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RESEARCH ARTICLE

DISPARITY IN TELECOMMUNICATION DEVELOPMENT ACROSS STATES IN INDIA

***,[1]Indrani Sengupta and [2]Dr. Pravat Kumar Kuri**

[1]Dr.B. C Roy Engineering College, Durgapur, India
[2]Department of Economics, The University Of Burdwan, India

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ABSTRACT

The present study covers 17 states and 1 union territory of India over the period 2000-14 to enquire into interstate disparity in tele-density and its evolution with time. The inequality trend and the nature of polarization across the states of India in terms of tele-density over the study period have been examined for the purpose. The study also delves into the possibility of sigma and absolute beta convergence of the states in terms of tele-density. The analysis is based on overall tele-density figures of the states as well as on figures segregated for the urban and rural areas of 17 states. Results show indication of decreasing trend in inequality across the states in terms of overall tele-density as well as for rural and urban tele-density. Esteban and Ray measure shows decrease in polarization when measured in terms of urban tele-density but for the overall tele-density and the rural tele-density a rise in polarization was observed during the study period. Further, study also gives a picture of sigma convergence and absolute beta convergence across states when tried on overall tele-density as well as rural and urban tele-density.

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INTRODUCTION

The telecommunication network in India is the second largest in the world, only next to China. India has moved a long way since the beginning of the phases of liberalization, regulatory evolution and technology upgradation, to achieve this end. It is now an accepted fact that the economic growth of a country is to a notable extent driven by this industry. There is a close relationship between a country's telecommunication infrastructure and economic development as the two are observed to go hand in hand. Expansion of telecommunication industry cannot happen without the proper environment ensured through a minimum level of economic development; while on the other hand, growth of an economy cannot be accelerated without the support of a good quality communication network. There exists a whole body of literature connecting telecommunication growth to economic development. To mention a few, Dutta A. (2003) studied the possibility of causality between telecommunications infrastructure and the level of economic activity as well as the direction of causality if any, based on 15 developing and 15 industrialized countries over the period 1970-1993. Roller, L. H and Waverman, L. (2001) have studied the ways in which telecommunication infrastructure may influence economic growth using data from 21 OECD countries over a period of 20 years from 1970 to 1990. Kateja A. and Jha D. (2008) have explored the relationship between telecommunication industry and economic growth in India using data from 1988 to 2007. Shiu A. and Lam P.L., (2008) have studied the causal relationship between telecommunications development and economic growth in China using dynamic panel data model covering 22 provinces of China over the period 1978-2004. Madden G. and Savage S. J., (1998) have investigated the relationship between economic growth, gross fixed investment and telecommunications infrastructure investment using data from 27 CEE transitional economies. Kaur K. and Malhotra N. (2014) focused on the causality between telecommunication development and GDP and its various sectoral components using time series data on India covering the period 1976-2012.

There is however a growing concern about the persistence of regional disparity in the penetration of telephones within the nation in spite of the best efforts put in by the Government to mitigate the gap by way of some forward looking telecom policies administered from time to time. The overall tele-density in India has shown an impressive growth surpassing the targets set in NTP 1994 and subsequently in NTP 1999, by a large margin. The tele-density of the country stood tall at 75.23 in end March, 2014. However the picture does not look that bright when we have a closer look into the state level performances. Data reveals that there is a wide disparity in the

****Corresponding author: Indrani Sengupta,***
Dr. B. C Roy Engineering College, Durgapur, India.

state-level tele-density figures. Yet another issue worthy of attention is the rural-urban digital divide. The Government of India has set up a Universal Service Obligation Fund (USOF) in June 2002 to give impetus to rural telephony - whose scope has been widened over the years to provide the rural and remote areas with subsidized telephone services. As a result of this effort, the rural tele-density by end March 2014 stood at 44.01, which is quite appealing. However, this figure is far behind the urban record of 145.46 achieved in the same year. Although both the figures have surpassed our expectations, it shows the urban tele-density has been about 3.3 times that of rural tele-density in that year, a fact which demands caution.

Importance of an enhanced telecommunication facility in the rural sector and in the less privileged states can be judged from the fact that growth of these areas in terms of income can only be speeded through the extensive use and spread of information technology in these regions (and in the country at large), which in turn requires well established telephone connectivity, as a pre-requisite. One silver lining in the sky in the midst of the cloud seems to be the growing importance of mobile telephony in the country, also in the rural areas. Our present study focuses on this aspect of inter-regional disparity in the tele-density development of the country. For this the state-wise co

mpound growth rates of tele-density have been computed. Further we made a note of the inequality and polarization trends in overall tele-density as well as in rural and urban tele-density figures across the states of India. Finally, the case of convergence in tele-density across the regions has been considered. The following are the objectives of the study:

Objectives

- To examine the extent of inequality and polarization in overall tele-density as well as in rural and urban tele-density across the states of India.
- To examine the possibility of convergence in overall tele-density as well as in rural and urban tele-density across the states of India.

Data sources and methodological Issues

For the study on overall tele-density, this study broadly covers 17 states and 1 Union Territory (Delhi) of the country. Data on state-wise tele-density during 2000-2014 has been taken from *Ministry of Statistical and Programme Implementation* (MOSPI). Some recalculation of tele-density has however been done in certain cases in order to bring uniformity in the dataset. Population projection figures reported by *Office of the Registrar General of India, Ministry of Home Affairs, Government of India* have been used for the purpose. For data on urban and rural tele-density *indiastat.com* has been referred. The empirical study has been broadly divided into 3 sections.

Estimation of growth: For the purpose of growth analysis the compound growth rates of overall tele-density and that of the urban and rural areas across the states of India are calculated for the entire period 2000-2014 and for the three sub-periods 2000-2005, 2005-2010 and 2010-2014. The compound growth rate formula used is

$$Y_t = Y_o (1 + r)^t$$

where Y_t and Y_o are the values of the indicator in the terminal year and the initial year respectively, for a particular state. 'r' is the compound rate of growth.

Measures of inequality and polarization

***Measures of inequality*:** For the inequality study the following measures of inequality are included which considers the population share of each state:

a. Lorenz Consistent Gini coefficient (GINI): This formula is derived from the Lorenz curve and is given by

$$GINI = 1/\mu \sum_{i=1}^{n}\sum_{j=1}^{n} f(y_i)\, f(y_j)\, |\, y_i - y_j\, |$$

y_i being the value of the indicator, $f(y_i)$ being the population share in state i and μ being the mean value of the indicator.

b. The Generalized Entropy (GE) set of measures which are also Lorenz consistent are presented below:

$$GE(2) = \sum_{i=1}^{n} f(y_i)[(y_i/\mu)^a - 1],\ a \neq 0,1$$

$$GE(1) = \sum_{i=1}^{n} f(y_i)(y_i/\mu)\log(y_i/\mu),\ a=1$$

$$GE(0) = \sum_{i=1}^{n} f(y_i)\log(\mu/y_i),\qquad a=0$$

The GE measures are sensitive to various parts of the distribution depending upon the value of a. y_i is the value of the indicator for state i, $f(y_i)$ is the population share of state i in total population, μ is the mean value of the indicator and n is the number of states. The study has calculated GE for a = 0, 1 & 2.

Polarization

Recent literature on inequality has focused on the distinction between inequality and polarization. An index of inequality highlights the distance of individuals from the global mean while overlooking clustering around local means. However, sometimes we observe 'disappearing middle class' and 'clustering around the extremes' of a distribution for a set of regions, defined, for example by states. In other words, there is an emergence of local means away from the global mean (Noorbakhsh, 2003). This phenomenon might be an evidence for development of polarization. There are some standard measures of polarization. The notable ones are the Esteban and Ray measure (1994), the Tsui and Wang measure (1998) and the Wolfson measure (1994 and 1997). We use the Esteban and Ray (1994) measure to verify generation or increase in polarization in the data. This index is based on two behavioral characteristics, namely, identification and alienation. In the level of individuals, identification of an individual increases the more the number of persons he can identify himself with, in terms of any chosen indicator. Alienation of an individual

from others in the group, on the other hand, is captured by the distance of the individual from others. The index is given by the following formula:

$$ER = A \sum_{i=1}^{n} \sum_{j=1}^{n} \pi_i \pi_j \pi_i^a | y_i - y_j |$$

where, in the state level study, n is the number of states, A is a normalization scalar, y_i is the value of the indicator for state i and π_i is the population size of state i. Here π_i^a is the identification function and $| y_i - y_j |$ is the alienation function with respect to each state. Polarization is then based on the product of the said two functions for each state, summed over all the states. The parameter a denotes the degree of polarization and its value lies between 0 and 1.6. The ER index is equivalent to the Gini coefficient when the value of a is assumed as 0. Higher the value assigned to a, higher is the weight given to polarization. We set the value of a to 1.5 for our study.

Convergence

Study on convergence necessarily involves two concepts: that of s- convergence and of β- convergence. There is said to be s-convergence when the dispersion of any measure of growth, across regions is found to decrease over time. β- convergence (absolute convergence) is said to occur when the poorer regions tend to grow at a faster rate than their richer counterparts and hence catch-up with them. In our study we attempt to find whether there has been any convergence in terms of tele-density across the states over the period under study using both the concepts. For s- convergence we have based our analysis on the coefficient of variation, which is the ratio of standard deviation to mean of the distribution, and the Gini Concentration coefficient. The latter is given by the formula:

$$GiniC = 2cov(y, r_y)/ N \bar{y}$$

$cov(y, r_y)$ being the covariance of the value of the indicator (y) and the rank of all the states (r_y) in terms of the indicator.

For testing absolute β- convergence we have used the cross section model of the form

$$g_{i,t,t-\tau} = [\ln(y_{i,t}) - \ln(y_{i,t-\tau})] /\tau = a + \beta \ln(y_{i,t-\tau}) + \varepsilon_{i,t}$$

where $g_{i,t,t-\tau}$ is the average growth rate of tele-density in the ith region between the period t and t-τ, $\ln(y_{i,t})$ and $\ln(y_{i,t-\tau})$ are the natural logarithms of the ith region's tele-density at times t and t-τ respectively, τ being the length of the time period considered. A negative value of the regression coefficient would imply absolute β- convergence, zero would mean no convergence and a positive value would indicate divergence.

RESULTS AND DISCUSSION

In the first phase, the compound growth rates of overall as well as rural and urban tele-density over the years have been computed for the states. In the second phase, analyses of the inequality trend and the degree of polarization across the states and across the rural and urban divide of every state have been attempted. In the third phase, the case of convergence has been verified.

Tele-density Growth Performance of the Indian States

We compute the compound growth rates of tele-density for the states/UT of India during 2000-2014 based on overall tele-density, urban and rural tele-density. Table 1 reports the values. For the overall tele-density we have considered 17 states and 1 Union Territory while for the urban and rural areas, growth rates have been computed only for the 17 states. From the table it is evident that the overall growth rate of tele-density for India has been quite impressive during the period 2000-2014. A bird's eye view shows that the states of Jammu & Kashmir, Bihar, Assam, Uttar Pradesh and Orissa were the first five fastest growing states during the period securing growth rates between 43.12% and 34.24%. Rajasthan, Haryana, Karnataka, Punjab, Madhya Pradesh, Andhra Pradesh, Kerala, Gujarat and Himachal Pradesh also registered good rates of growth during this period. The rest of the states showed moderate to slow growth rates. For a more detailed study on overall tele-density, the whole period has also been divided into three nearly equal sub-periods, 2000-2005, 2005-2010 and 2010-2014. During 2000-2005, Jammu & Kashmir, Punjab, Bihar, Kerala and Delhi registered good growth rates, ranging between 31.24% (Jammu & Kashmir) and 27.03% (Delhi), while Maharashtra (13.14%) and West Bengal (7.65%) were found to be the trailing states. Coming to the second sub-period (2005-2010), the growth rates of all the states have been found to increase significantly over the previous sub-period, excepting for Punjab whose growth rate has shown a drop. In this second sub-period, the highest growth rate in tele-density was achieved by Bihar (66.49%), followed by West Bengal (62.71%), Assam (60.80%), Orissa (58.25%), Jammu & Kashmir (57.87%) and Uttar Pradesh (55.28%). Comparatively low growth rates were registered by Delhi (27.63%), Punjab (28.02%) and Kerala (33.76%). However during the third sub-period, there has been surprisingly a huge drop in the overall growth rates of all the states.

The first place in this last sub-period was attained by Assam (12.91%), second place attained by Madhya Pradesh (12.26%), third place by West Bengal (12.21%) and the fourth by Orissa (11.57%). Looking to the figures on India for these three sub-periods we find that the growth rate in the third sub-period was least while it was highest during the second sub-period. To further analyze the tele-density growth in urban and rural areas of India, compound growth rates for urban and rural areas have been computed separately. The results have also been presented in table 1. For the urban and rural analysis 17 states have been considered. Delhi has been eliminated from this study. Due to non availability of data compound growth rates for rural and urban India could not be calculated. From the above table it can be further gathered that during the entire period (2000-2014), in terms of urban growth rates, Bihar, Madhya Pradesh, Orissa, Jammu & Kashmir, Uttar Pradesh and Rajasthan were the leading states followed by Andhra Pradesh, Kerala, West Bengal, Karnataka and Assam. On the other hand, Maharashtra, Punjab, Haryana and Tamil Nadu were the comparatively trailing states in terms of growth in tele-density in the urban areas. Dividing the entire period 2000-2014 into three sub-periods, namely 2000-2005, 2005-2010 and 2010-2014 bring out more useful facts.

Table 1. Compound Growth Rates of Overall and Area wise Tele-density Across States in India

States/UT	Whole period 2000-2014			2000-2005			2005-2010			2010-2014		
	Urban	Rural	Overall	Urban	Rural	Overall	Urban	Rural	Overall	Urban	Rural	Overall
Andhra Pradesh	24.28	31.26	29.98	28.99	18.80	24.81	38.08	59.06	43.27	4.02	16.96	8.57
Assam	22.53	44.43	37.29	17.94	25.79	21.36	41.95	96.53	60.80	6.94	16.79	12.91
Bihar	30.85	45.80	38.55	31.67	29.91	29.31	56.00	92.45	66.49	4.22	19.03	11.28
Gujarat	21.01	32.48	28.12	24.82	18.62	24.48	27.11	66.37	35.65	9.47	14.41	11.56
Haryana	19.72	34.23	31.72	24.12	23.62	26.37	28.45	69.67	40.69	4.80	11.00	8.07
Himachal Pradesh	21.69	27.22	30.98	26.77	20.70	24.88	34.25	50.56	43.33	2.25	10.06	7.40
Jammu & Kashmir	26.34	54.11	43.12	28.85	50.02	31.24	45.13	104.12	57.87	3.66	12.16	7.56
Karnataka	23.59	29.28	31.12	28.31	14.41	26.52	36.61	57.43	40.95	4.06	17.72	8.06
Kerala	24.22	21.84	29.14	37.51	19.18	27.37	32.71	35.60	33.76	0.73	9.56	4.60
Madhya Pradesh	29.01	29.42	30.53	35.55	-7.17	23.03	43.23	89.68	52.06	6.41	21.59	12.26
Maharashtra	17.47	41.80	19.49	16.02	43.55	13.14	27.11	66.00	38.11	8.11	14.68	11.35
Orissa	27.40	39.69	34.24	29.37	22.96	26.76	46.60	81.72	58.25	4.87	17.93	11.57
Punjab	19.23	29.74	30.76	30.20	23.17	31.08	20.22	51.48	28.02	5.72	14.06	9.19
Rajasthan	25.75	36.24	32.95	26.87	17.61	23.74	41.55	85.25	53.85	7.26	11.51	9.33
Tamil Nadu	19.52	43.98	25.81	15.18	44.04	20.26	37.87	68.64	45.57	4.71	18.10	10.59
Uttar Pradesh	25.92	44.27	34.72	26.86	22.07	25.50	43.59	100.07	55.28	5.88	18.15	11.26
West Bengal	24.17	40.70	22.39	18.53	25.10	7.65	46.78	85.12	62.71	6.76	15.66	12.21
Delhi	-	-	28.04	-	-	27.03	-	-	27.63	-	-	7.09
India	-	-	26.31	-	-	25.63	-	-	42.58	-	-	9.29

Source: Author's Calculation based on Urban, Rural and Overall Tele-density from 2000-2014

Table 2. Measures of Inequality in Overall Tele-density

Year	GINI	GE(0)	GE(1)	GE(2)
2000	0.7643	0.2607	0.2553	0.6389
2002	0.7383	0.2359	0.2462	0.6557
2004	0.7892	0.2727	0.2921	0.8495
2008	0.5453	0.1239	0.1370	0.3602
2012	0.3557	0.0526	0.0595	0.1472
2014	0.3468	0.0516	0.0581	0.1429

GINI: Lorenz Consistent Gini Coefficient;
GE: Generalized Entropy
Source: Author's Calculation

Table 3. Measures of Inequality in Tele-density for Rural and Urban Areas

Year	GE(1) (RURAL)	GE(1) (URBAN)	GE(2) (RURAL)	GE(2) (URBAN)
2001	0.413064	0.052321	1.192212	0.103304
2007	0.214791	0.020564	0.53484	0.043532
2011	0.046639	0.025846	0.098993	0.061978
2014	0.037183	0.010581	0.079023	0.022594

Source: Author's Calculation

It is clear from the table that substantive increase in the urban growth rates has been observed from the first sub-period to the second, for the states of Andhra Pradesh, Assam, Bihar, Jammu & Kashmir, Orissa, Rajasthan, Tamil Nadu, Uttar Pradesh and West Bengal. On the other hand, states like Punjab and Kerala have registered a decline in urban growth rates between the two sub-periods. However in the third sub-period, the urban growth rates of all the states have shown a drastic fall. Securing our attention on the rural sector we find that during the entire period under study, Jammu & Kashmir, Bihar, Assam, Uttar Pradesh, Tamil Nadu, Maharashtra and West Bengal were the front line states in the country in terms of growth rate of rural tele-density. Kerala registered the least growth rate in rural tele-density, standing at 21.84 during the period. A split of the entire period into the three sub-periods, 2000-2005, 2005-2010 and 2010-2014 was also tried. Interestingly it showed that Madhya Pradesh had registered a negative growth rate of -7.17 during the first sub-period but managed to bag a huge rise in growth rate in the second sub-period. In fact the data revealed that unlike the urban growth records, all the states have registered a huge rise in the growth rates of rural tele-density during the second sub-period, with Jammu & Kashmir and Uttar Pradesh even crossing 100. However in the third sub-period, this was reversed when all the states showed a marked fall in the growth rates.

Inequality Trends in Tele-density of Indian States

In order to measure the inequality trends in tele-density across the states, several measures of inequality have been computed. The inequality measures considered for the study are the Lorenz Consistent Gini Coefficient (GINI) and the Generalized Entropy (GE) set of measures for $a = 0, 1 \& 2$. The measures have been calculated for the alternate years. Table 2 compiles the results for overall tele-density. From the table it is gathered that all the measures of inequality have on the whole followed similar pattern with some slight differences. The Lorenz Consistent Gini coefficient (GINI) shows that compared to 2000 there was a reduction in inequality in 2002 across the states, which again increased in 2004. After 2004 there was a sharp decline in inequality across the states. This observation has been supported by the GE (0) and GE (1) set of measures

as well. However we find that the GE (2) measure have instead shown a different pattern from the rest of the measures, showing a constant rise in interstate inequality from 2000 to 2004, after which the inequality has rapidly decreased. The Lorenz Consistent Gini coefficient is seen to drop at a much faster rate than the GE measures suggesting that the sensitiveness of the two measures in different parts of the distribution are different.

Trend of Polarization in Tele-density

The standard measures of inequality fail to capture any clustering in a distribution and concentrates only on the interstate differences from the global mean. There might be, for example in a regional study, formation of clusters at the extremes of the distribution with a high intra-group homogeneity and yet a high inter-group heterogeneity and the situation getting worse over time (Noorbakhsh, 2003). This condition may arise even when inequality is found to decrease. The trend in polarization in our dimension of tele-density can be verified from Tables 4 and 5 below. In our study polarization is calculated using the ER measure, the value of the parameter a being set at as high as 1.5 so as to assign a large weight to polarization and enhance its distinction from the standard Gini coefficient measure.

Table 4. Esteban and Ray measure of Polarization

Year	ER
2000	0.057
2002	0.066
2004	0.112
2006	0.171
2008	0.315
2010	0.481
2012	0.637
2014	0.621

Source: Author's Calculation based on Overall Tele-density

It is clear from the above table that the polarization in the distribution has increased over the years with a mild drop in 2014 from the 2012 figure. The pace of increase was quite high till 2012. The overall picture shows evidence of polarization of overall tele-density in India, the degree of which has considerably increased over time. To delve further into the matter, polarization measures have been tried separately for the rural and urban areas as well. As presented in Table 5, we find that interestingly, polarization in urban area has witnessed a rise from 2001 to 2014 with some fluctuations in the intermediate years, whereas for the rural areas, a steady rise in polarization has been recorded during the period.

Convergence in Tele-density across States in India

According to the convergence theory, all regions tend to achieve their steady state level of growth over time and the farther is the region from its steady state value the faster is its speed of gravitation towards it. In the literature there are two concepts of convergence which is popular: the s- convergence and the (absolute) β- convergence. s- convergence of an indicator is said to occur when the dispersion of the indicator decreases over time. β- convergence, on the other hand, occurs when poorer regions tend to grow faster than the richer ones.

Table 5. Esteban and Ray measure of Polarization in Urban and Rural Areas

Year	ER (Urban)	ER (Rural)
2001	0.1119	2.22E-02
2007	0.249412	0.1058045
2011	0.8582879	0.3728551
2014	0.6256263	0.3820524

Source: Author's Calculation

s - Convergence

To look for any s- convergence in our problem of interest, we have computed the Coefficient of Variation (CV) and the Gini-concentration Coefficient (GiniC) for the years under study, in terms of overall tele-density. Table 6 presents the result.

Table 6. Measures of s- convergence in Overall Tele-density

Year	CV	GiniC
2000	1.186	-0.2626
2002	1.310	-0.2897
2004	1.536	-0.3239
2006	1.258	-0.2643
2008	0.959	-0.2084
2010	0.677	-0.1499
2012	0.599	-0.1359
2014	0.576	-0.1261

CV: Coefficient of Variation;
GiniC: Gini-concentration Coefficient
Source: Author's Calculation

From the table above, we find that considering only the magnitude of the GiniC, both the measures that are used to check for s-convergence demonstrate an increasing trend from 2000 to 2004. After 2004 the measures are found to decrease. Compiling the two we can infer that there has been an initial divergence in tele-density followed by convergence, post 2004, across the states/UT of India.

Table 7. Result of s-convergence for Rural and Urban Areas

Year	CV (Rural)	GiniC (Rural)	CV (Urban)	GiniC (Urban)
2001	1.759	-0.710	0.560	-0.231
2007	1.441	-0.499	0.519	-0.154
2011	0.772	-0.228	0.669	-0.203
2014	0.678	-0.194	0.586	-0.145

Source: Author's Calculation

Focusing on the s- convergence measures computed separately for the urban and rural areas, we find that the rural areas have registered a fall in both the measures of convergence indicating s-convergence. However for the urban area the picture is but the opposite. The CV measure indicates a mild degree of divergence on the whole for this area, though the GiniC measure indicates that there has been s-convergence with some fluctuations in the intermediate years.

Absolute β- convergence in Tele-density Across States in India

The possibility of β- convergence has been empirically tested using cross-sectional regression equation for annual average growth rates of tele-density regressed on the initial level of tele-density. The equation considered for analysis is of the form

$[\ln(y_{i,t}) - \ln(y_{i,t-\tau})] / \tau = a + \beta \ln(y_{i,t-\tau}) + \varepsilon_{i,t}$

the L.H.S being the average annual growth rate of tele-density of the ith state between the periods t and t-τ. τ is the length of time period. $\ln(y_{i,t})$ and $\ln(y_{i,t-\tau})$ are the natural logarithms of the ith state's tele-density at times t and t-τ respectively. A value of β in the range $-1<\beta<0$ implies convergence. Nearer the value of β to -1, the higher the speed of convergence and closer it is to zero, slower the speed of convergence. A value of 0 implies no convergence and a positive value implies divergence. The study has been done in three sections. In the first section the whole period (2000-2014) has been considered. In the second and third sections the periods (2000-2007) and (2007-2014) have been considered to compare the changes in the convergence pattern. For all the regressions robust standard errors have been estimated. Figures in the parentheses indicate the robust standard errors.

Table 8. Growth Regressions on Overall Tele-density for three Periods

Period	a	β	t-value (β)	p-value (β)	R^2
2000-2014	0.279484(0.00397324)	-0.0393890 (0.00433659)	-9.083	<0.00001 ***	0.899513
2000-2007	0.304279(0.0123816)	-0.0341897(0.00999609)	-3.420	0.00351 ***	0.397291
2007-2014	0.386304(0.0187821)	-0.0609478(0.00681960)	-8.937	<0.00001 ***	0.880859

*** indicates significant at 1% level
Source: Author's Computation

Table 9. Urban Growth Regressions on Tele-density for three Periods

Period	a	β	t-value (β)	p-value (β)	R^2
2000-2014	0.320461(0.0226121)	-0.0531244(0.0122569)	-4.334	0.00059 ***	0.738943
2000-2007	0.426580(0.0219705)	-0.0825076(0.0120109)	-6.869	<0.00001 ***	0.679382
2007-2014	0.393188(0.129253)	-0.0590672(0.0345419)	-1.710	0.10786	0.282919

*** indicates significant at 1% level
Source: Author's Computation

Table 10. Rural Growth Regressions on Tele-density for three Periods

Period	a	β	t-value (β)	p-value (β)	R^2
2000-2014	0.283926(0.00404877)	-0.0575314(0.00324446)	-17.732	<0.00001 ***	0.935216
2000-2007	0.308344(0.0158498)	-0.0610127(0.0165686)	-3.682	0.00222 ***	0.497662
2007-2014	0.451871(0.00577173)	-0.0883464(0.00406504)	-21.733	<0.00001 ***	0.959855

*** indicates significant at 1% level
Source: Author's Computation

From the table above, we get a clear picture of β-convergence for the overall tele-density figures for all the three periods since all the β coefficients are negative, although the speed of convergence is low. The p-values indicate that the β coefficients are quite significant in all the three cases. The R^2 is also high for the first and the third regressions though for the second the value is low. Thus it can be inferred from the above convergence analysis that although the differences in tele-density are wide across the states but this difference will lessen given a sufficient period of time. Test for absolute β-convergence have also been tried for the urban and rural areas separately across the 17 states of the country. Delhi had to be excluded from this analysis on rural and urban areas. Table 9 below shows the result of the regression fitted to urban data on tele-density for the purpose. The case of absolute β-convergence is very much evident from the table. For all the three periods the value of β coefficient is negative although the magnitude is small, indicating that the speed of convergence is low. For the period 2007-2014, the value of R^2 is very low for the regression fitted. Further, for this period, the value of the slope coefficient is also not significant, when considered robust standard error. Referring to Table 10 we find evidence of absolute β- convergence for all the three periods for the rural areas as well. The magnitude of the slope coefficient is however low indicating that for the rural sector as well the speed of convergence is low. The value of R^2 for all the three cases is quite satisfactory. Combining the above results reveal that there is a clear sign of absolute β-convergence in tele-density across the states of India. The results also indicate that in general the tele-density of the poorer states in India is growing at a faster rate than that of the richer states, although the speed of convergence is slow. Our convergence analysis thus finds evidence of σ-convergence as well as of absolute β-convergence across states in India in terms of overall tele-density and also separately in terms of urban and rural tele-density.

Gathering the two facts it can be perhaps said that in the long run the digital divide across the states will be resolved but attention should be paid on the rural-urban digital divide, a fact which has been repeatedly pointed out in various reports. Although the study has revealed that the compound growth rates in the rural areas have been on the whole more than that in the urban areas, this does not put an end to the worry. The Government must take steps to resolve this problem, and if need be, additional resources should be procured and schemes should be introduced for further betterment of wireless connection in this region.

Conclusion

This chapter focuses on the regional disparity in the penetration of tele-density in India. The study broadly covers the time period 2000-2014 and has been basically classified into 3 stages. In the first stage the compound growth rates have been analyzed on the basis of overall tele-density and the rural and urban tele-density. In the second stage inequality trend in

tele-density and the extent of polarization in tele-density across the states have been analyzed. In the third stage the case of convergence in tele-density across states based on the overall tele-density and the rural and urban tele-density have been tried. When considering the compound growth rates in overall tele-density during 2000-2014, states of Jammu & Kashmir, Bihar, Assam, Uttar Pradesh and Orissa were found to be the first five fastest growing states. Splitting the period into three sub-periods revealed that during (2000-2005), Jammu & Kashmir, Punjab, Bihar, Kerala and Delhi were the forefront states in terms of growth, while during the second sub-period (2005-2010), Bihar, West Bengal, Assam, Orissa, Jammu & Kashmir and Uttar Pradesh were the forerunner states in terms of growth. A point worth mentioning is that the growth rates in the second sub-period were much higher than in the first sub-period, excepting for Punjab whose performance has shown a decline in the second sub-period. In the third sub-period (2010-2014), a huge reduction in the growth rates for all the states was observed. Shifting our attention towards the urban tele-density, it was observed that during (2000-2014), Bihar, Madhya Pradesh, Orissa, Jammu & Kashmir, Uttar Pradesh and Rajasthan were the leading states whereas Maharashtra, Punjab, Haryana and Tamil Nadu had taken the backseat. Dividing the study period into the aforesaid three sub-periods reveals that there has been a substantive increase in the growth rates from the first sub-period to the second for the states of Andhra Pradesh, Assam, Bihar, Jammu & Kashmir, Orissa, Rajasthan, Tamil Nadu, Uttar Pradesh and West Bengal. On the other hand a decline in the growth rates was observed for Punjab and Kerala. There was a drastic fall in the growth rates in the third sub-period for all the states. Fixing our attention on rural tele-density we find that during (2000-2014), Jammu & Kashmir, Bihar, Assam, Uttar Pradesh, Tamil Nadu, Maharashtra and West Bengal occupied the front seat. Splitting the period into the three mentioned sub-periods revealed that there was a huge gain in the growth rates of all the states from the first sub-period to the second. Madhya Pradesh in fact recorded a huge jump in the growth rate from a negative figure in the first sub-period to a value close to 90 in the second sub-period. The third sub-period however witnessed a marked decline in the growth rates of all the states. Coming to the inequality measures, the overall tele-density figures has been found to show a gross decreasing trend over the period under consideration using the GE set of measures with some minor fluctuations in between. To check for the possibility of convergence in tele-density the concept of s-convergence and absolute β-convergence were tried. For s-convergence the CV and the GiniC measures have been computed. Analysis for s-convergence based on overall tele-density revealed that till 2004 there was a tendency towards divergence but post 2004 the values of the measures were found to decrease. While rural sector showed signs of s-convergence in tele-density using both the measures, the urban sector showed two opposing results. Using the CV measure we get a picture of s-divergence whereas using the GiniC measure we get a picture of s- convergence on the whole. For an absolute β-convergence test data periods (2000-2014), (2000-2007) and (2007-2014) were considered. Interestingly, for the overall, rural and urban tele-density absolute β-convergence across states was observed. Analysis also reveals a digital divide across the states and across the rural-urban areas. While the divide across the states may be diminished over time given the evidence of absolute β-convergence across states, the divide between urban and the rural areas is raising eyebrows. Effort should be made to reduce this divide, if need be through mobilization of additional resources in the rural areas to better the supporting infrastructure for the purpose and announcement of schemes to offer the services at a cheaper cost to the rural mass.

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