WORKING PAPER 210/2021

ROLE OF ICT DISSEMINATION AND DIGITAL FINANCE IN POVERTY ERADICATION AND INCOME INEQUALITY REDUCTION: A SUB-NATIONAL LEVEL STUDY FROM INDIA

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Price : Rs. 35

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Simontinti Das and Amrita Chatterjee

Abstract

Information and Communication technology (ICT) can boost economic growth and at the same time can create digital divide. The present paper explores both direct impact of ICT dissemination and its indirect impact through the channel of digital finance on poverty eradication and income inequality reduction at the sub-national level in India, considering rural-urban bifurcation. States are classified according to the incidence of poverty and income inequality. Ordered probit estimation confirms that the spread of ICT dissemination directly reduces the persistence of poverty in both urban and rural areas. Moreover, the application of ICT innovation in the financial sector or digital finance also has a positive impact on poverty eradication. However, in case of inequality removal, ICT innovation has no direct impact, though financial inclusion reduces inequality in both rural and urban areas. Interestingly, ICT diffusion in the banking sector dampens the positive role of financial inclusion on urban inequality reduction, whereas it has no impact on rural inequality. An important policy prescription should be strengthening ICT infrastructure along with a wider and uniform spread of digital finance among rural as well as urban populations so that more people can take advantage of ICT diffusion.

Keywords: *ICT innovation, Digital Finance, Poverty incidence, Income inequality, Rural-urban disparity*

JEL Codes: *O33, G2, I32, O18, R12*

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Acknowledgement

The author would like to thank the participants of 8th MSE Faculty Retreat for their valuable comments.

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INTRODUCTION

Information and Communication Technology (ICT) can accelerate economic growth and thereby alleviate poverty and reduce income inequality by increasing firm productivity, reducing information asymmetry in the labor market, strengthening social and human capital, and through the betterment of the political institution (Galperin and Viecens, 2017). These positive aspects motivate countries to invest generously in adopting these technologies in the last decade. One of the effective applications of ICT in banking sector is digital finance which implies delivery of financial services through mobile phones, internet, or electronic card without bank visits or dealing with financial service providers (Manyika, Lund, Singer, White, and Berry, 2016). Financial inclusion, which brings in so far unbanked population within the purview of formal banking sector, has long been accepted as a means to reduce poverty in developing and emerging economies (Mookerjee and Kalipioni, 2010, Emara and Mohieldin, 2020). Now digital finance also has a lot of potentials as it can contribute directly to GDP by providing easy access to finance for the poor, reducing the cost of financial intermediaries, providing credits to small, medium, and large businesses, and thereby boosting aggregate expenditure. ICT, however, being a skilled-biased technology, can intensify income inequality as well by exacerbating the skilled-unskilled wage gap. Moreover, digital finance requires the use of smartphones and a certain level of financial literacy which can also create a digital divide. Therefore, it may not have a very promising impact in case of developing countries (Chatterjee, 2020).

In India, one of the major objectives of development planning has been reduction, if not the removal of poverty and inequality (Beteille, 2003) and it has been recognized as one of the Millennium Development Goals (MDGs) as well. The policy debate about how investment in internet and telecommunication technology will contribute towards poverty alleviation and income inequality reduction and therefore will help in achieving MDGs has attracted a lot of attention in development

literature. India being a vast country with a lot of regional disparities faces an uneven spread of ICT diffusion as well as financial inclusion across states and between rural and urban areas. Moreover, even if usage of ICT applications such has mobile and internet are increasing in developing countries like India, other socioeconomic factors such as low educational attainment, poor per capita income, dominance of agricultural sector, lack of awareness and receptiveness towards new technology, may create hindrance in uniform spread and acceptance of digital finance. Though it is well documented in literature that both financial inclusion and ICT diffusion individually have direct impact on poverty and to some extent on inequality, there is a possibility that digital finance may not have homogeneous impact on poverty and inequality, which got largely unnoticed in the literature. ICT enabled banking services help banks to assess the creditworthiness of their customers and facilitate easy flow of credit and deposits thereby reducing exposure to informal credit market and subsequently helping to escape poverty trap. Therefore, the states with low incidence of poverty will be able to maintain and improve their income status reaping benefits from ICT innovations. However, the current paper hypothesizes that outreach of digital finance may be limited to a privileged few and therefore the benefits will get confined to them only. It may worsen the income gap between rich and poor; the haves and the have nots. Existing literature has not paid enough attention to this possible opposite impact of ICT on poverty and inequality once applied in banking sector. Thus, the objective of the current paper is to investigate whether applications of ICT affect the Indian states with various levels of incidence of poverty and inequality differently, exploring both direct and indirect impact i.e., when the diffusion of the technology takes place in the banking sector. The rural population, being disproportionately covered by the formal banking safety net, is expected to lag behind the urban population both in terms of financial inclusion and ICT diffusion. The paper thus draws attention towards whether the process of poverty alleviation and inequality reduction get differently affected by ICT application in the banking sector in rural and urban populations separately. The rest of the

paper is organized as follows: the next section discusses theoretical as well as empirical literature and poses the current problem in light of the research gap. Data exploration and methodological issues are explained in the next section. The following section summarizes the findings whereas the final section draws the conclusions and provides necessary policy prescriptions.

LITERATURE REVIEW

ICT diffusion is expected to have various direct and indirect effects on poverty and income inequality reduction. The literature review consists of various sub-sections addressing different facets of ICT dissemination and its developmental consequences.

ICT and Poverty

Galperin and Viecens (2017) have reviewed both theoretical and empirical literature to trace the link between internet technologies and growth leading to poverty alleviation and inequality reduction. The information and communication technology facilitates sharing of information in a very efficient way among individuals and firms. Traditional growth models by Romar (1990), Aghion and Howitt (1992) suggest that efficient communication of information and ideas would help firms to combine physical and human capital in such a way that output per worker improves and learning by doing further raises labor productivity (Howitt, 2004). Moreover, ICT applications such as mobile phones and the internet help dissemination of information which reduces Pareto-inefficiencies due to information asymmetry, reduces price distortions, improves the welfare of both consumer and producer, promotes efficient allocation of resources in the economy (Jensen, 2007; Aker, 2010; Camacho and Conover, 2011). Internet-enabled services help farmers to get better information about the price difference of crops across markets and weather conditions and help to improve the agricultural income of the rural population(Muto and Yamano, 2009;

Goyal, 2010; Beuemann, 2011). Another channel through which ICT contributes to poverty alleviation is through the accumulation of social and human capital. The use of mobile phones and the internet to explore personal networks within social groups facilitates easy access to information for the job-seekers, reduces the mismatch between demand and supply in the labor market, helps to increase employment through rural-urban migration, reduces geographical barriers (Lin, 2001, DeMaggio *et. al.*, 2001; Granovetter, 2005, Aker, 2010, Mansour, 2011; Mnag, 2012) especially beneficial for developing countries and more so for the rural people. Acquisition of ICT skills can also improve the employability of an individual especially in the service sector (Blanco and Lopez Boo, 2010), and also enhances income (DiMaggio and Bonikowski, 2008; Mossberger *et. al.*, 2007). Dissemination of ICT skills among school children as well as teachers can also play a significant role in human capital formation which is essential for productivity improvement. Another route through which ICT can be linked with poverty is transparency, accountability, and corruption of government. Studies suggest that widespread diffusion of the internet will help to bring more transparency in the functioning of political institutions, promote democracy and restrict corrupt practices of the political elites (Besley and Burgess, 2002, Stromberg, 2004, Anderson et al, 2011). This improves the quality of government service delivery including health care and better allocation of public resources among the voters. Here we note that all the above direct mechanisms may not necessarily help the poor to a great extent as put forward by Quibria and Tschang (2001). The effectiveness of ICT will be more in the case of developed countries than developing countries as the application of ICT is contingent upon some basic social and physical infrastructure. It, therefore, depends on at what stage of development the country is in.

ICT and Income Inequality

Another body of literature finds a link between ICT and income inequality. Technological progress, on one hand, can lead to an increase in labor productivity, skill-development, connection with the globalized

labor market and therefore has the potential to create a wealthier educated labor force. On the other hand, technology can make the production process less labor-intensive as automation and robot can replace low-skilled labor leading to a drop in their income. This will give rise to an increase in the gap between the wealthy and poor population and therefore intensifying income inequality. ICT has similar implications and more so because it has some pre-requisites such as a certain level of education, income, technological know-how, and some basic infrastructure. The impact of ICT on income distribution, however, has received less attention in development literature, despite being a major catalyst in globalization. ICT applications such as usage of mobile phones and the internet through its various positive externalities such as community radio, IT-enabled school education, etc lead to better access to information, reduce transaction and transportation costs, increase per capita consumption, provide better access to credit and insurance (Labonne and Chase (2009); Samuel, Shah, and Hadingham (2005); Overa (2006); Tong and Dall'erba, (2008); De Weerdt and Dercon, (2006) and Conley and Udry, (2010)), etc. These will act as factors reducing income inequality. On the other hand, several mechanisms show that ICT application may have adverse labor market implications widening the wage dispersion. The benefits of ICT can be disproportionately accrued to a handful of privileged high-skilled workers with ICT skills. This causes the reduction of productivity of low and semi-skill workers and exaggeration of the wage gap (Acemoglu 1998; Goldin and Katz 2008; Grossman (2001) Dunne *et. al.* (2004), Wessel (2013) Mnif (2016)). Moreover, technology may change at a faster pace than the pace of change of socio-economic and legal systems. This asymmetric developmental process creates economic stratification and widens the income gap (Falck, Heimisch, and Wiederhold 2016). Richmond and Triplett (2018) make an interesting observation with cross country evidence that fixed broadband subscription has more inequality increasing impact than inequality reducing impact of mobile phone attributing the difference to the cost of the technology. Thus, ICT being a

skill-biased technology, its impact on income inequality is mixed and most of the studies are country-specific.

Financial Inclusion, Poverty, Inequality

Financial inclusion is defined as access, availability and usage of the financial service and products by the organized financial sector to the marginalized unbanked population at a reasonable cost (Sarma, 2008). Financial inclusion is important for inclusive growth and its roles in welfare enhancement and poverty eradication are well accepted in developing economies (Chibba, 2009; Burgess and Pande, 2005; Lal,2017; Hussaini and Chibuzo, 2018; and Inoue, 2019, Park and Mercado (Jr.), 2015; Agyemang-Babu et. al., 2018; and Brei, Ferri, and Gambacorta, 2018). ICT diffusion has a very useful application in this context. As per World Bank (2014), the main objective of financial inclusion is to provide access, availability, and usage of financial services to the underprivileged and vulnerable population such as rural dwellers, women, low-income families so that they can receive the benefits of savings, borrowings, payment, and insurance. Financial inclusion helps millions of involuntarily excluded households to finance their consumption expenditure, investment, increase economic activity, cope with unexpected short-term shocks, better management of day-to-day finance, and most importantly avoid exploitation of informal money-lenders (Demirgüç-Kunt *et. al.* 2015, 2018). These positive aspects of financial inclusion make growth more inclusive and help in poverty reduction. However, extreme poverty is accompanied by large-scale inequality in developing countries. Therefore, apart from reducing extreme poverty by 2030, World Bank is keen to improve the prosperity of the bottom 40 percent of the population. Empirical literature however provides mixed evidence towards financial inclusion being effective for inequality reduction. A string of literature exhibits the negative impact of financial inclusion on income inequality (Mookerjee and Kalipioni, 2010; Clark, Xu, and Zou, 2006; Beck, Demirgüç-Kunt and Levine, 2007; Classens and Perotti, 2007; and Levine, 2007). Some of the studies address both the issues such as Park and Mercado (Jr.) (2015),

Agyemang-Babu et. al. (2018), Brei, Ferri, and Gambacorta, (2018) and Omar and Inaba (2020). They empirically prove that financial inclusion significantly reduces the poverty and income inequality simultaneously. Park and Mercado (2018) interestingly find that financial inclusion is effective in reducing poverty in high and middle-high income countries but not so for the low and low-middle income countries and has no impact on income inequality. Salazar-Cantú *et. al.* (2015) on the other hand show financial inclusion leads to higher income inequality up to a certain level and beyond that, it reduces income inequality within Mexican municipalities. By using data on MENA countries, Neaime and Gaysset (2018) discussed the positive effect of financial inclusion on mitigating income inequality but it does not have any significant impact on poverty eradication.

Digital Finance

With the application of ICT in the banking and financial sector, the concept of digital finance has been coined in the literature. Digital finance has immense potential in improving the lives of poor populations especially rural people. Despite various banking institutions, poor farmers still suffer due to information asymmetry, high transaction costs, and a shortage of collateral (Wang and He, 2020). The role of digital finance in reducing poverty and inequality has received very limited attention in the literature. There are however several advantages of digital finance that are the motivation of the current study. As already mentioned, ICT can alleviate information asymmetry by making a lot of information available to consumers. Digital finance provides similar advantages (Mishkin and Strahan, 1999; Gomber et al, 2007) by providing information related to bank account, online transactions, online fund transfer, online shopping platforms, etc and therefore will reduce information asymmetry between consumer and financial institution. Digital financial services also reduce transaction costs due to low marginal costs as new bank branches are not required to be established (Huang, and Wang, X, 2017; Liao et al, 2019). It also helps to get easy access to collateral-free loans for vulnerable rural farmers who face a lot of financial constraints due to a

lack of collateral (Bruett, 2007). Digital technology helps farmers to manage their cash flows and savings more efficiently and as a consequence, they would be able to protect themselves from any financial risk and get wider access to remittances from their social network (Apiors 2018).

Studies Focusing on India

In the context of India, various empirical studies have contributed to the literature, though most of them discuss the role of financial inclusion. There are limited studies on the role of ICT diffusion in poverty eradication and inequality reduction. In the Indian context, Kaur and Singh (2016) accept the presence of digital division, specifically between rural and urban regions. Cecchini and Scott, (2003) explain that the incidence of poverty increases with a rise in ICT penetration in rural India. Lokeswari and Aiswariya, (2017) and Maiti et. al (2020) support that ICT diffusion often raises the rate of exclusion specifically in rural India and aggravates income inequality. A study by Neogi (2020) argues that digital innovation affects HDI ranking but not the poverty and inequality at the sub-national level in India. This is one of very few papers, which discusses the issue of digital innovation, poverty incidence, and income inequality at the state level in India. In the context of financial innovation Burgess and Pande (2005) observe that the expansion of the branches of public banks helps to reduce the poverty incidence in rural India but it does not have any impact on the urban poverty level. Bhandari (2009) however contradicts Burgess and Pande (2005) by showing that financial inclusion does not have any significant effect in curbing poverty incidence either in a rural area or in an urban area. Lal (2017) estimates the impact of financial inclusion on poverty reduction through cooperative bank intervention. Regarding inequality, Ang (2010) estimates the Error correction model to show that financial inclusion significantly reduces income inequality. Meenakshi (2015) highlights the fact that the north-eastern region and eastern region suffer from severe inequality and these regions need special attention regarding financial inclusion to reduce the degree of inequality. Another interesting

paper by Gradin (2018) identifies various determining factors of income inequality. These are varying degrees of financial inclusion, the composition of the workforce, degree of urbanization, gender, age composition, caste, etc.

Research Questions and Contribution

Given this theoretical and empirical background, the current paper addresses the following pertinent research questions in the context of India at the sub-national level. Firstly, how does ICT diffusion affect poverty and inequality in India? Secondly, how does ICT affect poverty and inequality if they are applied through the channel of financial inclusion i.e., through digital finance? Thirdly, the success of ICT penetration in poverty and income inequality reduction is preconditioned by access to various types of social (education, financial literacy, age composition, etc.) and physical (electricity, teledensity, internet connectivity, etc.) infrastructural facilities. Determining factors are expected to have a disproportionate impact on poverty and inequality across different states. Also, within states rural and urban areas have different socio-economic patterns and therefore have different receptibility towards technological innovation. India experiences twelfth times increase in the technology gap between rural and urban areas during 2000 (Kaur and Singh, 2016). Does this digital divide raise the possibility of having the heterogeneous impact of ICT penetration on the prevalence of poverty and income inequality at the Indian sub-national level and across rural-urban areas? Finally, does ICT affect poverty and inequality differently given the fact that ICT creates a digital divide?

The present paper contributes to this body of literature by highlighting the role of digital finance in eradicating poverty and inequality in India at the sub-national level, which in our knowledge has not been addressed so far. The crucial contribution of this study is that it draws attention to the fact that ICT being a skill-biased and costly technology can widen the income inequality even if it becomes an effective tool for poverty eradication once coupled with financial

inclusion. The two contrasting aspects of ICT penetration in banking sector regarding poverty and inequality have not been explored in literature; the gap that the current study intends to fill up. Our study also highlights whether the rural and urban populations get disproportionately affected by these technologies. With the widespread adoption of digital technologies in the world and India not being far behind, the study can provide useful policy implications towards the achievement of Millennium Development Goals (MDGs) with the help of technological innovations but with a caution about a possible rise in income inequality.

The study intends to construct a composite multi-dimensional Financial Inclusion Index (FII) and Information and communication technology index (ITI) using the methodology prescribed by Sarma (2012) compiling the important indicators. Besides, other important control variables, like availability of various physical and social infrastructural facilities, per capita NSDP at a constant price and population are included to construct a complete inclusive model. Here fifteen major Indian states are considered for a panel ordered probit model for poverty analysis and a pooled ordered probit model for inequality analysis separately for the rural and urban population. The rural-urban bifurcation within a state appends an important contribution to the existing research.

Data Description, Data Exploration and Methodology

This section delineates the data description, index construction, data exploration, and methodology description.

Data Description and Index Formation

For the analysis 15 major Indian states[1] are considered. For poverty analysis, three years, [2]2004-2005, 2009-2010, and 2011-12, whereas for

[1]Andhra Pradesh, Assam, Bihar, Gujarat, Haryana, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Odisha, Punjab, Rajasthan, Uttar Pradesh, Tamil Nadu and West Bengal

inequality issue two years, 2004-05 and 2009-10 are considered. Poverty incidence is measured by the percentage of population below the poverty line and GINI is considered as the measure of income inequality[3]; for both rural and urban regions of a state. Central Statistics Office, Ministry of Statistics and Program Implementation, Government of India, Census 2001, 2011, Reserve Bank of India, various issues of Economic Survey, and indiastat.com are the main sources of data.

For the comprehensive analysis, the paper constructs four indices: Information Technology Index (ITI), Financial Inclusion Index (FII), Physical Infrastructure Stock Index (PISI), and Social Infrastructure Stock Index (SISI). These are all composite indices. Financial inclusion is measured by various indicators of banking outreach (Honohan, 2008; Ardic *et. al.*, 2011; Reyes *et. al.*, 2010). The present paper follows Sarma (2012)[4] methodology for constructing a composite index for both Information and Communication Technology (ITI) and Financial Inclusion (FII).

On the other hand, PISI and SISI are constructed by using Principal Component Analysis. During PCA, higher eigenvalues (>1) are considered to construct the corresponding weights. In this case, the first principal component is retained to construct the variables as it explains more around 80 percent variation of both the data set. The variable list used in the construction of ITI, FII, PISI, and SISI is given in Table 1.

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[2] The paper is concentrating on the time period after 2000 as the data on information and communication related variables and financial variables are not available before 2000.

[3]In case of estimation of income inequality, social infrastructure stock index is also included as the availability of social infrastructure like education and health facility is expected to affect the income inequality also.

[4]The present paper follows the methodology of Sarma (2008) and of Pal and Vaidya (2011). This method is based on the Euclidian distance of actual point from the ideal point. The ideal point of these composite indices is (1, 1, 1). Each of the indexes has three dimensions and highest value of each dimension is 1. Hence our ideal point is (1, 1, 1). The value of composite index as well as the value of individual dimensions lie between 1 to 0. Here equal weight is attached to each dimension, justifying the equal importance of all the dimensions in the composite index.

Table 1: Variable List of FII, ITI, PISI, and SISI

Variables used in FII	Variables used in ITI	Variables used in PISI	Variables used in SISI
(credit+deposit)/ GSDP (measuring usage dimension of financial inclusion)	Number of Internet Subscribers per 100 population	Length of National Highway (in km)	Number of Primary School (per 1000 pop)
number of deposit account and number of credit accounts per 1000 population (measuring accessibility dimension	Tele-density per 100 population	Length of State Highway (in km)	Number of High/Secondary schools (per 1000 pop)
number of bank offices per One lakh population (measuring availability dimension)	Mobile phone users per 100 population	Length of Railway (in km)	Total number of colleges (per 1000 pop)
Credit-deposit ratio (measuring usage dimension)		Power Consumers industrial (LV and MV) (in number)	Number of primary health centers (per 1000 pop)
		Total Power Consumers (LV and MV) (in number)	Number of beds in a government hospital (per 1000 pop)
		Cargo handled at port (in tones)	
		International cargo handled at the airport (in tones)	
		Number of Special Economic Zones	

Source: Data is collected from indiastat.com

Data Exploration

This section intends to describe the regional disparities in the rural-urban region at the sub-national level in India. Here regional disparities imply divergence in the prevalence of poverty, inequality, and variation in the spread of ICT diffusion. For the incidence of poverty, states are classified into five categories; highly rich states, medium rich states, middle-income states, moderately poor states, and severely poor states; depending on the percentile of the variable 'percentage of people below the poverty line. The classes are as follows: percentage of population below 25^{th} percentile (1st category having highly rich states), between 25^{th} and 50^{th} percentile (2^{nd} category having medium rich states), between 50^{th} and 75^{th} (3^{rd}category having middle-income states), between 75^{th} and 90^{th} (4^{th} category having moderately poor states) and above 90^{th} percentile (5^{th} category having severely poor states). As the order of category increases, more and more people are below the poverty line. Different classifications are made for an urban and rural region.

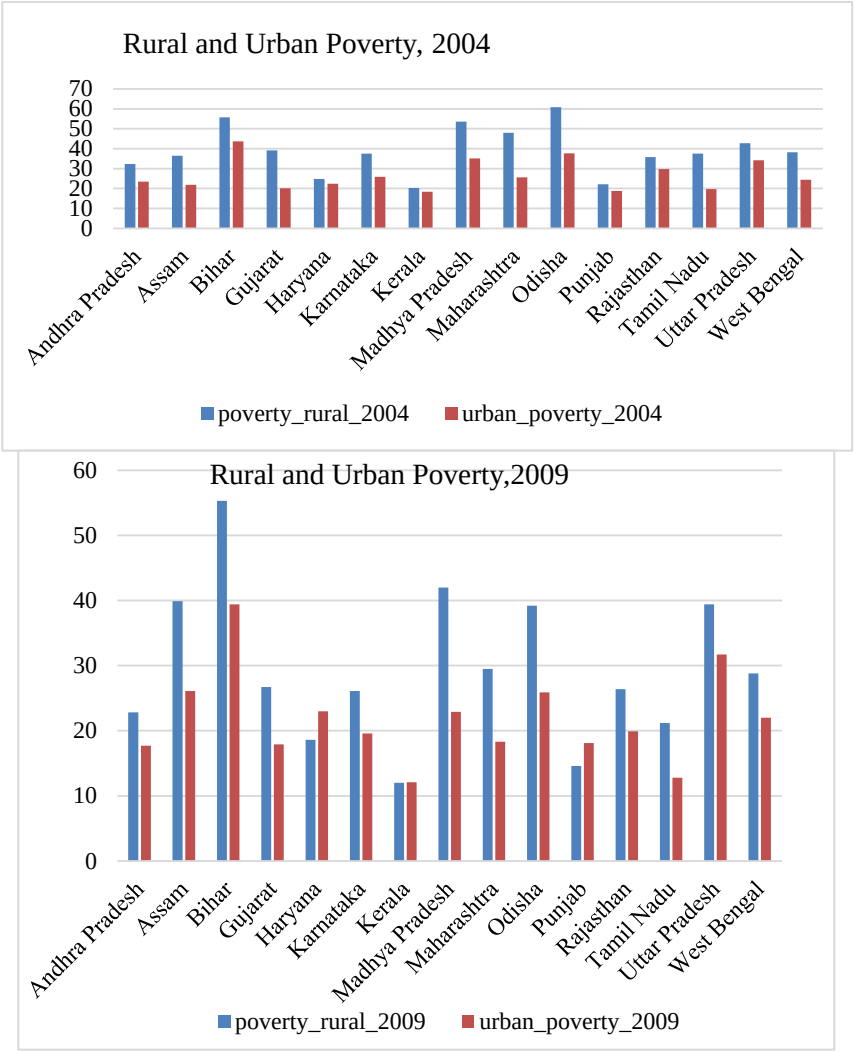
A similar type of classification is also done for the prevalence of income inequality at the state level. States are clustered in three groups using Gini by the K-mean clustering method. The highest cluster signifies the states with the highest income inequality; the second cluster includes the moderately unequal states whereas the lowest cluster clubs the most equal states. Here data are pooled for two years 2009 and 2011. Almost no change is there in the inequality status of the states over time.

Regional Disparities in Terms of Poverty Incidence and Income Inequality

There is a divergence in the poverty incidence at the sub-national level in India. Bar diagrams in figure 1 show that the incidence of poverty is more in rural areas than in urban areas in all the 15 states over time. Incidence of poverty is comparatively low in Kerala, Haryana, Punjab, Tamil Nadu, and Andhra Pradesh, whereas it is quite high in Bihar, Assam, Madhya Pradesh, Uttar Pradesh, and Orissa. Orissa, Rajasthan, Madhya Pradesh, and Maharashtra however experience perceptible

improvement in both rural and urban areas. Another interesting observation is that the prevalence of poverty becomes more intensified in urban areas than in rural areas in Punjab and Haryana over time.

Figure 1: Comparison of Rural-Urban Poverty Incidence



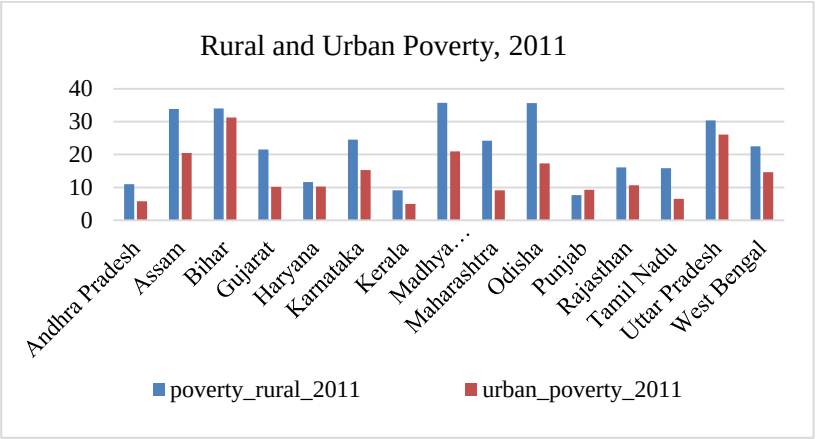
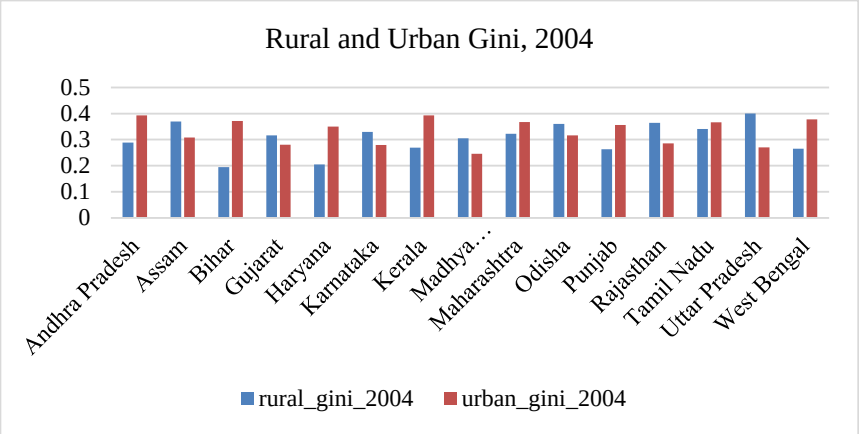
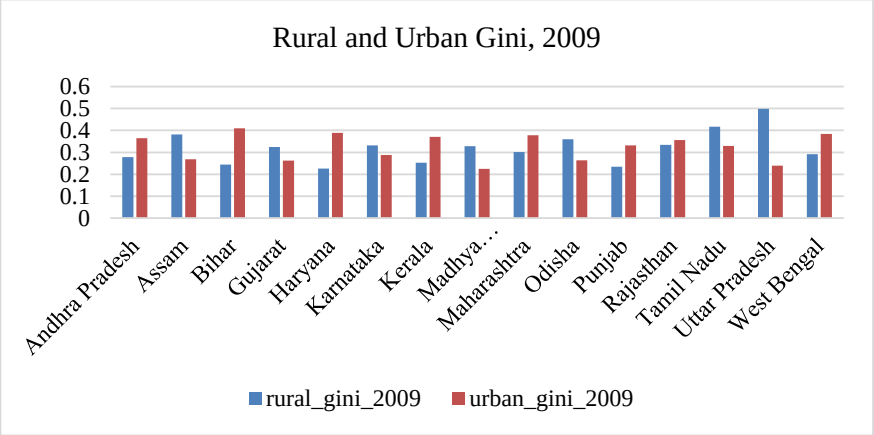


Figure 2 describes the comparative income inequality status of the states, considering rural-urban division. The relative status of rural-urban income inequality varies across the states. In Assam, Gujarat, Karnataka, Madhya Pradesh, Orissa, Rajasthan, and Uttar Pradesh, inequality is more severe in rural areas than in urban areas. The rest of the states experience the opposite trend. There are some special cases, like, two relatively rich states Punjab and Haryana, which are experiencing low rural but high urban inequality. Bihar and Kerala, being the states with the highest and lowest rural poverty respectively, are having the lowest rural inequality. Urban Kerala however is experiencing very high-income inequality though urban Bihar is having low inequality.

Figure 2: Comparison of Rural-Urban Income Inequality



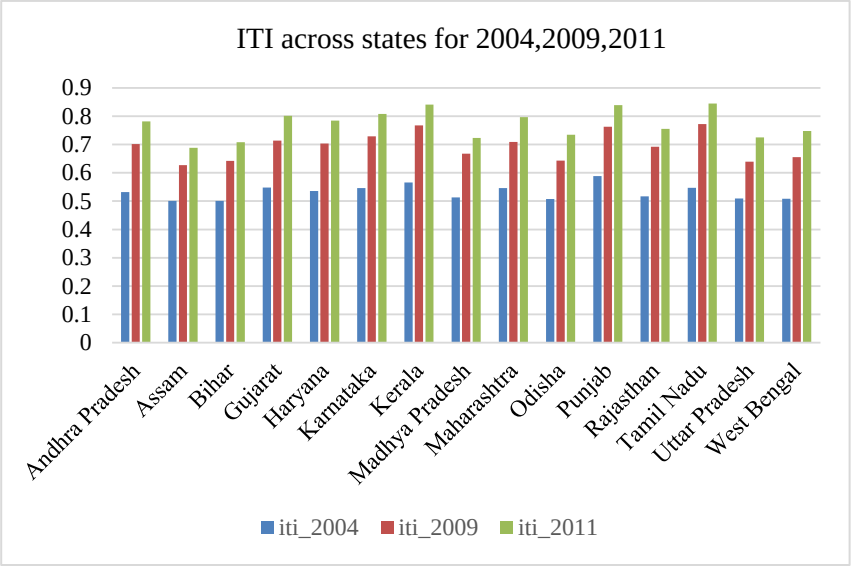


Divergence in the Spread of ICT Diffusion at Sub-national Level in India

Figure 3 describes the status of ICT diffusion across the states. ICT dissemination increases across all the states over time. Assam, Bihar, UP, Orissa have a slow spread of ICT facilities. Punjab, Kerala, Maharashtra, Tamil Nadu, and Karnataka are reasonably well-performing states. Gujarat is doing relatively well in ICT diffusion whereas WB and MP are lagging far behind. In Andhra Pradesh, the availability of banking facilities is though, moderately high but the degree of ICT diffusion remains

persistently low. A more disaggregated level analysis at rural and urban levels could give us a much better insight which is not possible due to the unavailability of data.

Figure 3: ICT Diffusion across 15 Indian States



Comparing poverty incidence, inequality status, and ICT diffusion rate, it can be observed that richer states like Kerala and Tamil Nadu are having well-spread ICT facilities whereas poorer states like Bihar, UP and Assam are lagging. However, rural inequality is high in states like UP, WB, MP, and Rajasthan who are not doing well in terms of ICT diffusion. Urban inequality is in general high as mentioned earlier, even in well-performing states like Kerala and Tamil Nadu. Punjab despite being a strong state in terms of ICT, suffers from high urban inequality though in rural areas inequality is low. On the other hand, Haryana, even with a moderate level of ICT is facing the same trend in inequality in rural and urban, though it has a reasonably rich rural and urban population. These observations give hint to the fact that ICT may create a digital divide and therefore can have diversified impacts on rural and urban populations,

both in terms of poverty and inequality. The diverging causal relations between the availability of supply-side facilities (like the spread of information and communication technology) and the prevalence of poverty and income inequality at the Indian sub-national level encourage us to undertake a more comprehensive econometric analysis for appropriate policy prescription.

Methodology

The conceptual framework used in this study is presented in terms of a schematic diagram in figure 4 (in appendix). To execute the conceptual model a panel ordered probit regression is estimated to analyze how the impact of ICT diffusion itself and through financial inclusion differ across the states with different levels of poverty incidence. Explanatory variables may not have similar effects at a different level of poverty. Some socio-economic factors may be important in poverty eradication for the states with a high degree of incidence, whereas the different sets of variables are important for the states with a medium or low level of incidence. The panel ordered probit analysis helps to capture these diversified effects. The incidence of poverty and inequality of a state is denoted by the following ranking.

(Level of Poverty)	= 1 if state is highly rich
	= 2 if state is medium rich
	= 3 if state is middle income
	= 4 if state is moderately poor
	= 5 if state is severely poor
(Level of income inequality)	= 1 for high inequality[5]
	= 2 for moderate inequality
	= 3 for low inequality

As the dependent variable is discrete in both the cases, limited dependent variables model of estimation is appropriate here. Ordered probit regression is a suitable methodology for econometric analysis, as

[5] Based on author's calculation through K-mean clustering

the dependent variable is ordered multinomial choice variable. In the case of poverty, panel framework is considered whereas, in the case of inequality, a pooled framework is used along with a time dummy[6].

Econometric analysis

The current paper aims to study the direct and indirect impacts of ICT diffusion on the incidence of poverty and income inequality in fifteen major Indian states. To accomplish the objectives a panel ordered probit regression is estimated to analyze how the impact of ICT diffusion itself and through financial inclusion differ across the states with different levels of poverty incidence. Explanatory variables may not have similar effects at different levels of poverty. Some socio-economic factors may be important in poverty eradication for the states with a high degree of incidence, whereas the different sets of variables are important for the states with a medium or low level of incidence. Panel ordered probit analysis helps to capture these diversified effects.

ICT diffusion, ICT induced Digital Finance and Incidence of Poverty

Econometric analysis comprises of two sections: direct impacts of ICT diffusion and ICT induced financial inclusion on rural-urban poverty and income inequality at Indian sub-national level during last the decade.

Under this section, we first estimate the direct effect of ITI as well as its components and various indirect effect of ITI on rural-urban poverty incidence at the Indian sub-national level.

The estimable equations are,

For the direct effect of ICT

$$(\text{Level of Poverty})_{itj} = a_0 + a_1(\text{ITI})_{it} + a_2\text{Log}(\text{Per capita NSDP at constant price})_{it} + a_3(\text{Education Index})_{it} + a_4(\text{SISI})_{it} + a_5(\text{Number of Factories})_{it} + a_6(\text{Real Export})_{it} + a_7(\text{Population})_{itj} + u1_{itj} \quad (1)$$

[6]Here only two years of data is available.

Where i= 1, 2, …., 15; states
t = 2004, 2009, 2011; j = rural, urban

For indirect effect of ICT through banking sector

$(\text{Level of Poverty})_{itj} = b_0 + b_1(\text{ITI*FII})_{it} + b_2\text{Log}(\text{Per capita NSDP at constant price})_{it} + b_3(\text{Education Index})_{it} + b_4(\text{SISI})_{it} + b_5(\text{Number of Factories})_{it} + b_6(\text{Real Export})_{it} + b_7(\text{Population})_{itj} + u2_{itj}$ (2)

Equation (1) depicts the direct impact of ICT on the incidence of poverty. Equation (2) intends to capture the impact of digital finance or ICT-enabled banking services through the Joint interactive term ITI*FII ($b_1$is the relevant coefficient). A positive value of b_1 implies that the impact of ICT diffusion on poverty incidence is amplified due to the increase in ICT-led financial inclusion.

Education index and Indirect effect of ICT

$(\text{Level of Poverty})_{itj} = c_0 + c_1(\text{ITI*Education})_{it} + \text{other control variables} + u3_{itj}$ (3)

Educational attainment increases the receptivity of ICT diffusion. The coefficient of the joint interactive term (ITI*Education) in equation (3) shows the impact of educational attainment on the affirmative role of ITI in poverty reduction (c_1 is the relevant coefficient). $c_1 > 0$ implies that the spread of education enhances the positive effect of ICT dissemination.

Table 2 describes the average marginal effects of the independent variables on rural-urban poverty incidence across fifteen major Indian states from the estimation of the ordered probit model. It describes the estimation result of equation (1). Results confirm that an increase in the information technology index (ITI) significantly raises the probability of being highly rich states and reduces the probability of being the severely poor states in urban as well as in rural areas across the

states. It infers that ICT diffusion through its various positive features helps people to increase their income so that they remain above the poverty level. The observation implies that ICT diffusion is capable of reducing poverty incidence in the urban and rural areas at the sub-national level, though the channels of operation may be different. In the urban area, ICT dissemination helps in increasing employability in the service sector, augmenting human capital, raising labor productivity, removing information asymmetry, and in turn improving transparency in Government operation (Besley and Burgess, 2002; Stromberg, 2004; Mossberger *et. al.*, 2007; DiMaggio and Bonikowski, 2008; Blanco and Lopez Boo, 2010; and Anderson et al, 2011). In the rural area, it helps in the dissemination of information about price discrimination, weather conditions, availability of job opportunities in different sectors, accessibility of various social policies, etc. (DeMaggio *et. al.*, 2001; Lin, 2001; Granovetter, 2005; Muto and Yamano, 2009; Aker, 2010; Goyal, 2010; Beuemann, 2011; Mnag, 2012). The people, thus, can use ICT applications more productively to improve their income and therefore to escape the poverty trap.

As far as other control variables are concerned, an increase in population significantly enhances the probability of being severely poor states however diminishes the probability of being highly rich states in the urban area, inferring that population boom can be one of the possible reasons for poverty. For a rural area, it has significant impact only on the severely poor states, not on the highly rich states. The study reveals that the growth of per capita NSDP[7] has significant role in both types of poverty eradication at the sub-national level in India. Economic growth raises the probability of being a highly rich state and reduces that of being a severely poor state. Educational attainment (measured by education index) also has a significant positive impact on the probability of being the highly rich state in the urban area; however, it does not have any significant impact in other cases.

[7] Measured by log(per capita NSDP at constant price)

Table 2: Average Marginal Effect of ITI (Direct Effect) on Rural-Urban Poverty Incidence

Poverty status	Urban		Rural	
	Category 1(highly rich states)	Category 5 (severely poor states)	Category 1(highly rich states)	Category 5 (severely poor states)
ITI	0.0090605**	-0.0042314**	0.0073683***	-0.0068648***
ln(Per Capita NSDP)	0.1964526**	-0.0917461*	0.3176671 ***	-0.2959578***
Education Index	1.129305*	-0.5274011	0.5059672	-0.4713896
SISI	-0.0000309	0.0000144	-0.0014984	-0.0014984
No of factories			5.89e-06	-5.49e-06
Export	1.51e-06	-7.06e-07	-1.20e-06**	1.12e-06**
Population	-0.0011203**	0.0005232**	-0.0006027	0.0005615*

Source: Authors' calculation; *** p<0.01, ** p<0.05, * p<0.1

Notably, the spread of ICT diffusion is asymmetric across rural-urban regions but it has similar affirmative impacts in poverty eradication in both areas. This result contradicts Heeks (2014), Neogi (2020), as they show that ICT dissemination fails to reduce rural poverty levels.

The baseline model shows that the spread of ICT infrastructure, population control, and economic growth are the major policy prescription for rural-urban poverty alleviation at the sub-national level in India.

Table 3 describes the estimated result of equation (2). The marginal effect of the joint interaction term of FII and ITI illustrates whether ICT diffusion through the channel of financial inclusion affects poverty incidence. This can be termed as the indirect effect of ICT diffusion on poverty eradication. The estimated average marginal effects of FII*ITI are significantly positive for the highly rich category and significantly negative for the severely poor category. It demonstrates that the application of ICT in the banking sector increases the probability of reducing the incidence of poverty in urban as well as rural areas. It infers that ICT diffusion in the banking sector helps to mitigate urban-rural

poverty. Here also the indirect impact of ICT through financial inclusion is homogeneous across the rural-urban area. This is anticipated that ICT-enabled finance or digital finance reduces transaction cost (Huang, and Wang, X, 2017; Liao et al, 2019), removes information asymmetry about the bank account, online transactions, online fund transfer, online purchase, etc (Mishkin and Strahan, 1999; Gomber et al, 2007) and also provides collateral-free loans to the vulnerable rural farmers who face a lot of financial constraints due to lack of collateral (Bruett, 2017).

Table 3: Average Marginal Effect of ITI (Indirect Effect) through Financial Inclusion on Rural-Urban Poverty Incidence

Poverty status	Urban		Rural	
	Category 1(highly rich states)	Category 5 (severely poor states)	Category 1(highly rich states)	Category 5 (severely poor states)
ITI*FII	.0001457***	-.0000713***	.0000901**	-.0000924 ***
ln(Per Capita NSDP)	.0841158	-.0411654	.2663574***	-.2731075***
Education Index	.926666	-.4535003	.296387	-.303898
SISI	-.0031803	.0015564	-.0027551**	.0028249*
No of factories			2.58e-06	-2.64e-06
Export			-9.92e-07**	1.02e-06
Population	-.0013121**	.0006421***	-.0007856*	.0008055*

Source: Authors' calculation; *** p<0.01, ** p<0.05, * p<0.1

Table 4 describes the estimated result of equation (3). The result confirms that improvement of educational attainment among rural-urban populations reinforces the poverty-reducing capacity of ICT innovation. The population being equipped with better educational attainment will be more inclined towards the use of technological innovations and therefore will be able to reap maximum benefit from it with wide dissemination of

information. It hence becomes more effective in employment generation and strengthens the impact on poverty eradication also.

Table 4: Average Marginal Effect of ITI (Indirect Effect) and Educational Attainment on Rural-Urban Poverty Incidence

Poverty status	Urban		Rural	
	Category 1(highly rich states)	Category 5 (severely poor states)	Category 1(highly rich states)	Category 5 (severely poor states)
ITI*Education index	.0248914***	-.0113883**	.0157149 ***	-.0159486 ***
Control variables	yes	Yes	Yes	Yes

Source: Authors' calculation; *** p<0.01, ** p<0.05, * p<0.1

The above observation validates that ICT diffusion is similarly effective in reducing rural as well as urban poverty. At the sub-national level of India, the spread of ICT innovation can be considered as a non-discriminatory policy in poverty alleviation. The present paper has also studied the impacts of individual components of ICT, like tele-density, mobile phone usage, and internet usage on poverty incidence across the rural-urban area at the Indian sub-national level which reveals the same homogeneous impacts (Result is given in table A.1 in Appendix A). Usage of telephones, mobiles, and the internet independently as well as through its application in the banking sector raise the probability of a state being highly rich and reduces the probability of a state to be severely poor, irrespective of rural-urban division.

Indian sub-national level study confirms that ICT diffusion and digital finance help to reduce the incidence of poverty irrespective of rural-urban division; hence these two can be effective tools in poverty eradication. On the other hand, population control can be another effective policy in this regard.

ICT Diffusion, ICT Induced Digital Finance and Income Inequality

ICT innovation has a debatable impact on income inequality. As already discussed, the literature suggests that ICT-based applications, such as the usage of the land phone, mobile, and internet, can improve the earning capacity of the marginalized population through employment generation, removal of information asymmetry, skill up-gradation, reduction in transportation cost, etc. This in turn may reduce income inequality in society. Conversely, another stream of the literature concludes that the benefits of ICT diffusion can be reaped only by a section of skilled workers. A large part of the marginalized population remains excluded from the developmental process. This can aggravate inequality. Besides, the spread of ICT can influence income inequality through the channel of financial inclusion. It has been established that ICT application helps in the spread of financial inclusion, which in turn provides banking services to the unbanked population. As a result, their income increases, and consequently inequality decreases.

To analyze the impact on income inequality, the same ordered probit model is estimated in pooled framework. Across the states, urban and rural income inequalities are classified into three categories; high inequality, moderate inequality, and low inequality. Here an interaction of ICT and FII has been taken to capture its indirect effect through the banking sector as literature accepts the effectiveness of fintech applications in financial inclusion (Pepper and Garrity, 2015; Chatterjee and Das, 2019).

The estimable equations are,

$$(\text{Level of income inequality})_{itj} = d_0 + d_1(FII)_{it} + d_2(ITI)_{it} + d_3(ITI*FII)_{it} + d_4\text{Log}(\text{Per capita GSDP at constant price})_{it} + d_5(SISI)_{it} + d_6(PISI)_{itj} + d_8(\text{population})_{itj} + d_9(\text{Education Index})_{itj} + u4itj \quad (4)$$

Where i= 1, 2, …., 15; states; t = 2009, 2011; j = rural, urban

Table 5 describes the estimation of equation (4).

Table 5: Average Marginal Effect of ICT Diffusion and Digital Finance on Rural-Urban Income Inequality

Inequality status	Urban		Rural	
	Category 1(highly Unequal States)	Category 3 (States with Lowest inequality)	Category 1(highly Unequal States)	Category 3 (States with Lowest inequality)
FII	-.1565844 ***	.1723964 ***	-.0540789	.0493389*
FII_ITI	.0013542 ***	-.0014909***	.0003317	-.0003026
Log (Per capita NSDP)	-.2552291	.2810024	-.7338518**	.6695303***
SISI	.0254165***	-.027983***	.0158198***	-.0144332**
PISI	.004698	-.0051724	.0061226*	-.005586***
population	.0030025*	-.0033057*	.0031605**	-.0028835**
Education index	.6141723	-.6761921	2.031566	-1.853501
Time code	-1.0837***	1.193133***	-.0418061	.0381418

Source: Authors' calculation; *** p<0.01, ** p<0.05, * p<0.1

In the case of income inequality, ICT has no significant direct impact on income equality[8] at the Indian sub-national level; rather ITI affects income inequality through the channel of financial inclusion. Moreover, results in table 4.5 demonstrate that the spread of financial inclusion in the urban area has significant positive impact on income inequality in the sense that it significantly raises the probability of having low-income inequality and significantly reduces the probability of having high-income inequality. The spread of financial inclusion hence helps to mitigate the urban income inequality, which finds support in Ang (2010) and Inoue (2019). The marginal effect of joint interaction term of FII and ITI can be termed as the indirect effect of ICT diffusion on inequality

[8] The individual results of ITI are not reported here

through its application in FII. It demonstrates that the application of ICT in the banking sector increases the probability of urban inequality. ICT application in the banking sector somehow weakens the overall affirmative role of financial inclusion to mitigate urban inequality. This is supporting the hypothesis that digital financial inclusion is creating a digital divide between haves and have-nots among the urban population and therefore only a privileged few are enjoying the benefits of digital finance. In the case of rural areas, the affirmative role of financial inclusion is significantly limited. Here spread of financial inclusion increases the probability of being a state of low-income inequality (similar conclusion from Ang, 2010; Meenakshi, 2015; Inoue, 2019; and Gradin, 2018[9]). The poorer section of the rural population is severely exploited by the informal credit providers. If increased availability of formal banking service reaches the targeted marginalized poor class in rural India, the poor unbanked population enjoys the facility of formal credit sector. They get the credit at a relatively subsidized rate of interest and other facilities designed for them. This, in turn, increases the income level of the poor marginalized class, and the incidence of rural income inequality declines. However, the composite index on ICT has no impact on income inequality; neither direct nor through digital finance. It may well happen that ICT is helping both the richer and the financially weaker section of the society to increase their income level which in turn is not affecting the income gap between people from different strata.

As far as the other control variables are concerned, an increase in per capita NSDP significantly reduces the probability of being high inequality states and raises the probability of being a low inequality state in the rural area. It indicates that an increase in per head income helps to eliminate dispersion in income distribution in rural Indian. It however does not have any impact on urban inequality. An increase in the availability of social infrastructure and population size significantly raises

[9]These studies undertake state level analysis. They do not consider rural-urban bifurcation within individual states. The present paper is unique in this way.

the probability of a state moving from low-income inequality to high-income inequality (Rudra (2004), and Chadha and Nandwani (2019)), irrespective of rural-urban bifurcation. The social infrastructure index consists of various education and health infrastructure-related parameters. This result implies that the availability of social infrastructure mainly benefits the high-income population rather than the low-income group. The distribution of benefits of developmental expenditure is highly skewed in both rural and urban areas. Only people with more financial power and political control avail the facilities of social and physical infrastructure. The poorer population remains excluded and hence income inequality increases. Availability of physical infrastructure intensifies the rural income inequality; however, it does not have significant impact on urban inequality. The estimated marginal effect of the time code is significantly positive for the low urban inequality category and significantly negative for the high urban inequality category, implying that over time probability of being states with low inequality increases and that of being states with high inequality declines in the urban area. State-level urban income inequality falls over time in India, but rural inequality does not show any such trend.

After considering the role of the composite index, individual ICT applications, like the usage of the land phone, mobile phone, and internet are considered for more comprehensive understanding. Table 6 describes the average marginal effects of individual components of ICT application on income inequality.

Table 6: Average Marginal Effects of Tele-density, Mobile and Internet Facility on Rural-Urban Inequality Incidence[10]

Inequality status	Urban		Rural	
	Category 1(highly Unequal States)	Category 3 (States with Lowest inequality)	Category 1(highly Unequal States)	Category 3 (States with Lowest inequality)
FII	-.0854086***	.0944201***	-.0478522***	.0444035***
Teledensity	-.0541441	.0598569	-.0645836**	.059929**
Tele density*FII	.0009443**	-.0010439**	.0007096**	-.0006584**
Control variables	Yes	Yes	Yes	Yes
FII	-.1046952***	.1075592***	-.049371***	.0426268***
Mobile	-.0627033	.0644185	-.014892	.0128577
Mobile*FII	.0013162***	-.0013522**	.0004412	-.0003809
Control variables	Yes	Yes	yes	Yes
Internet*FII	.0034925*	-.0040519**	.0008628	-0.0008832
Control Variables	Yes	Yes		

Source: Authors' calculation; *** p<0.01, ** p<0.05, * p<0.1

Disaggregate level study shows that individual ICT application has diverse impacts on rural and urban income inequality at the Indian sub-national level. The result delineates that usage of mobile phones and the internet does not have any direct impact on rural-urban inequality whereas tele-density reduces income inequality only in a rural area but not on urban inequality. The land phone has limited use in urban areas with the increasing popularity of mobile, especially smartphones; but in rural areas land phones may still find their relevance and can be effectively used to circulate important information. Different ICT applications indirectly influence inequality through the channel of financial inclusion mainly in Urban areas. In the urban area, an increase

[10]To avoid unnecessary lengthy representation, we are presenting only the marginal effects of individual components of ITI and their relevant interactions. For each component different version of equation (4) is estimated considering different form of ICT.

in tele-density, usage of mobile phones, and the internet dampen the affirmative impact of financial inclusion on income inequality, whereas only tele-density has a similar impact on inequality in the rural area. It infers that usage of a landline is more convenient for rural people in banking purposes though it is used by only a selected rich rural population; not so popular among urban people. On the other hand, usage of mobile and the internet aggravates the digital division problem only in the urban area. It can be attributed to the fact that these two sophisticated ITC supported gadgets do not have any detrimental effect on the positive impact of financial inclusion on rural inequality, as the rural population still lags in using these applications.

In the case of income inequality, the Indian sub-national study confers that ICT diffusion has diverging direct and indirect impacts through financial inclusion on inequality in the urban and rural areas. Relatively old ICT application, landline phone appears as an effective policy instrument in the rural area to mitigate inequality problem, but not for the urban area. ICT diffusion, like tele-density, usage of mobile phones, and the internet has indirect effects on urban inequality when applied in the banking sector. These applications aggravate urban inequality and have no impact on rural inequality. The proposition that 'ICT enabled financial inclusion reduces income inequality' does not hold for the rural-urban area at the Indian state level. Social infrastructural facilities aggravate the income inequality in both areas, whereas physical infrastructure and economic growth raise the probability of a state moving from low inequality to high inequality status only in the rural area. Population control policy can be an effective instrument in reducing both urban and rural inequality at the sub-national level.

CONCLUSION

There has been substantial evidence to accept that ICT innovation has a lot of potential in enhancing economic growth and eradicating poverty, though its impact on inequality is mixed. The current paper tries to

investigate the direct impact of ICT diffusion on the incidence of poverty and inequality and its indirect impact through its application in the banking sector for 15 major states of India with a clear distinction between rural and urban areas. Estimation of an ordered probit model suggests that ICT diffusion is indeed fruitful in helping states to escape poverty, both in rural and urban areas. Moreover, when applied in the banking sector it has enough potential to help states to move out of poverty tarp. The individual components of ICT such as mobile telephony, internet, and fixed telephone also have direct as well as indirect positive impact on the incidence of poverty eradication. ICT, when supported by an educated population, will be even more effective. However, the impact of ICT on the removal of inequality is still restricted in the urban area; that too is only through digital finance. An interesting finding observed by the current paper is that financial inclusion has a positive role in reducing income inequality in both rural and urban areas, but the application of ICT in the banking sector or digital finance to be precise dampens the positive impact of financial inclusion. Financial inclusion helps a substantial population to be free from exploitation of the informal credit market. Digital finance such as the usage of mobile banking, internet banking, or credit/debit card, however, is still confined among a handful of educated customers. That leads to an increase in income inequality in the urban area though it is completely ineffective in the rural area. Even with the application of individual components of ICT like land phone, mobile telephone, and internet in the banking sector, a similar outcome is observed in the urban area. In a rural area, only land phone has significance impact but the use of it in banking sector widens income inequality.

From the perspective of policy prescription, it can be suggested that ICT is an effective tool for poverty eradication in both rural and urban areas. Making the population better equipped through education and awareness to use ICT thus will be a key area to contribute for the Government. Further strengthening of ICT infrastructures like better internet connection, cheaper smartphones, and improved outreach of

banking facilities can help in the dissemination of information regarding technological advancement in agriculture, weather forecast, new government policies, employment generation, and a movement towards a cashless economy. Most importantly, the application of ICT in the banking sector can be made popular among the rural and urban population so that they get easy access to banking services from the comfort of their home. This will help them to get easy and collateral-free loans and therefore be able to manage their financial constraints. However, the uneven spread of ICT across states or within states creates a digital divide within the population and that can lead to an increase in income inequality. Thus, in urban areas where a better banking network prevails, banks can take up more initiatives to increase awareness about the benefits and security of online transactions; so that people who are capable of affording smartphones can make better usage of fintech applications. Once the digital divide gets reduced, it will help in reducing poverty and in the long run will reduce inequality as well. Therefore, the government has to make sure that on the one hand ICT infrastructure gets strengthened and on the other hand, people are trained and encouraged to reap the benefit of the technology. Some of the existing services like "Bank-Mitra" which helps people in the unbanked area (without ATMs and bank branches) to facilitate the process of opening and operating bank account, can be better utilized to make productive use of fintech services. Local self-help groups can help rural artisans to sell their products online so that they get a better price without middlemen. Local Panchayats with the help from district administration can organize training programs to educate the rural people about the usage and effectiveness of ICT applications.

References

Acemoglu, D. (1998), "Why do New Technologies Complement Skills? Directed Technical Change and Wage Inequality", *The Quarterly Journal of Economics,* 113: 1055–1089.

Aghion, P. and E. Howitt (1992), 'A Model of Growth Through Creative Destruction', *Econometrica* 60(2): 323–51.

Agyemang-Badu, A. A., K. Agyei and E. K. Duah (2018), "Financial Inclusion, Poverty and Income Inequality: Evidence from Africa", *Spiritan International Journal of Poverty Studies*, 2 (2)

Aker, J. (2010), 'Information from Markets near and Far: Mobile phones and Agricultural Markets in Niger', *American Economic Journal: Applied Economics* 2(3): 46–59.

Amadou, Dia., (2018), "Financial Inclusion and Poverty Reduction: Selected Approaches and Implications for Mali's Choice", *Academic Journal of Economic Studies*, Faculty of Finance, Banking and Accountancy Bucharest, "DimitrieCantemir" Christian University Bucharest, 4(4), pages 50-56, December.

Andersen, T., J.Bentzen, C.J. Dalgaard and P. Selaya (2011), 'Does the Internet Reduce Corruption? Evidence from U.S. States and Across Countries', *World Bank Economic Review* 25(3): 387–417.

Ang, James, B. (2008), "Finance and Inequality: The Case Of India", *CAMA Working Papers 2008-18,* Centre for Applied Macroeconomic Analysis, Crawford School of Public Policy, The Australian National University.

Apiors, E.; A. Suzuki (2018), "Mobile Money, Individuals' Payments, Remittances, and Investments: Evidence from the Ashanti Region, Ghana", *Sustainability* 2018, 10, 1409.

Ardic, Oya and Heimann, Maximilien and Mylenko, Nataliya (2011), "Access to Financial Services and the Financial Inclusion Agenda Around the World: A Cross-Country Analysis with a New Data Set", *World Bank Policy Research, Working Paper* 5537.

Banerjee Abhijit V. and Andrew F. Newman (1993), "Occupational Choice and the Process of Development", *Journal of Political Economy*, 101(2), 274-298 (25 pages).

Beck, T., Demirguc-Kunt, Asli, Levine, Ross, (2007), "Finance Inequality and the Poor", *Journal of Economic Growth,* 12 (1), 27–49.

Besley, T. and Burgess, R. (2002), "The Political Economy of Government Responsiveness: Theory and Evidence from India", *Quarterly Journal of Economics,* 117(4): 1415–52.

Beteille, Andre (2003), 'Poverty and Inequality', *Economic and Political Weekly,* 38(42) (Oct. 18-24, 2003), pp. 4455-4463.

Beuermann, D. (2011), "Telecommunications Technologies, Agricultural Productivity and Child Labor in Rural Peru", *Working Paper series* 2011-002, Lima: Banco Central de Reserva del Peru.

Bhandari, A.K. (2009), "Access to Banking Services and Poverty Reduction: A State-wise Assessment in India", *IZA Discussion Paper 4132.*

Blanco, M. and F. L_opez B_oo (2010), "ICT Skills and Employment: A Randomized Experiment", *Discussion Paper 5336, Bonn: IZA – Institute of Labor Economics.*

Brei, M., G. Ferri and L. Gambacorta (2019), "Financial Structure and Income Inequality", *BIS Working Paper No. 756.*

Bruett, T. (2007), "How Disintermediation and the Internet are Changing Microfinance", *Community Dev. Invest. Rev*. 2007, 3, 44–50.

Burgess, R. and R. Pande (2005), "Do Rural Banks Matter? Evidence from the Indian Social Banking Experiment", *American Economic Review,* 95(3), 780-795.

Camacho, A. and E. Conover (2011), "The Impact of Receiving Price and Climate Information in the Agricultural Sector", *Research Department Publications 4720*, Washington, DC: Inter-American Development Bank.

Cecchini, S. and C. Scott. (2003), "Can Information and Communications Technology Applications Contribute to Poverty Reduction? Lessons from Rural India", *Information Technology for Development*, 10 (2), 73-84, DOI: 10.1002/itdj.1590100203

Chadha, N. and B. Nandwani (2019), "Growth, Development Spending, and Inequality in Indian States", *Economic and Political Weekly*, 54 (11), 45-52.

Chatterjee, A., and S. Das (2019), "Information Communication Technology Diffusion and Financial Inclusion: An Inter-state Analysis for India", *Innovation and Development*, October, 2019, pp 1-23.

Chibba Michael (2009), "Financial Inclusion, Poverty Reduction and the Millennium Development Goals", *European Journal of Development Research,* 21, 213–230. doi:10.1057/ejdr.2008.17

Clarke, R.G. George, Xu, Lixin Colin, Zou, Heng- fu (2006), "Finance and Income Inequality: What Do the Data Tell Us?", *Southern Economic Journal,* 72 (3), 578–596.

Classens, Stijn, Perotti, Enrico (2007), "Finance and Inequality: Channels and Evidence", *Journal of Comparative Economics,* 35, 748–773.

Conley, T., and C. Udry (2010), "Learning about a New Technology: Pineapple in Ghana", *American Economic Review* 100 (1): 35–69.

Cyn-Young Park and Rogelio Mercado (2018), "Financial Inclusion, Poverty, And Income Inequality", *The Singapore Economic Review (SER),* World Scientific Publishing Co. Pte. Ltd., 63(01), 185-206, March.

De Weerdt, J., and S. Dercon (2006); "Risk-sharing Networks and Insurance against Illness", *Journal of Development Economics,* 81 (2): 337–356.

Demirgüç-KuntA., R. Levine (2007), "Finance and Economic Opportunity", Brown University, *mimeo*

DiMaggio, P. and B. Bonikowski (2008), 'Make Money Surfing the Web? The Impact of Internet Use on the Earnings of U.S. Workers', *American Sociological Review,* 73(2): 227–50.

DiMaggio, P.J.; E. Hargittai, W. Russell Neuman and J.P. Robinson, (2001), 'Social Implications of the Internet', *Annual Review of Sociology,* 27: 307–36.

Dunne, T., L. Foster, J. Haltiwanger, and K. Troske (2004), "Wage and Productivity Dispersion in United States Manufacturing: The Role of Computer Investment." *Journal of Labor Economics* 22 (2): 397–429.

Emara, N. and M. Mahmoud (2020), "Financial Inclusion and Extreme Poverty in the MENA Region: A Gap Analysis Approach", *Review of Economics and Political Science,* 5 (3), 207-230.

Falck, O., A. Heimisch, and S. Wiederhold (2016), "Returns to ICT Skills", *OECD Education Working Papers*, 134, OECD Publishing, Paris.

Fischer, Ronald and Huerta, Diego and Valenzuela, Patricio (2019), "The Inequality-credit Nexus", *Journal of International Money and Finance, Elsevier*, 91(C), 105-125.

Galor, Oded, Zeira, Joseph, (1993), "Income Distribution and Macroeconomics", *Review of Economics Studies,* 60, 35–52.

Galperin. Hernan and M. Fernanda Viecens (2017), "Connected for Development? Theory and Evidence about the Impact of Internet Technologies on Poverty Alleviation", Development Policy Review, 2017, 35 (3): 315-336.

Ghosh, Saibal and D. Vinod (2017), "What Constrains Financial Inclusion for Women? Evidence from Indian Micro Data", *World Development,* Elsevier, 92(C), 60-81.

Goldin, C., and L. Katz (2008), "The Race between Education and Technology", Cambridge, MA: Belknap Press.

Gomber, P. J.A. Koch and M.Siering (2017), "Digital Finance and FinTech: Current Research and Future Research Directions", *J. Bus. Econ. 2017*, 87, 537–580.

Goyal, A. (2010) 'Information, Direct Access to Farmers, and Rural Market Performance in Central India', *American Economic Journal: Applied Economics,* 2(3): 22–45.

Gradín, Carlos (2018), "Explaining Cross-state Earnings Inequality Differentials in India: An RIF Decomposition Approach", *WIDER Working Paper Series,* 024, World Institute for Development Economic Research (UNU-WIDER).

Granovetter, M. (2005), 'The Impact of Social Structure on Economic Outcomes', *Journal of Economic Perspectives,* 19: 33–50.

Grossman, V. (2001), "Inequality, Economic Growth and Technological Change: New Aspects in an Old Debate*",* Heidelberg: Physica-Verlag.

Heeks, R. (2014), "ICTs and Poverty Eradication: Comparing Economic, Livelihoods and Capabilities Models", Manchester: *Centre for Development Informatics Institute for Development Policy and Management, SEED.*

Honohan, P, (2008), "Cross-country Variation in Household Access to Financial Services", *Journal of Banking and Finance*, 32(11), 2493-2500.

Howitt, P. (2004), "Endogenous Growth, Productivity and Economic Policy: A Progress Report", *International Productivity Monitor* 8(spring): 3–15.

Huang, Y.P., Y.Shen, J.Y.Wang and F. Guo (2016), "Can the Internet Revolutionise Finance in China?", *China's New Sources Economic Growth,* 2016, 115.

Huang, Y.P. and X. Wang (2017), "Building an Efficient Financial System in China: A Need for Stronger Market Discipline", *Asian Economic Policy Rev.,* 2017, 12, 188–205.

Hussaini, Umaru and Imo Casmir Chibuzo (2018), "The Effects of Financial Inclusion on Poverty Reduction: The Moderating Effects of Microfinance", *International Journal of Multidisciplinary Research and Development*, 5(12), December 2018, 188-198.

Inoue, Takeshi (2019), "Financial Inclusion and Poverty Reduction in India", Journal of Financial Economic Policy, 11(1), 21-33.

Jensen, R. (2007), 'The Digital Provide: Information (Technology), Market Performance and Welfare in the South Indian fisheries sector', *Quarterly Journal of Economics,* 122(3): 879–924.

Kaur, K. and J. Singh (2016), "ICT Diffusion and Digital Divide in India: Implications for Economic Policies", *Pacific Business Review International, 1 (2),* 1–9.

Kenneth, M. and C. Kponou (2017), "Information and Communications Technology (ICT) Diffusion and Inequality in Africa", *Journal of Internet and Information Systems,* 7(1),1-7, https://doi.org/10.5897/JIIS2016.00 90.

Kumar Nitin (2013), "Financial Inclusion and Its Determinants: Evidence From India", *Journal of Financial Economic Policy,* 5(1), 2013.

Labonne, J. and R. Chase (2009), "The Power of Information: The Impact of Mobile Phones on Farmers' Welfare in the Philippines", *World Bank Policy Research Working Paper* 4996.

Lal, Tarsem (2018), "Impact of Financial Inclusion on Poverty Alleviation Through Cooperative Banks", *International Journal of Social Economics,* 45(5), 808-828.

Levine, Ross (1997), "Financial Development and Economic Growth: Views and Agenda", *Journal of Economic Literature,* 35, 688–726.

Levine, Ross (2005), "Finance and Growth: Theory and Evidence. Handbook of Economic Growth", Amsterdam, North Holland Elsevier.

Levine, Ross (2007), "Finance and the Poor", Brown University, Department of Economics.

Li, Linyang (2018), "Financial Inclusion and Poverty: The Role of Relative Income", China Economic Review, Elsevier, 52(C),165-191.

Liao, G., D. Yao and Z.Hu (2019), "The Spatial Effect of the Efficiency of Regional Financial Resource Allocation from the Perspective of Internet Finance: Evidence from Chinese Provinces", *Emerging Market Finance and Trade,* 2019, 1–13.

Lin, N. (2001), "Social Capital: A Theory of Social Structure and Action. Cambridge", Cambridge University Press.

Lokeswari, K. and S.S. Aiswariya (2017), "ICT Diffusion and Digital Divide: Implications for Rural Development", *Journal of Content, Community and Communication,* 6, June 2017, 36-42.

Maiti D., F. Castellacci and A. Melchior (2020), "Digitalisation and Development: Issues for India and Beyond", in Maiti D., Castellacci F., Melchior A. (eds) *Digitalisation and Development*. Springer, Singapore. https://doi.org/10.1007/978-981-13-9996-1_1.

Mang, C. (2012), "Online Job Search and Matching Quality", *Working Paper 147,* Berlin: IFO Institute – Leibniz Institute for Economic Research at the University of Munich.

Manyika, J., S.Lund, M. Singer, O.White and C. Berry (2016), "Digital Finance for All: Powering Inclusive Growth in Emerging Economies", *USA: McKinsey Global Institute, September.*

Michael Brei and Giovanni Ferri and Leonardo Gambacorta (2018), "Financial Structure and Income Inequality", BIS Working Papers 756, Bank for International Settlements.

Mishkin, F.S., P.E.Strahan (1999), "What will Technology Do to Financial Structure?", *Natational Bureau of Economic Research*.

Mnif, S. (2016), "Skill Biased Technological Changes: Case of the MENA Region", *Theoretical and Applied Economics,* 23 (3): 339–350.

Mookerjee, Rajen and Paul Kalipioni (2010), "Availability of Financial Services and Income Inequality: The Evidence from Many Countries", Emerging Markets Review, Elsevier, 11(4), 404-408, December.

Mossberger, K., C.Tolbert and R.McNeal (2007), "Digital Citizenship: The Internet, Society, and Participation", Cambridge, MA: MIT Press.

Mushtaq, R. and C. Bruneau (2019), "Microfinance, Financial Inclusion and ICT: Implications for poverty and Inequality", Technology in Society, 59, https://doi.org/10.1016/j.techsoc.2019.101154, November 2019, 101154.

Muto, M. and T.Yamano (2009), 'The Impact of Mobile Phone Coverage Expansion on Market Participation: Panel Data Evidence from Uganda', *World Development,* 37(12): 1887–96.

Neaime, Simon and Isabelle Gaysset (2018), "Financial Inclusion and Stability in MENA: Evidence from Poverty and Inequality", *Finance Research Letters,* Elsevier, 24(C), 230-237.

Neogi, C. (2020), "Effect of ICT on the Performance of Indian States in Terms of Human Development Indices", In: Maiti D., Castellacci F., Melchior A. (eds) Digitalisation and Development. Springer, Singapore. https://doi.org/10.1007/978-981-13-9996-1_11

Overa, R. (2006), "Networks, Distance, and Trust: Telecommunications Development and Changing Trading Practices in Ghana." *World Development* 34 (7): 1301–1315.

Pal R. and R. R. Vidya, (2011). "Outreach of Banking Services across Indian States, 1981–2007: Converging or Diverging?" *India Development Report, 2011*, Oxford University Press.

Park, Cyn-Young and Jr Rogelio V. Mercado (2015), "Financial Inclusion, Poverty, and Income Inequality in Developing Asia", *ADB Economics Working Paper Series, No: 426.*

Pepper, R. and J. Garrity (2015), "ICTs, Income Inequality, and Ensuring Inclusive Growth", *The Global Information Technol, Report* 2 (1), 31-38.

Quibria, mg and Ted Tschang (2001), "Information and Communication Technology and Poverty: An Asian Perspective", *MPRA Paper No. 2639.*

Rajeev, Meenakshi. (2015), "Financial Inclusion and Disparity: A Case of India", *ILO Working Papers 994883243402676*, International Labour Organization.

Rallet, A. and F. Rochelan (2007), "ICTs and Inequalities: The Digital Divide", In: Brousseau E. and Curien N., eds, Internet and Digital Economics, Cambridge University Press.

Reyes, G. P., L. D. A. Cañote and R. Mazer (2010), "Financial Inclusion Indicators for Developing Countries: The Peruvian Case", *Working Paper of SBS, Peru and CGAP.*

Richmond, K. and Russell E. Triplett (2018), "ICT and Income Inequality: A Cross-National Perspective", *International Review of Applied Economics,* 32:2, 195-214, DOI:10.1080/02692171.2017.1338677

Romar, Romer, P. (1990), 'Endogenous Technological Change', *Journal of Political Economy* 98(5): 71–101.

Rudra, N. (2004), "Openness, Welfare Spending, and Inequality in the Developing World" *International Studies Quarterly*, 48 (3), 683–709.

Salazar-Cantú1. J., Juvencio Jaramillo-Garza2, Bethzaira Álvarez-De la Rosa (2015), "Financial Inclusion and Income Inequality in Mexican Municipalities", *Open Journal of Social Sciences* 3(3):29-43, DOI: 10.4236/jss.2015.312004

Samuel, J., N. Shah, and W. Hadingham (2005), "Mobile Communications in South Africa, Tanzania and Egypt: Results from Community and Business Surveys", In *Africa: The Economic Impact of Mobile Phones*, Vodafone Policy Paper Series Number 3.

Sarma, M. (2008), "Index of Financial Inclusion", *Working Paper No.215, Indian Council for Research on International Economic Relations.*

Sarma, M. and JesimPais (2010), "Financial Inclusion and Development: A Cross Country Analysis", *Indian Council for Research on International Economic Relations*, 1-28.

Sarma (2012), "Index of Financial Inclusion – A Measure of Financial Sector Inclusiveness", *Berlin Working Papers on Money, Finance, Trade and Development, Working Paper No*. 07/2012

Stromberg, D. (2004), "Radio's Impact on Public Spending", *Quarterly Journal of Economics,* 119(1), 189–221.

Tewathia, N. (2020), "Digital Divide: How India and China Stack Up", In: Maiti D., Castellacci F., Melchior A. (eds*) Digitalisation and Development. Springer,* Singapore. https://doi.org/10.1007/978-981-13-9996-1_9

Tong, D. and S. Dall'erba (2008), "Spatial Disparities in the Chinese ICT Sector: A Regional Analysis", *Region et Developpement* 28: 111–129.

Wang X. and Guangwen He (2020), "Digital Financial Inclusion and Farmers' Vulnerability to Poverty: Evidence from Rural China", *Sustainability*, *12*(4),1668; https://doi.org/10.3390/su12041668

Wessel, T. (2013), "Economic Change and Rising Income Inequality in the Oslo Region: The Importance of Knowledge-intensive Business Services", *Regional Studies* 47 (7), 1082–1094.

Yılmaz, R. and J. Y. Koyuncu (2018), "The Contribution of ICT to Poverty Reduction: A Panel Data Evidence", *Social Sciences Research Journal,* 7 (4), 63-75, (December 2018), ISSN:2147-5237.

APPENDIX A

Figure 4: Schematic Representation of ICT Diffusion and its Impacts on Poverty and Income Inequality

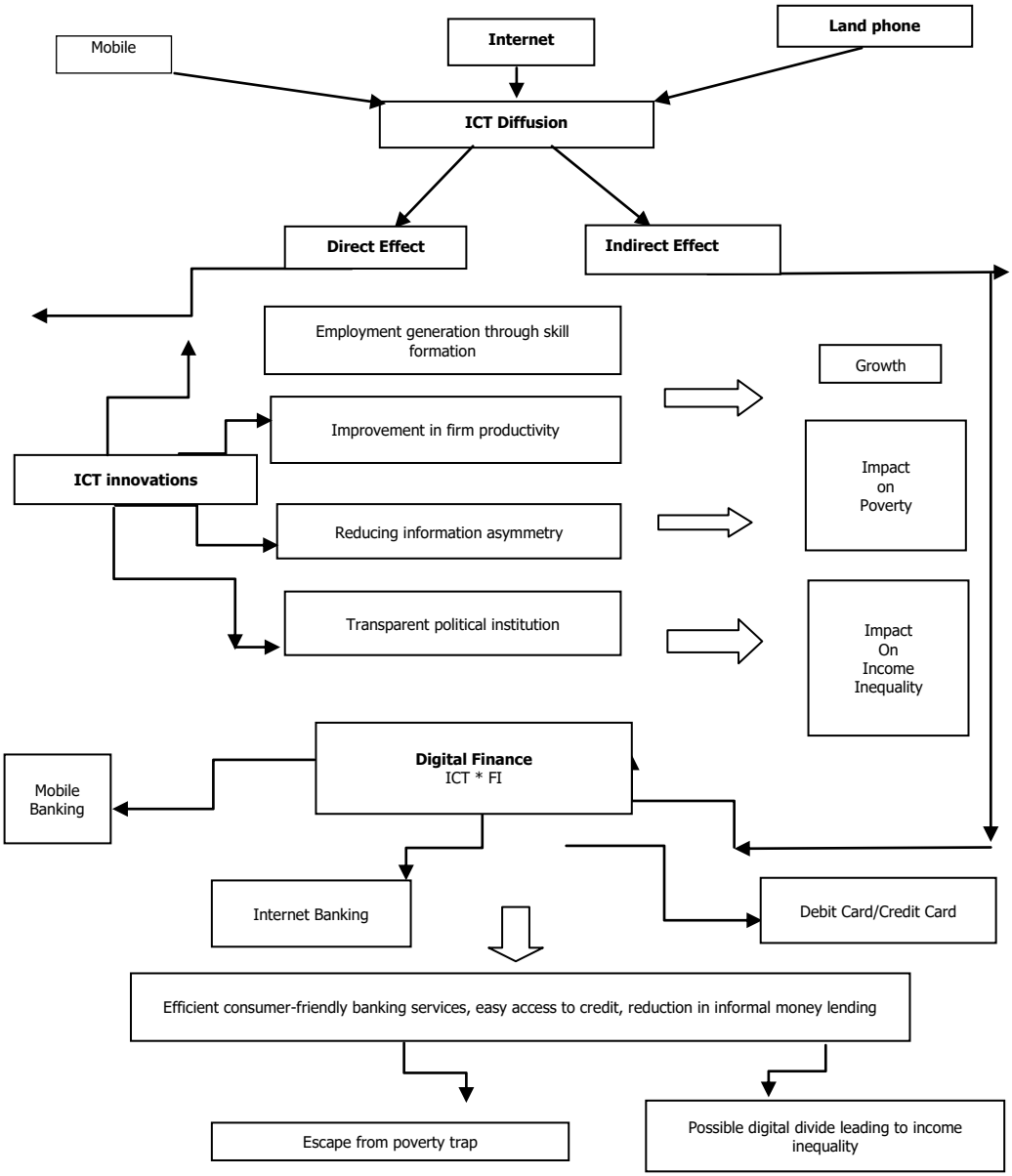


Table A.1: Average Marginal Effects of Tele-density, Mobile and Internet Facility on Rural-Urban Poverty Incidence[11]

Poverty status	Urban		Rural	
	Category 1(highly rich states)	Category 5 (severely poor states)	Category 1(highly rich states)	Category 5 (severely poor states)
Tele-density	.004789***	-.0021747***	.0026172***	-.0023278**
Control variables	Yes	Yes	yes	Yes
Tele-density*FII	.0000672***	-.0000336**	.0000359**	-.000034**
Control variables	Yes	Yes	yes	Yes
Mobile	.0061213***	-0.002677***	.0034188**	-.0029221**
Control variables	Yes	Yes	yes	Yes
Mobile*FII	.0000882**	-.0000424***	.000049***	-.0000442**
Control variables	Yes	Yes	yes	Yes
Internet	.1493122***	-0.0890689**	.1048429***	-.1253116**
Control variables	Yes	Yes	yes	Yes
Internet*FII	.0019069***	-.0011734**	.0011939***	-.0014543*
Control variables	Yes	Yes	yes	Yes

Source: Authors' calculation; *** p<0.01, ** p<0.05, * p<0.1

[11] To avoid unnecessary lengthy representation, we are presenting only the marginal effects of individual components of ITI and their relevant interaction.

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