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Abstract

There have been enough evidences to accept that Financial Inclusion (FI) and Information and Communication Technology (ICT) play positive role in economic growth, even though there are some exceptions. Moreover, we cannot deny the fact that ICT like mobile phone and internet penetration can strengthen the inclusiveness of formal banking sector. The present study has first examined whether ICT development can be an important determinant of Financial Inclusion by using a fixed effect panel data model. The results show that ICT is indeed an important determinant of FI. The same panel data of 41 countries was then used to test whether the growth process of the countries are influenced by Financial Inclusion and ICT diffusion in a dynamic Panel Data Model. Further the paper has investigated the role of FI powered by a better ICT penetration in fostering the growth of the nations using system GMM method by incorporating interactions between FI and ICT indicators. The results suggest that both FI and ICT individually and together through their close interaction can improve current year's growth. However, we need education, awareness and technical assistance to get sustained growth.

Key words: *Financial Inclusion, Growth, Information and Communication Technology, Dynamic Panel data model, System GMM estimator*

JEL Codes: L86, L96, C23,O0, G2

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INTRODUCTION

As per World Bank (2017)[1], "Financial inclusion means that individuals and businesses have access to useful and affordable financial products and services that meet their needs – transactions, payments, savings, credit and insurance – delivered in a responsible and sustainable way." The concept of financial inclusion has come to the limelight and has gained momentum especially in the context of developing economies as a measure, not only to reduce income inequalities, but also to decrease the overall poverty count. This development has been recent and has followed the World Bank's attemptsf to highlight the importance of financial inclusion in creating conditions that bring many of the "Sustainable Development Goals (SDGs)" within reach.

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.

[1] Available at: http://www.worldbank.org/en/topic/financialinclusion/overview

It is well accepted in the literature that financial inclusion is definitely helpful in promoting the economic growth, reducing income inequality and alleviating poverty (Levine (2004), Beck *et. al.* (2007). Demirguc-kunt *et. al.* (2008), Odeniran and Udeaja, (2010)). There have been studies proving the positive contribution of ICT diffusion to economic growth as well (Datta and Agarwal (2004), Dewan and Kraemer (2000) Pohjola (2001) Seo, Lee, and Oh (2009) (Nasab and Aghaei (2009); Vu (2011)). However, the present study intends to find out a close association between financial inclusion and ICT development by studying whether ICT is an important determinant of FI or not. We intend to contribute to the literature by investigating whether financial inclusion can improve the growth performance of the countries when it is supported by a well developed and more accessible information and communication technology. We therefore have chosen a panel data framework for a period of 2004-1015 with 41 countries. We have estimated fixed effect as well as Dynamic panel data models using system GMM technique to deal with the endogeneity issues which are frequent in growth regressions. Rest of the paper is arranged as follows. Next section gives the main motivation of this paper through a description of the existing literature. The following section describes the relevant indicators of Financial Inclusion (FI) and ICT including a description of the data. The section after this describes the methodology whereas the following summarizes the results. The concluding remarks are there in the last section.

LITERATURE REVIEW

Financial Inclusion and Economic Growth

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).

If aggregate production function approach is considered , then either Capital accumulation (Hicks, 1969) or a technological change (Schumpeter, 1912) are the two main channels through which the above mentioned financial effects contribute to a larger output via inputs like savings and investments.

Taking the capital accumulation channel as an example, the familiar Solow growth model shows that an increase in the savings rate will increase the steady-state levels of capital and per capita output. By bridging the gap between savers and investors, financial inclusion increases the total factor productivity in the economy. Also, by increasing the level of physical banking infrastructure the amount of capital in the economy is also increased. Lastly, financial inclusion plays the crucial role of increasing the amount of funds being made available in the market which will in turn reduce the borrowing costs. Thus capital will also increase.

The limitation of the Solow growth model is that it captures only the short-run and medium-run effects of increased financial inclusion. To explain technological progress or long-run economic growth, Schumpeterian model of growth was introduced.

Schumpeter opined that a well-developed financial sector is absolutely necessary, because the initial investment in new projects cannot always be covered by the entrepreneur himself. Without a financial sector channelizing the funds properly, it is impossible to bring in innovation and therefore permanent growth. Here comes the role of FI which encourages the low income earners to save more with innovative financial products (Odeniran and Udeaja, 2010). Ogunleye (2009) has linked FI to financial stability as the former promotes the latter by facilitating inclusive growth. Moreover, an inclusive financial sector helps inclusive growth by mobilizing the savings and investment in productive sector (Onaolapo, 2015).

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. Sarma 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.

However, contrary to all the above mentioned studies that show a positive effect of financial inclusion on economic growth, Barajas, Chami and Yousefi (2011) found negative effect of private credit on growth in Mena region. Estimation results by Sassia and Goaied (2012) also show a meaningful negative effect of bank development on growth on Mena countries. They have tried to explain that by the comparative lack of competition in MENA banking systems and the lack of capital account openness and privatization.

Information and Communication Technology and Growth

ICT development is increasingly considered a factor in economic growth because ICT is omnipresent in most business sectors, it improves continuously and therefore reduces costs for the users, and it also contributes to innovation and development of new products and processes (Andrianaivo and Kpodar,2011). ICT use improves market functioning and increases trade. Investments in ICT reduce costs because better communication systems lower transaction costs (Waverman, *et. al.*, 2005).

Datta and Agarwal (2004) point out that the economic benefits of ICT can be direct, through increases of employment and demand, and can also be indirect, notably through social returns. ICT supply also attracts Foreign Direct Investment (FDI) in new telecommunication

services. Therefore, ICT supply also influences the balance of payments (BOP). In addition to above, foreign companies are more likely to invest in countries with increased ICT development. ICT attract portfolio and venture capital. They improve market efficiency because they allow wider dispersion of market information to investors, thereby reducing information costs. Additional investments, jobs, new skills, and better local services stemming from FDI all benefit economic growth.

ICT enables firms to overcome the hindrances faced in adopting flexible structures and geographical locations. The increased geographic dispersion allows firms to not only increase productivity but also to exploit comparative advantages and save on costs. ICT development also strengthens the management in firms, through better intra-firm communication, and increased flexibility, owing to the removal of physical constraints on organizational communication. Moreover, good communication networks substitute for costly physical transport and therefore widen networks (of buyers and suppliers) and markets (Grace *et. al.*, 2005). They have also showed that reduced transaction costs from ICT favour trade because it gives developing countries opportunities to tap into global markets and increase sales range. The development of e-commerce fostered by ICT development increases efficiency and opens markets for developing countries. Businesses, such as handicrafts or ecotourism, expand and reach global audiences because of increased productivity. Market places become digital, and transactions are automated which reduces the costs and increases profitability for firms. Trade in services such as back office support or data entry and software management also benefit from new opportunities as ICT allow the outsourcing of information-intensive administrative and technical functions.

Dewan and Kraemer (2000) used a sample of 36 countries for a period of 1985-1993 to explain the "productivity paradox of ICT" which basically associates low level of ICT development to lack of proper

infrastructure and concluded in favor of a positive relationship between ICT and growth only for developing countries. Pohjola (2001) has showed that the positive relation holds even for a smaller subset of 23 OECD countries on the basis of data of 1980-1995. There are a few cross country studies who have concluded about positive relation between ICT and growth applying different methodologies like 3SLS (Norton (1992), Seo, Lee, and Oh (2009)) and Generalized Method of moments (Nasab and Aghaei (2009); Vu (2011)). Roller and Waverman (2001) on the other hand worked with 21 OECD countries and 14 developing countries for a period of 20 years to conclude that telecommunication network will have its positive impact on growth only when it reaches a certain level of infrastructure building. Similar results were obtained by Kathuria, Uppal and Mamta (2009) for an inter-state analysis of India where it was found that Indian states with higher mobile penetration has better growth performance and the impact gets amplified beyond 25 percent of mobile phone penetration.

But just like in the case of Financial Inclusion, there is a paradox in the ICT-growth nexus also. Some studies (Freeman and Soete, 1985, 1994, 1997; Aghion and Howitt, 1998)) suggest that ICT could impose negative impact on employment and labour market in developing countries by eliminating unskilled workers since they do not have the necessary skills to align with these developments and use it to their benefit. Also, decrease in employment in the economy not only comes through lack of necessary skills but also due to low absorption capability of the economy. ICT developments like e-commerce eliminate the middle men by directly connecting the producer with the consumers which in turn leads to lack of employment opportunities. This can increase poverty and income inequalities.

In line with these contrary findings, Lee, Gholami, and Tong (2005) check for the causality effect between ICT investment and growth in 20 countries. They show that ICT investment boost growth only in

developed countries while the causality is from growth to ICT investment in developing countries. Hassan (2005) using a panel data of 95 countries and 8 MENA region countries for a period of 1980-2001 could show a positive relation between ICT and growth for all countires except the MENA region countries.

Financial Inclusion, ICT and Growth

Efforts to include an increasingly larger section of the population within the purview of formal banking and financial services have resulted in the deployment of innovative solutions and outsourcing arrangements (Khan, 2011). The increasing use of information and communication technology in countries has contributed to the emergence of branchless banking services, thereby expected to improve financial inclusion. ICT developments facilitate better information flows. Hence it helps to address the problems of information asymmetries which usually lead to under-provision of credit in the market. The data collected on depositors can be used to analyze credit worthiness more efficiently and to facilitate deposit taking. Therefore ICT developments improve access to credit and deposit facilities, allow more efficient allocation of credit, facilitate financial transfers, and boost financial inclusion. In turn, this would stimulate private investment, and hence economic growth.

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.

Bassant (2011) suggested that in order to achieve inclusive growth with equality, it is absolutely necessary that the commercial banks opt for cost-effective technology such as near zero-balance bank account, Point of sale technology, mobile banking and ATMs. 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.

Andrianaivo and Kpodar (2011) investigated whether financial inclusion is one of the channels through which ICT diffusion can influence economic growth. Using the System Generalized Method of Moment (GMM) estimator on a panel of 44 African countries over the period 1988–2007, their results confirm a positive effect of ICT on growth and show that the effect of mobile phone development on growth is more important for countries with high level of financial inclusion. Moreover, they conclude that financially well-developed countries tend to grow faster when mobile penetration is high as shown by the positive and significant coefficient of the interaction term between mobile penetration and financial inclusion.

The MENA region paradox of negative relationship between financial development and growth has also been explained by the linkage of ICT development. 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. This implies that Mena countries need to reinforce ICT infrastructure develop e-finance in the region since it is a part of e-commerce.It is proved statistically that better connectivity, especially by increasing the number of internet users, has a stronger impact on growth when the level of credit to private sector is high, thereby also suggesting that the impact of ICT on growth is also strengthened depending on the threshold of financial inclusion (captured by the ratio of private credit to GDP in their study). This suggests that

Mena countries need to reinforce e-finance implantation which reduces monitoring costs for suppliers and information costs for consumers.

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 first objective of our paper is to investigate whether the ICT indicators are significant determinants of Financial Inclusion in a cross-country set up. Then we intend to reinforce that growth of these countries are influenced by financial inclusion and ICT indicators separately. However, our aim is also to establish the fact that Financial Inclusion when powered by a better ICT diffusion will lead to better growth performance.

DATA AND VARIABLES[2]

To fulfill the above mentioned objective we need to choose the appropriate indicators of ICT development as well as financial inclusion.

Indicator Variables

Indicators of Financial Inclusion

Sarma (2008, 2012) has considered three dimensions to measure the extent of financial inclusion, namely, (a) depth of access (b) availability to measure proximity of access and (c) usage to measure the extent and frequency of use by the customers.

(a) **Depth of access** measures the penetration of financial services. This can be measured by the number of accounts in each branch, number of accounts per 1,000 adults etc.

(b) **Availability indicators** reflect the depth of outreach of financial services, such as the access of bank branches or point of sale (POS) devices in rural areas, or demand-side barriers that

[2] Refer to Table A3 in Appendix for a complete list of variables and the data sources.

customers face to access financial institutions, such as cost or information.

(c) **Usage indicators** measure how clients use financial services, such as the regularity and duration of the financial product/service over time (e.g. average savings balances, number of transactions per account, number of electronic payments made).

For the purpose of our analysis, the financial inclusion indicators used are listed in table 1.

Table 1: Indicators of Financial Inclusion

Penetration Indicators	Deposit accounts with commercial banks (per 1,000 adults)
Availability Indicators	ATMs and Branches (per 1,00,000 adults)
Usage Indicators	Domestic Credit to private sector (percent of GDP) , Outstanding Deposit (percent of GDP)

Source of data on FI: Financial Access Survey (FAS) conducted by the International Monetary Fund.

Indicators of ICT Development

(a) **Mobile phone penetration:** The ICT variable of main interest in this study is mobile phone penetration, which is captured by mobile phone subscribers per 100 adults. The indicator includes (and is split into) the number of postpaid subscriptions, and the number of active prepaid accounts (i.e. that have been used during the last three months), made to a public mobile phone service using cellular technology, thereby providing access to the public switched telephone network (ITU, 2014[3]). Mobile phone penetration is expected to have a positive effect on economic growth, as well as on financial inclusion.

[3] http://www.itu.int/en/Pages/default.aspx

(b) **Fixed telephone:** Although mobile phone penetration is the factor of main interest, the presence of fixed telephone lines might as well have a positive impact on economic growth as it was looked at as a substitute until a few years ago before the breakthrough smart phone innovations, thereby making it appropriate to include in the model.

(c) **Internet usage:** The rise of the Internet is further assumed to reveal positive effects on economic growth, and is thus accounted for by including data on Internet users per 100 adults. Internet users are individuals who have used the Internet (from any location) in the last 12 months. Internet can be used via a computer, mobile phone, personal digital assistant, games machine, digital TV etc.

(d) **ICT import:** We also take into account the import of ICT goods (percent of total import goods) as an indicator. Information and communication technology goods imports include computers and peripheral equipment, communication equipment, consumer electronic equipment, electronic components, and other information and technology goods (miscellaneous).

Source of Data on ICT

The ICT Development index (IDI) is an index published by the United Nations International Telecommunication Union (ITU) based on internationally agreed information and communication technologies (ICT) indicators. IDI is calculated for 175 countries based on 11 ICT indicators, grouped in three clusters: access, use and skills.

We have used a panel data of 41 countries (refer to Table A1 in Appendix for a complete list of countries) for a period of 2004-2015. The chosen sample period is motivated by the fact that the rapid growth of mobile phones and other ICT development indicators took off towards the end of the 1990s, implying that data did not exist before. Also, data on financial inclusion which have been taken from "The Financial Access Survey" (FAS) conducted by the International Monetary Fund which only

started in 2004. The FAS is the sole source of global supply-side data on financial inclusion, encompassing internationally-comparable basic indicators of financial access and usage. Out of the 175 countries ranked by ITU, data for all the selected indicators of financial inclusion is only available for a set of 41 countries. So our final panel data consists of 41 countries being considered over a period of 12 years (2004-2015).

However, additional awareness needs to be raised in terms of sample heterogeneity, which may affect the results in terms of large standard errors.

Growth

Economic Growth performance is captured by annual percentage growth rate of GDP per capita based on constant local currency. Aggregates are based on constant 2010 U.S. dollars. Noteworthy, GDP is a measure of economic performance based solely on economic activities in the formal sector. There is however a tendency for fast-growing, low-income countries to underestimate their GDP, one reason being that changes in the composition of the economy are not consistently reflected in the calculation of GDP (Jerven, 2013). Although this type of countries are included in this study, the focus is not on levels of GDP but GDP growth, which somewhat mitigates such measurement errors. For other variables included in the models, data have mainly been obtained from the World Bank- World Development Indicators (WDI). Human capital is represented by educational attainment in terms of secondary school gross enrolment rate. Gross enrolment ratio is the ratio of total enrolment, regardless of age, to the population of the age group that officially corresponds to the level of education shown. Further included in the vector of growth determinants is government final consumption; measured as percentage of GDP, Trade openness and inflation; measured as the annual changes in Consumer Price Index. (Refer to Table A2 appendix for descriptive statistics). Here we must take a note of the fact that as there were some missing data in the middle as well as at the end of the series for some of the variables, the series for Education

and ICT imports are interpolated to find the missing observations in the middle. However, the end points were left as it is[4]. Thus we have unbalanced panel finally.

Econometric Model and Methodology

***Unit root test*:** Panel unit root test is conducted by using Im-Pesaran-Shin unit-root test (Im *et. al.*, 2003) for checking stationary of each of the variables for the entire period of 2004 to 2015. The results are presented in Table 2. The results reveal that except GDP per capita, GDP per capita growth rate, inflation, ICT import, outstanding deposits, GDP from Industry and GDP from services all other variables are nonstationary. However, the non-stationary variables are stationary at first difference. Since all the variables are not stationary at first difference, there is no long-run relationship among the variables and therefore co-integration test is not required.

Table 2: Im-Pesaran-Shin Panel Unit Root Test for the Annual Series of Each Variable (source: Author's Calculations)

Variable	w-t-bar statistic	p-value
GDP per capita	-3.2513	0.0006
GDP per capita growth	-4.0436	0.0000
Inflation	-6.8566	0.0000
ICT imports	-2.3295	0.0099
Outstanding deposits	-4.2471	0.0000
Industry	-2.8060	0.0025
Services	-1.9227	0.0273
Fixed telephone	1.1673	0.9471
Internet	2.2802	0.9887
Mobile	0.0969	0.5386
Domestic credit	1.1658	0.8782
ATM	3.0870	0.9990
Accounts	0.4622	0.6780
Branches	0.8431	0.8004
Education	0.5923	0.7232

[4] We have used *ipolate* command in STATA to interpolate.

Estimation of Panel Data Models

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):

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

In equation (1), 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 growth regression 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 (2).

$$\mathbf{Y_{i,t}= \beta_0 + \beta_1 Y_{i,t-1} +\beta_2 X_{i,t}+} \alpha_i + \delta_t + \epsilon_{i,t} \quad (2)$$

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

$$\mathbf{Y_{i,t}-Y_{i,t-1} = \beta_1 (Y_{i,t-1}- Y_{i,t-2})+ \beta_2 (X_{i,t}- X_{i,t-1})+} (\delta_t - \delta_{t-1}) + (\epsilon_{i,t} - \epsilon_{i,t-1}) \quad (3)$$

By construction, $(Y_{i,t-1}- Y_{i,t-2})$ in equation (3) 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.[5] 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[6]. 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 financial inclusion-growth nexus, ICT-growth nexus and to test whether

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

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

the impact of financial inclusion on growth is strengthened by better ICT infrastructure.

EMPIRICAL RESULTS AND FINDINGS

Model 1: Whether ICT Development is a Determinant of FI?

Following Kumar(2013), where the author has tried to investigate the determinants of financial inclusion in an interstate analysis based on India, in Model 1 we aim to investigate whether ICT variables play a significant role as determinant of Financial Inclusion or not. In Kumar(2013), the number of deposit accounts percent of population and number of credit accounts percent of population are taken as penetration indicator and are used as dependent variables. The exogenous variables are average population per bank branch (branch density), population density; net state domestic product; deposit SDP ratio and proportion of factories. This paper has used both fixed effect model and GMM technique to find a positive relationship between branch density and level of financial inclusion and concluded that the region's socio-economic and environmental set up has its role to play in shaping the habits of its residents. We use the same pathway to determine if ICT variables also are significant determinants of the penetration of financial inclusion along with other (usage and availability) financial inclusion indicators. We estimate the following panel data model:

$$Y_{it} = \beta_0 + \beta_1 X_{it} + \alpha_i + \delta_t + \epsilon_{i,t} \text{ (FE)} \quad (4)$$

$$Y_{it} = \beta_0 + \beta_1 X_{it} + \alpha_i + \delta_{i,t} + \epsilon_{i,t} \text{ (RE)} \quad (5)$$

In equation (4) and (5) dependent variable is the Penetration indicator of F.I.- Number of deposit accounts, , $\delta_{i,t}$ is the between entity error $\epsilon_{i,t}$ is the within-entity error and, X depicts the matrix of explanatory variables which include the following:

- Usage indicators of F.I - Domestic Credit to private sector (percent of GDP) , Outstanding Deposit (percent of GDP)
- Availability/ Access indicators of F.I. - ATMs and Branches (per 1,00,000 adults)
- ICT variables – Mobile phone users (per 100 people), internet users

(per 100 adults), fixed telephone line users (per100 people), ICT imports (percent of total imports)

- We have used log(GDP), education and value added of industry (percent of GDP) as control variable.

This model is based on a static linear panel data model. Linear panel data models are usually estimated with either a fixed effects or a random effects estimator. FE models are designed to study the causes of change within a country or entity. A time-invariant characteristic cannot cause such a change as that is constant for each country (Kohler, Ulrich, Frauke Kreuter, Data Analysis Using Stata, 2nd ed., p.245). Another important assumption of the FE model is that those time-invariant characteristics are unique to the individual and should not be correlated with other individual characteristics. However, in random effects (RE) model, unlike the fixed effects model, the variation across entities is assumed to be random and uncorrelated with the predictor or independent variables included in the model. Therefore it captures the influence of the differences across entities on the variation of the dependent variable. In RE model we can incorporate time-invariant variables. Moreover, if the variation within the entities is not much, then FE model may not give desired result and RE model can be chosen. Here, in our study though Hausman Test suggests RE model, we have used FE as well as RE models. The results do not vary much; but as there are only time-varying variables in our model we have reported the FE model as well (Table 3(a) and 3(b)).

Table 3(a) gives us the estimation results for the Fixed effect model where we intend to check whether ICT diffusion is an important determinant of FI. In the Model1 (column1), we see that the impact of internet users on the number of deposit accounts is positive and significant. This shows a significant impact of internet usage on the outreach of financial services. Other financial inclusion indicators like credit to private sector, ATMs and branches (per 100000 people) also show a positive and significant impact on the number of accounts (per

1000 people). Number of branches for the current year shows an insignificant effect but the last year's value shows a positive and significant effect on the count of deposit accounts this year. This reflects the gestation period taken by a new commercial bank branch to actually increase the number of people under the purview of formal banking system as reflected by number of deposit accounts. Level of industrialization also has a positive and significant impact on the number of accounts in Model1 thus implying that the higher the contribution of GDP that comes from industrial sector, higher will be the number of accounts in the formal banking sector. Income (measured by Log of GDP), which is a control variable in this model, is also highly significant and has a positive impact on financial inclusion.

In Model2 (column 2), we check for the impact of mobile phone subscribers (per 100 people) on the number of accounts. We find that the current year's value of mobile phone subscriptions has an insignificant effect on the number of deposit accounts. But in Model3 we observe that the 2 year lagged value has a significant and positive impact on the number of deposit accounts (per 1000 people). This implies that an increase in the number of mobile phone users takes a period of around two years to translate into increased level of financial inclusion. That may be because of lack of confidence or ability to use mobile phone to do financial transactions. In Model 4 (column 4), we introduce an interaction between mobile and internet and it is seen that the interaction term has a significant and positive coefficient. This implies that the number of mobile phone users will have a positive effect on the financial inclusion only if there is also adequate facility of internet in the economy. This can be primarily because mobile financial services can be accessed only with the availability of mobile internet in most of the countries. In Model5 (column 5), fixed telephone subscriptions (per 100 adults) is seen to have an insignificant effect on financial inclusion, which implies financial services are more efficiently provided by mobile phone rather than fixed telephone services.

TABLE 3(a): ICT as Determinant of Financial Inclusion

Accounts	Model 1	Model 2	Model 3	Model 4	Model 5
credit	5.616*	5.001	4.603	5.611*	4.851
	(3.242)	(3.387)	(3.824)	(3.233)	(3.152)
ATM	4.525*	6.243**	5.078*	5.167**	6.211**
	(2.293)	(2.467)	(2.778)	(2.195)	(2.577)
branches	-3.419	-4.462	-2.564	-3.106	-3.961
	(3.670)	(4.084)	(3.727)	(3.658)	(3.793)
L.branches	5.740*	7.285**	5.898**	6.242*	7.620**
	(2.984)	(3.389)	(2.700)	(3.114)	(3.295)
osDeposit	-0.983		3.089		
	(3.026)		(2.590)		
loggdp	827.83**	1,070.90***	951.76**	1,097.71***	1,090.73***
	(318.741)	(350.247)	(367.669)	(348.878)	(265.307)
Indstr	17.677*	7.293	14.371	13.037	8.699
	(10.306)	(10.979)	(14.388)	(10.189)	(11.673)
L.iedu	-8.190**	-6.897*	-8.285**	-6.193*	-7.619**
	(3.473)	(3.638)	(3.791)	(3.353)	(3.769)
internet	6.705**				
	(3.296)				
mobile		-0.098		-2.125	
		(1.570)		(1.706)	
L.mobile			-2.982		
			(2.608)		
L2.mobile			4.058**		
			(1.753)		
mobinternet				0.038*	
				(0.020)	
fixed					-5.992
					(7.730)
Constant	-6,222.42**	-7,963.74***	-7,171.90**	-8,385.85***	-7,998.98***
	(2,591.449)	(2,857.776)	(3,123.556)	(2,867.739)	(2,090.381)
Observations	427	429	391	426	430
R-squared	0.472	0.444	0.414	0.463	0.448
No. of Countries	41	41	41	41	41
F-test	13.88	15.29	11.10	14.36	13.39
(p-value)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)

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

In Table 3(b), we have reported the RE model and it can be observed that the results are similar.

Table 3(b): RE Model

VARIABLES	accounts	accounts	accounts	Accounts	accounts
credit	5.813*	5.353	4.741	5.845*	5.396*
	(3.206)	(3.377)	(3.675)	(3.228)	(3.186)
Atm	5.162**	6.687***	5.571**	5.792***	7.281***
	(2.107)	(2.390)	(2.682)	(2.152)	(2.371)
branches	-2.490	-3.815	-1.802	-2.552	-3.232
	(3.427)	(3.803)	(3.511)	(3.513)	(3.541)
L.branches	5.391*	6.988**	5.599**	6.074**	7.019**
	(2.829)	(3.326)	(2.714)	(3.005)	(3.250)
osdeposit	0.378		3.936*		
	(2.432)		(2.081)		
loggdp	508.8***	606.0***	548.2***	585.2***	661.2***
	(174.0)	(168.1)	(173.6)	(166.4)	(173.3)
indstr	15.13	6.382	12.90	11.41	4.379
	(10.18)	(11.24)	(14.51)	(10.32)	(11.80)
L.iedu	-7.551**	-6.564*	-8.024**	-5.925*	-6.112*
	(3.407)	(3.598)	(3.660)	(3.299)	(3.681)
internet	6.951**				
	(3.111)				
mobile		0.904		-0.802	
		(1.153)		(1.405)	
L.mobile			-2.123		
			(2.055)		
L2.mobile			3.798**		
			(1.683)		
mobinternet				0.0337*	
				(0.0203)	
fixed					-4.559
					(7.687)
Constant	-3,578***	-4,101***	-3,805***	-4,094***	-4,423***
	(1,209)	(1,122)	(1,139)	(1,152)	(1,108)
Observations	427	429	391	426	430
Number of ID	41	41	41	41	41

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

Model 2: Financial Inclusion- Growth Nexus

In this section we are trying the empirically test whether there is a significant relationship between per capita growth rate and FI. The generalized-method-of-moments (GMM) estimators for dynamic panel data (Arellano and Bond, 1991; Arellano and Bover, 1995; Blundell and Bond, 1998) are frequently getting applied in Growth literature. There are several advantages of using GMM panel estimators over purely cross-sectional estimators. Firstly, it helps to control for time fixed effects and cross section specific effects. Secondly, we can use appropriate lags of the independent variables as instrumental variables to deal with possible endogeneity in the regressors. Also, the variables treated as exogenous may suffer from an endogeneity problem. The GMM panel estimators allow us to address these econometric problems using lagged observations of the explanatory variables as instruments (internal instruments). Therefore we use two-step system GMM estimators to examine the impact of financial inclusion on Economic growth.

The econometric model is the following:

$$\text{pcGrowth}_{i,t} = \boldsymbol{\beta_0} + \boldsymbol{\beta_1}\,\beta_1\,\text{pc Growth}_{i,\,t-1} + \boldsymbol{\beta_2 X_{i,t}} + \alpha_i + \delta_t + \epsilon_{i,t} \qquad (6)$$

The empirical results of the several growth models are presented in Table 4-6. As pointed out by Arellano and Bover (1995) and Blundel and Bond (1998), the system GMM estimator is better than other estimators as it has lower bias and higher efficiency. All our econometric results report Arelleno-Bond test for serial correlation. As expected there is no evidence of model misspecification as null hypotheses of serial correlation in the first differenced errors at order 2 are accepted. Moreover, the moment conditions used are valid as we use the Sargan test to check whether the over identifying moment conditions are valid.

In estimating equation (6), GDP per capita growth is taken as the dependent variable and lagged value of GDP per capita growth is incorporated as an endogenous variable in the model. Other regressors

treated as endogenous are education (edu) (gross secondary enrolment rate) and Government consumption (gc). Indicators of financial inclusion (number of deposit accounts, branches, ATM, credit to private sector (credit) and outstanding deposit (ostdeposits) are then also added as endogenous variables one after another to check for the relationship between growth and F.I. Here we assume that higher growth can also help to improve FI of a country and therefore the indicators of FI should be considered as endogenous variables. Trade openness (trade) and inflation (Infl.) are used as purely exogenous control variables. Table 4 summarizes the results.

Results in Table 4 check for causal link between FI indicators (number of deposit accounts, ATM, credit to private sector, outstanding deposits and branches) and growth. All the FI indictors except outstanding deposits are having positive and significant impact on current year's growth, which implies with more and more people coming under the purview of formal banking sector, productive activities of the country are expected to improve and thereby fostering the growth of the countries. However, the previous year's values of these indicators are having negative effect on current year's growth. That means large number of new accounts, ATMs and new branches in the current year will start to mobilise funds in a better way and therefore it is having a better impact on growth performance. However, with lack of continued usage and proper utilisation of these financial instruments, the growth is not being sustained. The new bank branches might be clustered in one area or not in the correct location to capture financially backward population and hence, might not necessarily reflect the level of financial inclusion in the country. Thus even if number of bank branches have increased, it has failed to attract new customers and therefore could not cater to the target group. If the increase in the number of bank branches does not help in increasing financial inclusion, then it can be seen as merely an addition to the costs of the banks without effectively contributing to the growth of the economy. Thus establishment of new branches or ATM are

not sufficient, they should be in proper location and more accessible to the poorer section as they are the ones who depend more on non-institutional sources due to better accessibility and lack of official formalities like collateral etc. More awareness and more extension workers are needed to help them out and to motivate them to opt for banking services which is much more secured and is expected to make the process easier than before.

Outstanding deposits are amounts which may not appear as credit in the bank statement of the company immediately but will be received by the company. These types of deposits are expected to have a negative impact on the financial stability of the economy (Amatus and Alireza, 2015) as during the financial crisis the companies may withdraw these deposits and the banks will fail to continue its operations smoothly due to lack of fund. Thus the current year's value of outstanding deposit is expected have a negative impact on growth performance of the countries. Our results support this hypothesis. However, one year lagged value of outstanding deposit is having a positive impact on current year's growth process; this may be due to the fact that outstanding deposit appears in the actual bank account after a certain time lag.

The domestic credit extended to the private sector (as a percentage of GDP) in the current year has a positive and significant relation with growth. This implies that more accessible domestic credit from institutional sources will lead to more capital formation in the economy thereby leading to higher growth. This is a very positive implication of higher FI. However, the previous year's domestic credit is having negative impact on current year's growth .This can be explained by the underdeveloped nature of the credit market and its inability to assess potential clients efficiently enough. Quite a substantial amount of loans turn into Non-performing assets for the bank and hence negatively affect the economic growth. Here we have introduced an interaction term between domestic credit and value added from industry as a percentage

of GDP. We have considered both industry and the interaction term as endogenous regressor. This gives a very interesting result which implies the both industry and interaction of industry with credit are having positive impact on growth of the current year. As both are having positive and significant coefficient we can say that the marginal effect of credit is positive on current growth. Thus domestic credit, when extended to industrial sector has better possibility of being productive. However, the lagged values of both of these terms are having negative but significant coefficient. This implies that though in the current year the performance of the industrial sector is satisfactory, it is not able to continue the good performance in the subsequent years. Therefore the loans are not repaid in time and becoming non-performing asset for banks. Thus not only extension of credit at reasonable cost is important, but also judging the viability of the business is even more important.

Lagged GDP per capita is significant and positive thereby implying that previous year's good (bad) performance will be continued the next year as well. Turning to the other macroeconomic indicators like government expenditure, trade openness and education are having significant and expected impact on growth. Higher Government consumption (gc) dampens economic growth while trade openness and education foster economic growth. However, inflation is having a positive impact on growth which is counter intuitive.

Table 4: FI-Growth Nexus

VARIABLES	(1) growth	(2) Growth	(3) Growth	(4) growth	(5) Growth	(6) growth
L.growth	0.124***	0.00842	0.0875***	0.00731	-.0229914	0.124***
	(0.0241)	(0.0444)	(0.0310)	(0.0433)	(.0336278)	(0.0208)
Gc	-2.815***	-2.677***	-2.451***	-2.822***	-2.481356***	-2.680***
	(0.182)	(0.222)	(0.132)	(0.248)	(.3025672)	(0.185)
L.gc	2.128***	1.944***	1.818***	2.350***	1.849889***	2.074***
	(0.187)	(0.221)	(0.134)	(0.191)	(.216909)	(0.186)
Accounts	0.0103***					
	(0.00148)					
L.accounts	-0.0106***					
	(0.00158)					
Edu	0.283***	0.364***	0.278***	0.0782	0.141441**	0.395***
	(0.106)	(0.0915)	(0.0816)	(0.0636)	(.0617414)	(0.0692)
L.edu	-0.298***	-0.297***	-0.244***	-0.0537	-0.071748	-0.375***
	(0.108)	(0.106)	(0.0802)	(0.0636)	(0 .0603)	(0.0645)
Trade	0.0519***	0.0504***	0.0450***	0.0517***	0.02625***	0.0395***
	(0.00762)	(0.0114)	(0.00594)	(0.00819)	(.0080066)	(0.00819)
Infl.	0.0366	0.0833***	0.0853***	0.0325	0.060477*	0.120***
	(0.0382)	(0.0282)	(0.0168)	(0.0289)	(.0339643)	(0.0327)
ATM		0.168***				
		(0.0294)				
L.ATM		-0.218***				
		(0.0283)				
Branches			0.236***			
			(0.0282)			
L.branches			-0.266***			
			(0.0345)			
Credit				0.175***		
				(0.0427)		
L.credit				-0.190***		
				(0.0463)		
Creditindustry					0.008221***	
					(.0017145)	
L.creditindustry					-0.00924***	
					(.0018499)	
Industry					0.699126***	
					(0. 21703)	
L.Industry					-.8223752***	
					(.1782379)	
Ostdeposit						-0.0757**
						(0.0383)
L.ostdeposit						0.0734*
						(0.0432)
Constant	9.174***	5.721***	5.273***	4.070**	11.05**	5.770***
	(1.852)	(2.001)	(1.605)	(1.948)	(5.576)	(1.253)
Observations	389	396	395	395	395	392
Number of ID	41	41	41	41	41	41
Sargan	0.99	1.00	0.99	0.99	1	0.99
AR(2)	0.2249	0.1434	0.1725	0.1855	0.1	0.1780

Note: GMM two-step standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

Model 3: ICT - Growth Nexus

$$pcGrowth_{i,t} = \beta_0 + \beta_1 \, pc\ Growth_{i,\,t-1} + ICT\ variables + Control\ Variables + \epsilon_t \quad (7)$$

In equation (7), the dependent variable, endogenous variables and other control variables remain the same as the previous model. Now, we add the ICT development indicators as endogenous regressors to check for the relationship between ICT and growth. The indicators of ICT used are mobile phone subscribers (per 100 people), internet users (per 100 people), fixed telephone line (per 100 people) and ICT goods imports (percent total goods imports).

Table 5A: Causal link between Growth and ICT diffusion

VARIABLES	(1) growth	(2) Growth	(3) growth	(4) Growth
L.growth	0.0711**	0.0486	0.132***	0.142***
	(0.0343)	(0.0316)	(0.0404)	(0.0289)
Gc	-2.804***	-2.594***	-2.796***	-2.417***
	(0.264)	(0.181)	(0.181)	(0.181)
L.gc	2.363***	1.726***	2.246***	1.916***
	(0.220)	(0.0982)	(0.157)	(0.164)
mobile	0.209***			
	(0.0359)			
L.mobile	-0.247***			
	(0.0331)			
iedu	0.609***	0.370***	0.276***	0.362***
	(0.0775)	(0.120)	(0.0937)	(0.0453)
L.iedu	-0.558***	-0.318***	-0.336***	-0.376***
	(0.0615)	(0.110)	(0.0960)	(0.0461)
trade	0.0462***	0.0733***	0.0324***	0.0370***
	(0.00530)	(0.00733)	(0.00944)	(0.0112)
Inf	0.0637***	0.0742**	0.0413	0.120***
	(0.0244)	(0.0290)	(0.0354)	(0.0242)
Internet		0.242***		
		(0.0732)		
L.internet		-0.334***		
		(0.0759)		
Fixed			-0.0211	
			(0.138)	
L.fixed			0.115	
			(0.126)	
ICTimp				-0.0204
				(0.0564)
L.ICTimp				0.0721
				(0.0623)
Constant	1.971	7.073**	10.48***	6.405***
	(1.738)	(3.218)	(2.192)	(2.331)
Observations	395	392	397	396
Number of ID	41	41	41	41
Sargan	0.99	0.99	0.99	0.99
AR(2)	0.1	0.1256	0.2514	0.1851

Note: GMM two-step standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

5B: : Causal link between Growth and ICT diffusion (cont.)

VARIABLES	(1) growth	(2) growth	(3) growth
L.growth	0.00357	0.0433	0.0718
	(0.0304)	(0.0452)	(0.0654)
Gc	-2.392***	-2.702***	-1.699***
	(0.179)	(0.250)	(0.227)
L.gc	1.886***	1.921***	0.956***
	(0.225)	(0.248)	(0.266)
Edu	0.498***	0.782***	0.215***
	(0.0756)	(0.293)	(0.0591)
L.edu	-0.441***	-0.679**	-0.125**
	(0.0808)	(0.286)	(0.0592)
Mobile	0.116***		
	(0.0358)		
L.mobile	-0.163***		
	(0.0375)		
Mbinternet	0.00180***		
	(0.000615)		
L.mbinternet	-0.00176***		
	(0.000414)		
Trade	0.0370***	0.0605***	0.0509***
	(0.00719)	(0.0111)	(0.0153)
Inf	0.0635**	0.0823*	0.0503
	(0.0285)	(0.0446)	(0.0406)
Netedu		-0.00761*	
		(0.00405)	
L.netedu		0.00790**	
		(0.00381)	0.162
Services			(0.189)
			-0.0287
L.services			(0.232)
Netservice			
			-0.0377***
L.netservice			(0.00511)
			0.0356***

(contd…Table)

Internet		0.802**	(0.00634)
		(0.335)	(0.348)
L.internet		-0.911***	-2.357***
		(0.318)	(0.449)
Constant	4.010	2.412	-3.031
	(2.825)	(3.616)	(4.579)
Observations	390	392	391
Number of ID	41	41	41
Sargan	1.00	1.00	1.00
AR(2)	0.1	0.1429	0.1938

Note: GMM two-step standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

Table 5A summarises the empirical result of causal link between growth and ICT variables. It shows that the ICT penetration variables such as mobile phones and internet have positive and significant impact on current year's growth process. This is in line with the literature like Hassan (2005) and Sassi and Goaied (2013) which show that ICT is an essential part of economy's growth process; it improves the productive capacity and competitiveness by linking the country with the rest of the world. However, one year lag values of these variables are having negative but significant effect. This can be explained as follows. For low-income countries, the rapid accumulation of ICT eliminates unskilled workers and excludes poor people from workforce since they are not well furnished and qualified, so it will increase poverty and income inequalities. That may have a negative impact on growth. However, fixed telephone and ICT import (unlike Sassi and Goaied (2015)) are not having any significant effect on growth process. Fixed telephone, anyway, has lost its relevance gradually with wide spread penetration of mobile phone which connects the global economy quite easily.

In Table 5B, we have tried to see how internet can be better utilised to foster growth. The interaction term between mobile and internet is having positive and significant effect along with mobile alone on current period's growth. Thus mobile when powered by internet have

a better role to play in the growth process of the economy as the marginal effect of mobile will be positive. E-commerce and banking activities will be much benefitted with mobile internet services. However, the previous year's value of both mobile and mobile X internet have negative and significant effect on growth. Thus mobile internet may come up initially with lot of enthusiasm but finally it depends upon education level and the age group of the people who are using it. Unless it is used for productive purposes it will not be reflected in the growth performance of the economy. This gets explained by the interaction between education and internet. Education has positive and significant effect alone but interaction between education and internet (netedu) is having negative but significant effect on current growth. If the marginal effect is positive, then we may say that education has a significant role in efficient use of internet to enhance growth of the economy. Similar impact is suggested by interaction between service and internet (netservice). Internet is most widely used in service industry and therefore we have introduced it to interact with value added from service sector as a percentage of GDP. The interaction term is having negative and significant effect on current growth whereas the individual internet variable is having a positive and significant impact. So if finally the marginal effect is positive we can conclude that internet, when effectively used in service sector, will definitely speed up the growth process of the economy.

Model 4: Financial Inclusion, ICT and growth

$$pcGrowth_{i,t} = \beta_0 + \beta_1 \text{ pc } Growth_{i,\,t-1} + \text{F.I. variables} + \text{ICT variables} + [\text{Interaction between ICT and F.I. variables}] + \text{Control Variables} + \epsilon_t \quad (8)$$

To test whether financial inclusion is one of the channels through which ICT improves growth, we retain the model in which ICT development is measured by mobile penetration and add a variable of financial inclusion in the growth model to check how the coefficient of

ICT moves. We strengthen the analysis by including an interaction of mobile and internet penetration with financial inclusion variables in equation (8). We assess whether, by improving financial inclusion, ICT diffusion is at the same time reinforcing its own impact on economic growth.

Table 6 summarizes the results. Here we observe that both accounts and mobile-accounts interaction term (Mbacct) are having positive and significant impact (positive marginal effect of accounts) on growth of the current year. Thus the new accounts opened to bring people within the safety net of banking system will be more effective if mobile penetration in the country is better. Mobile banking services make banking transaction easier, thereby helping in better fund mobilization and better growth performance. However, the marginal effect of previous year's accounts is having negative and significant effect on current year's growth. It can be explained by the fact that unless the financially excluded or newly included people, specially of developing countries, are educated and aware of the benefits of the mobile banking services, the effectiveness of neither FI not ICT diffusion will be materialised. Exactly same argument can be put forward for interaction between mobile and branches (mobilebranch) and internet and branch (branchnet). A better branch network is definitely having positive and significant impact on growth; but when powered by better mobile penetration and better internet connectivity, it can operate much efficiently and thereby can foster economic growth. Thus FI when strengthen by better ICT diffusion is expected to help the country grow faster.

Table 6: FI, ICT and Growth linkage

VARIABLES	(1) growth	(2) growth	(3) growth
L.growth	0.138***	0.0716**	0.135***
	(0.0159)	(0.0307)	(0.0130)
Gc	-2.726***	-2.332***	-2.121***
	(0.157)	(0.183)	(0.115)
L.gc	2.149***	2.016***	1.810***
	(0.152)	(0.185)	(0.121)
Accounts	0.00323**		
	(0.00159)		
L.accounts	-0.00471***		
	(0.00159)		
Mbacct	6.46e-05***		
	(1.00e-05)		
L.mbacct	-6.24e-05***		
	(9.47e-06)		
Trade	0.0442***	0.0416***	0.0465***
	(0.00975)	(0.00625)	(0.00455)
Inf	-0.0476***	-0.0353*	0.0151
	(0.0150)	(0.0199)	(0.0189)
Mobile		0.168***	
		(0.0215)	
L.mobile		-0.183***	
		(0.0208)	
mobilebranch		0.000811***	
		(6.35e-05)	
L.mobilebranch		-0.000951***	
		(8.15e-05)	
Branches			0.0954**
			(0.0395)
L.branches			-0.0786**
			(0.0369)
branchnet			0.00146*
			(0.000762)
L.branchnet			-0.00264***
			(0.000601)
Constant	9.030***	4.531***	3.571***
	(1.367)	(1.324)	(1.070)
Observations	432	443	440
Number of ID	41	41	41
Sargan	1.00	1.00	1.00
AR(2)	0.1552	0.1277	0.1952

Note: GMM two-step standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

CONCLUSIONS

There have been enough evidences in support of a positive and significant relationship between Growth and Financial inclusion. Especially for developing countries, where the dominance of non-institutional credit is high, if economically backward people can be brought within the purview of formal banking sector, that can improve trading activity and economy can be more productive. This will not only foster economic growth but also will reduce poverty and inequality. Similarly, Information and Communication Technology (ICT) is expected to increase growth by improving market functioning and increasing trade. It can raise the efficiency level when used effectively in banking sector as well. It can be cost effective and improve accessibility of finance for the people through branchless banking and mobile banking. But contradictory theories suggest that ICT could impose negative impact on employment and labor market in developing countries. The rapid accumulation of ICT eliminates unskilled workers and excludes poor people since they are not well furnished and qualified, so it will increase poverty and income inequalities. However, there are not many studies that have tried to find how financial inclusion powered by a better ICT diffusion can foster the growth process of the economy. With modern economies moving towards cashless system to reduce financial mismanagement and corruption, this study seems to find its relevance well enough. We have tried to test these causalities by looking at a set of 41 countries, which is dominated by developing countries, over a period of 12 years using system GMM taking care of the endogeneity issue. Before that, we first try to establish a possible relation between ICT development and indicators of financial inclusion using the fixed effects estimator.

We see that there is a positive and significant relationship between financial inclusion and ICT indicators. Mobile phone seems to take some time to be associated with financial instruments. However, mobile services with internet facility show better effectiveness to improve financial inclusion. Hence ICT development can be used as instruments to

improve the level of financial inclusion in an economy. Next, we see that financial inclusion has a positive effect on growth which is in line with the contemporary results. The current values of indicators of FI such as number of deposit accounts, branches, credit to private sector and ATM are having positive and significant impact of current growth whereas the previous period's values are having negative impact on current growth. This gives us an interesting insight that initially new bank branches and new bank accounts with some amount of deposits may help to mobilise fund that year and show a better growth. But unless the branches and ATMs are properly located to capture the financially excluded people and motivate them enough to use these facilities continuously it will not have a sustained impact on growth process of the economy. Moreover, domestic credit extended towards private sector seems to be even more effective if provided to industrial sector.

The empirical analysis of causal link between ICT and growth process suggests that mobile and internet penetration have definite positive role on economic growth though fixed telephone has lost its relevance. The mobile when powered by internet service will be even more effective. Moreover, education and wide spread use of internet in service sector may also have its share of positive role to play in the growth process. However, previous period's values of ICT penetration variables are having negative impact on growth. That may be due to lack of skilled labour and technical knowledge that is preventing the developing nations to reap the benefit of the new technologies. Lastly, we look at the interaction between financial inclusion and ICT development and we are able to infer that financial inclusion is one of the channels through which ICT development affects growth. New bank accounts and new branches when coupled with better mobile and internet penetration will be more effective to foster economic growth.

Hence, ICT diffusion has the capability to boost financial inclusion by easing the provision of cost-effective financial services to the

disadvantaged section of the countries. Countries need to build adequate capacity of ICT infrastructure and also promote greater interaction between ICT and financial services by addressing the various hurdles posed by mobile banking like security concerns to experience higher levels of growth. At the same time mere strengthening of ICT or banking infrastructure will not help to boost the growth process. The countries need to concentrate on better capacity building in terms of producing skilled labour, educating people about mobile banking and internet banking along with the advantages of using these facilities, reducing the fear and uncertainty form their mind about wide spread use of technology in financial instruments, motivating them to come out of the bondage of non-institutional credit system and join the formal banking sector. Then only the benefits form FI and ICT diffusion can be used effectively to sustain the growth process of the economy.

APPENDIX

List of Countries

Table A1: List of Countries Used in the Data Set

S. No.	Country Name	Developed/Developing
1	Argentina	Developing
2	Austria	Developed
3	Belgium	Developed
4	Brazil	Developing
5	Bulgaria	Developed
6	Burundi	Developing
7	Cameroon	Developing
8	Chile	Developing
9	Costa Rica	Developing
10	Czech Republic	Developed
11	Ecuador	Developing
12	Estonia	Developed
13	Georgia	Developing
14	Guinea	Developing
15	Honduras	Developing
16	Hungary	Developed
17	India	Developing
18	Indonesia	Developing
19	Jamaica	Developing
20	Japan	Developed
21	Korea, Rep.	Developed
22	Latvia	Developed
23	Madagascar	Developing
24	Malaysia	Developing
25	Malta	Developed
26	Mauritius	Developing
27	Mexico	Developing
28	Moldova	Developed
29	Mozambique	Developing
30	Netherlands	Developed
31	Pakistan	Developing
32	Peru	Developing
33	Philippines	Developing

S. No.	Country Name	Developed/Developing
34	Rwanda	Developing
35	South Africa	Developing
36	Spain	Developed
37	Switzerland	Developed
38	Thailand	Developing
39	Turkey	Developing
40	Uganda	Developing
41	Ukraine	Developed

Table A2: Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
growth	492	2.575417	3.51159	-14.55984	13.83018
gc	492	15.7567	4.67324	6.764417	31.57298
inf	488	5.560831	5.109833	-1.418123	48.72428
trade	492	89.70498	50.2398	22.10598	324.502
iedu	438	80.45479	29.13452	10.76632	164.8117
Indstr	491	28.39329	7.520105	11.53846	48.52979
services	490	60.75664	10.24973	32.69546	82.81794
mobile	491	85.28588	41.00439	1.338877	162.5274
fixed	492	21.4042	17.26714	0	71.52809
internet	489	36.93944	27.87566	.3490605	93.9564
iICTimp	450	9.269181	7.209489	.7469034	48.33324
credit	491	61.24664	47.45157	3.785495	189.1945
ATM	490	51.67735	50.27795	.0395034	290.1428
branches	489	19.38808	20.0022	.3950343	104.22
accounts	479	1570.211	1481.467	1.256015	7984.025
osDeposit	485	46.44172	34.62888	.13	173.74

List of Variables, Definitions and Sources

Table A3: List of Variables, Definitions and Sources

VARIABLE NAME	DEFINITION	SOURCE
Growth - GDP per capita growth (annual percent)	Annual percentage growth rate of GDP per capita based on constant local currency. Aggregates are based on constant 2010 U.S. dollars. GDP per capita is gross domestic product divided by midyear population.	**WDI**
Govt. final cons. Exp.	General government final consumption expenditure includes all government current expenditures for purchases of goods and services (including compensation of employees).	**WDI**
Inf. rate	Inflation as measured by the consumer price index reflects the annual percentage change in the cost to the average consumer of acquiring a basket of goods and services that may be fixed or changed at specified intervals, such as yearly.	**WDI**
Trade openness (percent of GDP)	Trade is the sum of exports and imports of goods and services measured as a share of gross domestic product.	**WDI**
Gross enr. ratio(secondary)	Gross enrollment ratio is the ratio of total enrollment, regardless of age, to the population of the age group that officially corresponds to the level of education shown. Secondary education completes the provision of basic education that began at the primary level, and aims at laying the foundations for lifelong learning and human development, by offering more subject- or skill-oriented instruction using more specialized teachers.	**WDI**

Mobile(per 100 people)	Mobile cellular telephone subscriptions are subscriptions to a public mobile telephone service that provide access to the PSTN using cellular technology. The indicator includes (and is split into) the number of postpaid subscriptions, and the number of active prepaid accounts (i.e. that have been used during the last three months). The indicator applies to all mobile cellular subscriptions that offer voice communications.	**ITU**
Fixed landline(per 100 people)	Fixed telephone subscriptions refers to the sum of active number of analogue fixed telephone lines, voice-over-IP (VoIP) subscriptions, fixed wireless local loop (WLL) subscriptions, ISDN voice-channel equivalents and fixed public payphones.	**ITU**
Internet users(per 100 people)	Internet users are individuals who have used the Internet (from any location) in the last 12 months. Internet can be used via a computer, mobile phone, personal digital assistant, games machine, digital TV etc.	**ITU**
ICT goods imports (percent of total goods imports)	Information and communication technology goods imports include computers and peripheral equipment, communication equipment, consumer electronic equipment, electronic components, and other information and technology goods (miscellaneous).	**WDI**
Industrialisation-Industry, value added (percent of GDP)	It comprises value added in mining, manufacturing (also reported as a separate subgroup), construction, electricity, water, and gas.	**WDI**

Services-Services, value added (percent of GDP)	Services include value added in wholesale and retail trade (including hotels and restaurants), transport, and government, financial, professional, and personal services such as education, health care, and real estate services. Also included are imputed bank service charges, import duties, and any statistical discrepancies noted by national compilers as well as discrepancies arising from rescaling.	**WDI**
Domestic credit to private sector-(percent of GDP)	Domestic credit to private sector refers to financial resources provided to the private sector by financial corporations, such as through loans, purchases of nonequity securities, and trade credits and other accounts receivable, that establish a claim for repayment. The financial corporations include monetary authorities and deposit money banks, as well as other financial corporations where data are available.	**FAS-IMF**
Deposit accounts	Deposit accounts with commercial banks per 1,000 adults	**FAS-IMF**
Loan accounts	Loan accounts with commercial banks per 1,000 adults	**FAS-IMF**
ATMs	Automated Teller Machines (ATMs) per 100,000 adults	**FAS-IMF**
Bank Branches	Branches of commercial banks per 100,000 adults	**FAS-IMF**
Outstanding deposit	Outstanding deposits with commercial banks (percent of GDP)	**FAS-IMF**

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