.1	12	11.4	2795	1221	0.592	0.503	68.9	72	7.3	5	12.98	12.62	3129	1327	0.629	0.536
Kerala	71.8	77.8	8.8	8.2	14.2	13.9	4057	1197	0.685	0.594	73.9	79.3	9.4	8.8	15.06	14.64	4769	1139	0.718	0.608
Lakshadweep	69.4	73.4	8.8	8.2	13.6	13.3	4191	856	0.671	0.547	72	75	9	7.2	14.25	14.54	4964	652	0.7	0.528
Madhya Pradesh	62.3	65.5	5.9	2.8	11.7	10.9	1483	755	0.527	0.431	64.9	67.6	6.4	3.5	12.44	12.39	1716	870	0.56	0.47
Maharashtra	69.4	73.4	8.2	5.4	13	12.2	4062	1818	0.656	0.562	72	75	8.2	5.6	13.6	12.98	4614	2020	0.68	0.586
Manipur	71.8	77.8	11.6	8.9	13.6	12.8	1311	844	0.628	0.564	73.9	79.3	9.4	6.9	13.46	12.89	1435	905	0.621	0.555
Meghalaya	67.3	68	7.9	6.4	11.8	12.2	2127	1199	0.593	0.525	70.2	69.4	6.2	5.6	12.93	13.48	2343	1272	0.602	0.538
Mizoram	67.3	68	8.7	7.9	13	12.6	2359	1318	0.62	0.551	68.7	68.6	7.9	6.9	13.92	13.45	2644	1354	0.633	0.552
Nagaland	71.8	77.8	10.3	8.3	12.4	12.3	2677	1800	0.658	0.613	73.9	79.3	7.3	5.8	12.61	12.87	2885	1952	0.64	0.6
NCT of Delhi	68.2	72.3	9	6.1	13.4	13.2	8509	1366	0.706	0.557	70.8	74.1	9.4	7.2	14.33	14.12	9616	1450	0.738	0.588
Odisha	63.8	65.9	6	3.5	10.6	9.8	1669	709	0.53	0.425	67.3	69.4	6.3	3.9	11.11	10.83	1686	731	0.553	0.454
Puducherry	71.8	77.8	10	7.9	14.1	13.6	6262	1658	0.723	0.614	73.9	79.3	9.1	6.9	14.98	14.54	7682	1708	0.742	0.619
Punjab	69.1	73.4	7.3	5.4	12	12	3589	762	0.628	0.497	72	75.3	7.8	6.3	12.76	12.89	4015	637	0.659	0.505
Rajasthan	65.4	70	5.9	2.2	11.9	9.7	1815	1037	0.553	0.446	67.4	71.5	6.5	2.9	12.56	10.99	1921	1150	0.579	0.481
Sikkim	68.2	72.3	6.9	5.2	13	13.3	4589	2459	0.644	0.586	70.8	74.1	7.1	5.7	14.04	14.5	5234	2761	0.674	0.618
Tamil Nadu	68.2	72.3	7.1	5	13	12.6	3868	1683	0.637	0.553	70.8	74.1	7.8	5.9	14.05	13.72	4312	1758	0.672	0.584
Tripura	69.4	73.4	7.5	5.7	12.5	11.8	2713	1108	0.62	0.528	72	75	7.1	5.5	13.29	12.82	3312	1251	0.645	0.55
Uttar Pradesh	62.5	65.2	6.4	2.9	11.6	10.7	1337	372	0.525	0.372	65.1	66.7	6.9	3.6	12.49	12.39	1440	388	0.554	0.401
Uttarakhand	62.5	65.2	7.2	4.1	13.3	12.6	3547	1534	0.61	0.509	64.2	66.3	8.4	5.3	13.8	13.59	4054	1659	0.643	0.541
West Bengal	68.5	71.6	5.9	4.3	11	10.9	2403	683	0.575	0.46	70.2	72.7	6.5	4.6	11.85	12.04	2824	662	0.606	0.476
India	65.8	69.3	6.7	4	11.9	11.1	2622	1033	0.588	0.483	68.6	71.1	7.2	4.5	12.86	12.4	2785	1052	0.617	0.509