Has the ICT Diffusion been biased in India? Identifying Socio-Economic Factors for Policy at the Household level

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Abstract
Information and Communication Technology (ICT) possesses a great degree of potentialities to transform the economy, but the path of success is serendipitous. This is due to lack of pro-ICT infrastructure. India presently faces number of challenges in order to reach ICT to the miles. This paper examines the mapping of ICT diffusion and significant socio-economic factors affecting the diffusion. The scope for innovation and parallel socio-economic development have been highly hindered due to the extent of digital divide in India. The analysis is developed with the help of the household level nationalized database of NFHS (National Family Health Survey) - III round, 2005-6, DLHS (District Level Household Survey) 2007-8. The probit regression is applied to derive the significant socio-economic factors of ICT diffusion. The result suggests that the gap between rural and urban areas has actually been widened. The results of *Probit regression and interaction term effect* suggest that more emphasis should be on human development indicators like education, health, income generation, skill enhancement training, and local content.
Keywords: ICT, socio-economic disparities, policy implications.
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I. INTRODUCTION

Information and Communication Technology (ICT) contains a great level of potentialities in transforming the economy. Lack of factors associated with the use of ICT creates additional hindrance for the poor to catch up and fail to take the benefit of ICT applications. In a nutshell, it could also be mentioned that, ICT technology is actually going to substantiate the “vicious circle of poverty” unless a major parallel development takes place. This is due to the fact that the rural India is still lacking many basic infrastructure, education and income etc. It could be possible if the emphasis is more on the pro-ICT infrastructure than just having emphasis on the ICT diffusion. It is therefore important to discuss the issues of digital divide having posed with such differences.

Cecchini and Scott (2003) summarized a range of ICT-based applications aimed at poverty reduction in the context of rural India. The new wealth that has arisen in India from the ICT boom benefits the relatively wealthy and educated in the first instance but trickling down effect for the poor and uneducated is dubious since statistics paint a mixed picture. (Kambhampati 2002).

It has been argued that the location and density are the important factors behind internet penetration. These creat urban baiasness (Augereau and Greenstein (2001) of internet diffusion. Forman, Goldfarb, and Greenstein (2005) based on US data, show that, firms on average, in large cities adopted Internet technology faster than those in small cities or rural areas. They find evidence of both complementarity and substitutability between Internet use and cities. Their work also highlights evidence of increasing availability of local online content and local availability (Downes and Greenstein (2007) in large cities for the skewed diffusion of internet in urban areas as against rural areas.

The work of Walsham and Sahay (2006) and Avgerou (2008) deal with ICTs in developing countries, but Heeks (2006) argued that much of this literature do not address the question of what is meant by development. The first broad development category is summarized as *better lives for the poor*.

The Millennium Development Goals (United Nations, 2009) target to end poverty, hunger and improvement of health and education for the poor. ICTs are seen to have high potential in a number of these areas. The effective gathering and use of data through computerised health information systems is seen as a key prerequisite to improved health care delivery and the better assessment of health programmes (Braa et al 2004). Telecentres are a second area where ICTs have been widely applied with the aim of bridging the digital divide for the poor (Reilly and Gómez 2001), providing them with access to information and better freedom of choice. However, it is recognised that bridging the digital divide is not solely a matter of technology but also of the social, political, institutional and cultural contexts which shape people’s access and use of ICTs (Warschauer 2003). The usage of mobile phones is growing at a phenomenal rate in the developing countries as a whole (Heeks and Jagun 2007) and this can offer flexible support to the improvisation capabilities of the poor in trying to improve their lives, providing better economic and social opportunities.

One school of thought refers that ICT reduces the costs of performing isolated economic activities, particularly in rural settings, even when deployment costs are high. It has also been argued that the gross benefits from ICT adoption is less with the decrease in the size or density of a firm's location; other things equal. The density develops a better network and also helps in availability of other facilities. (Cairncross, 1997; Forman, Goldfarb, and Greenstein, 2005).

According to another school of thought ICT will lead to increasing concentration of economic activity. There are two reasons why ICT may lead to increase in concentration. First, increase in the size or population density of a location may increase the marginal benefit from electronic communication (Gaspar and Glaeser, 1998). This states that improvement in electronic communications increase the prevalence of face-to-face meetings, thereby increasing the value of locating in cities.[2] Moreover, increase in size of population adds the availability of complementary products and services that facilitate net benefits of ICT investment.

This paper attempts to critically examine the mapping of ICT diffusion especially to highlight the persisting gap of ICT use among rural and urban areas. This study also looked at the extent of socio-economic divide in terms of access to the ICT devices. This paper examines the significant factors which cause the digital divide and suggested policy measures based on the important factors.

The analysis is developed with the help of nationalized database of NFHS (National Family Health Survey) - III round, 2005-6 and DLHS (District Level Household Survey) 2007-8. The *Probit Regression Model* is applied[3] in the database of NFHS-III to analyze the determinants of diffusion.

II. THEORY ON ICT DIFFUSION

The common lens through which theorists study the adoption and development of new ideas is commonly known as Innovation Theory or Diffusion Theory. In its basic form, diffusion is defined as the process by which an innovation is adopted and gains acceptance by individuals or members of a community. Diffusion Theory represents a complex number of sub-theories that collectively study the processes of adoption. Perhaps the first and famous account of diffusion research was done in 1903 by French sociologist Gabriel Tarde (1903). Tarde plotted the original *S-shaped innovation curve* as he believed that most innovations have an S-shaped rate of adoption (Ryan and Gross (1943)[4]. Through the slope of the S-curve, Tarde could identify those innovations with a relatively fast rate of adoption (steep slope) versus those with a slower rate (gradual slope).

Several decades later, Ryan and Gross (1943) published their seminal study which described the diffusion of hybrid seed among a group of Iowa farmers. They discovered that diffusion was "a social process through which subjective evaluations of an innovation spread from earlier to later adopters rather than one of rational, economic decision making" (Valente, 1995). Theorists since (Abrahamson & Rosenkopf, 1997; Gladwell, 2000; Midgley &

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[2] This view is consistent with that of IS researchers who study how different types of communication media have different levels of information richness (Daft and Lengel, 1984; Daft et al., 1987). Media such as face-to-face communication, email, and telephone communication differ in terms of feedback capability, communication channels, utilization, source, and language (Bodensteiner, 1970; Holland et al., 1976). As a result of these differing capabilities, these media may be used to transmit different kinds of information.

[3] The analysis is developed with the help of SPSS-16 for cross tabulation results and STATA 12.0 for regression estimation.

[4] They noted that the rate of adoption of hybrid seed among a group of Iowa farmers followed an S-curve when plotted on a cumulative basis over time. Epidemic model was used.

Dowling, 1978; Rogers, 1995) have used and modified these basic categories to build upon the work of Ryan and Gross.

Several authors have studied the well-known fact that technology diffusion follows an *S-shaped* pattern. This empirical recurrence is documented by Griliches (1957), Davies (1979), and Gort and Klepper (1982), and Mansfield (1961), and is modelled in Jovanovic and Lach (1989) among others. Pierre-Francois Verhulst developed the Logistic growth model for population growth forecasting purposed in 1843. The logistic curve is otherwise known as S-shaped curve. Griliches (1957) was the first to employ it for innovation diffusion. McKnight, et al (2001) used this formulation in the context of ICTs.

An excellent work of diffusion modelling in economics is by Stoneman (2002). Adoption is the individual-level decision to use a new technology. Diffusion is the aggregation of a number of adoption decisions. Rogers (1995) defines it as “the process by which an innovation is communicated through certain channels over time among the members of a social system.” Diffusion research is then concerned with finding patterns across a large number of adoption decisions. The earliest economic models of diffusion were *epidemic models*. These models assumed that the diffusion of new technology is like that of an infectious disease. Non-adopters adopt a new technology when they come into contact with adopters and learn about the new technology. Over time, the number of users increases, leading to an increased probability of any given non-adopter learning about the technology. This increases the rate of diffusion initially. As more people adopt, the number of non-adopters declines, which eventually causes decrease in the rate of diffusion. This pattern of diffusion leads to the common *S-shaped curve* on the rate of technology diffusion with respect to time.

The *first modern technology diffusion* study was by Ryan and Gross (1943) where epidemic model was used to observe the diffusion of hybrid corn to Iowa farmers and find that social networks matter. Epidemic models are commonly used to help forecast the rate of aggregate technology diffusion. *Bass* (1969) uses an epidemic model to help predict the rate at which a product will diffuse. Fichman (2000) refers to epidemic models used to forecast the rate, pattern, and extent of technology diffusion as “diffusion modelling studies.” (For surveys of such studies, see Mahajan, Muller, and Bass (1990) and Mahajan and Peterson (1985). The central themes of these models—communications and social networks—are also prominent in recent economic research on technology diffusion. Papers by Goolsbee and Klenow, (2002) examined how these themes have influenced the diffusion of personal computers and by Bell and Song (2004) on use of online grocery services.

As noted above, in epidemic models technology spreads through interpersonal contact and information dissemination. *These models do not explicitly model the adoption decisions of individual users, nor do they allow for differences in the costs and benefits of adoption by different members of the population.* As a result, these models omit many important aspects of economic behaviour.

Probit (or rank) models emphasize population heterogeneity. Pioneered by David (1990), the most basic model assumes that the entire population has perfect information about the technology. Individuals (or firms) adopt the technology when the net benefit of adopting is positive. Since the probit model is the one most commonly used in economic diffusion modeling, it is worthwhile to consider it further. The basic probit model underlies any diffusion modeling that explicitly considers agents' tradeoffs between the costs and benefits of adopting, and it is the workhorse for many of the models.

III. MAPPING OF ICT IN INDIA

There are number of ways to define digital divide as mentioned in the literature. The divide in the pattern of ICT diffusion has been explained with the help of availability of data. For some indicators like density of ICT devices like telephone, internet and personal computers are collected from TRAI's (Telecom Regulatory Authority of India) reports. The household level or unit level digital divide has been emphasized throughout the section by computing and estimating from the household survey data of NFHS-2005-6 and DLHS 2007-8.

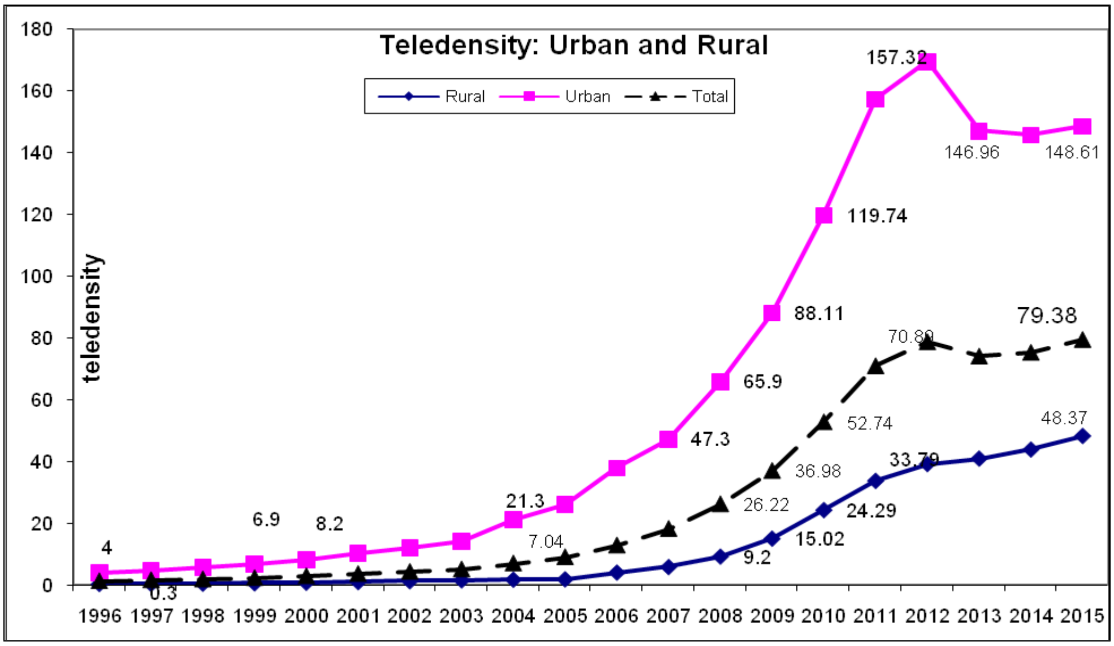
Teledensity
The diffusion of telephone is presently very wide spread. The data on telephone use and availability is composed of wireline and wireless telephone. Due to the evolution of cellular phone, the spread of subscribers has been unparallel. Teledensity was measured as number of subscriber per 100 people. Till March 2015, as per the TRAI report, tele-density has been accentuated to 79.38 per 100 persons of which urban tele-density stands at 148.61 and rural tele-density is of only 48.37 (Figure 1). The broadband subscriber was 99.2 million till March 2015. It is noticed that this spiral development has been initiated from 1999-2000 due to number of policy facilitations. However, the major impetus in the diffusion process has been since 2001 due to the National Telecommunication Policy (NTP), 2001.

Rural – Urban Divide

The rural – urban teledensity divide is clearly visible from figure-1. Till 2011, the urban tele-density has reached to 157.3 as compared to only 33.8 in rural areas as per the census 2011 data. This has also been validated with the TRAI reports as presented in the figure-1. The rate of growth is very fast in urban areas. Therefore, the gap has been persisting and widening. The favorable policies on telephone infrastructure development are indeed confined to the urban areas.

The Telecom sector continued to register an impressive growth in the year 2010-11. During the year, the number of telephone subscriptions increased from 621.3 million to 846.3 million, registering a growth of 36.2%. While the wireless subscription base increased by 227.3 million, the wireline base recorded a decline of 2.2 million. The wireless segment continued to dominate with a total base of 811.59 million connections. The overall tele-density in the country registered an increase from 52.7 at the end of March 2010 to 70.9 at the end of March 2011.

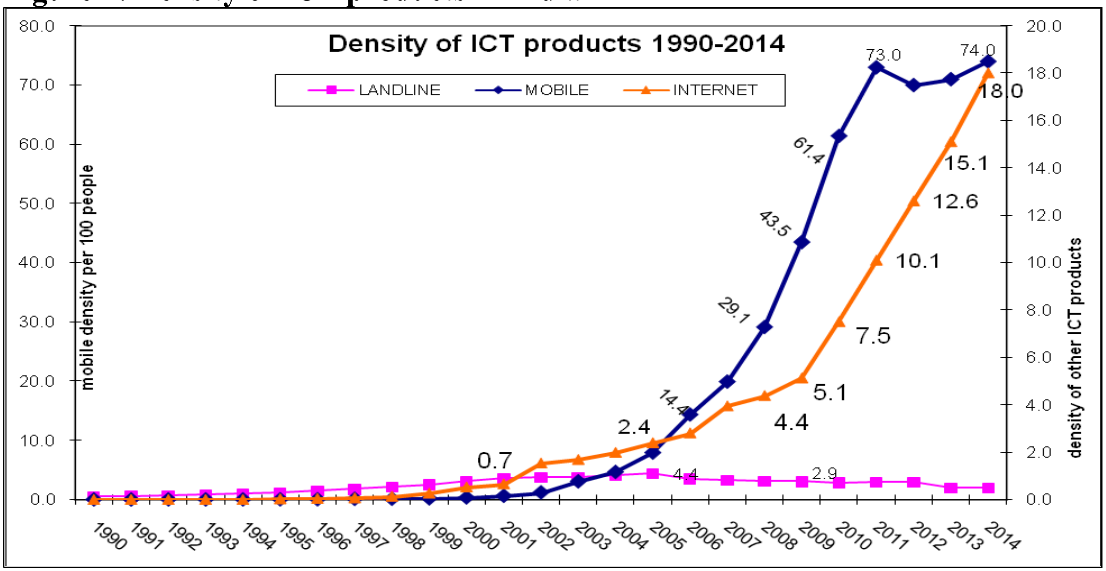
Figure 1: Teledensity in Urban and Rural Areas in India



Source: TRAI Reports of various years

The rural teledensity as on 31st March 2010 was 24.3 increased to 33.8 at the end of March 2011, as compared to the urban teledensity of 119.8 in 2010 and 157.3 in 2011. However, the growth rate of subscribers in rural areas during the year was higher at 40.6 % compared to 34.1% in urban areas (figure-1).

Figure 2: Density of ICT products in India



Source: TRAI reports of various years

The density of ICT devices is presented in the figure-2. Internet, landline and mobile telephone have been explained as per 100 persons. The major spiral in the mobile density has been since 2001. The reason behind this is majorly attributed to the NTP 2001. In contrast to the growth of mobile/wireless telephone, there has been a reverse growth of landline telephone since the same period. While the mobile telephone subscribers were 74 per 100 persons, the landline connections were only 2 per 100 persons in 2014. In contrast to the rapid growth in voice segment, the growth in the Internet and broadband connections was modest. The growth of internet subscribers has been slightly better since 1999 but still below the level of many countries in the world. The density of internet users reached to 18 per 100 persons in

December 2014 from 15.1 in 2013. The slow growth of Internet and Broadband connection can be attributed to the fact that the predominant mode of providing Broadband connection was by using digital subscriber line (DSL) technologies over copper pairs, which are limited in number and also due to geographical spread.

Density of all ICT products

In the process of understanding the diffusion of four types of ICT devices across different states in India clarifies different pattern based on the geographical position and type of states by their development. Table-1 presents household level holding of various ICT products by percentage. States like Odisha, Bihar, Jharkhand and Chhatisgarh etc. are among the bottom five states holding ICT products. Likewise this, other figures can be interpreted. (Table 1)

Table 1: Household Level Holding of Various ICT Products (in per cent**)**

	Radio		TV		telephone		computer	
top 5 states	Jammu & Kashmir	66.3	Manipur	84.1	Delhi	79.8	Goa	21.8
	Manipur	62.8	Goa	82.2	Goa	75.5	Delhi	18.8
	Kerala	42.0	Orissa	78.4	Kerala	72.1	Kerala	7.9
	Arunachal Pradesh	40.5	Andhra Pradesh	71.3	Punjab	69.7	Punjab	5.6
	Mizoram	37.3	Kerala	71.3	Himachal Pradesh	60.8	Mizoram	4.2
	India	**26.3**		**29.1**		**36.8**		**2.6**
bottom 5 states	Madhya Pradesh	19.0	Gujarat	29.4	Meghalaya	20.7	Orissa	1.4
	Chhattisgarh	16.9	Uttarakhand	26.4	Orissa	18.7	Chhattisgarh	1.3
	Orissa	16.8	Assam	25.8	Jharkhand	18.6	Jharkhand	1.2
	Gujarat	16.1	Uttar Pradesh	19.6	Bihar	18.0	Uttar Pradesh	1.0
	Andhra Pradesh	11.2	Punjab	11.8	Chhattisgarh	14.0	Bihar	0.5

Source: Computed from DLHS-III – household profile
Note: figures are in percentage out of total household in each state.

This information in this table-2 is from the unit level data of NFHS – III which highlights the gap among different groups. The fiugres mentioned are well indicative. The gaps are also observed between male and female for each of the background charateristics. 'Reading newspaper or magazine at least once a week' is varying by age and sex. Higher the age, this value is getting low. Male are more exposed to ICT devices than the female across categories.

Table 2: Exposure to ICT (in percentage of men and women of age 15-49)

background characteristics	reads a newspaper or magazine at least once a week		watch television at least once a week		listens to radio at least once a week		not regularly exposed to any media	
	female	Male	female	Male	female	Male	female	male
Age								
15-19	28.6	55.7	59.4	71.2	34.3	48.8	28.5	11.8
20-24	25.5	57.7	58	69.5	30.9	48.8	31.3	12.2
25-29	21.9	54.9	54.5	65.4	26.9	45.4	35.7	15.5
30-34	20.5	53.1	52.6	60.8	26.6	41.8	37.8	20.1
35-39	19.6	49.1	51.7	57.5	25.8	40.9	38.3	24.2

40-44	19.4	48	51.4	54.3	26.2	39.4	38.9	26.3
45-49	18.5	47.7	52.8	54.7	25.9	39.7	38.5	25.7
Residence								
Urban	41.6	69.4	82	83.9	31.7	45.3	12.6	6.2
Rural	13.7	43.6	41.9	51.2	27.3	43.7	45.4	25.3
Education								
no education	0.2	1.6	29.4	31.8	18.1	30.6	60.3	48.8
<5years complete	6.1	17.9	51.7	47.9	28.5	40.8	36.5	29.8
5-7years complete	19.1	45.2	62.8	59.5	30.6	42	25.3	18.9
8-9years complete	36.1	65.5	72.1	68.7	37.7	48.6	16.3	10.4
10-11years complete	52.9	79.6	82.5	78.6	39.7	49	7.9	5.3
12 or more complete	74.2	91.5	90.9	85.4	42.9	52.3	3	2
marital status								
Never married	40.6	62	70.8	74.7	38.5	49.6	18.9	9.8
Currently married	18.7	48.2	51.2	56.8	26.4	41.2	38.4	22.9
widowed/divorced/ separated/deserted	12.4	35.7	47.4	45	23.4	41.3	43.9	33.4
Religion								
Hindu	22.7	53.8	55.6	63.3	29.1	44.7	34.4	18
Muslim	18	45	45.5	57.2	27.3	43.7	41.7	21.7
Christian	40.2	60.1	68.6	71.9	30.5	43	20.3	13.3
Sikh	33	56	80.4	84	20.2	32.3	16	10.7
Buddhist/Neo-Buddhist	30.3	61.1	66.2	70.4	32	43.2	26.5	15.5
Jain	76.7	95.5	90.1	90.4	37.5	46.1	3.1	0
Other	9	21.5	22.2	30.4	16.7	34.8	68	46.5
caste/tribe								
SC	15.6	45.1	50.6	59.5	26.5	43.8	38.9	21.1
ST	10	29.5	30.3	39.5	20.9	36.3	57.4	37.8
OBC	19.9	54.1	53.1	63.1	28.1	46.2	36.8	17.4
Other	33.9	62.3	66	71.1	32.8	44.2	24.1	13
wealth index								
Lowest	2	17.1	13.9	24.5	16.3	34.4	73.7	49.3
Second	5.5	33.3	29.6	40.5	24.3	43.3	55.1	29.4
Middle	12.3	48.7	51.9	61.1	29.7	46.5	34.9	16
Fourth	27	65.3	75.3	79.8	33.6	48.2	16.2	6.7
Highest	59.7	84.8	92.5	93.1	36.8	46.1	3.9	1.7

Source: computed from the NFHS-III

IV. MODEL

The rural development wing of ICT is always debated due to the fact that realizing the poverty reducing potential of ICT is not guaranteed. ICT outreach requires huge capital as well as human capital development, which in turn incurs more costs. Thus, it requires attention from the public policy makers and institutional framework for allocating budget as well as to have a careful project design. Insufficient or lack of information and communication infrastructure, high access costs, and illiteracy have bestowed the benefits of ICT on the positive direction for urban segments of the population to the detriment of the poor and rural areas.

The arguments can be presented in a single model, which explains:

- Why the poor and the rich use different communications techniques? (through wealth index
- Why the nature of technical changes in new ICT has hitherto been biased towards the rich?
- How the consequences of this bias in technical change has been a widening of the digital divide, and

- What the policy implications are of the current diffusion process of new ICT?

This can be expressed with an information utility function of the consumer as U_i, which is in fact affected by number of factors, broadly categorised as capital and time.

$$\text{Max } U_i = f(K, T)$$

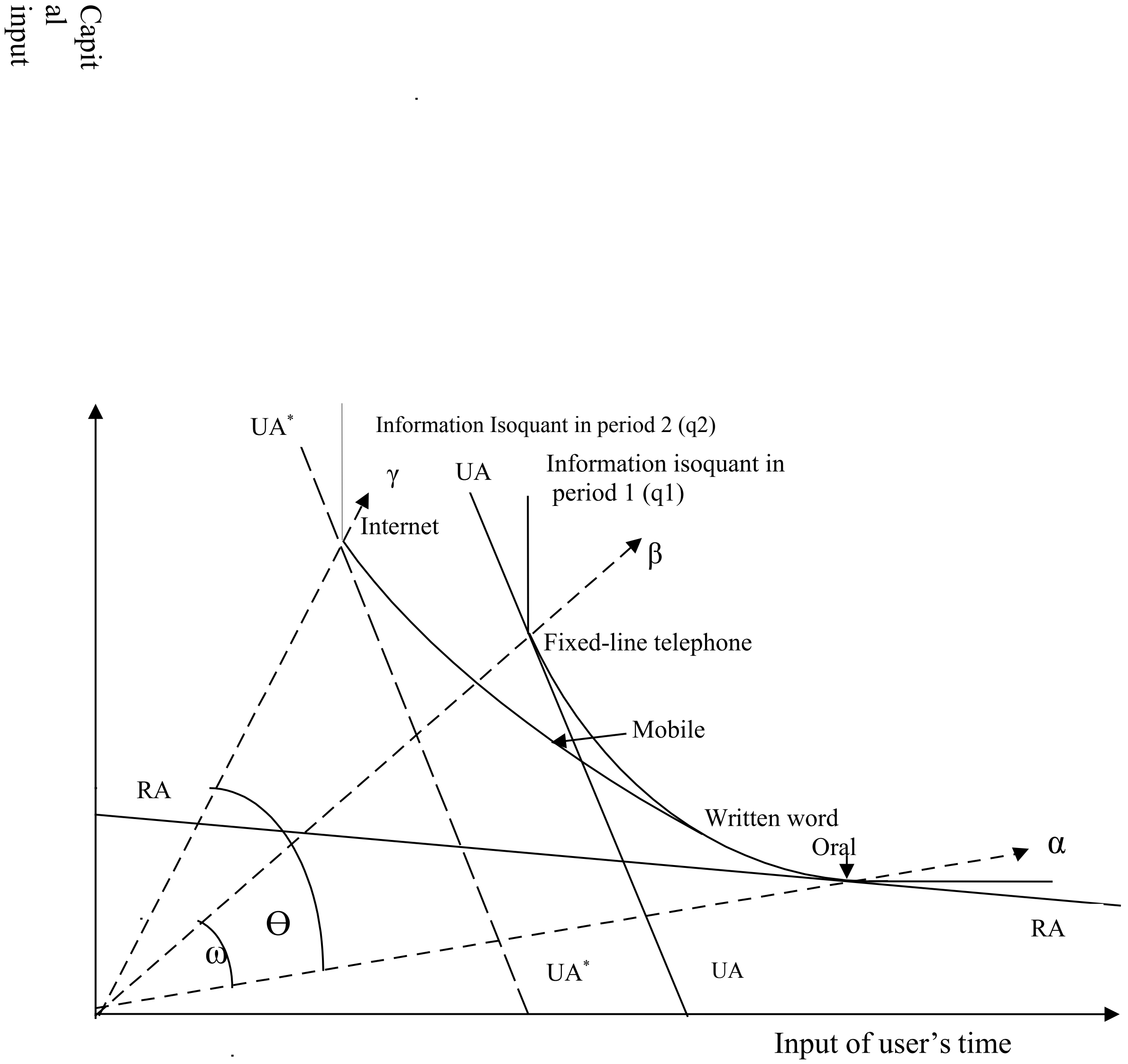
$$\text{s.t. } Y = r.\,K + w.\,T$$

The model is adapted from Keith Griffin's (Griffin, 1974) work on the generation and diffusion of Green Revolution technology in agriculture, which raised similar lines of issues related to the objectives of ICT.

Suppose that in the first period, ICT consists of three fixed-coefficient communications techniques (oral, written and fixed line telephony). Each technique requires different amounts of user time combined with different amount of capital (hard/software, human capital) to transmit a given amount of information. Since each technique is technically efficient, an information isoquant (q1) can be developed as a convex combination of techniques.

The ratio of hourly value of user time to the hourly user-cost of capital varies between urban areas (UA) and rural areas (RA). People in the urban areas are generally characterised comparatively richer than the rural areas. The value of time to the rural people is low due to under-employment and low productivity and mostly due to dependency on agriculture, while the use cost of ICT capital to them is very high due to constraints, imperfect capital markets and lack of infrastructure. Thus the relative price of capital faced by them is very high. By contrast, the value of time to the urban people is high and the user cost of ICT capital is lower as they are more likely to live and work in an infrastructure-rich environment where the network effect and spillover is good. Hence, the relative price of capital faced by them is low. This implies that the urban people and rural people choose different least cost ICT techniques, even if they face the same choice set (Isoquant). The rich choose to communicate by fixed line telephony (β), while rural people choose to communicate orally (α). The size of ICT divide in the first period is mentioned by the angle ω. (Figure 3)

Figure 3: Diffusion model of new ICT in rural and urban areas



In the second period, two new techniques become available (mobile telephony and computer access to the internet). Mobile telephones save on significant amount of associated infrastructure (transmission towers replace overhead/underground cables), but require the same amount of user time per unit of information communicated as fixed telephony. Communication over the internet is very fast, thereby saving user time, but requires much more capital than any of the existing techniques. This pattern of technical change implies that only the relatively capital-intensive segments of the isoquant shift in towards the origin. Two of the initial techniques remain unaffected (oral, written word), while one (fixed line telephony) becomes technically inefficient (obsolete). The new isoquant is q2.

The distributional consequences of this pattern of technical change are profound, because only the segment of the isoquant relevant to the urban areas. So, in the second period, the urban people switch from communicating by fixed telephony to using internet, while the poor remain communicating orally. Although in practice, the urban people are likely to use both mobile and the internet, but each for different purposes. Adding to this, mobile phones can in certain circumstances provide internet, similarly also for the rural areas.

This set of user pattern leads to a widening of the ICT gap as measured by the angle between the capital/labour ratio of the communication techniques used by the urban areas (γ) and that by the rural areas (α). The magnitude of the digital divide in the subsequent period (Θ) is clearly greater than in the previous period (ω).

The implication for a pro-poor ICT policy is clear. The relative price of capital to the rural areas should be reduced by improving access to training, extending the electricity to low income areas and by granting selective and temporary subsidies to poor users. In addition, the focus of R&D in ICT should shift to the poor-user techniques.

Probit Model

Epidemic model and Bass model were used earlier for ICT diffusion. But these models do not explicitly model the adoption decisions of individual users, nor do they allow for differences in the costs and benefits of adoption by different members of the population. As a result, these models omit many important aspects of economic behaviour. Later models including *Probit model* explicitly include these elements. *Probit models* emphasize population heterogeneity, thus considered for the analysis here.[5] This model based on the information utility theory which is affected by number of unobservable utility index, called a *latent variable* that is determined by many explanatory variables. Thus, larger, the value of the latent variable, greater is the probability to own and use ICT products.

$$Ii = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + ...$$

Given the assumption of normality, the probability that I_i* is less than or equal to the minimum threshold limit can be computed from the standardized normal CDF[6] as:

[5] The Kernel Density function of the error term approximates to follow a normal density function. Thus probit model is appropriately chosen.

[6] Normal CDF: if a variable X follows the normal distribution with mean μ and variance σ^2, its PDF is

$$f(X) = \frac{1}{\sqrt{2\sigma^2\pi}} e^{-(X-\mu)^2/2\sigma^2}$$

and its CDF is

$$F(X) = \int_{-\infty}^{X_0} \frac{1}{\sqrt{2\sigma^2\pi}} e^{-(X-\mu)^2/2\sigma^2}$$

where X_0 is some specific value of X.

$$P_i = P(Y = 1 \mid X) = P(I_i^* \leq I_i) = P(Z_i = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \ldots..) =$$

$$= F(\alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \ldots..)$$

Where $P(Y = 1 \mid X)$ means the probability that a household uses ICT given all those explanatory variables.
In order to obtain the information utility index, I_i, and α, β_i

$$Ii = F^{-1}(I_i) = F^{-1}(P_i) = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \ldots..$$

V. PROBIT REGRESSION RESULTS

The probit estimates confirm the idea that socio-economic factors indeed affect the probability of having an ICT product. The probability estimate is derived here for four products as computer, telephone (mobile + landline), TV and Radio as per the availability in the NFHS data set. Some of the variables are considered as dummy like news paper (0=not at all, 1<once a week, 2=at least once a week, 3=every day), electricity, education level, age group and de facto residence (categorised as 1: capital, 2: small city, 3: town and 4: countryside).

For the diffusion of computers the variables like occupation, wealth index score, newspaper, member of households, electricity and level of education variables are quite significant at one per cent level. For telephone diffusion caste, wealth, news paper, electricity, education and place of residence are very significant variables (Table3). The probability to have a TV is significantly affected by marital status, wealth, reading newspaper, member of the households, electricity, level of education, age group. For Radio, although some of the variables are significant, but the some coefficients are just the reverse to other ICT products (caste, newspaper, level of education, and age group etc.). Some of the coefficients are misleading the standard theoretical arguments of the probability of diffusion. This can further be verified with the help of marginal effect analysis. The pseudo R^2 and the overall level of significance are very good. The standard error is closed to zero for most of the coefficients.

Table 3: Probit Regression of each ICT products

	Computer	Telephone	TV	Radio
Caste	0.0031	0.0399*	-0.0127	0.0302*
	[0.02]	[0.01]	[0.01]	[0.01]
Occupation	-0.0020*	-0.0003	-0.0003	-0.0023*
	[0.00]	[0.00]	[0.00]	[0.00]
Marital Status	0.1276	-0.0021	-0.2027*	-0.2341*
	[0.15]	[0.09]	[0.07]	[0.06]
Wealth Index Score	0.0002*	0.0000*	0.0001*	0.00001*
	[0.00]	[0.00]	[0.00]	[0.00]
Newspaper#	0.0719*	0.0866*	-0.0653*	0.0760*
	[0.02]	[0.01]	[0.01]	[0.01]
HH members	0.0117**	0.0635*	0.0441*	0.0314*
	[0.01]	[0.00]	[0.00]	[0.00]
Electricity#	1.1720*	0.8983*	0.6710*	0.3864*
	[0.10]	[0.03]	[0.03]	[0.01]
Edn Level#	0.1543*	0.1312*	0.0931*	-0.0117
	[0.05]	[0.03]	[0.02]	[0.02]
Residence	-0.0393	0.4076*	0.0407	0.3985*
	[0.07]	[0.04]	[0.04]	[0.03]
age group#	-0.0068	0.0066	-0.0691*	0.0406*
	[0.02]	[0.01]	[0.01]	[0.01]

Constant	-0.9794*	-3.5607*	-0.0983	-1.2460*
	[0.3872]	[0.21]	[0.16]	[0.12]
Number of obs	29134	29134	29139	29132
Prob > chi2	0	0	0	0
Pseudo R2	0.743	0.5435	0.4224	0.1602

Source: Computed from NFHS-III

Note: #dummy; * p<0.01, **p<0.05, ***<0.10; SE is in the brackets

Effect of Reference Category

The interaction effect of probit analysis justifies the argument of having an asset as a comparison to other categories of a variable. The probability of holding a computer as a function of caste is quite unclear to understand. But it is easier to understand that how General category people posses a computer as compared to the reference category, i.e. SC. Similarly between OBC and SC or ST and SC etc. In this variable, ST, OBC and General category people are having the probability of holding a computer is positive and also significant at one per cent level. The reverse trend is followed in TV use (Table 4).

Married as compared to unmarried is having the probability to hold less of Computer, telephone and radio but just the reverse in case of TV.

Wealth index is further categorized as poorest, poorer, middle, rich and richest. With the order of higher degree of wealth index, the probability of all ICT holdings increase and almost all are significant at one per cent level. Thus, wealth is a very important indicator of ICT diffusion.

Table 4: Interaction Effect of Reference Category

	Computer	(Std. Err.)	Telephone	(Std. Err.)	TV	(Std. Err.)	Radio	(Std. Err.)
Caste SC®								
ST	0.39*	0.08	-0.08**	0.04	-0.42*	0.03	0.02	0.02
OBC	0.20*	0.07	0.13*	0.03	-0.11*	0.02	0.05*	0.02
Gen	0.34*	0.07	0.18*	0.03	-0.15*	0.02	0.08*	0.02
DK			0.27	0.17	-0.06	0.12	-0.07	0.11
Married Never®								
Current	-0.23	0.44	-0.49***	0.28	0.79*	0.26	-0.01	0.20
Past	-0.14	0.45	-0.50***	0.29	0.57**	0.27	-0.16	0.20
Wealth Poorest®								
Poorer	3.15*	0.27	3.90	.	0.64*	0.03	0.58*	0.03
Middle	3.57	.	4.50*	0.08	1.15*	0.03	0.98*	0.03
Rich	3.95*	0.11	5.31*	0.07	1.85*	0.04	1.24*	0.03
Richest	4.87*	0.10	6.54*	0.08	2.91*	0.04	1.56*	0.03
News Paper No®								
Once a week	0.13**	0.06	0.13*	0.03	-0.02	0.02	0.12*	0.02
at least once	0.21*	0.06	0.23*	0.03	-0.04	0.03	0.19*	0.02
Everyday	0.47*	0.06	0.46*	0.03	-0.07***	0.04	0.29*	0.03
Electricity No®								
Yes	0.52***	0.29	0.25*	0.06	0.70*	0.02	-0.26*	0.02
Education No®								
Primary	0.06	0.10	0.02	0.04	0.13*	0.02	0.05**	0.02
Secondary	0.01	0.08	0.16*	0.04	0.20*	0.02	-0.01	0.02
Higher	0.68*	0.09	0.57*	0.04	0.49*	0.05	0.18*	0.03
Residence Capital®								
Small city	-0.08	0.05	0.12*	0.04	-0.04	0.04	-0.17*	0.03
Town	-0.09**	0.04	0.19*	0.03	0.01	0.03	-0.02	0.02
Countryside	-0.20*	0.05	0.63*	0.03	-0.07*	0.02	0.31*	0.02

Age 15-19®								
20-24	-0.21***	0.12	0.01	0.06	0.03	0.04	-0.01	0.03
25-29	-0.20	0.12	0.01	0.06	-0.02	0.04	-0.02	0.03
30-34	-0.16	0.12	0.03	0.07	-0.11*	0.04	0.04	0.03
35-39	-0.13	0.13	0.06	0.07	-0.12*	0.04	0.09**	0.04
40-44	0.01	0.17	0.20***	0.10	-0.13**	0.06	0.10***	0.05
45-49			0.15	0.21	-0.11	0.12	0.17***	0.09
Constant	-6.91*	0.54	-7.08*	0.30	-2.65*	0.27	-1.55*	0.20
Number of obs.	46060		46060		46071		46059	
Prob > chi2	0		0		0		0	
Pseudo R2	0.4341		0.4341		0.4319		0.0959	

Source: Computed from NFHS-III
* p<0.01, **p<0.05, ***p<0.10

Reading newspaper as a dummy variable categorised as 'not reading at all', 'once a week', 'at least once' and 'everyday'. For the diffusion of computer, telephone and radio is increasingly positive across groups that confirm newspaper as an important indicator, except diffusion of TV. The coefficients of other categories in the newspaper group are negative as compared to people who don't read at all. People who watch TV may not feel necessary to go for reading newspaper for further information.

Households having electricity posses more ICT products except radio which doesn't necessarily requires electricity.
Education as a factor clarifies the understanding that with the increase in the level of education, the probability increases and most of the coefficients are significant. Thus education plays an important part of ICT content.

Place of resident matters for the diffusion of computer a lot. As already argued in the literature that network effect, agglomeration do really matter much. This is due to the fact that the spread of computer and internet requires huge entry cost. The supporting infrastructure for this also possible if the user is more. Thus, the probability of computer is becoming lesser the father from the capital. Here capital is the reference category.

Age matters more for the young age to use more of ICT products except the use of radio. The newly developed devices attract more of young age people than the old as evident is this result.

The results in this table is very appropriate and robust as average coefficient is strongly significant (prob>chi2 approximate to zero) and the pseudo R^2 is closed to 0.5 except for radio.

VI. CONCLUSION

The present scenario of ICT diffusion as analysed is skewed. The analysis from the NFHS data assures the differences by various ways. The theoretical model also well examines the divide between rural and urban areas. This explains the theoretical arguments for 'why poor and rich use different communication technologies', and the biasness of this towards rich. This points out that there would be a possibility of widening the gap, hence suggest appropriate pro-poor ICT policies at utmost importance.

The probit regression for each product indicated that caste, size of the household, occupation, value of asset holding, marriage and location of the household in rural or urban areas are significantly affecting the use of ICT products. The role of education is also important. The interaction effect also confirms the conclusion that place and inherent network effect, sex, education, local content, age (young age), occupation and caste are the dominant factors affecting ICT diffusion significantly.

Urban-Rural divide is increasing primarily due to negligible ICT coverage in rural areas as compared to urban and policies must ensure rural tele-density to increase.

- ✓ This would only be possible when rural growth is mobile and competition driven, like in urban areas.
- ✓ At present, there is less rural mobile coverage and the growth is majorly PSU driven. Unless it is competition driven, growth will continue to be stagnant, but this has to be followed with caution.

As mentioned, it is understood that the gap between rural and urban has actually been widened. It is needed that the major effort could be to transform the local spoken and written languages into universally used set of computer codes, fonts, and so on. But this is only a beginning. The second need is for operating systems and for useful software- so-called applications-that are relevant to and that speak to the needs of the local people. This could be ascertained by the so-called “generic” software that helps the rural people to know the application quickly. There is no scepticism to the fact that the wealth created by a successful software industry could be shared by other sectors of the population. But so-called ‘market forces’ are not adequate to ensure this outcome. Required instead are government policies, actions, and plans, along with the dedication of individuals, real stakeholders and enterprises that benefit from the IT boom, to make sure the wealth created through various channels could aid those who live ordinary lives.

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