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Analyzing and Forecasting the Mobile Teledensity Growth in India

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Abstract
Telecommunications industry is vital for the economic growth of any country, as it helps promote international trade as well as social, economic and regional development. Mobile phones which were introduced in 1995 in India, have now become the dominant means of communication. The number of mobile phone subscribers has increased from 0.03 million in 1995-1996 to 867.8 million in 2012-2013, leading India to become one of the world's fastest growing mobile markets. The main aim of this paper is to analyze the various factors involved in the diffusion of mobile phones in India from 2004-2013 and then forecast the future rate of growth of mobile teledensity till 2023. A regression equation has been established for the teledensity across 21 Indian states. Various non-linear models have been studied, and under assumed saturation level, the logistic distribution function is used for forecasting the growth of mobile phone subscribers in India. The projected growth in the mobile subscriber base which will have important implications for the future growth strategies of telecom companies, handset manufacturers and vendors.

1. Introduction

Telecommunications Industry in India has witnessed an astonishing growth ever since the advent of mobile phones in 1995. The number of cell phone subscribers has grown from a meagre 0.03 million in 1995-1996 to 867.8 million in 2012-2013, making India one of the fastest growing mobile markets in the world and ranking second in the world, in terms of the number of mobile phone subscribers. Mobile teledensity represents the number of mobile phone connections per hundred individuals living within an area.

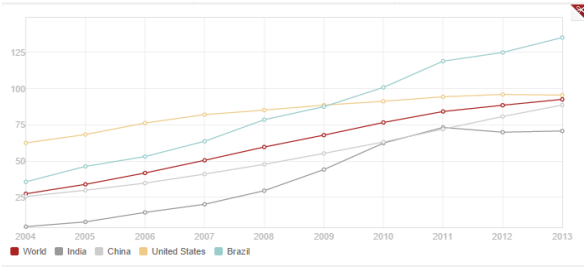

Fig: 1. Relative Growth of Teledensities (data source: worldbank. data.org)

Figure 1 shows the growth of teledensity in India in the period 2004-2013, relative to the growth in China, United States, Brazil and the world on a whole. However, we see that despite of having the second largest mobile subscriber base, India lags behind in terms of teledensity (As indicated by the World Bank data).

To understand the growth of mobile teledensity, we need to have a thorough analysis of the factors that affect the teledensity in India.

The mobile market in India is predominantly supply driven. However, certain demand side factors such as income also play an important role in the adoption of mobile phones in India. Various studies have been carried out to understand the diffusion of mobile phones in the developed countries; while there have been only a few for the developing nations. This paper analyses both demand and supply side factors responsible for the adoption of mobile phones in India in the period 2004-2013 and then forecasts the mobile teledensity upto the year 2023 using the logistic S curve model. The paper proceeds in the following manner. Section 2 discusses the factors affecting the teledensity in India. Section 3 deals with the diffusion model of the mobile teledensity in India. Section 4 presents the model estimation and the estimated forecasts. Section 5 summarizes the conclusions and recommendations of the paper.

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2. Factors Affecting Teledensity in India

The government policies of liberalization, deregulation and competition have played a pivotal role in the growth of telecommunications industry in India. Increased competition has led to a dramatic fall in the tariff rates which has further accentuated the growth of mobile phone subscribers. However, we notice that the share of rural subscribers has continually been increasing while the share of urban subscribers shows a decline.

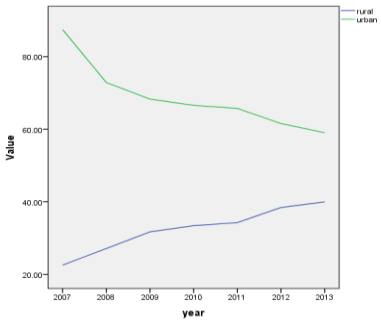

Fig: 2-Change in Percentage of Rural as well as Urban Subscribers

After a comprehensive research of the telecommunications industry, the factors that seem to have a considerable impact on the growth of teledensity are GDP, disposable income of the state and presence of wirelines. Other factors such as the growing popularity of the prepaid service, advent of Chinese mobile phones and mobile number portability have also been considered.

2.1 GDP Per Capita

GDP per Capita can be calculated by taking the gross Domestic product (GDP) of a region and then dividing it by the number of people in the country. It is an indicator of the financial capacity of consumers to purchase mobile phones and associated services and accessories.

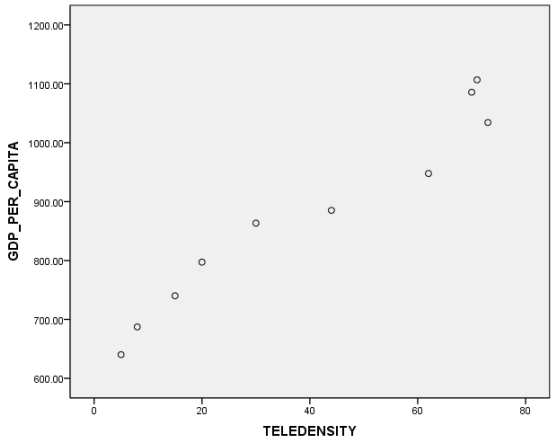

Fig: 3. GDP Per Capita versus Teledensity

Figure 3 shows the scatterplot of GDP per capita varies with teledensity. We can see a positive slope emerging in the scatterplot. An increase in GDP reflects the development of a country and thus, it indicates that, with increasing buying capacity, people of India have adopted mobile technology at a high pace. Also, the Pearson correlation coefficient between the two is found to be 0.973 ($p<0.01$) which indicates that there is a strong relationship between the two.

2.2 Disposable Income across Indian States

The amount of money that is available with the households for spending and saving after they have accounted for their income taxes is referred as the disposable income.

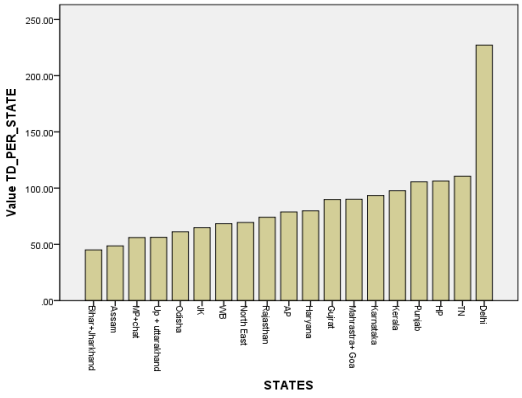

Fig: 4-Variation of Teledensity in Indian States

In the initial years of mobile adoption (upto 2007 in India), the developing nations allocated a large share of their household budget, as compared to the previous years, to communication on account of reduced expenses in transportation, food and clothing etc. In general, this share can be in the order of 0.8 to 1.6 percent in developed markets, is in the 1.9 to 3.9 percent range in emerging ones, and may exceed 10 percent in some low-income markets. [1]

In this paper, we have studied the variation of teledensity amongst the Indian states and then analysed the correlation between the teledensity and the disposable income in each state.

The states with the lowest teledensity are 3 of the 4 BIMARU states i.e. in Bihar, Madhya Pradesh and Uttar Pradesh although the fourth BIMARU state Rajasthan is relatively well off. This coincidence might be attributed to the sociological conditions of the state. On analysing the correlation between Teledensity and disposable income of a state, we see that teledensity increases linearly with disposable income up to certain limit, around INR 70,000 and then the role of disposable income vanishes and what we see is formation of random distribution suggesting after certain level of financial stability.

2.3 Presence of Wirelines

There is a common belief that countries which have high penetration of wire lines services will take it much longer to adapt to wireless services. The high mobile penetration rates in countries such as Jamaica, Russia, and South Africa have been associated with the absence of legacy phone systems. Yet the highest levels of mobile phone adoption generally appear in countries where there are high levels of fixed phones, such as Sweden, Norway, Hong Kong, and Singapore. At a minimum, the issue is a tricky one.

Fig 5 shows the increase in teledensity in India from the year 2004 to 2013. The graph shows that a steep increase in teledensity has taken place after the year 2008. This is roughly the period when the number of fixed telephone connections in India showed a decline. The wire line subscription has fallen down from around 38 million in 2008 to 30 million in 2013.

2.4 Other Factors

According to a recent survey by Nielson in India, almost 97% of the mobile phone users in India have a prepaid connection. Prepaid phones and SIM cards are the key reasons why mobile subscriber levels are growing so rapidly in emerging regions. The traditional postpaid market called for a commitment to subscribe to a mobile service for one or two years and incurred high usage charges. The introduction of prepaid stimulated, the market for occasional or variable demand. It allowed adoption of mobile phones by users with variable usage needs and variable means to pay for access to the mobile network [1]. The average tariff rate has fallen from 16 rupees per minute in 1995 to around 90 paisa in 2014. Also, the advent of Chinese mobile phones and policies such as Mobile number portability has further accentuated the growth of mobile phone subscribers.

To establish a relation between the teledensity across Indian states and the various factors affecting them, we use

multiple regression analysis. The explanatory variables that have been taken are: Literacy rates (LIT_RATE), Disposable Income (DI) and GDP per capita (GSDPPC) across the 22 Indian states. The data points have been checked for Normality, linearity and homoscedasticity (the assumptions of regression) with the help of residual plots in the statistical software SPSS. The regression equation for teledensity across states is established as:

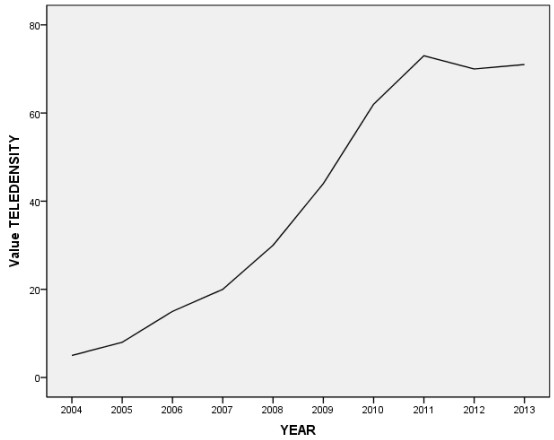

Fig: 5. Growth of Teledensity in India

TD_STATE = 13.513 + (0.00001312) DI + (0.00007726) GSDPPC + (0.350) LIT_RATE (1)

The R sq. value of the above regression equation is .736, which means that this model explains 73.6% of the variability of the response data around its mean, in the equation. The F statistic for final regression is 12.056, which is greater than 4. Hence, this is a statistically significant result.

3. Diffusion Model

Figure 5 shows that the growth of teledensity in India typically follows a non-linear curve. Any successful Innovation over a period of time follows a S shaped curve (Mohamed and Bodger, 2005; Botelho and Pinto, 2004; Geroski, 2000). During an early phase of diffusion only a few members of the social system adopt the innovation whereas, over time, many people opt for innovation as the diffusion process unfolds. Finally, during the maturing phase, the rate of diffusion goes down when diffusion curve approaches saturation level. [2] We assume that the growth of mobile teledensity in India follows a S shaped curve.

S shaped curves can be described by a number of different functional forms, such as Logistic, Gompertz, exponential etc. However, Logistic and Gompertz are the most widely used forms. The equation for logistic model in the case of mobile teledensity function is given by:

$$P(t) = \frac{K}{1 + Ae^{-kt}} \quad (2)$$

Where P(t) represents the Mobile density at period t, K represents the Saturation level, A represents the parameter that determines the location of the curve, k represents the parameter that determines the shape of the curve and t is the value assigned to time at period t. The equation for Gompertz model is given by:

$$P(t) = KAe^{-kt} \quad (3)$$

Where P(t) represents the Mobile density at period t, K represents the Saturation level, A represents the parameter that determines the location of the curve, k represents the parameter that determines the shape of the curve and t is the value assigned to time at period t. Using curve fitting, we have determined that Logistic model best fits the curve for teledensity growth in the period 2004-2013. Here, the value of R square is 0.967, which implies that the value of R is 0.98, and this model can be used to predict the value of teledensity upto 98 percent accuracy.

4. Forecasting

Considering that the mobile teledensity curve in India follows an S shaped logistic growth function, it will converge to a certain maximum value as time passes by. This maximum value is termed as the saturation point of the curve. Based on the past research conducted in developed as well as developing nations, and the current economic conditions in India, this paper assumes the saturation level to be 90. Past analysis of themobile share in developed and developing countries reveals that the saturation level of mobile share in developed countries could be anywhere between 50% and 70% whereas the same would be between 80% and 90% for developing countries. [2].

Assuming K to be 90 and using the logistic curve function, we obtain the parameters for predicting the teledensity for 2014.

Table: 1. Parameter Estimates for Forecasting Teledensity in 2014

	Model Summary					Parameter Estimates	
Equation	R Square	F	df1	df2	Sig.	Constant	b1
Logistic	.959	185.141	1	8	.000	.276	.599

We apply the value of the parameters in the equation for logistic function and obtain the result as:

$$\frac{90}{1+0.276e^{-0.599}} = 78.15$$

Which implies that there will be approximately 78 mobile phones per 100 persons in 2014. In the same way we forecast teledensity upto the year 2023. Table 2 gives the values of the forecasted teledensity upto the year 2023.

Table: 2. Forecasted Teledensity upto 2023

YEAR	TELEDENSITY
2014	78.15
2015	79.27
2016	80.54
2017	81.72
2018	82.74
2019	83.62
2020	84.36
2021	84.98
2022	85.51
2023	82.74

Figure 6 shows us the projected path of mobile teledensity in India. We can see that it closely resembles an S shaped curve. . Based on the previous years' data and our estimated forecast, we can see that there is a steep growth in the mobile teledensity up to the year 2012 followed by a slight decline in the teledensity, which can be attributed to some government policies, such as the deactivation of unused sim cards etc. Teledensity gradually increases from 2016 to 2022 and then declines in 2023. However, we can see that the slope is not very steep and the growth will take place gradually at a slow pace and then start declining thereafter. The present trend shows that by the year 2023, we will have 83 mobile phones per 100 people. According to our forecast, we can say that the average rate of growth in the teledensity would be 0.01% per annum in the period from 2014-2023. With this forecast, it is possible to predict the number of mobile phones to be used in the country, if we take a correct estimation of the population growth in India. This shall prove to be beneficial for the future growth strategies and expansion plans of the mobile operator companies and the handset manufacturers. It will also help the Government formulate policies and shall give an estimate of the revenues to be generated. In table 3, we have estimated the mobile connection demand in India using the projected population growth data from the worldbank.org and the estimated teledensity forecast in the paper.

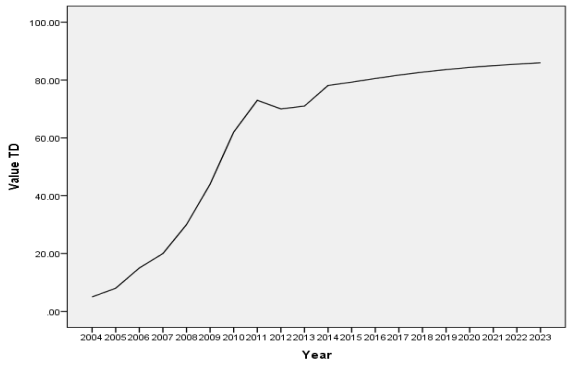

Fig: 6. Projected path of Teledensity in India

Table: 3-Mobile Phone Demand in India

Year	Projected population growth	Number of mobile phones
2014	1267402000	988573560
2015	1282390000	1013088100
2016	1297075000	1050630750
2017	1311476000	1075410320
2018	1325620000	1100264600
2019	1339553000	1125224520
2020	1353305000	1136776200
2021	1366878000	1161846300
2022	1380244000	1187009840
2023	1393372000	1156498760

5. Conclusion

In this paper, we studied the diffusion of mobile technology in India wherein we concluded that the growth follows a logistic S-curve and will be approaching the saturation phase soon whereas it followed steep growth in years 2008-2012, followed by a slow gradual growth in the following years, where the teledensity increased from 71 in 2013 to 83 in 2023.

We analyzed the various factors that played an important role in such quick adoption and evolution of telecommunications in India. We could see that factors like GDP, disposable income, revenue, presence of landlines etc. had a strong correlation with the teledensity growth curve and played a major role in its evolution. We saw how government policies (deregulation etc) and companies actions (de-activating unused sim) affect the usage pattern significantly. We also analyzed various other minor factors such as sociological conditions of the region, competition amongst the telecom operators, advent of Chinese mobile phones etc.

We studied the adoption variation across the different Indian states and then established a regression equation for the same. We also studied the various non-linear models of a growth of innovation and tried to fit their curve on the teledensity growth curve. We came to a conclusion that the logistic S shaped curve fits the best, and based on that, we tried to forecast the future teledensity upto 2023.

This forecast for teledensity growth can help in predicting the subscriber base around that time, which shall further help the telecom companies, handset manufacturers and vendors to predict their further growth strategies in India. Improving regulatory risk and moderating competition in India will support the credit profiles of the country's top telecoms.

However, this research can be further extended to highlight the divide between the rural teledensity and the urban teledensity. As rural development is the backbone of our economy, the factors for rural teledensity can be analyzed meticulously and then further strategies can be developed to augment the growth.

References

[1] K. S. Kalba, The Global Adoption and Diffusion of Mobile Phones, 08-20

[2] S. K., Singh, The diffusion of mobile phones in India, Telecommunications Policy, 32, 2008, 642–651

[3] Telecom Regulatory Authority of India (website)/www.trai.gov.in/

[4] Department of Telecommunications (website)/www.dot.gov.in/worldbank.data.org