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Performance of Telecommunications in India: Panel Arellano-Bond GMM Estimation of Teledensity

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Abstract

The growth of telecommunications infrastructure and its performance is at the heart of the digital economy, essential for information and citizen-centric services. Though India has made rapid strides in the provision of the telecommunications network, the teledensity is uneven across the states of India. This paper analyses the determinants of teledensity and its distribution dynamics across 18 Indian states over 15 years between 2004 and 2018 using kernel density plots and the dynamic panel fixed effects Arellano-Bond GMM estimation technique. The AB-GMM estimates show the network externality, NSDP per capita, service sector share in NSDP and literacy rate are the important determinants of relative teledensity across the states of India. The kernel density plots indicate a gradual reduction and convergence of teledensity across states over the years. The half-life estimate suggests that the speed of convergence is 1.13 years i.e it takes 1.13 years to converge in teledensity across the states of India.

Keywords: Telecommunications, Teledensity, Convergence, Kernel Plots, Arellano-Bond GMM Estimation

JEL classification: B23, C14, C23, L96, O14

Introduction

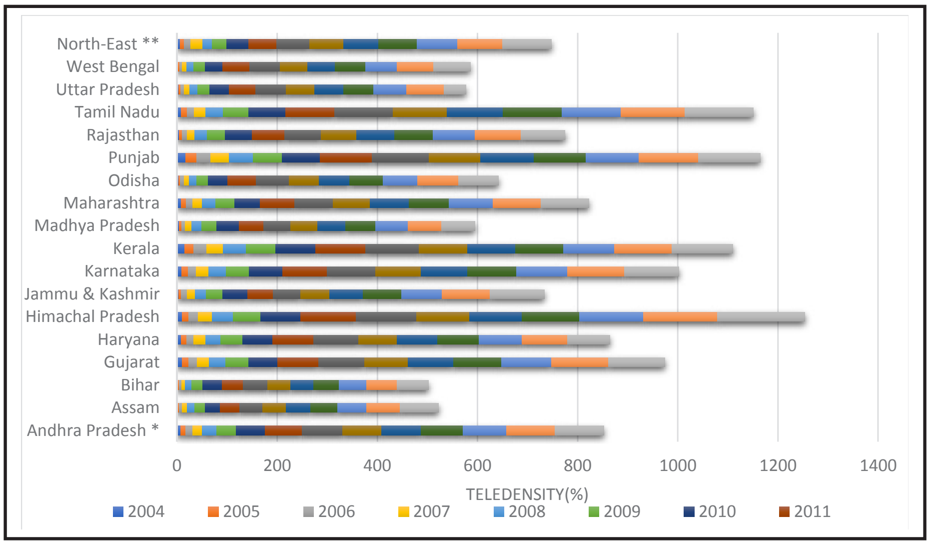
Among the essential infrastructure in any economy, telecommunications is the lifeline of an economy and in fact, a base of the modern quality of human life. Within the service sector, telecommunications is the most important and fast-growing segment. The significance of information and communications technology (ICT) for economic growth, particularly telecommunications, is well recognized in the literature and research studies. Telecommunications infrastructure investment and the derived services provide significant benefits, and their presence enhances the productivity of productive units (Roller & Waverman, 2001). The telecommunications infrastructure is not the same as other types of infrastructure, such as economic and social overheads. The major difference between telecommunications technology with other infrastructure lies in its networks structure and the externality arising out of the networks. Telecommunications networks provide not only more values to the users but also the values increase with more and more uses and users. The ability to communicate at will increases the ability of firms to engage in new productive activities as the information intensity of the production process increases. However, Sridhar and Sridhar (2007) points out that the impact of telecommunications infrastructure on economic growth in developing countries is less significant than in developed economies.

The size, growth, utilisation and performance of telecommunications infrastructure are generally assessed in terms of teledensity, the number of subscribers per 100 people. In India, the teledensity has increased from less than 1 percent in 1994 to more than 90 percent by 2017. As of 2017, there are 1204.98 million telecom subscribers, consisting of 697.06 million (58 percent) urban users and 507.92 million rural subscribers. In urban India, teledensity is 172.28 and 57.55 in rural India. The Indian telecommunications sector is the second largest in the world in terms of the number of subscribers (TRAI, 2008; Yadav et al., 2015). It has registered an annual growth rate of about 20 percent. The telecommunications sector has been contributing to GDP and job opportunities at large in the Indian economy. In 2017, about 3 percent of Indian GDP is from the telecommunications sector. The telecommunications sector reforms and developments in India have been an unambiguous success from a macro and temporal perspective. The Indian telecommunications sector has emerged as the emerging sector and witnessed exponential growth since the 1990s.

Telecommunications in India was once considered a natural monopoly, and the post-1990 structural reforms and liberalization policies introduced privatization and encouraged competition in the provision of telecommunications services. The National Telecom Policy (NTP) of 1994 set the stage for private sector entry and in 1997 the Telecom Regulatory Authority of India (TRAI), an independent regulatory body, was established in India. The accompanied technical developments in the telecommunications infrastructure in India has made possible telecommunications services at affordable prices even to the end-users. Such dramatic progress in telecommunications services has made possible the provision of knowledge based services easier. This great competitive advantage of India has been recognized globally as most multinational telecommunications firms have a presence or service utilization originating in India. Since the telecommunications services for business is of recent origin, the industry is largely dominated by private firms in India. The private sector telecommunications services play a major role and have witnessed impressive growth in the Indian telecommunications sector in recent years. Subsequent National Telecom Policies of 1999, 20,12 and 2018 place the telecommunications sector in the heart of the digital India program, enabling data and citizen-centric services.

Despite having a pan-India telecommunications policy and impressive effects of the telecommunications sector on economic growth not only at the national level but also in the states, the expansion and utilization of telecommunications services have not been the same in the states and there exist a wide gap in teledensity across states of India. Compared with other developed economies, the growth of the teledensity of India varies widely and there exists a wide disparity in teledensity between the states in India (Barman et al., 2018). The disparity in teledensity among the Indian states is sometimes attributed to the frequent failure in telephone services and its effect on economic performance (Ghosh & Prasad, 2012). Fig. 1 presents an overview of the teledensity across Indian states between 2004 and 2018, indicating the disparity in teledensity across states of India. While Himachal Pradesh, Tamil Nadu, Punjab and Kerala are the few states which have performed well in terms of teledensity, Bihar, Assam, West Bengal, Uttar Pradesh, and Madhya Pradesh are the states which did not perform well in terms of teledensity.

Studies on the role and contribution of the telecommunications infrastructure to economic development largely focus on the aggregate effects at the national or cross-country levels. Studies that examine the causes and consequences of regional disparities in teledensity are rare. It has been pointed out that developing countries have a less significant effect of telecommunications on economic activity because the critical mass or the threshold level has not been achieved (Sridhar & Sridhar, 2007). A state-level study by Barman et al. (2018) analysing the telecommunications divide among 16 major states has not taken into account two important states viz. Tamil Nadu and West Bengal where telecommunications play an important role due to the existence of metropolitan cities in these states.



Note: Telesensity is the total number of mobile and landline subscribers per 100 inhabitants. * Including Telangana. ** Including all states in North-East India.
Source: Department of Telecommunications, Government of India.

Fig. 1: Teledensity in States of India

Hence, this paper tries to understand the reason behind the disparity in teledensity that exists across Indian states. The main objectives of this paper are to understand the dynamics of telecommunications distribution and the determinants of teledensity in 18 Indian states during the 15 years between 2004 and 2018. The panel data are sourced from the Government of India Department of Telecommunications (DoT) and the Reserve Bank of India Handbook of Statistics on the Indian Economy. The variables used are teledensity, NSDP per capita, service sector share in NSDP, electricity consumption and literacy rates of states of India. In the econometric estimation, this paper uses the parametric unit root test to test the stationarity property of relative teledensity and nonparametric kernel density distribution dynamics to determine the distribution of relative teledensity. The determinants of teledensity are estimated by a dynamic panel fixed effects Arellano-Bond GMM method.

Review of Literature

Datta and Agarwal (2004) analyze the impact of telecommunications investment on economic growth and the convergence hypothesis in 22 OECD countries. The results of the dynamic fixed effects estimation indicate that there exists a strong relationship between macro variables and economic growth, and the countries at an earlier stage of development are likely to gain the most from investing in telecommunications implying that telecommunications investments are subject to diminishing returns.

Roller and Waverman (2001) examine the impact of telecommunications infrastructure on economic development in 21 OECD countries over a period of 20 years from 1970 to 1990. They find significant two-way causation between economic growth and investments in telecommunications. Further, the existence of network externality is analyzed using a nonlinear function and the results show that an increase in telecommunications infrastructure could create higher growth effects.

Koutroumpis (2009) studied the impact of broadband on economic growth in 22 OECD countries for the period 200-2007. They find an increasing return to broadband telecommunications investments and persistent network effects. They also find that the broadband infrastructure investment critical mass is at 30 percent, implying that about half of the population has broadband access. The returns to broadband connection are higher in the Scandinavian countries due to their higher use.

Sridhar and Sridhar (2007) analyze the impact of landline and cell phone penetration on economic development to examine the relationship between telecommunications infrastructure investment and economic growth in developing countries. The 3SLS results show that the penetration of landline and cell phone connections affect economic growth significantly. However, the low penetration relative to the penetration in OECD countries dissipates the convergence hypothesis. They also find that the demand for landline connections is related to the traditional economic factors, but not the cell phone demands.

Zahra et al. (2009) examine the impact of telecommunications infrastructure development and economic growth for 24 low income, middle income, and high-income countries over a period of 18 years using a Solow type equation and convergence hypothesis. The fixed effects and random effects results show that the macro variables are significantly related to economic growth. There exist increasing returns to scale in telecommunications investment and a convergence.

In the Indian context, Ghosh and Prasad (2012) examine the impact of telephone penetration on the economic growth of India over 26 years from 1980-1981 to 2006-2007 using annual data and employing cointegration and Granger causality tests. The cointegration test shows no long-term relationship between the macro variables used. The failure of the cointegrating relationship is attributed to the fact that India has not reached the critical mass of users to have any impact because of the social disparity across and within states. The Granger causality test indicates unidirectional causation from telephone connectivity to growth in the short run. The impulse response function result shows that the positive response of GDP to innovations in telephone services and the initial level is restored with a four-year gap.

Barman et al. (2018) analyze the telecommunications divide among 16 major Indian states and the impact of telecommunications on the service sector by analyzing the pattern, distribution dynamics, and drivers of teledensity for a period of 15 years. The kernel density distribution dynamics indicate a convergence of teledensity across Indian states. However, the Markov transition probability matrix of the evolution of the distribution dynamics of teledensity over time shows a slow speed of convergence. The Arellano and Bond panel GMM estimates show that NSDP and the lagged teledensity have a significant impact on teledensity across Indian states. The study finds convergence in teledensity in rural areas but not in urban areas. Further sensitivity diagnostics show the robustness of the baseline model wherein the effect of NSDP and lagged teledensity on teledensity remains positive and statistically significant.

Data and Methodology

This paper uses the annual data on teledensity, NSDP per capita, literacy rate, service sector share in NSDP, and electricity consumption for 18 Indian states for 15 years from 2004 and 2018. The data is obtained from the Government of India Department of Telecommunications (DoT) and the Reserve Bank of India Handbook of Statistics on the Indian Economy. The per capita NSDP is for the 2011-12 base year. As the service sector is important not only for economic growth but also for telecommunications services growth, the service sector share in NSDP has been included. Teledensity is defined as the total number of mobile and landline subscribers per 100 inhabitants. Teledensity is considered an indicator of telecommunications penetration in the country. Following Barman et al. (2018), the relative teledensity is defined as:

$$Relative\ teledensity_{it} = Teledensity_{it} - \overline{Teledensity_t} \quad (1)$$

where the relative teledensity in the *i*-th state at time *t* is the difference between the state teledensity and the average national teledensity.

Parametric Panel Unit Root Test

Since the data are time series, parametric panel unit root tests are used to test the stationarity of the series. The usual panel unit root tests are the Levin, Lin and Chu (2002), Im, Pesaran and Shin (2003) and Pesaran (2007) unit root tests that test the stationarity of relative teledensity.

Levin, Lin and Chu (LLC) Test: If the deviations from equilibrium are persistent, the panel unit root test is more powerful than the individual cross section unit root tests. The LLC unit root test can be specified as:

$$\Delta y_{it} = \rho y_{it-1} + \sum_{j=1}^{p_i} \delta_{ij} y_{it-j} + \alpha_i x_{it} + \varepsilon_{it} \quad (2)$$

where y_{it} is the relative teledensity in state i at time t, x_{it} is a vector of deterministic variables and α_i are the corresponding vector of coefficients. To overcome the problem of unknown lag order p_i, the LLC test is implemented with three steps. The first step is the Augmented Dickey-Fuller (ADF) test for individual cross-sections with varying lag orders across individual states:

$$\Delta y_{it} = \rho y_{it-1} + \sum_{j=1}^{p_i} \delta_{ij} y_{it-j} + \alpha_i x_{it} + \varepsilon_{it} \quad (3)$$

Given T, the maximum autoregression order (lag) order p^{max} is chosen. However, since p_i is not known, two auxiliary ADF regressions are run to get orthogonalised residuals:

Δy_{it} on Δy_{it-j} (j=1,2,3…,p_i) and x_{it} obtain residuals $\hat{e}_{it}$ (4)

$\Delta y_{i,t-1}$ on Δy_{it-j} (j=1,2,3…,p_i) and x_{it} and obtain residuals $\hat{v}_{it-1}$ (5)

These residuals are then standardised to control for individual state heterogeneity. Normalising $\hat{e}_{it}$ and $\hat{v}_{it-1}$ by the regression standard error:

$$\tilde{e}_{it} = \frac{\hat{e}_{it}}{\hat{\sigma}_{\varepsilon i}} \text{ and } \tilde{v}_{it-1} = \frac{\hat{v}_{it-1}}{\hat{e}_{\varepsilon i}} \quad (6)$$

$$\text{Or} \quad \hat{\sigma}^2_{\varepsilon i} = \frac{1}{T-p_i-1}\sum_{t=p_i-2}^{T}(\hat{e}_{it} - \hat{\rho}_i \hat{v}_{it-1})^2 \quad (7)$$

where $\hat{\sigma}_{\varepsilon i}$ is the standard error from each ADF cross section regression.

Under the null hypothesis of a unit root, the long-run variance is estimated by:

$$\hat{\sigma}^2_{yi} = \frac{1}{T-1}\sum_{t=2}^{T}\Delta y^2_{it} + 2\sum_{j=1}^{k}\omega_{kj}\left[\frac{1}{T-1}\sum_{t=2+j}^{T}\Delta y_{it}\Delta y_{it-j}\right] \quad (8)$$

where k is a data-dependent truncation lag that ensures the consistency of $\hat{\sigma}^2_{yi}$ and $\omega_{kj}\left(= 1 - \frac{j}{k+1}\right)$ is a Bartlett kernel. For each cross-section i, an estimate of the ratio of the long run to short-run innovation standard deviation is obtained as:

$$\hat{s}_i = \frac{\hat{\sigma}_{yi}}{\hat{\sigma}_{\varepsilon i}} \quad (9)$$

An estimate of the average standard deviation is given by:

$$\hat{s}_n = \frac{1}{n}\sum_{i=1}^{n}\hat{s}_i \quad (10)$$

Finally, pooling all the cross section and time series observations the panel standard error is obtained as:

$$\tilde{e}_{it} = \rho \hat{v}_{it-1} + \tilde{\varepsilon}_{it} \quad (11)$$

Then, the LLC test is to test $H_0: \rho = 0$ with the t-test.

Im, Pesaran and Shin (IPS) Test: The LLC test is restrictive as it requires ρ to be homogeneous across cross-sections. Allowing heterogeneous coefficients of y_{it-j}, Im et al. (2003) propose averaging of the individual ADF unit root test statistics when ε_{it} is serially correlated across cross-sectional units. The null hypothesis is that each series in the panel contains a unit root and while some but not all individual series contain unit roots is the alternative hypothesis:

$H_0: \rho_i = 0,\ H_1: \rho_i < 0$ for i=1,2,…,n_1 and $H_1: \rho_i = 0$ for i= n_1+1,..,N (12)

The IPS t-bar statistic is defined as the average of the individual ADF statistics:

$$\bar{t} = \frac{1}{N}\sum_{i=1}^{N} t_{p_i} \quad (13)$$

where t_{p_i} is the t-statistic for $H_0: \rho_i = 0$ for all i.

Pesaran (CIPS) Test: While the LLC and IPS tests are based on the assumption of cross sectional dependence, Pesaran (2003) suggests augmenting the ADF regressions with the lagged cross sectional mean and its first difference to capture the cross sectional dependence. The cross sectionally augmented Dickey-Fuller (CADF) regression can be specified as:

$$\Delta y_{it} = \alpha_i + \rho_i^* y_{it-1} + \beta_i \bar{y}_{t-1} + \gamma_i \Delta\bar{y}_t + \varepsilon_{it} \quad (14)$$

where $\bar{y}_t$ is the average of all cross sections. The cross-sectional dependence is accounted by a factor structure in the lagged cross sectional average and its first difference. If the error term or the factor is serially correlated, the first difference lags of y_{it} and $\bar{y}_t$ are included in the regression:

$$\Delta y_{it} = \alpha_i + \rho_i^* y_{it-1} + \gamma_0 \bar{y}_{t-1} + \sum_{j=1}^{p} \gamma_{j+1} \Delta\bar{y}_{t-j} + \sum_{q=1}^{p} \tau_q \Delta y_{it-q} + \varepsilon_{it} \quad (15)$$

where a sequential test or an information criterion gives the degree of augmentation. The Pesaran (CIPS) panel unit root t-statistics is obtained as averaged lagged values from the CADF regression for each cross sectional unit ($CADF_i$):

$$CIPS = \frac{1}{n}\sum_{i=1}^{n} CADF_i \quad (16)$$

Nonparametric Kernel Density Distribution Dynamics

The parametric methods assume a specific distribution function for the relative teledensity and do not explain the distribution dynamics of it across states over time. Nonparametric methods that allow the distribution of relative teledensity to be empirically determined are well suited to analyse the distribution dynamics of teledensity over space and time. The probability densities of relative teledensity across states are estimated by the kernel density estimator:

$$\hat{f}(y) = \frac{1}{nh}\sum_{i=1}^{n} K\left[\frac{y_{it} - \bar{y}_t}{h}\right] \quad (17)$$

where h is the bandwidth and K is the kernel function. The kernel density estimator weighs each cross section observation y in the range [0,1]. The weight is determined by the distance between observation y_i and the average y. This density estimate provides a visual of the shape of the relative teledensity distribution and an understanding of its dynamic evolution through time.

Empirical Analysis

Table 1 presents the descriptive statistics of the variables included in the empirical analysis. The descriptive statistics show that Himachal Pradesh has the highest teledensity of 94.30 while Bihar has the lowest teledensity of 39.06 per 100 inhabitants. Kerala has the highest literacy rate with 94.31 while Bihar has the lowest literacy rate of 63.28. Maharashtra has the highest share of the service sector to NSDP with 5491.37 billion and Himachal Pradesh has the lowest share of service sector to NSDP with 280.59 billion. While Andhra Pradesh consumes 1536.06 kilowatts of electricity, Assam has the lowest electricity consumption of 216.93 kilowatts. The per capita NSDP of Maharashtra is ₹122735.3 crores and Bihar has the lowest NSDP per capita of ₹24829.13 crores. In West Bengal, the share of service sector in NSDP is the highest of ₹8150.83 crores and that in Assam is the lowest of ₹603.63 crores.

Table 1: Descriptive Statistics of Variables

State	*Teledensity (TD)*		*Service Sector Share in NSDP (SER)*		*Literacy Rate (LR)*		*Electricity Consumption (EC)*	
	Mean	*Std. Dev.*	*Mean*	*Std. Dev.*	*Mean*	*Std. Dev.*	*Mean*	*Std. Dev.*
AP*	65.85	25.82	3863.67	2352.49	67.68	2.17	1536.06	821.69
Assam	39.50	18.50	603.63	335.11	73.08	2.97	216.93	45.51
Bihar	39.06	17.48	1039.13	475.07	63.28	4.91	157.46	59.08
Gujrat	74.69	29.51	2162.19	906.60	78.92	2.95	1462.82	233.31

State	Teledensity (TD)		Service Sector Share in NSDP (SER)		Literacy Rate (LR)		Electricity Consumption (EC)	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Haryana	67.85	24.65	1281.20	664.77	76.31	2.53	1616.07	270.09
HP	94.30	38.06	280.59	137.08	83.43	2.10	1205.06	124.89
J&K	54.96	24.67	374.18	268.22	68.32	3.86	992.65	121.92
Karnataka	77.64	29.87	3803.07	3462.69	76.86	4.94	920.72	121.33
Kerala	84.46	26.79	2059.31	1034.73	94.31	1.04	611.04	90.81
MP	46.51	18.05	1307.25	701.22	69.88	1.85	700.77	144.29
Maharashtra	63.23	25.59	5491.37	2239.83	82.89	1.81	1121.58	116.49
North East**	56.57	24.27	415.81	186.02	65.32	2.11	2157.85	374.44
Odisha	49.74	24.08	608.27	232.77	73.87	3.25	592.23	51.64
Punjab	88.57	28.68	1028.20	586.68	76.46	2.05	1711.45	140.17
Rajasthan	60.62	25.11	1580.86	890.99	66.68	1.89	831.07	137.23
Tamil Nadu	89.10	37.33	3268.28	1733.10	80.75	2.20	1207.53	161.80
UP	47.16	21.26	8150.83	11064.40	68.82	3.78	414.72	86.39
West Bengal	45.64	21.89	2558.70	1062.75	77.02	2.53	457.61	65.17

Note* Including Telangana. ** Including all states in North-East India.

The estimating dynamic panel fixed effects regression equation of the determinants of teledensity is specified as:

$$TD_{it} = \beta_1 TD_{it-1} + \beta_2 NSDP_{it} + \beta_3 SER_{it} + +\beta_4 LR_{it} + \beta_5 EC_{it} + \lambda_i + \eta_t + \varepsilon_{it} \tag{18}$$

where λ represents state fixed effects and η represents time fixed effects. Applying OLS estimation to the above equation may provide biased and inconsistent estimates. The lagged teledensity variable may be endogenous as it may be correlated with the (unobserved) state-specific fixed effects. Therefore, the Arellano-Bond Generalised Method of Moments (GMM) estimation is used in the empirical estimation. The fixed effects are eliminated by taking differencing.

It is common in telecommunications literature to estimate a value known as the half-life. The half-life is the required time to dissipate by one-half for any deviations from the steady-state (Barman et al., 2018). The half-life is estimated from the autoregressive coefficient in the panel unit root test equation as:

$$h(\rho) = \frac{\ln(0.5)}{\ln(\rho)} \tag{19}$$

where ρ is the AR(1) coefficient and h(ρ) is the half-life.

Table 2: Panel Unit Root Tests and Half-Life

Stationarity	Test	Statistic	Average	Half-Life
At levels	Levin, Lin and Chu t*	-2.7985**	-0.45793	1.13
At first difference	Im, Pesaran and Shin W-stat	-4.7296**	-	-
	Pesaran CIPS	-1.202**	-	-

Note: ** significance at 5 percent level.

Table 2 presents the results of the panel unit root test, along with the half-life. The LLC test rejects the null hypothesis of the unit root test at 5 percent level of significance and stationarity at levels by assuming there is a homogeneity of the coefficient of the AR(1) across cross section. The IPS test also rejects the null hypothesis at 5 percent at the first difference by assuming heterogeneity of the coefficient of the AR(1) across cross section. The Pesaran CIPS test rejects the null hypothesis and stationarity at the first difference by assuming cross-sectional dependence. The rejection of the null hypothesis by all the panel unit root tests imply that relative teledensity across states converges to a steady-state. The estimate of half-life estimate from the coefficient of AR(1) of the LLC test shows that about 1.13 years is required to dissipate by half the deviations of state teledensity from the national average.

Towards an understanding of the relative teledensity distribution dynamics in states of India, nonparametric kernel density plots for the years 2004, 2008, 2011, 2012 and 2018 are presented in Fig. 2. In 2004, a majority of the states lie on the negative side implying that state teledensity is lower than the national average. The comparatively smaller peak on the positive side shows few states have teledensity higher than the national average. In 2008, there the distribution is on the negative side and so wide implying a significant disparity between the states. The 2012 plot also show a similar distribution but there is not a distinct peak implying that a number of states have teledensity higher than the national average. The kernel density distribution for 2018 indicates that the states are moving from the negative side to the positive side implying a considerable improvement in teledensity in the states of India.

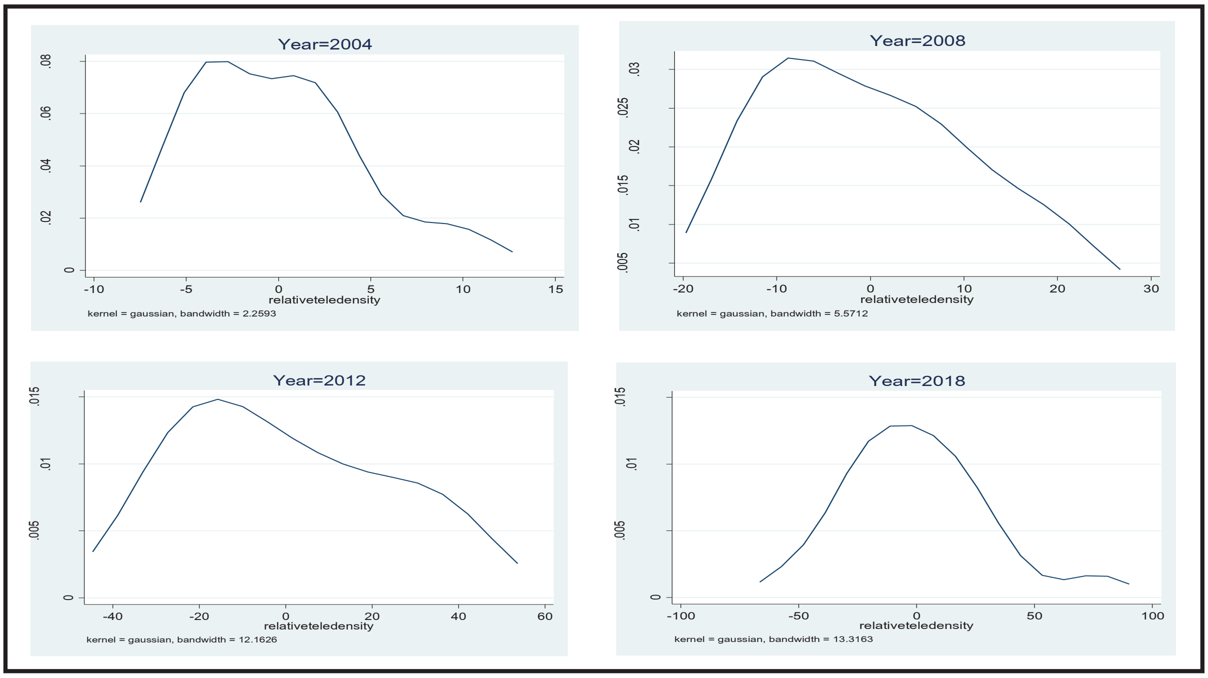


Fig. 2: Kernel Density Plots of Relative Teledensity

Table 3 presents the panel dynamic fixed effects Arellano-Bond GMM estimates of teledensity in states of India, along with the results of autocorrelation and Sargan tests. The estimated coefficient of NSDP per capita is positive and statistically significant. On average, an increase in NSDP per capita by one percent has the effect of increasing teledensity in states by 23 percentage points. This shows that more demand for telecom services is required as the economy grows. The coefficient of the lagged teledensity is also positive and statistically significant at 5 percent level. The coefficient of network externality is also a significant 0.30. These estimates together accord well as the subscriber base of the telecom network increases so also the network externality arising out of it. The estimated coefficient of the service sector share in NSDP is significantly positive, with a point estimate of 3.14. A one percent increase in service sector share in NSDP increases teledensity by 3 percent on average. The estimated coefficient of literacy rate is significantly positive with a point estimate of 0.18. As the literacy rate increases by one percent, the teledensity rises by 0.18 percentage points. The coefficient of electricity consumption is positive but insignificant indicating no significant effect of electricity consumption on teledensity.

Table 3: Arellano-Bond GMM Estimates of Teledensity in States of India

Variable	*Estimate*	*Std. Error*	*P>|z|*
Lagged teledensity	0.303**	0.011	0.00
ln(NSDP)	22.81**	1.159	0.00
ln(share of service sector in NSDP)	3.147**	0.533	0.00
Literacy rate	0.181**	0.601	0.003

Variable	*Estimate*	*Std. Error*	*P>|z|*
Electricity consumption	0.001	0.00	0.101
Autocorrelation order 1	-2.324#	-	0.021
Autocorrelation order 2	1.205#	-	0.228
Sargan test	17.199+		0.246@

Note: # z-statistic. + Chi^2 value. @ Prob.> chi^2. ** significant at 5 percent level.

Conclusion

Given the importance of telecommunications for economic development, this paper analyses the determinants of telecommunications performances across 18 Indian states over 15 years from 2004-2018. The relative teledensity across states is computed to understand the performance of the telecommunications of states. Among the states, Himachal Pradesh has the highest teledensity of 94.30 while Bihar has the lowest teledensity of 39.06 per 100 inhabitants. The panel unit root test of LLC, IPS and Pesaran CIPS tests are used. The distribution dynamics and the determinants of teledensity are examined using kernel density plots and the dynamic panel fixed effects Arellano-Bond GMM estimation technique. The panel unit root tests show that the null hypothesis was rejected at levels for the LLC test and at the first difference for the IPS test and Pesaran CIPS implying that relative teledensity across states converges to a steady-state. The kernel density plots show a disparity in teledensity across Indian states and gradual improvement over the years, indicating convergence. The half-life estimation indicates that the speed of convergence is 1.13 years i.e it takes 1.13 years for the states to converge. The NSDP per capita and network externality are important factors in the teledensity of states. The service sector share in the NSDP and literacy rate are the other significant factors that determine the teledensity in the states of India.

As for the impact of investment in the telecommunication sector, it proves beneficial to the development of the economy as telecommunication networks and network externality are the requirements of economic growth. As most of the telecom service providers are multinational companies, the FDI flows increase in the telecom sector of the economy, providing more employment and tax revenues. While the contribution of the telecom sector to growth is not huge, yet it is significant. Being greenfield projects, telecom infrastructure setup needs huge investment for which the governments need to subsidize its expansion. Policy and regulatory mechanisms should promote a competitive environment for international and domestic investments to spur the growth of the telecom sector and reduce telecom tariffs

The results of this study provide strong evidence that telecommunications networks that are efficient and balanced infrastructure significantly foster economic growth, reduce regional connectivity and shrink the digital divide. Apart from the positive side of the telecom sector growth in India, the telecom sector also faces serious challenges. The first and foremost challenge is the poor teledensity in rural areas for which steps to overcome this problem are needed. An added problem is the poor standards in service provision, lack of network security, and importantly low awareness and patronage. The lack of sufficient service provider companies, low broadband penetration and high-frequency charges pose big challenges for telecom penetration in rural and poor households. Poor quality human resources in the information technology and telecom sector and the lack of R&D activities in the telecommunications sector for home production of equipment necessitates big imports of telecom equipments.

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