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Information and Communication Technology Diffusion and Financial Inclusion: An Interstate Analysis for India

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Abstract

Financial Inclusion has its primary objective in providing access to useful and affordable financial products and services that meet the needs of so far unbanked population for transactions, payments, savings, credit and insurance in a responsible and sustainable way. The penetration of banking services in India has made reasonable progress though there are still regional disparities with especially the rural and female population lagging behind. However, not only access but also usage of financial services matters. Moreover, as there is a strong initiative towards digitalized cashless economy in India, it is important to examine whether the country is ready for a more technology-driven financial system. As far as the diffusion of telecommunication technology is concerned, India has made a remarkable progress in urban areas giving rise to significant digital divide between rural and urban India. With spread of mobile and mobile internet though, this divide has come down to some extent. Thus if this inclination towards mobile technology can be properly channelized to improve the access as well as usage of financial services through spread of mobile banking then more and more people can be brought under the purview of institutional credit system leading to reduction in poverty and inequality. The current paper intends to study the role of information and communication technology (ICT) diffusion in improving the status of financial inclusion across the different states of India. Two separate indices for Financial Inclusion and Information Technology Diffusion are formed and the states are clustered to club the states similar in terms of their performance. Then the paper tries to test whether ICT diffusion is one of the indicators of Financial Inclusion in India. The dynamic panel data analysis helped us to identify the role of technology as well as other socio-economic factors which can contribute in interstate disparities in FI. The results show that technology does play an important role in improving financial inclusion. As the elderly people in rural as well as urban areas are still not that familiar with mobile and internet, they may not be able to get benefited by ICT revolution. But lack of education and more importantly poor status of financial literacy play a very vital role in FI

Key words: *Financial Inclusion, Information and Communication Technology Diffusion, Dynamic Panel Data Model*

JEL Codes: *JEL: L86, L96, C23, G21*

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INTRODUCTION

World Bank (2017) defines Financial Inclusion as individual and businesses having access to useful and affordable financial products and services that meet their needs for transactions, payments, savings, credit and insurance, delivered in a responsible and sustainable way. The development of the concept of financial inclusion came into limelight as a measure to reduce poverty and inequality as part of World Bank's "Sustainable Development Goals". Thus the main goal of financial inclusion is delivery of banking services to the vast section of vulnerable groups such as disadvantaged and low-income population.

As far as the banking sector in India is concerned, banking sector reforms in India had a few major policy decisions that need attention in the context of Financial Inclusion. To promote a greater access to financial services in a more balanced manner, the 1:4 license rule of RBI came into existence in 1977 which required a bank to open 4 branches in unbanked locations in order to open a branch in a location with one or more branches. This rule however got abolished in 1992-93 and banks were allowed to close down unprofitable branches. Moreover, deregulation of interest rates and entry of new private banks may also have some influence on deposit mobilization and allocation of credit to backward regions. The reorientation of priority sector lending after 1999-2000 may have also allowed the banks to reorient their loan portfolio towards more well-off sectors thereby having implications on the outreach of the banking services across different states in the post reform period (Pal and Vidya,2011). However, with the current drive of making the financial sector more digitalized and with the aim of moving towards a cashless economy, another dimension can be added to the aspect of Financial Inclusion and that is telecommunication and information technology diffusion in different states of the country.

Until a few years ago, Information and Communication Technology (ICT) was seen only as a tool to increase connectivity globally. But the recent technological revolution in terms of smart phones and use of internet to expand businesses has extensively transformed the way we live, work and communicate. One of the major changes brought in by the mobile phone revolution is the possibility to access banking services and carry out monetary transactions through the mobile device, which has become known as mobile financial services. This breakthrough technology is expected to increase the number of people under the purview of the banking system. Digitalized payments for health, education or other social safety nets may yield big benefits for individuals, in addition to improving efficiency for governments and aid agencies by reducing transaction costs and leakage. Thus, if the mobile phone expansion is combined with the rise of financial services to bridge the existing financial infrastructure gap, there is tremendous potential for previously underserved groups to gain access to the formal financial sector.

India's telecommunication sector has grown remarkably with tele-density increasing from 0.6 telephones per 100 people in 1991 to about 60 per 100 people in 2010 (Telecom Regulatory Authority of India (TARI), 2010). However, this growth has predominantly been confined to urban areas with much of the rural areas being uncovered giving rise to a growing "digital divide" within the country (Sunil Mani, 2011). As per TARI, the total tele-density in India in April 2017 is 93.23 percent with urban tele-density being 172.28 percent whereas rural tele-density being 57.02 percent. As far as mobile subscription in the country is concerned, it can be observed that there has been a steady increase in average number of mobile subscribers from 2003, thereby increasing the ratio of mobile to fixed telephone to 14.17 in 2009 from a negligible amount. Here also we must keep in mind that mobile usage remained mostly an urban phenomenon in mainly the poorer states. However, the revolution of mobile technology paved the way for a better spread of internet

services. Internet services were introduced in India in 1995 with establishment of Vedesh Sanchar Nigam limited and were opened to private participation in 1998. But the diffusion of this technology was low with broadband connection mainly because of lack of personal computer and a fixed telephone service. With mobile internet spreading its wings the usage has definitely increased. As par a report by Internet and Mobile association of India, the estimated number of mobile internet users in June 2017 is 420 million with rural India growing at a much higher rate than urban India. Thus mobile and mobile internet has played an important role in reducing the digital divide.

Now, the next step forward is bringing the financial services under the purview of mobile phone and internet services. ICICI bank was the first to start its e-banking services in 1994. By 2002, half of the Indian banking institutions allowed their customers to perform some kind of banking transactions through internet. These kinds of services definitely change the traditional way of banking transactions and allow the customers to move to a cashless system. However, the question is how well India as a country with a wide difference in the financial, physical as well as educational infrastructure is ready to bring the unbanked population within the purview of institutional credit system and whether ICT has any role to play in this context. This is the main motivation of the current paper. The paper intends to find the interstate differentials in determinants of financial inclusion with main focus being on ICT diffusion. The paper is structured in the following way. Section 2 discusses the relevant literature. Section 3 deals with construction of FI and ICT index and descriptive statistics to assess the interstate differential in both FI and ICT penetration. Section 4 contains the econometric model and analysis of the results. The concluding remarks are there in section 5.

LITERATURE REVIEW

According to Schumpeter (1912), Gurley and Shaw (1960), McKinnon (1973) and Shaw (1973), banking development is favourable to the economic growth because banks' activity increases the mobilization of the saving, improve the efficiency of the resources allocation, and stimulate the technological innovation. Levine (2005) and Beck *et. al.* (2008) have also agreed to the fact that a well-developed financial system has a positive impact on the growth process of the economy. However, financial inclusion aims to make available the formal financial services to all sections of the economy, especially to the vulnerable and financially excluded people at affordable cost and therefore is expected to promote economic activity. As Babajide *et. al.* (2015) have pointed out there are four distinct channels of economic growth through financial inclusion: (i) providing low cost reliable means of payment to all, especially the low income group; (ii) the role of financial intermediation in increasing the volume of transaction and allocation of resources from the surplus units to the deficit units of the economy and in the process improve resource distribution (Odeniran and Udeaja, 2010); (iii) risk management that the financial system provides by curtailing liquidity risks, thereby enabling the financing of risky but more productive investments and innovations within the economy (Greenwood and Jovanovic,1990; Bencivenga and Smith, 1991); (iv) providing information on possible investment and availability of capital within the system (Levine, 2005).

Now, financial inclusion may affect the poor through two channels: aggregate growth and changes in the distribution of income. Financial inclusion enhances growth and reduces inequality through trickle down effects. The key findings of Beck *et. al.* (2007) were that financial inclusion not only reduces income inequality but also benefit the poor disproportionately and is strongly related with poverty alleviation. Khan (2011) explained that improved financial services would lead to increased economic activities and employment opportunities for rural

households, as more economic activities raise the disposable income, leading to more savings and a robust deposit base for the bank, resulting in inclusive economic growth. Hariharan and Marktanner (2012) found a strong positive correlation between a country's FI and total factor productivity (TFP) and concluded that FI has the potential to increase the financial sector savings portfolio, enhance efficiency of intermediation, and boost entrepreneurial activities which finally results in economic growth. Kigsley (2013) has highlighted the role of FI in addressing issues such as global poverty, income inequality, under development and welfare. With more and more people coming under the purview of financial system, their combined impact contributes to faster development process. Sharma and Pais (2010) found that FI reduces the dominance of informal financial institutions which are exploitative in nature and access to formal financial services increases efficiency of the resource allocation and reduces cost of capital.

As far as Indian Banking Sector is concerned, it has been well accepted in literature that in spite of making remarkable progress in terms of financial viability, profitability and competitiveness, it has failed to reach the underprivileged section of the population and Financial Inclusion is the channel through which they can escape the grip of poverty (Binswanger and Khandker (1995) , Eastwood and Kohli (1999), Bell and Rousseau (2001), Leeladhar, 2006; Subbarao, 2009a, Thorat, 2007). There are several important determinants of financial inclusion. For example, availability of banking amenities and strong bank branch network (Feldstein and Horioka, 1980; Ford and Poret, 1991); Information and communication technology like mobile phones, fixed phones, cost of call (Mihasonirina and Kangni (2011); branch network in capturing banking access and branch density (Subba Rao, 2007; Burgess and Pande, 2003; Leeladhar, 2006; The World Bank, 2008a). Nitin Kumar (2013) has used a panel data of 29 major states and union territories of India to show that branch network is unambiguously an important factor in financial inclusion apart from proportion of factories and employee

base. Gupta (2011) has pointed out several factors which are responsible for low level of financial inclusion in India. The demand side barriers are like complexity in financial services provided by Banks, lack of branches in remote areas, limited literacy and easy access to informal sector. The supply side barriers are lack of legal identity of the people and low outreach of the banks.

Given this background, we can infer that we should look for some technological innovation that will improve the outreach of the banking system, minimize the procedural hazards of the financial services and reduce the travel time and cost to the bank branches. ICT can definitely play an important role in this direction though financial literacy as well as technical support is the prerequisite. Now, ICT has been accepted as an important tool to foster growth in several studies (Norton (1992), Seo, Lee, and Oh (2009), Nasab and Aghaei (2009); Vu (2011), Roller and Waverman (2001)). In Indian context Kathuria, Uppal and Mamta (2009) showed that Indian states with higher mobile penetration has better growth performance and the impact gets amplified beyond 25 per cent of mobile phone penetration. ICT and mobile phone penetration can indeed reduce the transaction costs of financial intermediaries including formal commercial banks, microfinance institutions and cooperatives, and therefore expand their businesses. ICT also facilitate the emergence of branchless banking by increasing the flexibility of businesses. As Onaolapo (2015) pointed out innovative financial inclusion calls for delivery of financial services outside conventional branches of financial institution by using ICT and non-bank retail agents like post offices. The delivery mechanism under this system needs to depend on mobile banking services and other ICT based services like Point-of-sale device networks to communicate between retail agent, financial service provider and the customer in a branchless banking system. Findings of Sassia and Goaied (2012) reveal that the interaction term of between financial development and ICT penetration is significantly positive which

proves that economies in Mena region can benefit from financial development only once a threshold of ICT development is reached.

Given the perusal of the above literature, it is appearing that a better ICT development has the potential to improve the status of financial inclusion in a country. Thus the main objective of our paper is to investigate whether the ICT indicators are significant determinants of Financial Inclusion in an inter-state analysis. Moreover, the paper intends to study whether the different socioeconomic status of different states have its own influence of the level of financial inclusion. The objective of the paper is two-fold. First we construct a composite index of both Financial Inclusion and Information Technology diffusion and try to assess the status of 16 major Indian States through cluster analysis. Secondly, we attempt to analyse the role of information technology in improving the status of Financial Inclusion. We use a dynamic panel data framework to fulfil this objective. We also incorporate the role of some socioeconomics factors such as education, dominance of rural population in the state, dominance of above 60 years population, in making proper use of the benefits of information technology.

INDEX CONSTRUCTION AND INTERSTATE COMPARISON

The measurement of Financial Inclusion has got enough attention in literature and different methods are employed, such as Econometric Methods by Honohan (2008) and Ardic *et. al.*(2011) or using various indicators of banking outreach Reyes *et. al*. (2010). However, we have followed Mandira Sharma (2012) for constructing a composite index for both Financial Inclusion (FII) and ICT (ITI). This index is basically a multidimensional index based on macroeconomic data on banking sector outreach following the second approach. It is based on three main dimensions of an inclusive financial system such as accessibility, availability and usage of banking services. The IFI is constructed to capture information on these dimensions in a single number lying

between 0 and 1, where 0 indicates complete financial exclusion and 1 indicates complete financial inclusion in an economy. This approach is similar to that used by UNDP for computation of some widely used development indices such as the HDI, the HPI, the GDI etc.

Following Sharma (2012) we compute a dimension index for each dimension of financial inclusion. The dimension index d_i, as computed by the formula (1), measures the country's achievement in the ith dimension of financial inclusion. A weight w_i lying between 0 and 1 is attached to the dimension i, indicating the relative importance of the dimension i.

$$d_i = w_i \frac{A_i - m_i}{M_i - m_i} \quad (1)$$

where

w_i = weight attached to the dimension i, $0 \leq w_i \leq 1$

A_i = actual value of dimension i

m_i = lower limit on the value of dimension i, fixed by some pre-specified rule.

Mi = upper limit on the value of dimension i, fixed by some pre-specified rule.

Financial inclusion aims to provide the formal financial service at a reasonable cost to the non-banked population. Hence accessibility, availability as well as the utilization are important aspects to comprehend financial inclusion (Pal and Vaidya, 2011; Sharma, 2012, Kumar, 2013). Accessibility is measured by number of deposit account and number of credit accounts per 1000 population whereas availability of the banking services is measured in two ways; number of bank offices per 1000 sq. km measuring geographical penetration and number of bank office per 10 lakh population measuring demographical penetration (Pal and Vaidya 2011). As pointed out by Sarma (2012) availability of services can be indicated by the number of bank outlets (per 1000 population) and/or by the number of ATM per 1000 population. We have however used only number of bank office per 1 lakh population due to lack of continuous

data on ATMs. Utilization of banking services is measured in terms of number of deposit account per 1000 population, number of credit account per 1000 population, deposit as a per cent of GSDP, credit as a per cent of GSDP and credit-deposit ratio (Beck et. al, 2007; Pal and Vaidya, 2011; Kumar, 2013). This paper has used volume of credit and volume of deposit as a percentage of GSDP. We have used data for 16 major states of India for the year 2005-2014[1]. As far as the choice of upper and lower limit of the value of each dimension is concerned, we have used the lowest and highest value of each dimension among all the states including all the years. Following Pal and Vaidya (2011) and Sarma(208), we have used equal weightage for each indicator to construct the Financial Inclusion (FII) as well as Information Technology Indices (ITI).

$$FII= 1-\sqrt{\frac{(1-d_1)^2+(1-d_2)^2+(1-d_3)^2+(1-d_4)^2+(1-d_5)^2+(1-d_6)^2+(1-d_7)^2}{7}}$$

$$ITI== 1-\sqrt{\frac{(1-d_1)^2+(1-d_2)^2+(1-d_3)^2}{3}}$$

The values of the indices lie between 0 and 1 where the higher value of FII signify better outreach of the banking services and higher value of ITI signify better communication technology. Moreover, as we consider the minimum and maximum values of any measure from the entire sample in order to calculate the standardize the value of that measure, the resultant values of the indices are comparable across states and over time.

Data Description:

In this section we will try to provide a comparative analysis of the status of both Financial Inclusion and Information Technology diffusion in the major 16 states of India.

[1] Major source of data is Indiastat.com

Table 1: Descriptive Statistics of Various Indicators of Financial Inclusion Index

Credit and Deposit amount as a proportion of GSDP										
Year	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
No. of Observation	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00
Mean	0.78	0.86	0.99	1.14	1.28	1.39	1.56	1.72	1.87	1.98
Standard Deviation	0.30	0.35	0.40	0.54	0.57	0.59	0.68	0.72	0.76	0.81
Minimum	0.44	0.51	0.60	0.69	0.78	0.91	1.04	1.13	1.21	1.25
Maximum	1.58	1.84	2.17	2.74	2.86	2.96	3.43	3.51	3.76	4.06
Number of bank account per 1000 population										
Year	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
No. of Observation	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00
Mean	536.83	554.53	583.59	643.66	707.86	765.03	831.41	912.67	1027.38	1181.24
Standard Deviation	205.39	205.70	214.47	233.13	240.19	258.32	269.33	286.67	328.12	384.28
Minimum	246.76	245.18	257.94	280.86	324.48	350.03	393.81	453.31	512.64	590.91
Maximum	924.82	920.22	951.10	985.59	1039.86	1164.00	1187.92	1347.28	1547.69	1829.06
Number of bank offices per lakh population										
Year	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
No. of Observation	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00
Mean	7.19	7.20	7.38	7.73	8.03	8.45	8.88	9.60	10.33	11.34
Standard Deviation	2.50	2.55	2.69	2.84	2.98	3.18	3.41	3.73	4.13	4.57
Minimum	4.08	4.02	4.00	4.03	4.11	4.30	4.42	4.70	4.98	5.61
Maximum	12.64	12.70	13.19	13.72	14.37	15.12	15.85	16.98	18.27	19.86

Table 2: Ranking of the States in Terms of FII

STATE	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
AP	6	6	6	6	4	3	3	3	3	3
Assam	16	16	16	16	15	15	15	15	16	16
Bihar	15	15	15	15	16	16	16	16	15	15
Gujarat	10	10	10	10	10	10	10	10	9	9
Haryana	8	8	8	7	7	7	7	7	7	7
HP	7	7	7	8	8	8	8	9	10	10
Karnataka	3	3	3	5	5	6	6	6	6	5
Kerala	1	1	1	1	2	2	1	2	2	2
MP	14	14	14	14	14	14	14	14	14	14
Maharashtra	5	5	4	2	1	4	5	4	5	6
Orissa	11	11	11	12	12	11	11	11	11	12
Punjab	4	4	5	4	6	5	4	5	4	4
Rajasthan	12	12	12	11	11	12	13	13	13	13
TN	2	2	2	3	3	1	2	1	1	1
UP	13	13	13	13	13	13	12	12	12	11
WB	9	9	9	9	9	9	9	8	8	8

Table 1 depicts the descriptive statistics of three indicators of financial inclusion; credit and deposit amount as a proportion of GSDP, number of bank account per 1000 population and number of bank offices per lakh population. In the context of credit-deposit amount as a proportion of GSDP, mean, maximum, minimum and standard deviation increase over time. In 2014, the average credit-deposit amount as a proportion of GSDP is 1.98. Maharashtra has its maximum value whereas Assam has the minimum one. Mean, standard deviation, maximum and minimum value of other two variables, number of bank account per 1000 population and number of bank offices per lakh population also show an increasing trend with a minor fluctuation 2006. In 2014, Bihar has the minimum number of bank account per 1000 population (590.91) and minimum number of bank offices per lakh population (5.61). Bank account per 1000 population is highest in Tamil Nadu (1829.06 bank account per 1000 population). Himachal Pradesh has maximum number

of bank offices per lakh population (19.86 bank offices per lakh population).

Cluster Analysis

If we take a look at the composite FI index and how the states have changed their position over time (table 2), we will observe that, Assam and Bihar have continued to most poor performers whereas Tamil Nadu and Kerala have consistently occupied the top most position. The rest of the states have performed moderately lying between these two sets of the states. However, if we look carefully in the ranking of the states we can identify some homogeneity among some states and accordingly they can be clubbed together by using cluster analysis. K-mean cluster analysis with k=5 has been done to classify the states based on their ranking in terms of FII (see table A-1 in appendix for the clusters over time). As the states have not changed their position much over time, we can find 5 clear clusters of states: 1. Assam and Bihar; 2. MP, Odisha, Rajasthan and UP; 3. Gujarat and WB; 4. Haryana and Himachal; 5. Karnataka, Kerala, Maharashtra, Punjab, TN and AP. The clusters are in ascending order of their average values of FII.

To check whether the movements of the states over time are statistically significant we have constructed Kendall's Index of Rank Concordance. Kendall's Tau is a non-parametric measure of relationships between columns of ranked data. The Tau correlation coefficient returns a value of 0 to 1, where: 0 is no relationship and 1 is a perfect relationship. It may be seen from table A-2 (in Appendix) that null hypothesis of no association among ranks of different years is rejected decisively for all years at 5 percent level of significance. This implies that cross-sectional dispersion of FII is not diminishing over time. It is clear that there exists stability in ranks obtained by various states with regard to their level of FII. So, overall gap among states is not showing any evidence of narrowing down.

Table 3 presents the descriptive statistics of various information technology related variables. All three variables, tele-density, number of internet subscriber per 100 population and mobile phone per 100 population, increase significantly along with wide variation during the time period 2005 to 2014. In 2014, average tele-density is 79.35 compared to 9.25 in 2005. Tamil Nadu has highest tele-density and Bihar has lowest value. The average number of internet subscriber per 100 population increases from 0.08 in 2005 to 5.20 in 2014. Internet facility is maximum in Kerala and lowest in Uttar Pradesh in recent year. Similarly the mobile usage increases 5.59 per 100 population in 2005 to 83.06 per 100 population in 2014. Tamil Nadu has highest number of mobile users and Assam has lowest number of mobile user per 100 population in 2014.

Table 3: Descriptive Statistics of Various Indicators of Information Technology Index

Tele-density										
Year	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
No. of Observation	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00
Mean	9.25	13.09	19.13	27.13	49.91	55.10	79.09	83.84	77.28	79.35
Standard Deviation	5.80	6.94	9.19	11.91	15.91	16.72	23.82	24.14	20.82	21.18
Minimum	2.36	5.34	7.32	10.43	26.91	29.99	45.85	46.61	45.72	46.10
Maximum	21.94	27.61	37.05	47.89	74.81	80.36	118.64	120.67	108.17	111.14
Number of internet subscriber per 100 population										
Year	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
No. of Observation	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00
Mean	0.08	0.61	0.92	0.45	1.21	1.46	1.78	0.13	1.11	5.20
Standard Deviation	0.09	0.43	0.64	0.32	0.82	1.00	1.25	0.14	0.78	2.77
Minimum	0.00	0.09	0.14	0.07	0.19	0.22	0.05	0.00	0.11	1.73
Maximum	0.35	1.54	2.23	0.99	2.68	3.37	4.11	0.43	2.79	10.07
Mobile phone per 100 population										
Year	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
No. of Observation	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00
Mean	5.59	9.89	16.29	25.42	37.21	52.51	59.28	77.97	79.25	83.06
Standard Deviation	3.73	4.84	7.21	9.90	11.10	15.21	15.68	17.62	18.20	18.25
Minimum	1.02	3.94	6.26	11.61	24.03	33.41	36.16	46.34	48.02	51.84
Maximum	14.63	20.96	31.69	43.84	58.94	86.74	89.92	107.98	108.78	116.18

Now, if we observe the composite IT index (Table 4), Assam and Bihar continue to be at the bottom even in terms of IT. Karnataka, Kerala, Maharashtra, Punjab and TN have been the top 5 states though Maharashtra, Punjab and TN have shown considerable up and down movement. If we compare the ranks of the states with respect to both FI Index and ICT Index we can find some interesting observations. For example, AP, for which even if ITI rank is low it has done reasonably well in FI. Secondly, Gujarat has Come down from 3rd to 7th position in ITI rank; but FII rank is consistently low (9, 10). For Himachal Pradesh there

has been steady progress in terms of spread of ICT (7→3), but not reflected in improvement in FI, rather it has deteriorated (7→10). WB, even with low ranks in terms of ICT (10,13), has maintained 9th position consistently in FII; may be political stability and a well-performing Panchayat-raj regime has contributes positively; though the position is not very high.

Table 4: Ranking of the States in Terms of ITI

STATE	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
AP	9	9	9	9	9	9	9	9	9	8
Assam	15	15	14	15	16	16	16	16	16	16
Bihar	16	16	16	16	14	14	15	15	15	15
Gujarat	3	6	6	6	6	6	6	7	7	7
Haryana	8	8	8	8	8	8	8	8	8	9
HP	7	7	3	3	2	1	4	3	3	4
Karnataka	6	5	5	5	5	5	5	6	5	5
Kerala	2	2	2	2	3	3	2	4	4	2
MP	11	13	11	11	11	11	14	13	12	12
Maharashtra	5	3	7	7	7	7	7	5	6	3
Orissa	14	12	15	14	13	13	12	12	13	13
Punjab	1	1	1	1	4	4	3	1	2	6
Rajasthan	10	10	10	10	10	10	10	11	10	10
TN	4	4	4	4	1	2	1	2	1	1
UP	12	14	13	13	15	15	13	14	14	14
WB	13	11	12	12	12	12	11	10	10	11

ECONOMETRIC MODEL AND METHODOLOGY

The panel estimation can be first implemented using a fixed-effects model (FEM) which incorporates individual-specific (time-invariant) effect (α_i) and time-specific
(individual-invariant) effect (δ_t):

$$Y_{it} = \beta_0 + \beta_1 X_{it} + \alpha_i + \delta_t + \epsilon_{i,t} \quad (2)$$

In equation (2), Y_{it} represents endogenous variable for ith country at t th period. β_0 is the intercept term and X_{it} is matrix of exogenous variables. β_1 is vector of associated parameters. α_i is the individual-specific time invariant effect and δ_t is time-specific individual invariant effect. ϵ_{it} is usual stochastic disturbance term following normal distribution with mean 0 and variance σ^2. The dependent variable is for ith country and t th period is explained by a set of exogenous variables, some unobservable individual-specific (α_i) and time-specific (δ_t) factors.

The estimation could also be done by introducing a dummy variable for each country to deal with the country specific effects and using a Least Squares Dummy Variable (LSDV) estimator. But the fixed effects model, within itself, allows the intercept to vary with individual units,i (the country- specific effects). It is obtained by Ordinary Least Squares on the deviations from individual means instead of individual effects. Therefore, using the fixed effects model is a simpler way of estimation for this kind of a study.

However, the fixed estimator can provide biased estimations if the number of time periods is small, and if the lagged value of the dependent variable, Yi,t-1 , is also correlated with the individual effects α_i (Matyas and Sevestre, 2008). In particular, the estimation of these type of regressions may have some problems (Bond *et. al.*, 2001). First, explanatory variables may be endogenous and be correlated to the idiosyncratic error term because of reverse causality or measurement errors. The fixed effects estimator fails to deal with the problems of endogeneity and hence leads to inconsistent estimations of results that are expected to have a downward bias (Bonnefond, 2014). Second, omitted variables can bias the estimation. In such a situation Holtz-Eakin *et. al.* (1988) and Arellano and Bond (1991) suggested estimating dynamic panel data models using the generalized method of moments (GMM). GMM solves the problem of endogeneity by adding the lagged value of dependent variable as an explanatory variable as in equation (3).

$$Y_{i,t}= \beta_0 + \beta_1 Y_{i,t-1} +\beta_2 X_{i,t}+ \alpha_i +\delta_t + \epsilon_{i,t} \quad (3)$$

The authors proposed to first-differentiate the equation in order to eliminate individual specific effects:

$$Y_{i,t}-Y_{i,t-1} = \beta_1 (Y_{i,t-1}- Y_{i,t-2})+ \beta_2 (X_{i,t}- X_{i,t-1})+ (\delta_t - \delta_{t-1}) + (\epsilon_{i,t} - \epsilon_{i,t-1}) \quad (4)$$

By construction, $(Y_{i,t-1}- Y_{i,t-2})$ in equation (4) is correlated with the error term $(\epsilon_{i,t} - \epsilon_{i,t-1})$. Arellano and Bond (1991) have suggested the use of instrumental variables technique (for $t \geq 2$) where lagged levels of the lagged endogenous variable, $Y_{i,t-1}$ can be used as instruments for $(Y_{i,t-1}- Y_{i,t-2})$, and the lagged levels of the explanatory variables $X_{i,t}$, as instruments for $(X_{i,t}- X_{i,t-1})$. This is called the first- differentiated GMM estimator.

But according to Blundell and Bond (1998), this technique has limitation of giving biased results if the sample size is finite. Also, if the dependent and independent variables are continuous in nature, then their lagged values cannot be considered as reliable instruments.

To deal with the potential bias and imprecision of the first-differenced GMM estimators, additional moment conditions are proposed for an equation expressed in levels (Arellano and Bover, 1995; Blundell and Bond, 1998) known as system GMM estimator.

This estimator combines: (i) the standard set of equations in first-differences, $(Y_{i,t-1}- Y_{i,t-2})$and $(X_{i,t}- X_{i,t-1})$ variables, with suitably lagged levels as instruments, (ii) with an additional set of equations in levels, $Y_{i,t-1}$ and $X_{i,t}$, variables, with suitably lagged first-differences as instruments (Bonnefond,2014). Blundell and Bond (1998) have also developed a two-step GMM estimator to address the problem of heteroscedasticity. The two-step estimation method is proved to be asymptotically more efficient

than the first step method by Blundell and Bond (1998), using Monte Carlo simulations. However, they also underline that the two-step estimation may produce downward biased results when using finite samples. Windmeijer (2005) proposes a finite sample correction for the variance-covariance matrix when using the two-step GMM estimator.

The consistency of the system GMM estimator is based on two hypotheses. First, the set of instrumental variables must not be correlated with the error terms. This hypothesis is tested using Sargan/Hansen test of overidentifying restrictions.[2] Second, the absence of second-order autocorrelation (AR2) in residuals must be verified, while a negative first-order autocorrelation (AR1) may be detected. This second hypothesis is tested using Arellano-Bond tests for AR1 and AR2.

Roodman (2009) shows that using too many instruments can produce biased results in GMM estimation[3]. Although the empirical literature provides little evidence on the maximum number of instruments to use, the minimum standard is to have less instruments than individuals (Roodman, 2009).

Hence for the purpose of our study, given the sample size, we use the system GMM estimator (Blundell and Bond (1998)) to assess the impact of ICT on Financial Inclusion.

[2] The Hansen test is implemented instead of the Sargan test when the estimations are adjusted for heteroscedasticity.

[3] In particular, Sargan and Hansen tests can be weakened by the use of too many instruments (Roodman,2009).

Empirical Results and Findings

Multiple models are estimated to assess the role of ICT on Financial inclusion. The dependent variable in all the models discussed in this section is natural logarithm of Financial Inclusion Index. In model 1 (table 5) we have got lagged value of the dependent variable as the independent variable apart from other independent variables. All the independent variables are in terms of their natural logarithms. Thus the coefficients are interpreted as elasticities. The ICT index has a positive and significant impact on state-level financial inclusion thereby reinforcing our hypothesis. With widespread use of mobile banking and introduction of internet banking in almost all nationalised and private banks in India, it can be easily anticipated that ICT has helped in motivating people to come under the purview of formal banking system by reducing the technical hassles in day-to-day banking services. The other independent variable which is considered as endogenous variable is lnGSDP for which the current year's value is not significant; however the lagged value of GSDP has positive and significant impact on the dependent variable. Thus states with high per capita income last year are expected to do well as people take some time to get channelize their income into savings and take resort to formal baking sector. We have also considered the interaction term between the current year's per capita GSDP with current value of IT index which is coming negative and significant; but the marginal effect of ITI of FII at the mean value of per capita GSDP is coming positive. This result reinforces our conjecture that ITI has a positive impact on FII. If we look at the individual components of IT index, mobile seems to be the most effective instrument in financial inclusion. It may be because of the fact that people are still not that tech-friendly to use internet or mobile internet facility for financial transactions; moreover, they may be still sceptical about the cyber security issue. Merely, communicating with bank's customer service centre or receiving messages regarding accounts statement are what people are more comfortable with. Definitely percentage of rural population or concentration of senior citizens may play significant role in

determining the inclination towards usage of technology. These issues are addressed in subsequent sections. Level of formal industrialization has also its share of contribution in motivating people to go for banking sector. States with more number of factories are expected to perform well in terms of financial inclusion (refer to table 6).

Table 5: Relation between FII and ITI

VARIABLES	lnFII	lnFII	lnFII
L.lnFII	1.097***	1.063***	1.088***
	(0.0868)	(0.0817)	(0.0928)
L2.lnFII	-0.226**	-0.149	-0.249**
	(0.101)	(0.0958)	(0.0973)
Lnpercapitansdp	0.00400	-0.00246	0.00609
	(0.00607)	(0.00479)	(0.00607)
L.lnpercapitansdp	0.0190**	0.0129	0.0221**
	(0.00893)	(0.00795)	(0.00957)
IT_lnNSDP		-0.0270***	
		(0.00918)	
lnITI	0.0299**	0.297***	
	(0.0152)	(0.0882)	
Lnmobile			0.00764***
			(0.00243)
Constant	-0.255*	-0.112	-0.359**
	(0.138)	(0.107)	(0.152)
Observations	128	128	128
Number of ID	16	16	16

Note: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Impact of growth performance

As can be observed from Table 6, column 2 and 3, that current value of growth (difference between $\ln(PCGSDP)_t$ and $\ln(PCGSDP)_{t-1}$ and an interaction term of ITI and growth are coming insignificant. However, interestingly the lagged values of both are having positive and significant impacts. The marginal impact of growth on FII evaluated at the mean

value of ITI is also coming positive. Thus the emerging states with higher growth rates are showing better performance in terms of financial inclusion. Moreover, the lagged value of both PCGSDP and an interaction term between PCGSDP and ITI are also having positive and significant effect on FII. It implies that growth in past year reinforce the positive influence of ITI on financial inclusion. Similarly, the marginal impact of PCGSDP on FII evaluated at the mean value of ITI is positive. But the interesting result is that the marginal impact of growth is more than marginal impact of absolute per capita income. Thus not only higher growth matters more than higher value of per capita income, but also it takes some time (one period lag) to have its impact on savings 21ehavior of individuals.

Table 6: Impact of Growth on FI

VARIABLES	(1) lnFII	(2) lnFII	(3) lnFII
L.lnFII	1.056***	1.149***	1.041***
	(0.0754)	(0.0864)	(0.124)
L2.lnFII	-0.180*	-0.195*	-0.220**
	(0.103)	(0.101)	(0.105)
Lnpcnsdp	0.00450		0.00621
	(0.00619)		(0.00575)
L.lnpcnsdp	0.00914		0.0292**
	(0.00965)		(0.0128)
lnITI	0.0279**		
	(0.0125)		
Lnfactory	0.00703**		
	(0.00290)		
ITIlnpcnsdp			-0.00768***
			(0.00277)
Growth		-0.0158	
		(0.0124)	
L.growth		0.215***	
		(0.0749)	
growthITI		-0.0820	
		(0.0626)	
L.growthITI		0.460***	
		(0.151)	
L.ITIlnpcnsdp			0.0101***
			(0.00322)
Constant	-0.218	0.000652	-0.397**
	(0.135)	(0.00947)	(0.181)
Observations	128	128	128
Number of ID	16	16	16

Note: Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Role of age Composition, Rural Population and Education

As already discussed, ICT being a sophisticated technology, its effective usage depends upon education level, age of the consumer and residing

area. Education is one of the most important factors in inspiring people not only to move towards formal banking sector but also towards usage of technology. Even if head of the family is not enlightened with education, the younger generation can teach them the positive sides of formal banking system and protect them from the exploitation of informal credit market. Moreover, they can help them to manage their account with a mobile phone which is very commonly available. Our results are very much in line with this conjecture. We can observe from table 7 that the coefficient of joint interactive term of education, measured in terms of gross enrolment ratio at the secondary level, and ITI index is positive and significant. The elasticity of education with respect to FII is also coming positive and significant. Moreover, the marginal impact of ITI evaluated at mean value of education is also positive. Thus the higher level of education raises the efficacy of information technology and enhances its positive impact on financial inclusion. On the other hand, the percentage of rural population per square kilometre has a negative impact implying that the states with higher rural population are less financially included. This is as per expectation as sometime rural people are lagging behind in terms of education, adoption of new technology and awareness. They are usually more dependent on easily available informal credit market.

In subsequent regressions, we can observe that population above the age of 60 is not very familiar with application of smart phone in handle financial transactions. Thus the interaction terms of percent above the age of 60 irrespective of rural or urban with IT index is having negative and significant impact of FII. It is understandable that the senior citizens are still not comfortable as well as confident to use mobile or internet enabled mobile banking services in both rural and urban areas. Thus technology may not be much effective in states where percent of senior citizen is reasonably high in achieving a better financial inclusion.

Table 7: Impact of Social Variables

VARIABLES	(1) logfii	(2) Logfii	(3) Logfii	(4) Logfii
L.logfii	1.291***	1.092***	1.084***	1.080***
	(0.126)	(0.124)	(0.124)	(0.103)
L2.logfii	-0.403***	-0.182	-0.176	-0.129
	(0.116)	(0.132)	(0.131)	(0.116)
Logiti	-0.941*	0.0705	0.0806*	0.0335
	(0.546)	(0.0480)	(0.0461)	(0.0540)
Lnedu	0.255***	0.0249	0.0223	
	(0.0972)	(0.0381)	(0.0375)	
ITIpop60		-0.668***		
		(0.198)		
lnofpeopleabove60		-0.0989*		
		(0.0532)		
Lnruralpoppersqkm	-0.0593**	-0.0460**	-0.0475**	
	(0.0300)	(0.0231)	(0.0224)	
ITIedu	1.581**			
	(0.779)			
ITIrupop60			-0.603***	
			(0.174)	
lnrabovev60			-0.0893*	
			(0.0473)	
ITIurpop60				-0.645**
				(0.280)
lnuabv60				-0.117***
				(0.0443)
Urbanpoppersqkm				
Constant	-0.115*	0.0277	0.0322	0.00252
	(0.0662)	(0.0372)	(0.0356)	(0.00414)
Observations	96	96	96	96
Number of ID	16	16	16	16

Note: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

State Specific Effect

In this subsection we intend to identify the inter-state differential in terms of performance in financial inclusion. In this context, we would like to introduce the concept of financial literacy and performance of different states in terms of Financial Literacy. Organisation for Economic Co-operation and Development (OECD) defined financial literacy as "the process by which financial consumers/investors improve their understanding about the financial products, concepts, risk and through information, instructions and/or objective advice, develop the skills and confidence to become more aware of financial risks and opportunities to make informed choices, to know where to go for the help, and to take other effective actions to improve their financial well-being". As pointed out by Anshika and Singla (2017), India has very low level (24 percent) of financial literacy compared to BRICS (28 percent) countries and European countries (52 percent). A survey by Standards & Poors (2014) shows over 76 percent Indian adults lack basic financial literacy and are unable to understand the most basic and key financial concepts which may play as a vital bottleneck to financial inclusion. National Centre for Financial Education Report (2015) gives an overview of the status of financial literacy of different states and union territories (Table 8). We present the relevant data for the states included in our study in ascending order of financial literacy.

Table 8: Comparison of General and Financial Literacy Across States

State	General Literacy	Financial Literacy
Bihar	50 percent	8 percent
Odisha	64 percent	9 percent
UP	57 percent	10 percent
Punjab	67 percent	13 percent
HP	73 percent	16 percent
Maharashtra	73 percent	17 percent
Assam	61 percent	20 percent
Rajasthan	56 percent	20 percent
Haryana	68 percent	21 percent
WB	67 percent	21 percent
TN	72 percent	22 percent
MP	59 percent	23 percent
AP	60 percent	23 percent
Karnataka	67 percent	25 percent
Gujarat	68 percent	33 percent
Kerala	84 percent	36 percent

Source: Anshika and Singla (2017)

Table 8 shows that there are states like Bihar, Orissa and UP, having just about 10 percent financial literacy which is dismal compared to Gujarat and Kerala which are having about 36 percent financial literacy. These 3 states are very poor in terms of general literacy as well. Interestingly, some states like HP and Maharashtra, in spite of having a reasonable high general literacy, are lagging far behind in terms of financial literacy. On the hand states like MP and AP are relatively good in terms of financial literacy but poor in terms of general literacy. Thus we can observe that states which are having very high level of general literacy may not necessarily have high level of financial literacy, Kerala being one exception.

If we analyse cluster-wise, Assam, Bihar, UP, MP, Orissa and Rajasthan are forming the two clusters occupying the lowest positions. As

pointed out by Kumar and Subramanian (2012), in the period of 2001-2009 except two states i.e. Bihar and Orissa, other states are lagging far behind compared to the rest of the major states, though they have improved their performance from the period of 1993-2001. Regarding Bihar and Rajasthan, though they have shown good growth performance during the 1st decade of 21st century, their growth rate of per capita NSDP over the entire period of 1993-2009 is not impressive. Thus they are consistently low growth states. In terms of education and financial literacy states like Bihar, Orissa and UP are very poor performers. On the other hand MP, Rajasthan and Assam are relatively better in terms of financial literacy though overall literacy is so poor that the states are not able to do well in financial inclusion. This is also the reason for poor diffusion of information and telecommunication technology. The next cluster consists of West Bengal and Gujarat. The per capita growth of Gujarat has shown a remarkable improvement for the period of 2001-2009 compared to the decade before whereas WB has maintained consistent growth over the entire period of 1993-2009. Both the states are similar in terms of general literacy though Gujarat is relatively better in financial literacy than WB. These states have maintained a consistent position in financial inclusion though they are not very good in terms of diffusion of ICT. Some other factors such as political stability which is common for both the states may have played an important role in their consistent performance of financial inclusion. The next cluster consists of Himachal Pradesh and Haryana; both showing similar growth performance during the concerned period. They are good in terms of general literacy and not far behind in financial literacy as well. Himachal has shown considerable progress in ICT diffusion and it has done well in terms of Bank branch density as well. These have kept this state in the 2nd best performing cluster. Coming to the top performing set of states which consist of Punjab, AP, Kerala, Tamil Nadu, Karnataka and Maharashtra, we can observe that Kerala, Tamil Nadu, AP and specially Maharashtra have shown very high growth rate during 2000-2009 and Punjab and Karnataka have low growth performance. Kerala and Tamil

Nadu have consistently shown good positive relationship between growth and FII. They are reasonably good in terms of ICT diffusion as well. For Maharashtra growth performance is main factor which is reflected in highest credit and deposit amount as a percentage of GSDP even if it has not done very well in terms of ICT diffusion. However, Punjab is a state which has consistently shown good ICT diffusion except in last 1 or 2 years; but due to low growth performance could not reach a very high position in FI index. AP in spite of having modest growth and good financial literacy, due to lack of technology diffusion was initially lagging behind; however has moved up later on. Karnataka has also shown one to one relationship between ICT and FI with good financial literacy though there is much scope for general literacy to improve. Thus by and large, almost all states have shown significant positive relationship between ICT diffusion and FI supported by good growth performance and well spread education thereby validating our empirical findings.

CONCLUSIONS

This paper intends to investigate the role of ICT in improving the FI among the major Indian states. Two separate composite indices are constructed for FI as well as ICT to find out the relative position of the states. We have also clustered the similar states to club them in terms of their performance in FI. 5 major clusters are identified in terms of FI and have ranked them so that we can find out the specific factors responsible for their status. The dynamic panel data analysis helped us to identify the role of technology as well as other socio-economic factors which can contribute in interstate disparities in FI. The results show that technology does play an important role in improving financial inclusion so does per capita NSDP and more importantly growth of per capita NSDP. As the elderly people in rural as well as urban areas are still not that familiar with mobile and internet, they may not be able to get benefited by ICT revolution. But lack of education and more importantly poor status of financial literacy play a very vital role in FI. Thus policy makers should be

careful about spreading general as well as financial awareness about the positive side of use of technology so that more and more people of all age group and economic status come forward to be a part of formal banking sector.

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APPENDIX

Table A1: Clusters of States in Terms of FII

Year	Clusters
2005	• Assam, Bihar • MP, Rajasthan, UP • Gujarat, Odisha • Haryana, Himachal, WB • AP, Karnataka, Kerala, Maharashtra, Punjab, TN
2006	• Assam, Bihar, MP, Rajasthan, UP, Odisha • Gujarat, WB • Haryana, Himachal • AP, Karnataka, Maharashtra, Punjab, Kerala, TN
2007	• Assam, Bihar • MP • Odisha, Rajasthan, UP • Gujarat, WB, Haryana, Himachal • AP, Karnataka, Kerala, Maharashtra, Punjab, TN
2008	• Assam, Bihar, MP • Rajasthan, UP, Odisha, Gujarat, WB, Haryana, Himachal • AP, Karnataka, • Punjab, TN • Kerala, Maharashtra
2009	• Gujarat • Assam • Bihar • Rajasthan, UP, Odisha, WB, MP, Haryana, Himachal • AP, Karnataka, Kerala, Maharashtra, Punjab, TN
2010	• Assam, Bihar • Rajasthan, UP, Odisha, MP • Gujarat, Haryana, Himachal, WB • AP, Karnataka, Maharashtra, Punjab, • Kerala, TN
2011	• Assam, Bihar, MP • Rajasthan, WB, UP, Odisha, Gujarat, Himachal, • Haryana • AP, Karnataka, Maharashtra, Punjab, • Kerala, TN

2012	• Assam, Bihar • Rajasthan, UP, MP, Odisha • Gujarat, Himachal, WB • Haryana, Karnataka • AP, Maharashtra, Punjab, Kerala, TN
2013	• Assam, Bihar, MP • Rajasthan, UP, Odisha, Gujarat, Himachal • Haryana, WB • Karnataka, Maharashtra, Punjab, • AP, Kerala, TN
2014	• Assam, Bihar, MP • Rajasthan, UP, Odisha, MP • WB Himachal, Gujarat • Haryana, Karnataka, • AP, Maharashtra, Punjab, Kerala, TN

Table A2: Kendall's Index of Rank Concordance

	rank2005	rank2006	rank2007	rank2008	rank2009	rank2010	rank2011	rank2012	rank2013	rank 14
rank2005	1.0000									
rank2006	0.9167*	1.0000								
	0.0000									
rank2007	0.9000*	0.9833*	1.0000							
	0.0000	0.0000								
rank2008	0.8167*	0.9000*	0.9167*	1.0000						
	0.0000	0.0000	0.0000							
rank2009	0.8333*	0.8500*	0.8667*	0.9167*	1.0000					
	0.0000	0.0000	0.0000	0.0000						
rank2010	0.8667*	0.8500*	0.8667*	0.8833*	0.9000*	1.0000				
	0.0000	0.0000	0.0000	0.0000	0.0000					
rank2011	0.8833*	0.8667*	0.8500*	0.8667*	0.8833*	0.9500*	1.0000			
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000				
rank2012	0.8333*	0.8167*	0.8333*	0.8500*	0.8667*	0.9667*	0.9500*	1.0000		
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000			
rank2013	0.8500*	0.8333*	0.8167*	0.8333*	0.8167*	0.9167*	0.9333*	0.9500*	1.0000	
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
rank2014	0.8500*	0.8333*	0.8167*	0.8000*	0.7833*	0.8833*	0.9000*	0.9167*	0.9667*	1.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	

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