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Analysing Physical Infrastructure Disparity among Indian States: Evidence of Convergence?

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ABSTRACT

Disparities among countries in the world and among the regions of a particular country in terms of economic aspects of human life have remained a great issue for discussion in the economic literature. Different studies have shown that the neo-classical approach of convergence does not fit in the Indian context and there is growing disparity among Indian states in terms of per capita income/output. The researchers have explained various factors to this divergence and found infrastructure development as one of the important factors. In other words, this positive association between infrastructure and economic growth suggests that convergence/divergence of infrastructure facilities among Indian states may translate into convergence/divergence of economic growth among these states. So, this study tries to analyse the level disparity in Indian states in terms of physical infrastructure for the period of 2005 to 2019. With the help of coefficient of variance technique, the study has found that the states have been characterized by high level of dispersion in all dimensions of physical infrastructure *i.e.* road, railway, availability of power, telecommunication and irrigation facility. However, the trend analysis result shows that the disparity is reducing over the time suggesting the presence of σ-convergence among states in terms of physical infrastructure. The largest reduction of dispersion has been occurred in terms of teledensity followed by road, power availability and irrigation facility. On the other hand, the length of rail route has shown some sign of σ-divergence. Overall, the study suggests that government should try to pace up this convergence process in physical infrastructure as this convergence can contribute in reducing the growth related disparities among states.

Keywords: Infrastructure, Regional Disparity, Convergence, Indian states

INTRODUCTION

Disparities among countries in the world and among the regions of a particular country in terms of economic aspects of human life have remained a great issue for discussion in the economic literature. The government of countries like India which have some socialist approach towards the economic development, have to be much concerned about the balanced growth of different region of the country. To bring all sections of people and regions in the mainstream of country, not only in terms of per capita income but also in terms of overall socio-economic development, should be the primary objective of the government. The debate on disparities is associated with the debate on convergence and divergence of the economy. Based on the Solow model which states that due to diminishing return on capital per worker the economy with low initial base has tendency to grow faster that the economy with large initial base leading to convergence among economies if they all have same steady state of equilibrium, the debate started to begin on whether this tendency actually occurs across countries and across different regions of any particular country. With a dominance of about three decades in Growth Economics, the Solow model started to being criticized during 1980s by the new growth theorists on the empirical

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evidence of no convergence, leading to the emergence of endogenous growth model.

Over the time, Barro and Sala-i-Martin had modelized the concept of convergence describing two features of convergence – absolute or σ-convergence and relativeor β-convergence. The β-convergence is also characterized by two types – unconditional β-convergence and conditional β-convergence. In Solow model, unconditional β-convergence implies that with same production function, saving rate, population growth and technical progress, all economies will converge to the same steady state level of output. On the other hand, the concept of conditional β-convergence implies that if there is difference among economies on the level of any of the above conditions, then every economy will reach to its own steady state level of output. In other words, the growth rate is negatively associated with the initial level of output conditioning upon technological progress, saving behaviour etc. The absolute or σ-convergence is nothing but the reduction of overall dispersion among economies which can be measured in terms of standard deviation (SD) or coefficient of variance (CV). Here, one point could be noted that although β-convergence is necessary condition for σ-convergence, yet not sufficient. The reason is that while a higher growth rate in poor economies could lead them closer to rich ones, a small growth rate in rich economies (due to large initial base) might result in more dispersion among economies.

Most of the studies onó-convergence (or divergence) and β-convergence (or divergence) have been done either in terms of output or per capita income due to the theoretical framework provided by the Solow model and Endogenous Growth model. However, disparities in terms of other variables e.g. population characteristics, education or health related indicators and infrastructure facilities etc. are being analysed largely by use of σ-convergence (or divergence).

Since within a country the different regions or states are assumed to be homogenous in the context of production technique, saving behaviour and technological progress etc., they may have much more tendency of β-convergence than the cross-country evidence. Contrary to this, as we will see in the literature review section, Indian states have experienced divergence in terms of per capita income. This situation invited researchers to lay emphasize upon other factors that could explain this divergence. One of the most important factors that came into view, and as suggested by economic literature also, was infrastructure development. In Indian context, infrastructure development is positively associated with economic growth.

In light of the above discussion, it would be quite interesting to study the dispersion in infrastructure development among different Indian states. So, this study tries to analyse the physical infrastructure related disparity among Indian states for the period of 2005 to 2019. This paper is divided into five sections. This first section is about the introduction of the study. The second section is literature review followed by third section as data and methodology and forth as result and analysis. In section five we conclude the study.

Literature Review:

There is a lot of research that has been carried out in investigating the convergence or divergence across countries in the world and across regions in a particular country. Sala-i-Martin (1994) has reviewed some cross-sectional evidences and concluded that there is strong evidence of convergence in the regions of U.S., Japan, Germany, France and U.K. etc. In case of India, however, this situation does not hold true. The earlier studies, mostly of which were concerned for period 1960s to 1990s, have concluded that Indian states are diverging in terms of per capita income [Ghosh *et al.* (1998), Rao *et al*. (1999), Ahluwalia (2000) and Dasgupta *et al.* (2000) etc.]. However, Cashin and Sahay (1996) and Nagaraj *et al.* (1998) have found absolute convergence and conditional convergence, respectively. Similar results had been found during the previous decade. While Chitke (2011) and Sanga and Saban (2017) have found that there is divergence in Indian economy, Cherodian and Thirlwall (2015) have got some sign of weak conditional convergence for the period of 1999-2000 to 2010-11. What one can say on the basis of the results of these studies is that neoclassical framework about convergence doesn't fit to the Indian economy. The reason may be the more diverse nature of Indian society that pretend all of its region to be a homogenous economic unit.

Various studies have focused on particular variables to explain the growth differences among the states. Along with the nature of particular state economy, state government policies, population characteristics and trade opportunities etc., infrastructure facilities have come out to be one of the most important factors in determining the growth rate in different states. Several studies have pointed out the positive impact of infrastructure

development on growth of India and its states [Ghosh and De (2004), Sahoo and Dash (2009), Agarwalla (2011), Mohanty and Bhanumurthy (2019), Shameem and Rajeshwari (2023) etc.]. In other words, if the level of infrastructure among states has more dispersion over the time, then there would be increasing economic growth disparities in those states and *vice versa*. Along with this, some of these studies have emphasized that physical infrastructure is more important component than social and financial infrastructure.So, this study tries to analyse the disparities among Indian states in terms of physical infrastructure.

METHODOLOGY

As we have discussed that disparities of variables other than economic growth or per capita income can be analysed mainly by the concept of σ-convergence, this study incorporates the σ-convergence technique, that is the overall dispersion, to analyse the disparities of physical infrastructure among Indian states. We have used five main components of physical infrastructure – length of road (in per 100 km²), length of rail-route (in per 1000 km²), irrigation facility (percentage of net irrigate area to net sown area), per capita availability of power (in kwh) and telecommunication facility (in no. of telephone subscription per 100 persons). The data has been taken on road, rail-route, irrigation facility and power availability for the period of 2005 to 2019 for 21 major states[1]. Data on teledensity is collected for 17 states because there is no separate data on teledensity for Uttarakhand, Jharkhand, Chhattisgarh and Manipur. Data has been collected from RBI's Handbook of Statistics on Indian States. To analyse the σ-convergence (or divergence), we have used coefficient of variance (CV) technique of measuring dispersion calculated by

$$CV = \frac{\sigma}{x} x100$$

where, σ = standard deviation and x = mean of a particular type of physical infrastructure in the given year.

After that, to see whether a particular type of physical infrastructure is converging or diverging in absolute terms, a time trend of CV for the period 2005 to 2019 has been estimated by the following equation:

$$Y_t = \alpha + \beta t + u_t$$

If the estimated β coefficient is statistically not different from zero, then we may say that the dispersion among states on particular type of infrastructure has remained constant over the time. However, if β coefficient turns out to be statistically different from zero then the positive β coefficient will imply that there is σ-divergence which means that disparities among states is increasing. In similar way, a negative β coefficient means σ-convergence leading to the reduction of disparities among states. This type of analysis can have serious implication for India, provided the positive association between infrastructure development and economic growth.

RESULTS AND DISCUSSION

In post-liberalization period, India has witnessed a massive improvement in its economic growth process. Contrast to prior 1980s, the economy has succeeded to get rid of from the so-called Hindu growth rate and has gained the momentum of more than 5 per cent per annum of GDP growth rate. During 2000s, the growth has accelerated to an average 6.73 per cent per annum. Meanwhile, the per capita income (measured in per capita NNI) has grown with an average of 4.90 per cent per annum. This growth acceleration also demands the growth in infrastructure facilities for its further sustenance. Although the country has well performed in expanding its infrastructure facilities, yet it was felt that infrastructure investment was not sufficient to meet the requirement of the fast-growing economy. Besides, the equal distribution of this infrastructure development among states is subject to investigation.

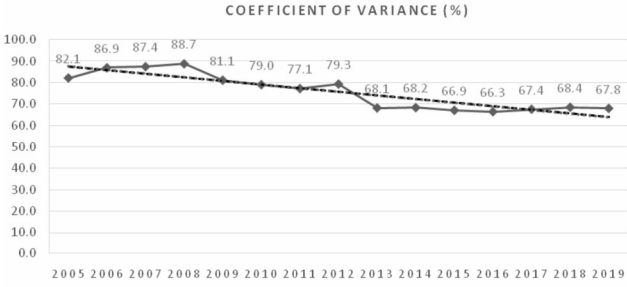
This section examines the level of disparities among Indian states in terms of physical infrastructure – roads, railways, power availability, teledensity and irrigation and the trends associated with these disparities.

Roads:

India, with its about 63 lakh kilometre length, accounts the world's second largest road network and has expanded its road network in recent decades. For instance, the total road length of India in 2005 was

1. These states are – Andhra Pradesh, Assam, Bihar, Chhattisgarh, Gujrat, Haryana, Himachal Pradesh, Jammu & Kashmir, Jharkhand, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Manipur, Odisha, Punjab, Rajasthan, Tamil Nadu, Uttarakhand, Uttar Pradesh, West Bengal.

29,62,463 km. (excluding JRY roads) which has increased to 54,31,757 km. in 2019. The state with highest road length in 2019 is Maharashtra followed by Uttar Pradesh, Assam, Madhya Pradesh and Karnataka. However, if we look in terms of road density (measured in per 100 km² area), Kerala is at the top followed by Assam, West Bengal, Bihar, Punjab and Tamil Nadu (Table A1 in the Appendix).



Author's Calculation

Fig. 1 : Road Infrastructure Disparity in India

Table 1 : Dependent Variable: CV_{Road}

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Constant	89.18239	2.078075	42.91587	0.0000
Time	-1.691616	0.228558	-7.401265	0.0000
R-squared 0.808199				

Author's calculation

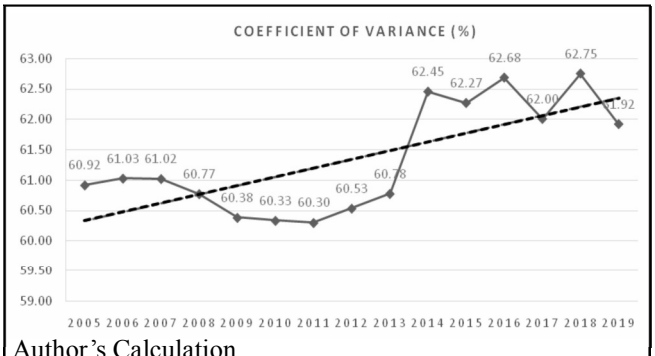
There is a large disparity among states in the context of road infrastructure. As it can be seen in Fig.1, during 2005 the coefficient of variance (CV) is about 82 per cent. In 2008, it had reached to the highest of the considered period of 88.7 per cent after that it starts declining to 67.8 per cent in 2019.

Although, there is high level of disparity among states in road infrastructure, the time series analysis presented in Table 1 shows that this disparity is reducing over time. The coefficient of time variable is significantly negative even at 1 per cent level of significance. This result points out that there is ó-convergence among Indian states in terms of road infrastructure during 2005 to 2019. It can also be understood with the growth rate of road length (in per 100 km²) in different states. The states e.g. Jammu & Kashmir, Jharkhand, Punjab, Himachal Pradesh and Maharashtra which were lagging behind from the average of 111 km in 2005 have achieved a significant growth of 12 per cent, 10.55 per cent, 8 per cent, 7.89 per cent and 7.31 per cent, respectively, compared to the average annual growth of 4.23 per cent of the 21 selected states (Table A1 in Appendix). On the other hand, some states which were in a better position with respect to the average e.g. Kerala (2.89%), West Bengal (2.51%) and Tamil Nadu (2.91%) have recorded comparatively smaller growth in road length. However, a value of 67 of CV in 2019 shows that there is a lot of work that has to be done for the further convergence in road infrastructure in India states.

Railways:

Railway is also an important part of physical infrastructure. Being common mode of transportation in India, it accounts world's fourth largest rail network with 68,103 km of rail route. The Indian Railway has been going out through various changes in recent years. Some changes and policy initiatives that have been taken place are – 96 percent electrification of the rail route, introduction of semi-high speed trains (Vande Bharat trains), plan for India's first bullet train (Mumbai-Ahmedabad High Speed Rail, MAHSR), two dedicated freight corridors (Western DFC and Eastern DFC) for connecting different region of the country and other policy initiatives such as re-innovation of various railway stations, coach modifications and solar system plantation for achieving the target of net zero by 2030 etc. But when we come to the inter-state comparison, there is lot of disparity among states in terms of rail route density (measured by length of rail routeper 1000 km² area).

As can be seen in Fig. 2, the coefficient of variance of rail infrastructure for 21 selected Indian states was 60.92 per cent in 2005. The CV has remained somewhat stable between 60 to 62 per cent during the considered period. The trend analysis shows that although the coefficient of time variable is significant at 5 per cent level, the value of coefficient is small but positive



Author's Calculation

Fig. 2 : Rail Infrastructure Disparities in India

Table 2 : Dependent Variable: CV_{Rail}

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Constant	60.19110	0.354539	169.7728	0.0000
Time	0.143847	0.038994	3.688946	0.0027
R-squared	0.511431			

Author's calculation

Table 3 : Dependent Variable: CV_{power}

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Constant	57.48107	0.629825	91.26511	0.0000
Time	-0.374229	0.069272	-5.402353	0.0001
R-squared	0.691837			

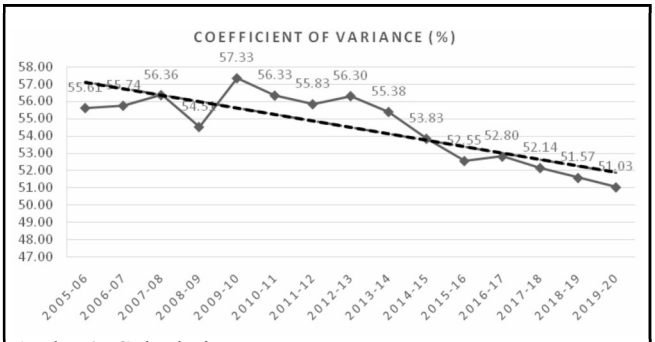
Author's calculation

suggesting a mild divergence among states in terms of rail infrastructure. The states such as West Bengal (47.66 km), Punjab (44.97 km), Haryana (38.52 km) and Bihar (39.51 km) have much higher rail route density than the average of selected 21 states (22.51 km) in 2019 (Table A2 in Appendix). On the other hand, hill area states such as Manipur, Jammu & Kashmir, Himachal Pradesh and Uttarakhand which (along with Chhattisgarh) have less than 10 km per 1000 km² of rail route.

Availability of Power:

Power or energy is one of the essential requirements to boost the economic activity of any country. India has made a considerable progress in the power sector since independence. With a total installed capacity of 1713 megawatts in 1950, India has expanded its generation capacity to 382 gigawatts in 2021. Besides, the per capita power consumption has also increased from 18 units to 1161 units in the same period. However, diversifying its power generation from non-renewable sources which accounts to more than 60 per cent of total generation to renewable sources has remained a great issue for India. Along with this, large differences among states regarding the availability of power is also a huge concern for states' economic growth. Fig. 3 shows the inter-state disparity associated with the per capita availability of power during 2005 to 2019. The figure shows that there is also a large difference among Indian states in terms of power availability as we can see that coefficient of variance is much higher to more than 50 per cent throughout the period.

However, the trend analysis shows a negative time trend coefficient of 0.37 which is significant even at 1 per cent level. The result makes us to conclude that although there is high level of disparity, yet the Indian states have been able to reduce this disparity over the time. So, the result implies that there is σ-convergence in India regarding the power availability during 2005 to



Author's Calculation

Fig. 3 : Inter-state Disparity in Per Capita Power Availability

2019. The state wise analysis confirms this convergence. While those states which have per capita availability of power much larger than the average of 580 kilowatt-hour of selected 21 states in 2005-06 such as Punjab (1338 kwh), Gujarat (1034 kwh), Maharashtra (868 kwh) and Tamil Nadu (863 kwh) etc. have recorded average annual growth rate less than the average annual growth of 4.33 per cent of all 21 selected states (Table A3 in Appendix). On the other hand, those states which were lagging behind such as Bihar, Assam, Uttar Pradesh, Madhya Pradesh and Rajasthan have scored a higher CAGR (compound annual growth rate) than the average CAGR of all the selected states.

Telecommunication:

As a key component of infrastructure, the evolution of India's telecom sector started during 1980s. After the technological development across world in telecommunication and economic reforms of 1991-92, the sector has experienced a great progress. Now India is world's second largest telecom market with a total of 1.72 billion subscriber base (wire and wireless) in 2023[2]. In recent years, the country has also increased its teledensity (number of telephone subscription per 100

2. https://www.investindia.gov.in/blogs/opportunities-indian-telecommunication-sector#:~:text=It%20has%20increased%20by%20nearly,85%2C356%20Cr%20(%2411.38%20Bn).

population) which has rose to 90 in 2019 from 9 in 2005 with an average growth of 17 per cent per annum.

The country has also well performed in reducing the inter-state disparity related to tele-services. Measured in terms of teledensity, Fig. 4 shows that there is a great improvement in disparity across Indian states.

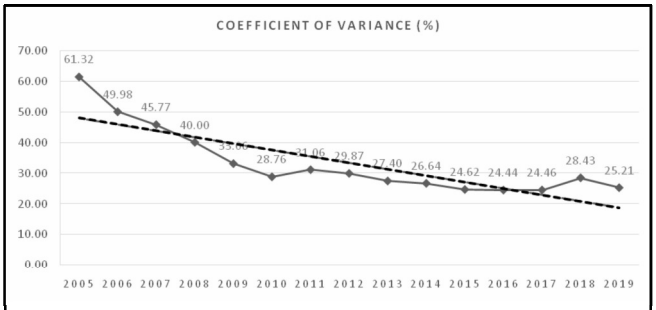
As we can see from the figure, there is a downward sloping trend line of coefficient of variance (CV) for teledensity (here, coefficient of variance is calculated for 17 states as there is no separate data on teledensity for Chhattisgarh, Jharkhand, Manipur and Uttarakhand since 2011 because the data of these states are included in the teledensity data of Madhya Pradesh, Bihar, Uttar Pradesh and North East-I, respectively). The time trend analysis suggest that coefficient of time variable is significantly negative with value of 2.08 even at 1 per cent level, confirming the σ-convergence in teledensity across states. The reduction in the value of CV from 61 in 2005 to 25 in 2019 have caused due to the higher growth achieved by Bihar (24%), Assam (24%), West Bengal (24%), Odisha (22%), Uttar Pradesh (21%), Jammu & Kashmir (21%), Madhya Pradesh (19%) and Rajasthan (19%) than the average annual growth of all 21states (17%) since these states were lagging behind from the average teledensity of all 21 states, that is, 9 per 100 population in 2005 (Table A4 in Appendix). However, these states are still lagging in 2019 such that the relative position of states has remained almost unchanged throughout the period.

Irrigation Facility:

Although the share of agriculture in India's GDP has been declining since independence, agriculture is still a prominent source of income and employment for rural population. The agriculture in India had been considered as the gamble of monsoon due the geographical conditions of its different regions and lack of irrigation facility. Since rural consumption is crucial for demand generation and, hence, output determination in Indian economy; a good irrigation facility for agriculture could have positive impact on sustaining the rural consumption, income and employment generation.

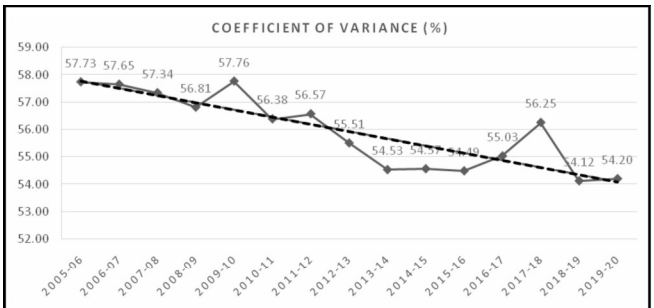
The present study analyses the level of irrigation facility (measured in percentage of net irrigated area to net sown area) as a part of physical infrastructure across the selected states. The Fig. 5 shows the level and trend of disparity associated with irrigation among states.

Fig. 5 shows that Indian states are also characterized by large disparity in terms of irrigation facility. Here it should be cleared that this type of disparity is much associated with the geographical conditions of states. While areas of Indo-Gangetic Plain have somewhat good irrigation facility, the southern, south-western and north-eastern hilly areas have not so (Table A5 in Appendix). The time trend analysis over the period, as shown in Table 5, reflects some sign of σ-convergence among states in terms of irrigation facility. The coefficient of time variable in this case is although negative and significant at 1 per cent level, yet the value of coefficient (0.26) is not much impressive. This has resulted in relatively small reduction



Author's Calculation

Fig. 4 : Inter-state Disparity in Teledensity



Author's Calculation

Fig. 5 : Inter-state Disparity in Irrigation Facility

Table 4 : Dependent Variable: $CV_{teledensity}$

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Constant	50.08889	3.312447	15.12142	0.0000
Time	-2.085964	0.364321	-5.725627	0.0001
R-squared	0.716051			

Author's calculation

Table 5 : Dependent Variable: $CV_{irrigation}$

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	58.03945	0.388892	149.2430	0.0000
T	-0.263682	0.042772	-6.164756	0.0000
R-squared	0.745119			

Author's calculation

in coefficient of variance (CV) barely from 57.73 in 2005-06 to 54.2 in 2019-20. So, despite the occurrence of σ-convergence, there is high level of disparity in irrigation facility across the states.

Conclusion:

To know why some economies grow faster than other economies and would these economies be equalize at any point of time, are some of the most debatable issues in Growth Economics. Based on neo-classical model of convergence, various studied have found convergence in the regions of developed countries. Contrast to this, the studies on Indian economy have suggested that the neo-classical model of convergence does not fit to the country since the regions of country are diverging over the time. Researchers have explained different factors for this divergence. One of those factors is identified as the inter-state disparity across states in terms of infrastructure facilities which have led to the economic growth differences among states.

In present study, we have deal with the physical infrastructure related disparity among 21 Indian states for the period of 2005 to 2019. The analysis has shown that the states have been characterized by high level of dispersion in all dimensions of physical infrastructure *i.e.* road, railway, availability of power, telecommunication and irrigation facility. However, the trend analysis result shows that the disparity is reducing over the time suggesting the presence of σ-convergence among states in terms of physical infrastructure. The largest reduction of dispersion has been occurred in terms of teledensity followed by road, power availability and irrigation facility. The length of rail route, although, has shown some sign of σ-divergence yet overall coefficient of variance was almost stable during the whole period. In short, the study has found the presence of σ-convergence in physical infrastructure for India. This result may have great implication for Indian economy as empirical evidences have shown a positive impact of infrastructure on economic growth. Consequently, convergence in physical infrastructure can contribute in reducing the growth related disparities among states. Hence, the study suggests that government should try to pace up this convergence process in physical infrastructure as different states are still struggling from low level, in one or other form, of infrastructure development.

Appendix

Table A1: Length of Total Road in Indian States (km per 100 km^2)

State/Union Territory	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Average Annual Growth Rate
ALL INDIA	90.12	91.69	94.91	96.57	108.65	112.02	115.30	120.63	131.78	136.97	139.09	143.08	152.03	161.71	165.24	4.12%
Kerala	436.19	481.56	508.08	526.87	516.24	517.02	517.77	554.35	476.11	497.80	501.39	516.71	619.00	661.52	668.84	2.89%
Assam	266.18	275.15	284.87	293.65	302.13	305.20	308.25	362.37	367.34	399.83	416.27	420.10	430.63	438.06	508.84	4.41%
West Bengal	220.48	224.28	234.83	238.61	326.94	328.79	337.13	355.38	348.94	353.51	333.51	356.87	362.88	370.84	319.84	2.51%
Odisha	138.17	138.22	138.27	138.34	147.16	149.98	166.23	163.58	178.32	181.86	182.20	185.02	195.03	197.79	196.29	2.37%
Tamil Nadu	135.48	137.90	139.03	139.33	144.58	146.13	147.89	177.00	183.00	195.46	200.76	200.71	201.01	207.61	208.47	2.91%
Bihar	127.39	127.57	127.57	127.57	132.07	135.97	138.74	147.10	209.47	222.76	218.78	219.28	222.54	308.58	316.69	6.26%
Andhra Pradesh@	119.77	122.52	123.26	125.44	84.45	85.69	86.53	93.24	95.13	109.28	109.85	106.99	108.28	133.88	108.21	-0.67%
Karnataka	109.71	111.69	132.38	133.19	143.33	146.07	146.92	158.05	159.26	163.29	167.79	180.15	188.25	184.84	186.82	3.61%
Uttar Pradesh	106.54	109.39	113.05	118.16	136.63	156.18	161.98	167.31	180.95	164.87	172.41	175.33	177.67	181.11	183.83	3.70%
Punjab	92.31	89.68	89.62	89.71	154.70	162.62	167.18	186.39	195.47	206.82	209.22	215.20	276.98	283.22	293.60	8.02%
Manipur	73.91	73.91	73.91	73.91	79.38	83.33	85.69	86.23	93.33	97.02	108.60	110.97	123.67	130.69	145.07	4.60%
Gujarat	73.16	73.86	74.29	74.80	78.32	79.39	79.68	83.23	84.50	91.35	92.99	91.39	92.30	102.92	127.22	3.76%
Maharashtra	71.80	71.64	72.52	72.57	129.80	132.16	133.41	128.91	191.62	197.81	197.63	199.35	202.78	203.61	206.97	7.31%
Uttarakhand	66.67	67.43	73.23	76.74	82.89	87.57	92.14	98.40	109.78	112.98	117.69	114.09	130.47	98.81	128.50	4.47%
Haryana	64.82	65.72	66.49	67.24	81.50	84.31	94.38	96.44	96.07	96.55	104.69	109.66	184.08	113.14	113.75	3.82%
Chhattisgarh	53.50	54.66	54.52	55.06	64.90	67.66	69.50	56.03	66.01	69.96	72.14	70.87	72.37	75.88	77.72	2.52%
Madhya Pradesh	53.18	53.46	53.66	53.77	60.31	61.61	64.00	65.29	74.23	90.83	93.73	94.06	111.16	118.08	118.42	5.48%
Rajasthan	43.76	44.54	46.72	50.11	63.56	65.25	70.51	72.64	66.07	70.49	72.51	74.30	77.61	91.57	91.59	5.05%
Himachal Pradesh	42.12	42.42	62.78	65.20	79.87	83.94	86.15	90.62	95.60	97.69	99.86	100.15	112.82	111.18	131.54	7.89%
Jharkhand	22.63	22.65	22.67	21.99	26.06	27.98	29.99	32.96	46.50	51.76	53.57	83.78	87.65	99.18	101.92	10.55%
Jammu & Kashmir	21.51	21.74	21.76	22.02	24.24	25.42	26.61	35.86	43.99	38.57	38.56	49.04	62.52	107.19	118.39	12.04%
Mean	111.39	114.76	119.69	122.11	136.15	139.63	143.37	152.92	160.08	167.17	169.72	174.95	192.37	200.94	207.26	4.23%
Std	91.46	99.72	104.63	108.36	110.38	110.28	110.57	121.20	108.94	114.03	113.61	115.97	129.75	137.37	140.62	
CV	82.11	86.89	87.41	88.74	81.07	78.98	77.12	79.26	68.05	68.21	66.94	66.29	67.45	68.36	67.84	

Source: Authors' Calculation from RBI Handbook of Statistics on Indian States.

Table A2: Length of Rail Route in Indian States (km per 1000 km^2)

State/Union Territory	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Average Annual Growth Rate
West Bengal	43.45	44.07	44.07	44.52	43.83	43.83	44.36	45.07	45.49	45.86	45.86	46.59	46.64	46.64	47.66	0.62%
Punjab	41.66	42.35	42.35	42.35	42.35	42.35	42.37	42.81	43.98	45.05	45.05	45.05	45.05	45.05	44.97	0.51%
Haryana	36.12	36.08	34.83	33.18	35.13	35.13	34.83	35.13	36.87	36.87	36.87	38.70	38.68	38.68	38.52	0.43%
Bihar	35.90	35.36	36.22	36.18	37.33	37.89	38.36	38.21	38.83	38.65	38.78	39.62	39.44	38.79	39.51	0.64%
Uttar Pradesh	35.47	35.47	35.59	35.50	36.12	36.22	36.37	36.53	36.66	37.02	37.15	37.68	38.05	42.85	36.62	0.21%
Tamil Nadu	32.07	32.07	31.69	31.76	31.58	31.22	31.23	30.32	30.96	30.96	30.96	30.96	30.97	30.99	30.99	-0.23%
Assam	31.95	29.12	29.12	29.12	29.12	31.02	31.03	31.35	31.35	31.46	31.50	31.15	31.11	31.43	32.11	0.03%
Kerala	27.02	27.02	27.02	27.02	27.02	27.02	27.02	27.02	27.02	27.02	27.02	26.89	26.89	26.89	26.89	-0.03%
Gujarat	26.96	26.95	27.08	27.18	27.18	25.50	26.89	26.82	26.82	26.83	26.83	26.83	26.83	26.96	27.14	0.05%
Andhra Pradesh	18.92	18.85	18.80	18.80	18.85	19.06	19.14	19.14	19.35	13.06	13.30	13.46	13.88	13.88	13.90	-2.04%
Maharashtra	17.96	17.96	17.94	17.99	18.21	18.21	18.21	18.21	18.60	18.60	18.60	18.67	18.80	18.63	18.91	0.34%
Rajasthan	17.06	17.06	17.27	16.61	17.11	16.89	16.90	17.01	17.16	17.15	17.23	17.22	17.22	17.32	17.35	0.11%
Madhya Pradesh	15.91	15.91	15.84	15.84	16.06	16.05	16.07	16.07	16.07	16.14	16.15	16.22	16.59	15.67	15.89	-0.01%
Karnataka	15.55	15.65	15.67	15.67	15.68	16.02	16.02	16.11	16.83	17.11	17.11	17.11	17.85	18.24	18.46	1.15%
Odisha	14.64	14.66	14.43	15.33	15.32	15.32	15.81	15.86	16.10	16.16	16.24	16.52	16.69	16.75	16.84	0.94%
Chhattisgarh	8.57	8.77	8.77	8.77	8.77	8.77	8.78	8.79	8.85	8.85	8.85	8.97	8.99	8.96	8.97	0.30%
Uttarakhand	6.45	6.45	6.45	6.45	6.45	6.45	6.45	6.45	6.45	6.45	6.45	6.36	6.36	6.38	6.38	-0.08%
Himachal Pradesh	5.12	5.12	5.12	5.12	5.12	5.32	5.32	5.32	5.32	5.32	5.32	5.32	5.32	5.32	5.60	0.61%
Jammu & Kashmir	1.36	1.36	1.36	1.61	2.36	2.52	2.52	2.52	2.52	2.69	2.94	2.94	2.94	2.94	2.94	5.27%
Manipur	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.58	0.58	0.58	18.65%
ALL INDIA	19.31	19.27	19.26	19.25	19.47	19.46	19.61	19.65	19.91	20.02	20.09	20.29	20.49	20.82	20.51	0.40%
Mean	21.61	21.52	21.48	21.45	21.68	21.74	21.89	21.94	22.26	22.07	22.11	22.31	22.44	22.65	22.51	0.27%
Std	13.16	13.13	13.11	13.04	13.09	13.12	13.20	13.28	13.53	13.78	13.77	13.99	13.92	14.21	13.94	
CV	60.92	61.03	61.02	60.77	60.38	60.33	60.30	60.53	60.78	62.45	62.27	62.68	62.00	62.75	61.92	

Source: Authors' Calculation from RBI Handbook of Statistics on Indian States.

Table A3: Per Capita Availability of Power in Indian States (kilowatt-hour)

State/Union Territory	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	Average Annual Growth Rate
Punjab	1338	1430	1593	1529	1618	1716	1581	1665	1700	1738	1793	1917	1979	1995	2048	2.88%
Gujarat	1035	1067	1137	1201	1327	1333	1233	1549	1465	1593	1715	1717	1821	1931	1890	4.10%
Haryana	1023	1094	1213	1259	1515	1543	1402	1507	1704	1831	1871	1929	2003	2117	2149	5.07%
Maharashtra	868	920	969	989	1048	1105	1048	1068	1101	1184	1258	1239	1331	1407	1381	3.14%
Tamil Nadu	863	969	1025	1029	1147	1203	1063	1056	1220	1286	1339	1448	1467	1515	1507	3.79%
Jammu & Kashmir	756	787	824	858	979	1004	868	921	971	1045	1119	1131	1199	1265	1317	3.76%
Himachal Pradesh	701	822	957	1027	1114	1212	1182	1275	1296	1273	1277	1280	1363	1403	1510	5.25%
Andhra Pradesh	687	765	807	875	968	1003	1006	971	1052	1140	1020	1099	1180	1289	1322	4.46%
Karnataka	650	756	742	768	796	882	884	933	950	980	997	1089	1108	1173	1191	4.12%
Chhattisgarh	602	632	644	695	516	488	572	666	736	831	991	928	1011	1021	1164	4.49%
Uttarakhand	590	660	806	915	982	1090	1009	1059	1136	1193	1253	1284	1327	1359	1421	6.04%
Rajasthan	547	561	630	662	762	794	721	785	846	952	979	983	1029	1161	1184	5.29%
Madhya Pradesh	524	544	592	577	580	640	570	610	680	731	859	906	963	1042	1044	4.70%
Kerala	426	462	480	489	540	558	583	611	631	663	695	727	746	746	787	4.17%
Odisha	408	456	503	549	569	610	541	580	585	621	634	638	684	758	700	3.67%
West Bengal	306	324	348	378	409	447	419	458	468	513	517	523	554	570	587	4.45%
Uttar Pradesh	265	291	309	327	358	390	361	383	409	436	466	530	593	582	606	5.67%
Manipur	226	198	231	220	199	233	183	200	201	249	298	271	304	333	341	2.79%
Jharkhand	144	154	165	190	201	222	183	205	213	224	229	240	235	257	268	4.26%
Assam	142	150	166	171	176	190	183	194	227	254	265	279	282	295	297	5.05%
Bihar	87	93	96	106	119	130	109	124	142	181	228	242	256	287	304	8.69%
ALL INDIA	563	607	648	672	726	766	709	751	793	852	901	938	978	1029	1043	4.20%
Mean	580	625	678	705	758	800	748	801	844	901	943	971	1021	1072	1096	4.33%
Std	323	349	382	384	435	450	417	451	468	485	496	513	532	553	559	
CV	56	56	56	55	57	56	56	56	55	54	53	53	52	52	51	

Source: RBI Handbook of Statistics on Indian States.

Table A4: Teledensity in Indian States (number of wired and wireless phones per 100 population)

State/Union Territory	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Annual Growth Rate
Punjab	21.90	27.60	37.10	47.90	58.30	75.40	104.10	113.10	103.00	107.22	103.79	106.10	118.28	123.45	125.35	12%
Kerala	18.80	25.50	33.50	45.30	58.50	80.40	100.00	106.60	96.09	96.19	95.41	102.33	114.75	121.61	126.15	14%
Himachal Pradesh	13.10	18.80	28.60	41.20	55.50	79.40	111.10	120.70	105.39	105.59	114.52	127.61	147.86	174.46	146.37	17%
Gujarat	12.70	17.00	24.10	33.60	45.20	58.50	81.90	91.10	87.23	90.54	95.61	100.06	113.71	112.45	107.21	15%
Karnataka	12.20	17.10	25.10	34.50	45.20	67.80	87.80	97.20	91.24	92.45	97.54	101.89	113.39	109.05	110.04	16%
Tamil Nadu	11.40	14.70	22.60	35.10	50.50	74.30	97.70	116.60	108.17	111.14	117.52	118.13	128.41	136.36	116.94	17%
Haryana	10.80	14.50	23.10	30.40	43.80	59.70	82.60	89.40	76.44	81.44	82.67	85.88	91.01	84.44	97.66	16%
Maharashtra	10.00	13.10	18.80	27.40	37.90	50.30	69.00	77.20	73.97	77.32	80.75	87.06	95.88	95.50	92.83	16%
Andhra Pradesh	9.50	13.50	19.60	28.30	39.60	57.20	74.40	80.90	77.19	79.52	84.15	86.40	97.18	97.21	97.55	17%
Rajasthan	6.10	9.70	15.50	23.70	37.20	52.80	65.40	73.00	70.85	75.39	77.76	83.36	92.02	87.83	85.34	19%
Madhya Pradesh	5.20	7.10	12.20	20.30	30.10	45.20	48.90	53.80	53.55	56.04	60.25	64.23	67.07	67.02	70.11	19%
Jammu & Kashmir	5.10	12.20	16.10	21.80	32.80	49.90	50.90	54.80	58.57	66.80	76.93	80.02	95.91	109.19	89.43	21%
Uttar Pradesh-(E&W)	4.10	6.90	10.80	16.20	24.90	38.50	53.00	60.90	56.83	57.27	60.51	65.83	74.03	71.36	68.63	21%
Odisha	4.00	7.60	9.50	15.00	23.30	39.30	56.40	65.80	60.21	60.90	66.85	69.09	80.74	80.28	75.74	22%
West Bengal	3.00	5.50	8.60	14.40	22.50	34.80	53.40	61.50	54.18	55.13	60.69	63.16	73.59	73.73	71.39	24%
Assam	2.80	5.70	9.70	14.70	20.70	30.00	39.00	46.60	46.51	48.74	53.95	57.64	66.97	76.87	68.81	24%
Bihar	2.40	5.30	7.30	12.60	22.20	38.00	42.30	48.90	45.72	46.10	51.20	54.36	60.99	63.16	59.95	24%
ALL INDIA	9.00	12.70	18.20	26.20	37.00	52.70	70.90	78.70	73.32	75.23	79.36	83.40	93.01	93.30	90.10	17%
Mean	9.01	13.05	18.95	27.20	38.13	54.79	71.64	79.89	74.42	76.93	81.18	85.48	95.99	99.06	94.68	17%
Std	5.52	6.52	8.67	10.88	12.61	15.76	22.26	23.86	20.39	20.49	19.99	20.89	23.48	28.17	23.87	
CV	61.32	49.98	45.77	40.00	33.06	28.76	31.06	29.87	27.40	26.64	24.62	24.44	24.46	28.43	25.21	

Source: RBI Handbook of Statistics on Indian States.

Table A5: Irrigation Facility in Indian States (per cent of net irrigated area to net sown area)

State/Union Territory	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Average Annual Growth Rate
Punjab	95.87	97.32	98.21	97.84	97.96	97.88	98.84	99.16	99.95	99.98	100.00	99.95	99.95	99.81	100.00	0.28%
Haryana	82.33	84.08	84.17	80.45	86.45	82.06	87.48	88.30	83.81	84.44	83.93	89.91	92.72	90.89	95.35	0.98%
Uttar Pradesh	78.61	80.33	79.70	81.12	80.67	81.00	83.07	84.09	84.78	86.69	86.41	86.56	86.64	87.02	87.57	0.72%
West Bengal	59.21	59.21	59.21	59.22	59.21	59.33	59.22	59.21	59.21	59.22	59.22	59.21	59.21	59.20	59.20	0.00%
Bihar	56.89	61.11	62.33	63.67	57.46	57.62	56.56	56.52	55.85	56.59	56.83	58.59	59.23	60.29	60.25	0.38%
Tamil Nadu	55.68	56.36	56.58	58.12	58.54	58.78	59.45	58.16	56.83	56.57	58.62	54.87	56.63	55.98	56.40	0.08%
Uttarakhand	44.66	45.10	45.17	45.09	45.86	46.47	47.48	47.88	46.79	47.14	47.28	47.61	48.89	49.85	49.69	0.71%
Jammu & Kashmir	42.51	41.64	41.96	42.49	43.13	43.85	42.76	43.62	43.59	42.88	47.21	44.39	44.15	46.14	42.78	0.04%
Andhra Pradesh	40.87	43.88	43.18	44.35	42.18	45.00	45.61	41.15	46.74	46.94	44.18	44.74	45.68	46.22	48.93	1.21%
Gujarat	40.19	43.24	42.47	42.88	44.33	41.09	44.84	44.84	44.84	46.08	48.16	48.61	48.92	51.86	53.52	1.93%
Madhya Pradesh	37.95	43.20	43.70	43.54	46.03	47.23	51.76	55.69	61.31	62.43	61.28	64.85	69.50	74.64	80.69	5.16%
Rajasthan	37.38	38.75	37.69	35.58	34.46	36.30	39.49	42.90	41.88	44.99	44.04	45.45	44.60	46.59	48.92	1.81%
Odisha	35.67	36.28	38.37	39.11	28.73	27.42	28.65	28.45	27.70	28.14	29.30	27.37	25.11	27.26	27.72	-1.67%
Karnataka	28.26	29.15	30.06	31.83	32.58	33.17	34.60	34.93	35.84	35.73	32.41	31.50	31.88	37.81	39.20	2.20%
Chhattisgarh	26.20	27.15	28.22	28.43	28.25	28.87	30.25	31.02	31.20	31.36	31.74	31.86	32.37	33.45	32.97	1.54%
Manipur	22.67	22.67	21.70	22.03	22.22	20.98	18.90	15.86	18.30	18.02	16.70	15.99	16.37	16.33	16.31	-2.17%
Himachal Pradesh	19.29	19.22	19.93	20.04	19.70	20.26	20.55	20.80	20.77	21.35	21.78	20.80	20.26	21.59	22.08	0.90%
Kerala	18.81	18.66	18.57	18.67	18.57	20.03	20.05	19.34	19.36	20.26	20.46	18.76	19.22	19.86	20.24	0.49%
Maharashtra	18.70	18.70	18.70	18.71	18.70	18.71	18.70	18.70	18.70	18.70	18.70	18.70	18.70	18.70	18.71	0.00%
Jharkhand	7.54	6.78	7.62	7.31	8.16	11.52	12.24	14.94	15.68	14.95	15.37	19.50	16.00	18.03	19.29	6.46%
Assam	5.09	5.09	5.09	4.98	7.01	5.76	5.73	11.43	10.74	10.47	10.60	13.05	13.11	13.44	15.75	7.83%
ALL INDIA	43.10	44.87	44.81	44.85	44.51	44.97	46.61	47.65	48.44	49.18	48.77	49.83	50.56	52.18	53.94	1.51%
Mean	40.69	41.81	42.03	42.17	41.92	42.06	43.15	43.67	43.99	44.43	44.49	44.87	45.20	46.43	47.41	1.02%
Std	23.49	24.10	24.10	23.95	24.21	23.72	24.41	24.24	23.99	24.24	24.24	24.69	25.43	25.13	25.70	
CV	57.73	57.65	57.34	56.81	57.76	56.38	56.57	55.51	54.53	54.57	54.49	55.03	56.25	54.12	54.20	

Source: Authors' Calculation from RBI Handbook of Statistics on Indian States.

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