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Effectiveness of public funding for rural telecom and broadband: Lessons from the universal service obligation fund, India

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The 19th ITS Biennial Conference 2012

“Moving Forward with Future Technologies: Opening a Platform for All”

18 - 21 November 2012, Thailand

**Effectiveness of Public Funding for Rural Telecom and Broadband: Lessons from the
Universal Service Obligation Fund, India**

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from the Universal Service Obligation Fund, India**

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Effectiveness of Public Funding for Rural Telecom and Broadband: Lessons from the Universal Service Obligation Fund, India¹

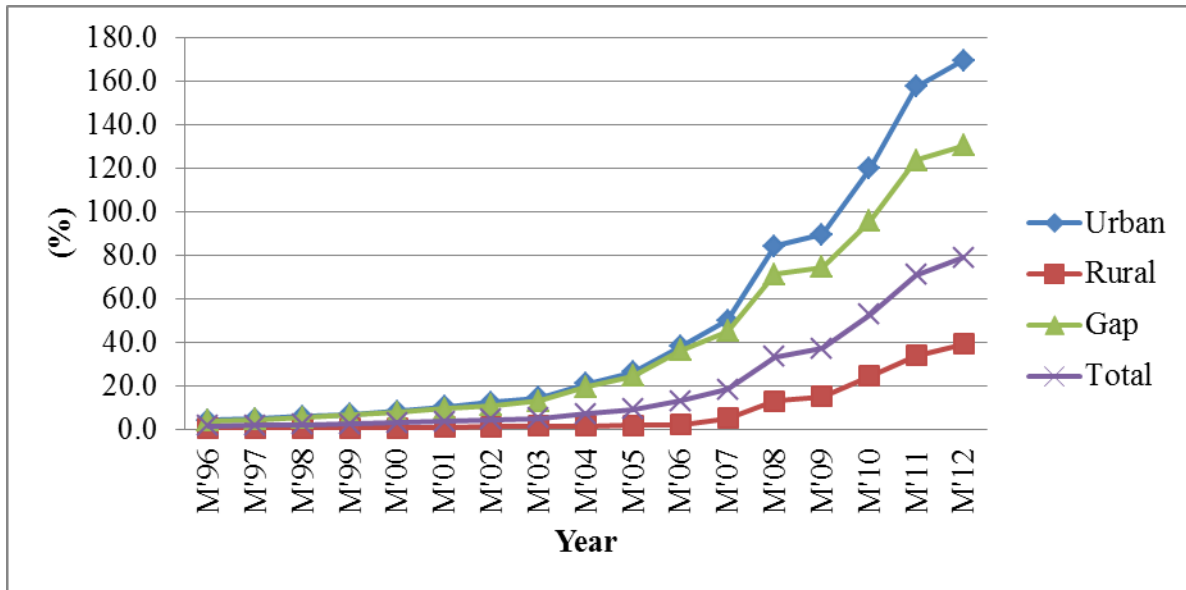
Despite the growing telecom penetration in India, largely driven by mobiles, the increasing gap between urban and rural teledensity (RTD) is a cause of concern. As of March 31, 2012, the teledensity was 78.7% with nearly 951 million subscribers. While the urban teledensity (UTD) was 169.6%, the rural teledensity (RTD) was 39.2%² showing a difference of 130.4%. Ten years back, this gap was 11.0%. We believe that the differential in broadband access would be even starker (We could not get the segregated data on the urban and rural broadband penetration).

Figure 1 and Table 1 give the growth of teledensity, UTD, RTD and the gap from March 31, 1996 to March 31, 2012. Given that nearly 67% of India's population is rural, such huge disparities have implications for equitable development as mobiles and broadband are considered drivers of economic growth. Besides the disparity in urban and rural growth, there are significant differences in teledensity across states in India, which could lead to potential differentials in economic growth.

¹The research assistance provided by Ms. Sneha Jhala, and data analysis done by Ms Neha Hathiari and Ms Kavita Tatwadi, Research Associates, IIMA-IDEA Telecom Centre of Excellence, is thankfully acknowledged.

²<http://pib.nic.in/newsite/erelease.aspx?relid=83035>, accessed on June 22, 2012

Figure 1: Teledensity Trends



(Source: TRAI, *The Indian Telecom Services Performance Indicators Reports, Various Years*, <http://www.trai.gov.in/WriteReadData/PIRReport/Documents/>, accessed on April 25, 2012)

To overcome the market challenges of telecom services in rural areas, the Indian government, like several other governments (e.g. in Uganda, Chile and Malaysia) [Baek, et. al. 2006] created the Universal Service Obligation Fund (USOF) to be funded by contributions from the revenues of all operators.

Recent results released by USOF indicated that it had contributed very little to the overall growth in RTD even after nearly ten years of the funds availability and deployment, innovative design of schemes and support for private sector involvement for ensuring efficiency in deployment. Most of the growth had come about because of penetration by private operators³ [Jain and Raghuram, 2010], while the USOF had an unspent amount of US \$ 4.37bn by the end of financial year 2011-12.

³ERU (Economic Resource Unit), DoT, accessed on June 23, 2012

1.0 Objectives

The paper has two parts, both of which bring out the implications for USOF and its programs for increasing RTD. The first part critically analyzes the overall design of the USOF program and the performance of its various schemes with respect to the stated goals. Next, we examine the organizational structure, resources and processes adopted by USOF with a view to highlight how these influence USOF goals. Since USOF has so far focused predominantly on voice network roll-out, we also examine organizational changes, if any, required in the context of broadband.

Since states in India have significant variation in their economic and developmental parameters, the paper develops models for RTD based on socio-economic characteristics of states to identify factors contributing to faster roll out. Such an analysis would help in sequencing of roll out in rural areas.

Key Words: Rural Telecom Services, Design of Universal Service Obligation Fund, Impact Assessment, Public-Private Partnerships

The use of telecom services especially mobiles and broadband, has helped to bring about socio- economic transformations. This effect is more pronounced in rural areas due to the poor existing physical infrastructure. Since broadband, more than mobiles and other telecom services is a key driver of economic activities, and increasingly of access to public services, differential access of broadband between urban and rural areas has policy implications for equitable growth.

2.0 Background and Institutional Structure of the Indian Telecom Sector⁴

Like several other countries in the world, Indian telecom sector had undergone significant reforms over nearly last three decades. From service provision from a state owned monopoly of Department of Telecom (DOT) under the Ministry of Communications and IT, MTNL (for service provision in Mumbai and Delhi) and VSNL (international services) until the early 1990s, by 2010 competition and private players had been introduced in all segments of the services such as fixed, National Long Distance (NLD), International Long Distance, mobile, etc. Corporatization of DOT into BSNL in 2000, privatization of state owned incumbents and introduction of competition through private players had led to both public and private players. In 1992, two mobile private operators per service area and one fixed line operator had been licensed through auctions. These operators were required to use the GSM standard in the 900 MHz band. The services were licensed on the basis of service areas called ‘circles’ that were administrative units of DOT and later those of BSNL. These were usually co-terminus with state boundaries. Besides the state owned incumbents, one private operator per circle could also provide fixed services by participating and winning in the auction.

⁴*This section has been excerpted from a note: “Indian Telecom Service Sector (As of May 2010)”, by the author Prof Rekha Jain, IIMA, accessed on June 20, 2012.*

The Telecom Regulatory Authority of India (TRAI), set up in 1997, was the regulatory authority mandated with tariff regulation, fixing interconnection terms, maintaining quality of services etc. The Telecom Dispute Settlement and Appellate Tribunal (TDSAT) was a quasi-judicial body that adjudicated and settled disputes between service providers or licensor and licensee and reviewed appeals against TRAI directions. Appeal against TDSAT lay with the Supreme Court of India.

As of September 2012, the telecom sector in India was contributing significantly to economic growth and also provided the infrastructure for other services to be carried out efficiently. The number of telecom subscribers in the country reached 944.81 million as on July 31, 2012.

With this the overall teledensity (telephones per 100 people) has touched 77.79 percent.

According to CCAOI⁵, the total telecom services revenue in India is projected to grow at a compound annual growth rate (CAGR) of 15.8% from 2010-14 to touch the revenues of US\$ 82 billion. The India mobile subscriber base is set to cross 1.5 billion connections by 2015⁶.

This growth was poised to continue through the forecast period, and India was expected to remain the world's second largest wireless market after China in terms of mobile connections.

The booming domestic telecom market led by mobile services had been attracted huge amounts of investment which was likely to accelerate with the entry of new players and launch of new services such as 3G.

⁵Cyber Cafe Association of India (CCAOI), available at <http://www.ccao.in/UI/links/fwresearch/Research%2013%20June.pdf>, accessed on September 29, 2012

⁶CMAI Association of India, accessed on September 30, 2012

Competitive Scenario

By September 2012, there were six large players, Bharti Airtel, BSNL, Idea Cellular Limited (ICL), Reliance Infocomm, Tata Teleservices and Vodafone Essar, who had a pan India or almost pan India presence. Some relatively smaller players (who had operations in a few circles only) were also active. Several of them and some new players acquired licenses in January 2008 as a part of DOT's new guidelines for licensing. Among the large players, scale and scope of operations varied considerably. Some of them were a part of larger Indian industrial conglomerates, (ICL, Reliance and Tata Teleservices), while some others were a part of larger global telecom companies (Vodafone), or were public operators (BSNL, MTNL) and yet others like Bharti were Indian operators that had acquired telecom licenses in a number of countries.

3.0 Background of USOF

Commercial viability of rural telecom services is poor as cost of provisioning of services is high and propensity to pay is low. Therefore, government support is necessary to roll out services. In this context the government of India set up the Universal Service Obligation Fund (USOF) with the objective of providing affordable and reasonable telecom services in the rural and remote areas.

The Indian Telegraph (Amendment) Act, 2003 gave statutory status to the Universal Service Obligation Fund (USOF). The resources for implementation of USO are raised through a Universal Service Levy (USL) which has presently been fixed at 5% of the Adjusted Gross

Revenue (AGR) of all telecom service providers except the pure value added service providers like Internet, voice mail, e-mail service providers etc.⁷

USOF framework allows for public-private partnership. As USOF provides subsidy to telecom operators to serve the rural and remote areas where commercial viability is low, it paves the way for inclusive growth of the rural India and also incentivizes the operator to venture into market-segments which are commercially non-attractive. As per the USOF, “The primary function of USOF Administration is to provide the necessary financial incentive to bridge universal access/service gaps and to monitor service delivery as per agreed terms and condition”⁸.

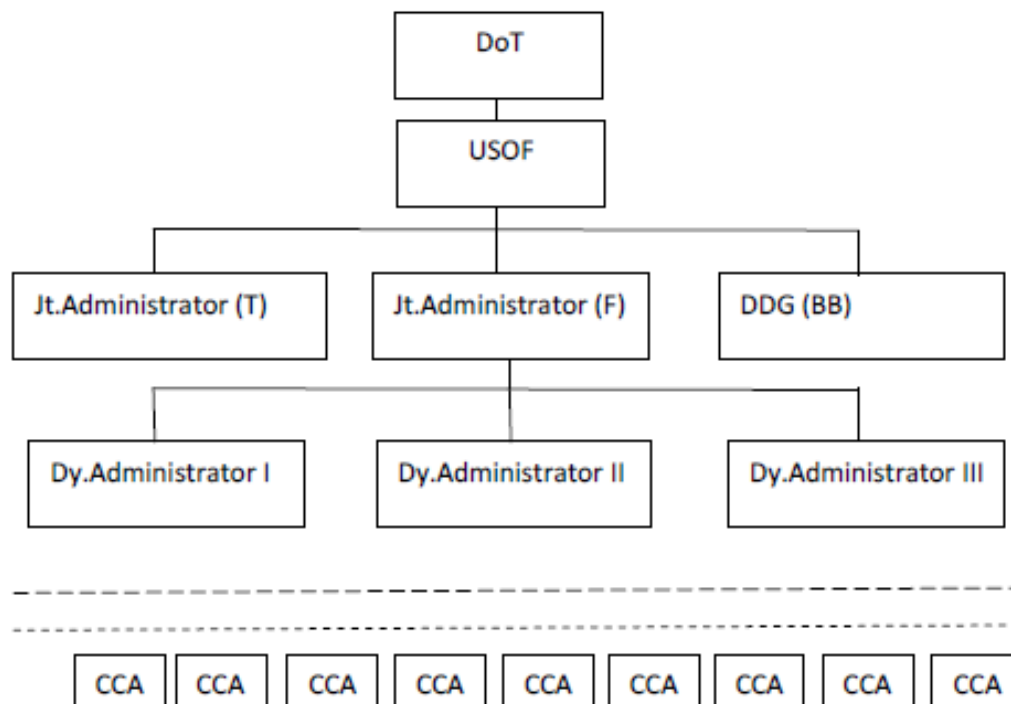
Administrative Structure of USOF

The USOF is managed by administrator of USOF. The USOF functions under DoT and figure 2 gives the organization structure of the USOF.

⁷<http://usof.gov.in/usof-cms/home.jsp>, accessed on May 1, 2012

⁸*Effective Implementation and Monitoring of USOF schemes*, retrieved from <http://usof.gov.in/usof-cms/pdf21may/softcopyofreportreleasedinconference/report.pdf> accessed on April 25, 2012

Figure 2: Administrative Structure of USOF ⁹



⁹Source: www.nicf.gov.in/ppt/USO_Constituton_Admin.ppt, accessed on April 25, 2012

Part I: Analysis of USOF Performance

4.0 Design of USOF¹⁰

The USOF has six streams as follows:

- a. Stream I: Provision of Public Access Services – This stream covered operation and maintenance of village public telephone (VPT), replacement of multi access radio relay technology (MARR), and provision of a second public phone in the villages having population of more than 2000 and where there were no existing public call office (PCO). It also provided for upgradation of public phone kiosks to public tele centres at the block (administrative aggregation of villages) headquarters.
- b. Stream II: Provision of household telephones (RDELs) covered household phones in 1685 or two-thirds of the total rural sub-districts and for provision of services in rural and remote areas for household phones installed before April 1, 2002 and covers the difference between the rentals actually charged vis-a-vis the rates prescribed by TRAI. This stream provided subsidy for both capital and operational expenses. With the phasing out of ADC in 2008, BSNL was given support for the subsequent three years towards this. This stream also provides support for RDELs installed after April 1, 2002.
- c. Stream III: Creation of infrastructure for provision of mobile service in rural and remote areas. This stream provided for subsidy to both public and private operators for putting up shared passive infrastructure. This was bid on reverse

¹⁰http://usof.gov.in/usof-cms/usof_schemes.htm, accessed on May 2, 2012

auction basis to the operator who sought the least amount of subsidy. Each such tower was to be shared by three service providers. The service providers had also been selected on the basis of reverse auctions.

- d. Stream IV: Provision of wireline broadband connectivity to villages in a phased manner, including optional subsidy for terminals, modems and equipment for uninterrupted power supply. Provision of rural kiosks providing broadband connectivity was also a part of the stream.
- e. Stream V: Creation of general infrastructure in rural and remote areas for development of telecommunication facilities.
- f. Stream VI: Introduction of new technological developments in the telecom sector in rural and remote areas.

5.0 Performance of Various USOF Schemes

Table 2 shows that the funds collected by USOF until March 31, 2012 were Rs 439.5bn. Cumulatively, until March 31, 2012, the USOF had disbursed Rs 221.08 bn since its inception on April 1, 2002. Of this Rs 151.6 bn had been disbursed to various operators towards the various schemes and Rs 69.5 bn had been disbursed to BSNL towards reimbursement of license fee and spectrum charges until 2005-06. This was seen as necessary to compensate for BSNL's high cost of service provision in rural areas. The balance of funds amounted to Rs 218.4 bn.

After a steady increase in disbursements from 2007-08, the peak disbursement of Rs 31.00 bn was in 2010-11. In 2011-12, the disbursement was nearly half at Rs 168.8 bn. Nearly 86% of the disbursements had gone to the state owned BSNL (Table 3), with Reliance Infocomm and

Tata Teleservices Ltd getting 6% and 5% respectively. The other remaining 3% was provided to other private operators.

Stream I: Examination of table 4 shows that cumulatively Rs 25.4 bn, amounting to nearly 10.9% of the total amount had been disbursed. This stream provided for public access. 8.5% of the disbursements were made to BSNL and the remaining to private operators. Private operators had been involved in provision of community phones. Of the 40,694 such phones (Table 5), BSNL had provided 21,958 and private operators had provided 18,736. While BSNL had provided phones in all states, the private operators had not participated in the more ‘difficult’ states such as Assam, Jharkand, Jammu and Kashmir etc.

Stream II: The maximum amount of disbursements (nearly 80%) had been done in this stream (Table 4). Since this stream provided for wire line connectivity that was relatively more expensive, this approach was not cost-effective. Further, since there was no way of linking the socio-economic conditions of the household to the subsidized access.

For providing Stream II services, a total of 1685 (Table 6) service areas representing the poorer districts were identified. Of this, BSNL won the bid in 1267 areas while the remaining were to be serviced by the private operator [Jain and Raghuram, 2010]. On the other hand, on examining the number of DELs provided by BSNL and the private operators all together, we find that on record, the private sector has provided far more (Table 6). However, monitoring of the availability of lines has found various discrepancies in the lines claimed to be provided by the private operator and those actually provided. A review of Table 6 indicates that the private sector was involved in laying these lines in those states which have a higher socio-economic profile such as Tamilnadu, Gujarat, and Andhra Pradesh etc. The most vulnerable

states in terms of their economic profile and terrain such as Assam, J&K, the North East, Chattisgarh, Jharkhand did not receive any bids from the private operators.

Stream III: Provision of mobile shared infrastructure and services had a contribution of 1.5%. A status of the scheme showed that while a large majority of towers had been completed, the service provision had yet to start services. Therefore, despite the scheme having started in 2008, on the ground result was extremely limited. Of the 81 “clusters” which indicated the groupings of districts, 63 were won by BSNL. Of the 7353 towers that were to be provided, 5758 were awarded to BSNL.

Stream IV: Nearly 1.3% of the total disbursements had been done under this scheme providing for nearly 3,60,900 BB connections as of June 30, 2012. The per connection cost was nearly Rs 5000.

Stream IV, V and VI: Very small quantum of disbursements had been made under these schemes.

6.0 Analysis

- 1) **Participation of the Private Sector vis-a-vis the Public Sector:** As in many other developing countries such as Peru, Nigeria, Mongolia, India’s USOF was designed to provide viability gap funding¹¹. Although the USOF envisaged that such a mechanism would be attractive to the private sector, the data above shows that it was not the case. BSNL as almost the sole recipient of USOF disbursements. This was in line with developments in some other developing countries as well where a majority of funding

¹¹<http://www.ictregulationtoolkit.org/en/Section.3176.html>, accessed on September 25, 2012

had gone to the incumbent fixed line operators. Most private sector allocations were in the better-off states compared to BSNL that, in almost all cases, bid and won in all states.

The near absence of involvement of private operators in these states indicates that either the bids were too low for it to make any commercial sense. In addition, BSNL was willing to bid low, either to preclude other operators or did not have an orientation towards covering its costs. Alternatively, its cost of service provision was low. Any of these alternatives is a conjecture, since it is difficult to get disaggregated costs of BSNL service provision to do the analysis.

While from the USOF perspective, having to pay lower viability gap funding is good, having a public operator as a dominant provider raises some issues. These include the inability of USOF Administrator to impose penalties due to delays in roll outs. This difficulty arises as both USOF Administrator and BSNL are under the DOT, and the practice of one government entity imposing liquidated damages on another is not prevalent. The net outcome is delays in service provision. Since telecom is seen as a driver of economic growth, it also indicates losses to the government. In balance, a somewhat higher cost of service provision but with strict time penalties may be a better option. Alternatively, if USOF is made independent [Jain and Raghuram, 2010], then contractual compliance by both the public and private sector may be more enforceable.

- 2) ***Wider Consultation Process:*** The planning for disbursement of USOF is done by the office of the USOF. A wider process of consultation amongst stakeholders could lead to more acceptance and useful outcomes. The majority of funding has gone to support wireline services in rural areas. This continued to get allocation of nearly 80% of the

planned disbursements, despite the increasing aspirations of owning a mobile phone in rural population. So, several sections of the rural population could not use mobile services as the infrastructure did not exist. Such kind of anomalies between supply and demand could be ironed out with more stakeholder participation [Jain and Raghuram, 2010]. Further USOF needed to develop a longer term vision for itself and what it should achieve in collaboration and consultation with a wide variety of stakeholders. This would allow it to move away from working only on year to year budget basis.

The current organizational structure of USOF however does not support the above. Its large field organization is devoted to monitoring the outcomes and streamlining the claims and disbursement process which is largely manual. However, with field based electronic upload of data, a large part of this task could be automated. The authors' current involvement with USOF is to show the feasibility of the same.

- 3) ***Focus on Backbone Creation:*** While the focus since the inception of USOF has been on provision of access network and services, since 2012, the focus has shifted to backbone infrastructure. As per recommendations of the Telecom Regulatory Authority of India in its National Broadband Plan¹², a nationwide high speed optical fibre backbone is to be created using the USOF funds. To oversee its deployment, TRAI recommended setting up the National Fibre Optic Agency that would both oversee the implementation of such a network and would also be a holding company for State Optic

¹²TRAI, *Recommendations on National Broadband Plan*, December, 2010. Available at <http://www.trai.gov.in/WriteReadData/Recommendation/Documents/Rcommendation81210.pdf>, accessed on May 7, 2012

Fibre Agencies. This was probably modelled on the plans of various countries such as UK and Australia that had recommended or set up separate agencies.

- 4) ***Appropriate Organizational Structure:*** TRAI's conception of a National Fibre Optic Agency was modelled on initiatives in various other countries such as Australia and UK. Australia had set up the National Broadband Network Company as a wholly government owned company that would be the wholesale provider of bandwidth for other agencies and organizations. However, the Australian agency was set up in PPP mode and was under the Australian Department of Broadband Communications and the Digital Economy (DBCDE) rather than under the telecom regulator. NBN Co bought over the infrastructure of the dominant service provider, Telstra. TRAI has envisaged that the National Fibre Optic Agency would be responsible for establishing the network in 63 cities identified under a mission for urban renewal as well as be the holding company with 51% stake in State Optic Fibre agencies.

In UK, Broadband Delivery UK (BDUK), in the Department of Culture, Media and Sport working in the PPP mode involving the Telecommunications, IT and broadcasting sectors, digitalization of content, protection of Intellectual Property through the modernization of Copyright and other laws has been set up. British Telecom (BT), the dominant UK Telecom carrier, is responsible for upgrading the broadband connectivity of rural and remote areas.

In both the Australian and UK case, the broadband initiatives are in departments outside telecom sector as broadband is seen as having larger scope than provision of

infrastructure. In Australia, it is the Department of Broadband Communications and the Digital Economy (DBCDE) and in UK, it is BDUK and the Department of Business Innovation and Skills that are at the forefront of broadband related initiatives.

- 5) ***Reduction in USOF Contribution:*** There have been large unspent amounts in the USOF to the extent of Rs 218.4 bn which is nearly 50% of the cumulative collections until June 30, 2012. Since USOF collection is on the basis of 5% revenue share of all service providers, they have sought reductions in the quantum of contributions. They argue that a reduction in this component will allow them to offer cheaper services and thus allow for deeper penetration. Scenario analysis of the reduction in the license fee and spectrum charges to possible increase in the subscriber base and consequent changes in the service tax revenues was provided by [Jacob and Jain, 2011]. It showed that a reduction in the license fee and spectrum charges by small amounts ranging from 0.25% -0.50% could lead to higher penetration. The increase in subscriber base assumed in the model was consistent with the growth rate of subscribers. Such an increase would lead to service tax receipts that would offset the reduction in the fee.
- 6) ***Little Focus on Mobile, Broadband and Innovative ICT Services:*** As in many other developing countries (Brazil, Chile, Mongolia), the focus of India's USOF has largely been on fixed wire line infrastructure.

Part II: Linking RTD to State Economic and Development Parameters

7.0 Background

Not only is there a difference between rural and urban teledensities, at the national level, there are significant variations in these parameters across states. The states also differ significantly on parameters such as Agri GDP per capita¹³, percentage of Village Electrification (VE)¹⁴, and Rural Literacy Rate (RLR). For example, the Agri GDP of J&K, N.E II, and Uttarakhand are Rs. 9881.52, Rs. 13464.29, and Rs. 11,421.15 respectively which is considerably smaller in comparison to other states. Similarly the percentage of VE is 31.10 in Jharkhand which is very low relative to other states (Table 7). Given these parameters the RTD of these states is also low in comparison.

Previous studies linking RTD to various development parameters are those that link teledensity to GDP per capita, telecommunications staff and length of wait times to acquire and maintain telephones [Mbarika, et. al., 2003], and demand of landline and mobile phones in developing countries [Sridhar and Sridhar, 2007]. An earlier paper [Jain and Raghuram, 2005] has examined the relationship of RTD (state wise) with literacy rate, Urban Teledensity

¹³ Agri GDP Per Capita – The term refers to the share of Agriculture and allied services in the GDP per capita.

¹⁴ Village Electrification: “A village would be declared as electrified if

- i. Basic infrastructure such as Distribution Transformer and Distribution lines are provided in the inhabited locality as well as the Dalit Basti/ hamlet where it exists. (For electrification through Non-Conventional Energy Sources a Distribution transformer may not be necessary).
- ii. Electricity is provided to public places like Schools, Panchayat (village administration) Office, Health Centres, Dispensaries, Community centers etc. and
- iii. The number of households electrified should be at least 10% of the total number of households in the village.”
(Source- http://powermin.nic.in/rural_electrification/definition_village_electrification.htm, accessed on October 27, 2012)

(fixed), per capita state domestic product (SDP), per capita rural income, and percentage of rural population. The model was developed for fixed line telephones.

Based on previous studies, we developed a model of RTD based on regression analysis of state wise UTD, RLR, Agri GDP per capita, and % VE. Percentage VE is an indicator of the level of development of business activities, enterprise and possible demand in public places.

8.0 Proposed Model

Based on prior work we propose a regression model where the:

- Response Variable is Rural Teledensity (RTD) (%)
- Predictor Variables are percentage UTD, RLR, VE and Agri GDP per capita.

We have used the following data for our model:

- UTD and RTD (as on November 30, 2011) data from Economic Resource Unit from the website of USOF, accessed on October 25, 2012.
- Rural Literacy Rate (provisional census data of 2011) from the website of Planning Commission of India accessed on April 12, 2012.
- Rural Electrification data from the website of Ministry of Power accessed on October 25, 2012.

We hypothesize the following:

H1: There is a positive relation between UTD and RTD.

H2: There is a positive relation between Rural Literacy Rate (RLR) and RTD.

H3: There is a positive relation between Agri GDP per capita (in Rs.) and RTD.

H4: There is a positive relation between % Village Electrification (VE) and RTD.

Test of significance of the x_i coefficients (Individual significance) for any parameter β_i ,

$$H_0: \beta_i = 0 \text{ vs } H_a: \beta_i \neq 0$$

Testing of significance of regression as a whole

The null and alternative hypothesis for test of overall significance is

$$H_0: \beta_1 = \beta_2 = \dots \beta_p = 0$$

H_a : One or more of the parameters are not equal to zero.

The regression model is $y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \dots + \beta_p x_p + \varepsilon$

Therefore the Rural Teledensity equation becomes-

$$RTD = B_1(UTD) + B_2(RLR) + B_3(\text{Agri GDP/c}) + B_4(VE) + \varepsilon$$

where:

RTD= Rural Teledensity (%)

UTD= Urban Teledensity (%)

RLR= Rural Literacy Rate (%)

Agri GDP/c= GDP per capita from Agriculture and allied services.

VE= Village Electrification (%)

ε = Error term

and B_0, B_1, B_2, B_3, B_4 are estimates of $\beta_1, \beta_2, \beta_3, \beta_4$

The Error term ε captures the randomness of the system. An error can occur because of the limited population taken into consideration, due to human limitations and due to errors in observation and errors in measurement.

Results

We used Mini Tab software to run the regression. The output is as shown below-

The variables are standardized before running the regression. Standardization of variable is important because we would like to compare the predictor variables to see their comparative strength in explaining the regression. Since the different predictor variables have been measured in different units we needed to standardize them to compare them.

Regression Analysis: zRTD versus zUTD, zAgri GDP, zRLR, z% VE

The regression equation is
$$zRTD = 0.667 zUTD + 0.406 zAgri\ GDP + 0.129 zRLR + 0.177 z\%VE$$

Predictor	Coef	SE Coef	T	P	VIF
Constant	-0.00000	0.09030	-0.00	1.000	
zUTD	0.66684	0.09754	6.84	0.000	1.108
zAgri GDP	0.4061	0.1001	4.06	0.001	1.166
zRLR	0.1290	0.1035	1.25	0.232	1.248
z% VE	0.1774	0.1081	1.64	0.122	1.362

S = 0.403848 R-Sq = 87.1% R-Sq(adj) = 83.7%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	4	16.5536	4.1384	25.37	0.000
Residual Error	15	2.4464	0.1631		
Total	19	19.0000			

Source	DF	Seq SS
zUTD	1	11.1343
zAgri GDP	1	4.3847
zRLR	1	0.5957
z% VE	1	0.4389

We see from the above output that the p-value for RLR and VE (0.232 and 0.122

respectively) are not significant as p-value should be ≤ 0.05 . We ran a stepwise regression

(forward). The output is as below-

Stepwise Regression: zRTD versus zUTD, zAgri GDP, zRLR, z% VE

Alpha-to-Enter: 0.15 Alpha-to-Remove: 0.15			
Response is zRTD on 4 predictors, with N = 20			
Step	1	2	3
Constant	1.658E-17	1.05E-16	-1E-16
zAgri GDP	0.53	0.48	0.4
T-Value	2.63	4.63	3.94
P-Value	0.017	0	0.001
zUTD		0.736	0.697
T-Value		7.08	7.24
P-Value		0	0.00
z% VE			0.22
T-Value			2.15
P-Value			0.047
S	0.874	0.453	0.411
R-Sq	27.69	81.68	85.79
R-Sq(adj)	23.68	79.52	83.13
Mallows Cp	68.2	7.3	4.6

With three steps that were carried out in this analysis we reached the final model, and thus there are only three variable added from the original four (all of the three variables are significant at the 15% level as desired) for the accepted model.

The RLR being non-significant does not feature in the stepwise regression. The p-values of zAgri GDP, zUTD, and z%VE are all significant. The adjusted R-Sq is 83.13 which says that the variables in the equation explain 83.13 % of the change in the response. The Adjusted R-Sq is the adjusted value that takes into account the number of variable in the model.

The Mallows C_p ¹⁵ is a further measure of how good a 'fit' the model is (the closer the value is to the number of parameters, i.e. variables + 1, the better the fit). In the third step it is 4.6 which is correct as it should be $K+1$ (where K is the number of variables in the regression equation, which is 3 over here UTD, Agri GDP, and VE).

Checking for assumptions about the error term in the regression model

Randomness and constant variance

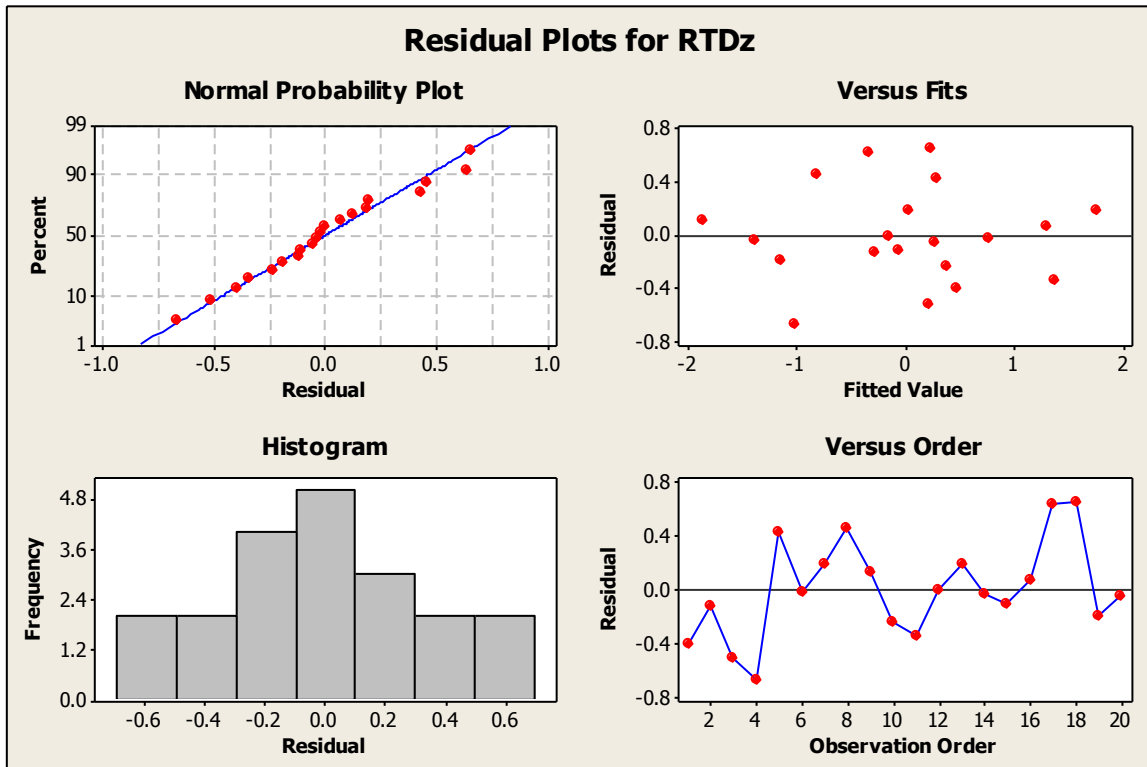
In figure 3 we see that the scatterplot of the standardized residuals against the fitted values is random and does not show any pattern or trend indicating that the error term ϵ is a random variable with a mean or expected value zero. This also proves the assumption of constant variance of the error term.

Normality of the error term

We see that residuals follows straight line in a normal probability plot which shows that the assumption that the error term is normally distributed random variable is reasonably satisfied. The histogram shows a bell shape pattern further proving that the error term is normally distributed.

¹⁵ http://www.statistics4u.info/fundstat_eng/cc_varsel_mallowscp.html, accessed on October 30, 2012

Figure 3: Plots of residuals from the regression equation



Since all the assumptions of ‘multiple regression’ have been met, we can reject the null hypothesis and say that at least one of the variables (factors) is non-zero. The standardized regression equation for our model is therefore:

$$\mathbf{Z}'_{\text{RTD}} = 0.4 \mathbf{Z}_{\text{Agri GDP/c}} + 0.697 \mathbf{Z}_{\text{UTD}} + 0.22 \mathbf{Z}_{\% \text{VE}}$$

The rank order of influence of the predictors on RTD is given by the standardized beta coefficients. UTD with $B=0.697$ has the greatest influence on RTD followed by Agri GDP/c ($B=0.4$) and %VE ($B=0.22$)

9.0 Implications

1. **Effect of UTD:** Our regression model shows that there is a significant contribution of UTD of a state on its RTD. 69.7% of the variance in RTD is being explained UTD (keeping the other two variables constant). As also is observed in Table 7 the states having low UTD (Chhattisgarh, Jharkhand, NE-II, and Uttarakhand) also have low RTD. This proves that the converse too is true.

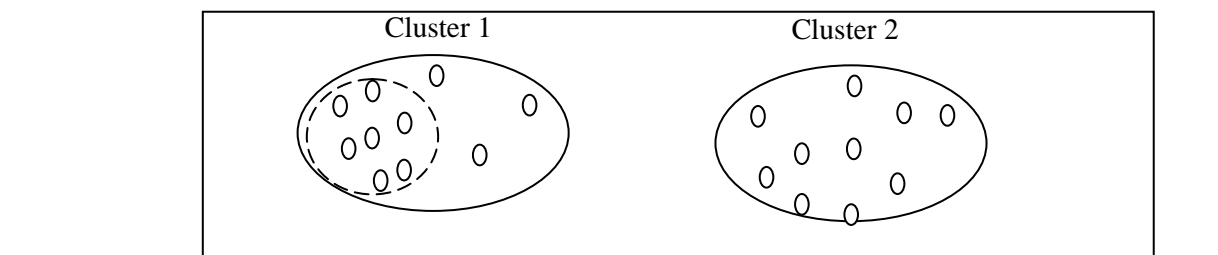
One implication of this is that the USOF could use a cluster approach for increasing its footprint in areas where the UTD is already high [Jain and Raghuram, 2005]. USOF should divide states into smaller clusters (districts and sub-districts) and invest in deployment of infrastructure in those clusters where UTD is high and RTD is just below 25% which is considered as threshold to reach the critical mass [Kathuria, et. al., 2009]. With a lower investment, such a strategy would lead to greater take-off of rural penetration. In areas where UTD is high and RTD is higher than 25%, private operators would find it commercially viable to provide services. USOF may have smaller role in such areas, where it can work on promoting green telecom and facilitating public access.

2. **Effect of Electrification:** Our model also shows that there is a significant effect of % VE on the RTD. % VE (keeping the other two variables constant) accounts for 22.0% of the variance in RTD¹⁶.

¹⁶ 100% electrification does not guarantee that there is a regular power supply from the electric grid. The quality of electricity also is an important factor. Telecom infrastructure investment makes more sense at places where there is constant or regular power supply.

The implication is that USOF should plan for sequencing roll out in states along similar lines of analysis at the district and sub district level. It should examine the VE along with RTD for planning a roll out. It should identify the areas where VE is high and RTD is lower than 25%, to provide support. With lower investment such a strategy would lead to greater take-off in the rural areas. In areas where VE is high and RTD is higher than 25%, private operators are more likely to provide services on a commercially viable basis. USOF may have smaller role in such areas, where it can work on promoting green telecom and facilitating public access. Further, it could refine this approach by examining geographical clustering along this dimension. For example (see Figure 4) if there are two clusters of villages say Cluster 1 and Cluster 2 with the percentage electrification being same but with different geographical concentration of electrification. In Cluster 1 the electrification is concentrated geographically while in Cluster 2 it is spread out. It would be beneficial for USOF to target Cluster 1 where the possibility of effective penetration will be more than that of cluster 2 where the electrification is scattered. This is because wherever the electrification is concentrated geographically, the commercial viability of the network deployment increases.

Figure 4: Cluster Approach for USOF Support with similar percentage of Electrification



3. Effect of Agri GDP/c and allied services– Agri GDP/c is an understated estimate for the Rural GDP but we have used it because agriculture is one of the predominant sources of income in the rural areas and reflects the financial capacity of the rural consumers. Though now agriculture’s contribution to the GDP has become low, half of the Indian workforce still works in the agriculture sector¹⁷.

Rural GDP may be considered as a proxy for rural literacy. A cluster having high Agri GDP/c will provide enough incentive to the service providers to lay the telecom infrastructure, as there would be a sizeable population who would possibly subscribe to the services.

4. Effect of Rural Literacy Rate –In our stepwise regression model the variable ‘RLR’¹⁸ was automatically eliminated by the software because its p-value was not significant (as it would have been >0.05). This proves that Rural Literacy Rate does not have a direct impact on RTD. This indicates that people with resources are likely to buy mobile phones irrespective of their literacy level.

10.0 Conclusion

Public funding of USOF streams has not contributed to any significant increase in RTD. It has also not led to substantive mobile infrastructure provision. Its role in broadband roll out has also been limited.

¹⁷ http://articles.timesofindia.indiatimes.com/2012-03-17/varanasi/31204312_1_agriculture-icar-farmers, accessed on October 30, 2012

¹⁸ http://www.nlm.nic.in/nlmgoals_nlm.htm, accessed on October 27, 2012

While the framework of USOF was to involve the private sector, its objectives of doing so have been successful only to a limited extent. For this the DOT and TRAI need to review the structure of the USOF, its ownership and relationship with the DOT as well as the role of BSNL. The USOF needs to seek out more avenues for private sector involvement as it would bring in efficiency in deployment. It may also bring in greater accountability as the ownership of BSNL by DOT has not resulted in effective contractual oversight for timely implementation of rural telecom service provision. Further, the design of the USOF needs to incorporate emerging technologies, so as not to widen the digital divide between urban and rural areas.

We have developed a model of RTD penetration based on UTD, % VE, and Agri GDP/c. This model is used to suggest a sequencing of USOF roll-out and more effective use of USOF. We suggest that the USOF needs to define coverage areas at a more disaggregated level than states, as is the current practice. A more nuanced and refined approach to roll out could lead to more effective use of the USOF. Such an approach would lead to better match of public resources to private investments.

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Appendix

Table 1: Teledensity in India from March 1996 to March 2012

	Urban	Rural	Gap	Total
1996	4.0	0.3	3.7	1.4
1997	4.8	0.3	4.5	1.6
1998	5.8	0.4	5.4	1.9
1999	6.9	0.5	6.4	2.3
2000	8.2	0.7	7.6	2.9
2001	10.4	0.9	9.4	3.6
2002	12.2	1.2	11.0	4.3
2003	14.3	1.5	12.8	5.1
2004	20.8	1.6	19.2	7.0
2005	26.2	1.7	24.5	9.1
2006	38.0	1.9	36.1	12.8
2007	50.0	4.9	45.1	18.3
2008	84.2	12.9	71.2	33.2
2009	89.4	14.9	74.5	36.9
2010	119.8	24.3	95.5	52.7
2011	157.3	33.8	123.5	70.9
2012	169.6	39.2	130.3	78.7

(Source: TRAI, *The Indian Telecom Services Performance Indicators Reports, Various Years*, <http://www.trai.gov.in/WriteReadData/PIRReport/Documents/>, accessed on April 25, 2012)

Table 2: USOF Fund Status

Financial Year	Funds Collected as UAL (as per DoT A/Cs)	Funds allocated	Funds disbursed	Reimbursement of LF and Spectrum Charges to BSNL	Balance
2002-03	1653.6	300.0	300.0	2300.0	-946.4
2003-04	2143.2	200.0	200.0	2300.0	-356.8
2004-05	3457.7	1314.6	1314.6	1765.7	377.5
2005-06	3215.1	1766.9	1766.9	583.0	865.3
2006-07	3940.7	1500.0	1500.0	0.0	2440.7
2007-08	5405.8	1290.0	1290.0	0.0	4115.8
2008-09	5515.1	1600.0	1600.0	0.0	3915.1
2009-10	5778.0	2400.0	2400.0	0.0	3378.0
2010-11	6114.6	3100.0	3100.0	0.0	3014.6
2011-12	6723.6	1688.0	1688.0	0.0	5035.6
Total	43947.5	15159.4	15159.4	6948.6	21839.5

(Source: <http://www.usof.gov.in>, accessed on September 25, 2012)

Table 3: Subsidy Disbursement to Various Service Providers from FY 2002-03 to FY 2010-11

Service Providers	Subsidy Disbursed (Rs. Cr)	% Share
BSNL	11639.6	86.0
RIL	737.3	6.0
TTSL	720.9	5.0
TTML	313.4	2.0
Others	60.2	1.0
Total	13571	100.0

(Source: <http://www.usof.gov.in>, accessed on September 25, 2012)

Table 4: Operator wise number of SDCAs where RDELs are to be provided

Sl. No.	Service Area	Service Provider	Total number of eligible SDCAs	Number of (SSAs)/SDCAs			
				BSNL (171)	RIL (61)	TTL (37)	TTL (MH) (5)
1	Andaman & Nicobar		0	0	0	0	0
2	Andhra Pradesh	BSNL,RIL	117	81	36	0	0
3	Assam	BSNL	26	26	0	0	0
4	Bihar	BSNL,RIL,TTL	56	44	3	9	0
5	Jharkhand	BSNL	66	66	0	0	0
6	Gujarat	BSNL,RIL	120	99	21	0	0
7	Haryana	RIL, TTL	16	0	3	13	0
8	Himachal Pradesh	BSNL,RIL	22	11	11	0	0
9	Jammu & Kashmir	BSNL	19	19	0	0	0
10	Karnataka	BSNL,RIL,TTL	117	66	43	8	0
11	Kerala	BSNL,RIL	15	10	5	0	0
12	Madhya Pradesh	BSNL,RIL,TTL	230	209	10	11	0
13	Chhattisgarh	BSNL	88	88	0	0	0
14	Maharashtra	BSNL,RIL,TTL (MH)	228	172	13	0	43
15	North East-I	BSNL	27	27	0	0	0
16	North East-II	BSNL	50	50	0	0	0
17	Orissa	BSNL	96	96	0	0	0
18	Punjab	BSNL,RIL,TTL	18	5	1	12	0
19	Rajasthan	BSNL,RIL,TTL	203	118	5	80	0
20	Tamil Nadu	BSNL,RIL	24	6	18	0	0
21	UP(East)	BSNL,RIL,TTL	84	39	15	30	0
22	UP(West)	RIL,TTL	21	0	12	9	0
23	Uttaranchal	BSNL	29	29	0	0	0
24	West Bengal	BSNL,RIL	13	6	7	0	0
	Total		1685	1267	203	172	43

(Source: USOF, <http://www.usof.gov.in>, accessed on September 29, 2012)

Table 5: Circle-wise progress report of RCPs upto 31.05.10

Sl. No.	Service Area	To be provided			To be provided			Achievement		
		(As per Agreement)			(Reconciled Figures)					
		BSNL	RIL	Total	BSNL	RIL	Total	BSNL	RIL	Total
1	Andaman & Nicobar	0	0	0	0	0	0	0	0	0
2	Andhra Pradesh	3677	1865	5542	3671	1761	5432	3671	1761	5432
3	Assam	1913	0	1913	1913	0	1913	1913	0	1913
4	Bihar	1302	3254	4556	1224	3243	4467	1224	3243	4467
5	Jharkhand	451	0	451	448	0	448	448	0	448
6	Gujarat#	1829	272	2101	1461	66	1527	1461	66	1527
7	Haryana	145	626	771	88	402	490	88	402	490
8	Himachal Pradesh	95	0	95	36	0	36	36	0	36
9	Jammu & Kashmir	122	0	122	56	0	56	56	0	56
10	Karnataka	1528	669	2197	1528	451	1979	1528	451	1979
11	Kerala	1	0	1	1	0	1	1	0	1
12	Madhya Pradesh	1759	0	1759	1730	0	1730	1730	0	1730
13	Chhattisgarh	627	0	627	627	0	627	627	0	627
14	Maharashtra	3140	305	3445	1735	185	1920	1735	185	1920
15	North East-I	505	0	505	256	0	256	256	0	256
15A	Meghalaya	28	0	28	28	0	28	28	0	28
15B	Mizoram	21	0	21	21	0	21	21	0	21
15C	Tripura	456	0	456	207	0	207	207	0	207
16	North East-II	193	0	193	186	0	186	186	0	186
16A	Arunachal Pradesh	7	0	7	7	0	7	7	0	7
16B	Manipur	95	0	95	89	0	89	89	0	89
16C	Nagaland	91	0	91	90	0	90	90	0	90
17	Orissa	936	0	936	936	0	936	936	0	936
18	Punjab	43	225	268	43	183	226	43	183	226
19	Rajasthan	1416	0	1416	1413	0	1413	1413	0	1413
20	TN & Pondichery	1424	1769	3193	1416	1441	2857	1416	1441	2857
21	Uttar Pradesh (East)	2295	4721	7016	1770	4062	5832	1770	4062	5832
22	Uttar Pradesh (West)	344	0	344	344	0	344	344	0	344
23	Uttaranchal	5	3183	3188	4	3075	3079	4	3075	3079
24	West Bengal	1072	4542	5614	1072	3867	4939	1072	3867	4939
	Total	24822	21431	46253	21958	18736	40694	21958	18736	40694

(Source: <http://www.usof.gov.in>, accessed on September 25, 2012)

Table 6: Status of RDELs provided as on 31.03.10

Sl. No.	Service Area	Total number of eligible SDCAs	Cumulative number of RDELs provided since 01.04.2005				
			BSNL	RIL	TTL	TTL (MH)	Total
1	Andaman & Nicobar	0	0	0	0	0	0
2	Andhra Pradesh	117	222867	354275	0	0	577142
3	Assam	26	65549	0	0	0	65549
4	Bihar	56	123097	14807	200537	0	338441
5	Jharkhand	66	52701	0	0	0	52701
6	Gujarat	120	222150	181451	0	0	403601
7	Haryana	16	0	19075	224167	0	243242
8	Himachal Pradesh	22	14334	80013	0	0	94347
9	Jammu & Kashmir	19	26214	0	0	0	26214
10	Karnataka	117	205294	407572	108811	0	721677
11	Kerala	15	554	237149	0	0	237703
12	Madhya Pradesh	230	521441	111065	226292	0	858798
13	Chhattisgarh	88	153340	0	0	0	153340
14	Maharashtra	228	462851	113658	0	794244	1370753
15	North East-I	27	51221	0	0	0	51221
16	North East-II	50	26858	0	0	0	26858
17	Orissa	96	157752	0	0	0	157752
18	Punjab	18	18578	5004	324270	0	347852
19	Rajasthan	203	213725	88115	584168	0	886008
20	Tamil Nadu	24	47114	292686	0	0	339800
21	UP(East)	84	202785	74674	320564	0	598023
22	UP(West)	21	0	144330	106917	0	251247
23	Uttaranchal	29	55634	0	0	0	55634
24	West Bengal	13	6356	62932	0	0	69288
	Total	1685	2850415	2186806	2095726	794244	7927191

(Source: <http://www.usof.gov.in>, accessed on September 25, 2012)

Table 7 - State Wise Data for RTD, Agri GDP, Village Electrification, and Rural Literacy rate

Sr. No.	States	RTD (as on 30-11-2011) %	UTD (as on 30-11-2011)	Agri GDP per capita (Rs)	% Village electrified as on 31-03-10 (Provisional)	Rural Literacy Rate
1	Andhra Pr.	37.3	189.8	175233.2	100.0	61.1
2	Assam	28.1	142.8	84373.6	85.6	70.4
3	Bihar	30.1	313.5	44205.1	61.3	61.8
4	Chhattisgarh	2.8	17.3	86413.1	96.9	66.8
5	Gujarat	50.2	140.1	165041.2	99.7	73.0
6	Haryana	50.5	157.1	235233.0	100.0	72.7
7	Himachal Pr.	74.4	474.4	14114.4	98.2	82.9
8	J & K	29.2	116.1	9881.5	98.2	65.0
9	Jharkhand	1.8	13.5	60648.6	31.1	62.4
10	Karnataka	38.8	185.5	139615.2	99.9	68.9
11	Kerala	56.2	252.7	172627.0	100.0	92.9
12	Madhya Pr.	33.2	157.6	90359.9	96.4	65.3
13	Maharashtra*	40.6	137.0	127724.3	88.3	77.1
14	N.E I**	62.6	230.2	13147.0	65.7	84.9
15	N.E II***	8.0	37.2	13464.3	69.2	75.6
16	Orissa	32.8	208.9	88778.2	62.6	70.8
17	Punjab	62.9	180.1	312383.2	100.0	72.5
18	Rajasthan	41.9	158.6	107384.2	71.1	62.3
19	Tamil Nadu	53.4	159.0	127146.6	100.0	73.8
20	Uttar Pradesh	30.8	165.5	799543.2	88.3	67.6
21	Uttarakhand	9.7	31.6	11421.2	97.1	77.1
22	West Bengal	40.4	173.4	121955.8	99.5	73.0

(Source: (i) <http://www.usof.gov.in>, (ii) www.rural.nic.in, and (iii)

http://www.powermin.nic.in/JSP_SERVLETS/internal.jsp, accessed on October 25, 2012)

* Teledensity for state of Maharashtra is including Goa

**N.E I is NORTH-EAST- I (comprising Meghalaya, Mizoram & Tripura)

***NORTH-EAST- II (comprising Arunachal Pradesh, Manipur & Nagaland)